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Original scientific paper

THERMAL CHARACTERISTICS OF A NEW SYSTEM FOR VACUUM AND HEAT COGENERATION APPLIED IN PAPER MACHINES

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A b s t r a c t: A new energy efficient thermal system for cogeneration of vacuum and heat in paper machines is proposed in this paper. The paper machines are large consumers of electrical energy and thermal energy. A turbo compressor – turbo expander unit is proposed in the new concept for generation of vacuum. The turbo compressor vacuum pump is driven by a steam turbo expander, consuming high pressure and high temperature boiler steam. The steam exiting the turbo expander is used, generating heat for paper machine drying processes. The needs for vacuum and heat at different segments of a paper machine are analyzed. The characteristics of single stage high pressure ratio centrifugal compressors are analyzed and possibilities for their application in the proposed new system are estimated. The implementation of the new system can results in significant increment of the energy efficiency of the paper machine production process.

Key words: cogeneration; vacuum; heat; turbo compressor – turbo expander unit; energy efficiency

ТЕРМИЧКИ КАРАКТЕРИСТИКИ НА ЕДЕН НОВ СИСТЕМ ЗА КОГЕНЕРАЦИЈА НА ВАКУУМ И ТОПЛИНА ПРИМЕНЕТ НА МАШИНИ ЗА ХАРТИЈА

А п с т р а к т: Предложен е еден нов енергетски ефикасен термички систем за когенерација на вакуум и топлина на машините за хартија. Машините за хартија се големи потрошувачи на електрична и топлинска енергија. Во новиот концепт за генерирање на вакуум е предложена турбокомпресорско-турбоекспандерска единица. Турбокомпресорот е погонуван од турбоекспандер кој користи високопритисна и високотемпературна пареа од парен котел. Излезната пареа од турбоекспандерот се користи за генерирање топлина за процесот на сушење на машината за хартија. Анализирани се потребите од вакуум и топлина на различни сегменти од машината. Анализирани се карактеристиките на едностепените високопритисни центрифугални компресори и оценети се можностите за нивна апликација во предложениот нов термички систем. Имплементацијата на предложениот нов систем може да резултира во значително подобрување на енергетската ефикасност на производствениот процес на машините за хартија.

Клучни зборови: когенерација; вакуум; турбокомпресорско-турбоекспандерска единица; енергетска ефикасност

INTRODUCTION

The production and consumption of paper in the world continuously increases. The paper Industry is large and significant consumer of heat energy and electrical energy. Recent development of the paper production technology and processes has resulted in reduction of heat energy consumption [1]. Implementation of the ejector thermocompression technology is an effective way to prevent steam and condensate leakages (losses) into the environment and to improve the paper production process energy efficiency [2, 3].

The electrical energy consumption of the vacuum system is significant part of the total electrical energy consumption in the paper production technological processes. The optimal intensity of the vacuum in different segments of the paper machine is defined with technological requirements of the

production processes. Mechanical drying of the paper tape is realized by pressing of the tape and by vacuum. Thermal drying is achieved by evaporation of the water contained in the paper tape. The humidity of the paper tape at the inlet on the thermal drying section, which determined the thermal energy (steam) consumption, directly depends on the intensity of the vacuum. The total energy efficiency (thermal and electrical) of a paper machine directly depends on the intensity of the vacuum. The possibilities of application of co-generative (power and heat production) and three-generative (power, heat and cool production) in the paper industry are discussed by Nikolić et al. [4].

The characteristics of different vacuum systems with turbo compressors, screw compressors, two-phase ejectors and mechanical vacuum pumps with water ring are analyzed in our previous works [5, 6]. The mechanical vacuum pumps with water ring have wide application in the paper industry. Their efficiency coefficient is very low $\eta = 0.2 \div 0.3$ [7]. For high capacity paper machines turbo compressor vacuum systems are applied. The traditional turbo vacuum systems contain low speed multi-stage turbo compressors.

Recent developments and technologies considered for oil-free direct-driven variable-speed centrifugal compressors (active magnetic bearing technology; high speed permanent magnet motor technology) are discussed by Brasz [8] and by Schiffmann and Favrat [9, 10]. Suggestions and recommendations for optimal design of the centrifugal compressor flow field are given by Šarevski and Šarevski [3]. The developmental achievements in the fields of material and strength sciences and the achievements related to development of high speed high pressure ratio transonic centrifugal compressors can be used for development of centrifugal compressor vacuum pump systems. The target is to develop high speed high pressure ratio single-stage centrifugal compressor for the turbo compressor – expander unit as a main element of the new system for vacuum and heat cogeneration in paper machines.

A co-generative system for simultaneous production of vacuum and heat applied in the paper machines is the subject of investigation in this article. A turbo compressor – turbo expander unit is proposed in the new concept for generation of vacuum. The unit contains a single-stage centrifugal compressor directly driven by a single-stage turbo expander. The characteristics of the centrifugal compressor are analyzed in this work. The optimization of the boiler steam parameters and characteristics of the turbo expander as an element of the turbo compressor – turbo expander unit will be subject of investigations in our next works.

The purpose of this paper is to propose and introduce the new system for vacuum and heat cogeneration, to determine the characteristics of single-stage high pressure ratio transonic centrifugal compressors and to estimate the possibilities for their application in the novel co-generative systems with a turbo compressor – turbo expander unit.

INFLUENCE OF THE VACUUM INTENSITY ON THE ENERGY EFFICIENCY OF PAPER MACHINES

The intensity of the vacuum in different segments of the paper machine is defined with technological requirements of the production process. An example of the paper tape movement in a paper machine is given in Figure 1.

Mechanical drying of the paper tape is realized by pressing of the tape and by vacuum. In the first segment (I), when the paper tape is above the sieve, the vacuum needed is $0.1 \div 0.2$ bar. In the second segment (II, Gauch press) the pressing of the paper tape and vacuum is applied. The intensity of the vacuum is $0.5 \div 0.8$ bar. The third segment is the felts drying section. The intensity of the vacuum is $0.5 \div 0.6$ bar. In the fourth segment (IV, wet press, Saug-roller) the pressing of the tape and vacuum drying is realized.

The vacuum intensity on different paper machine segments depends on: characteristics of the paper tape, thickness of the tape; characteristics of the paper machine, tape speed; characteristics of the sieve and felts; characteristics of the vacuum system etc.

The aim of the previous text is not to define drying process, because it is defined by drying technology, but to emphases the necessity of different intensity of the vacuum in different paper machine segments, and to accept the dependence of the vacuum intensity on the characteristics of the paper tape, paper machine, drying process and vacuum system characteristics.

Thermal drying is achieved by evaporation of the water contained in the paper tape. The humidity of the paper tape at the inlet of the thermal drying section, which determined the thermal energy (steam) consumption, directly depends on the intensity of the vacuum.

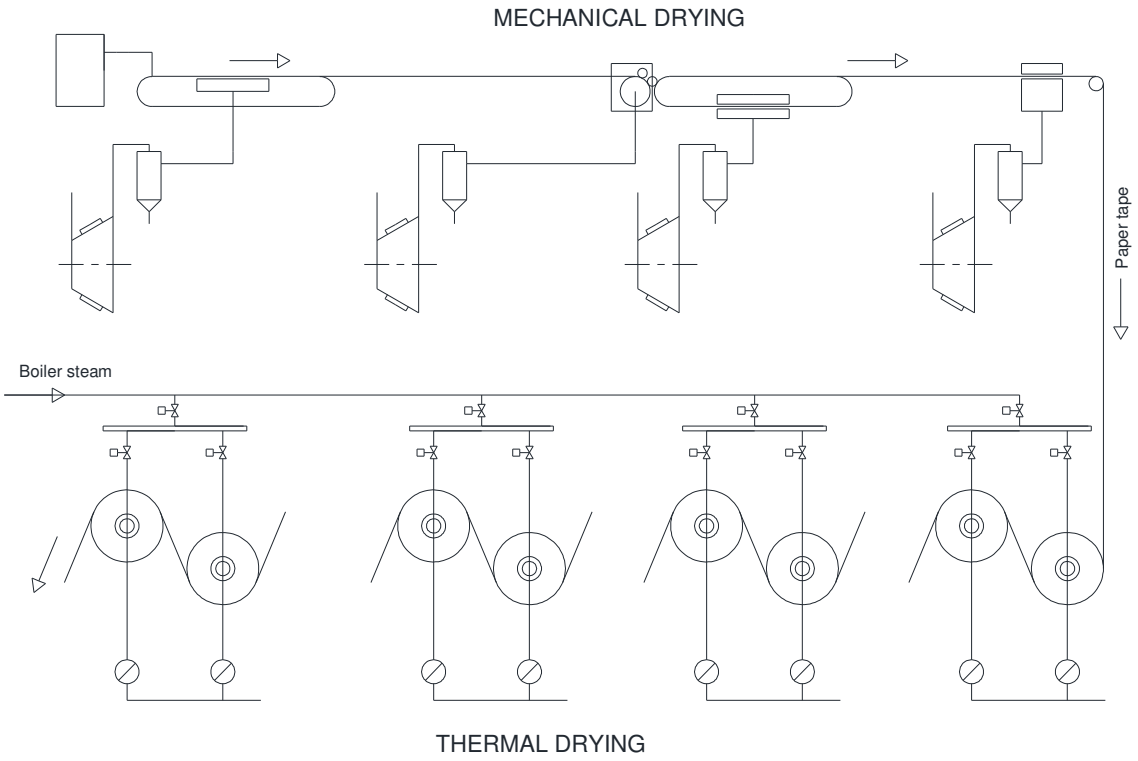

Fig. 1. Vacuum system and heat system in a paper machine

Each percentage decrease moisture in the paper tape obtained by mechanical drying, which can be achieved by intensifying the vacuum means reducing the consumption of steam, or thermal energy to a few percent. It means that the total energy efficiency (thermal and electrical) of the paper machine directly depends on the intensity of the vacuum.

Optimization of the vacuum system on the paper machines, based on the criterion of the maximum overall energy efficiency (thermal and electrical) includes achieving optimum vacuum in the system, optimizing the coupling element of vacuum system of the paper machine, the optimization of vacuum system elements (pipeline, valves, separators, etc.), the optimal choice of the vacuum pumps and achieving optimal functioning of the vacuum pumps in operating conditions with the highest efficiency coefficients.

VACUUM AND HEAT COGENERATION IN PAPER MACHINES

A new system for vacuum and heat cogeneration in paper machines is proposed. A schematic diagram of the system is given in Figure 2. A turbo compressor – turbo expander unit is proposed in the new concept for generation of vacuum. The unit contains a single-stage centrifugal compressor directly driven by a single-stage turbo expander. The boiler steam firstly comes into the turbo expander, where it expands generating mechanical work to drive the turbo compressor. The steam exiting the turbo expander is used for heat generation in the drying cylinders for drying purposes.

The turbo compressor – turbo expander units should be optimally installed in the paper machine vacuum system. The units generating the highest vacuum are connected with segments (drying cylinders) which need lower drying temperatures (Figure 2). The optimization of the boiler steam parameters (pressure and temperature) and characteristics of the turbo expander as an element of the turbo compressor – turbo expander unit will be subject of investigations in further works and case studies for a particular paper machine.

The vacuum and heat cogeneration system should be designed by the requirements for heat (steam) drying in different segments of the paper machine. According to our preliminary studies and considerations a balance between steam consumption for the mechanical power for turbo unites vac-

uum generation and for the drying heat power generation can be obtained. If additional vacuum capacity is needed, then additional electrically direct driven single-stage centrifugal compressor should be proposed, applying the active magnetic bearing technology, high speed permanent magnet motor technology (high frequency electrical drivers technology) and achievements in the field of high speed, high pressure ratio, transonic centrifugal compressor technology.

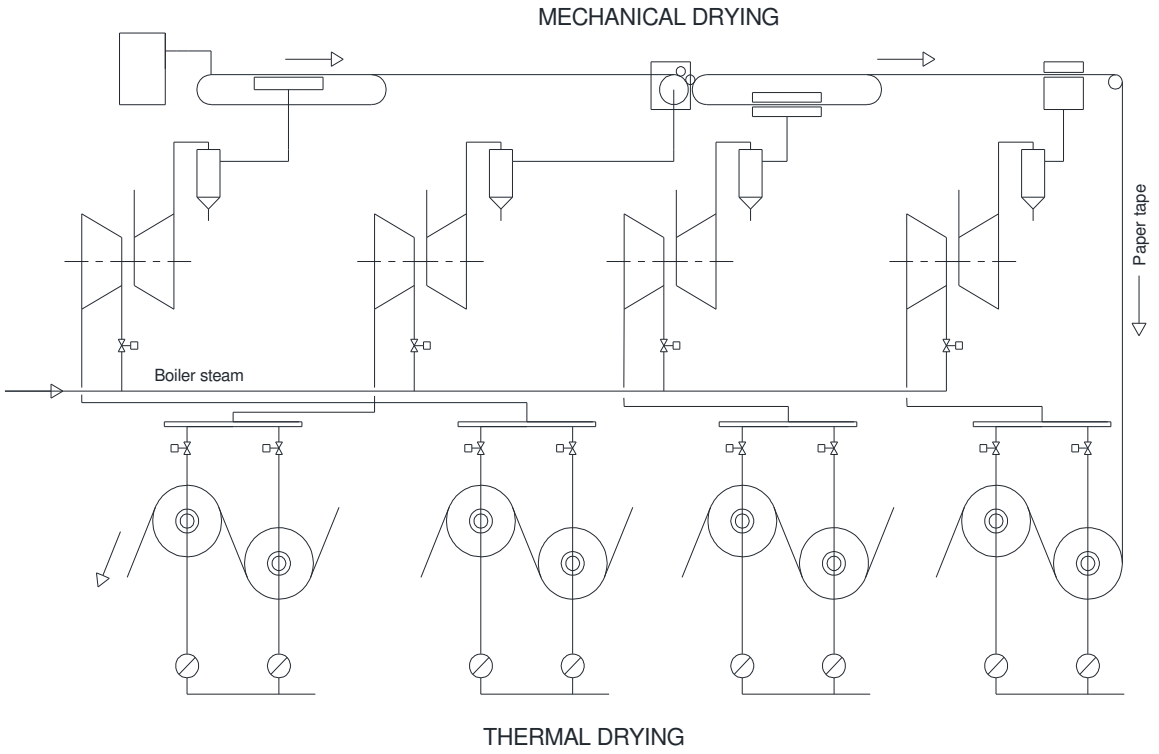

Fig. 2. System for vacuum and heat cogeneration in paper machines

Complete or partial substitution of the electrical energy for vacuum generation can be obtained with optimal implementation of the new system for vacuum and heat cogeneration in paper machines. Energy and exergy analysis of the new system show that the proposed system has advantage in comparison with traditional systems by technical, economical and environmental reasons.

CHARACTERISTICS OF CENTRIFUGAL COMPRESSORS

Recent developmental achievements in the fields of material and strength sciences have moved the boundary limitations of impeller speed peripheral speed over 700 $m \cdot s^{-1}$ [3]. These achievements, along with the achievements related to development of high speed high pressure ratio transonic centrifugal compressors, provide the possibilities for development of centrifugal vacuum pump units and implementation of single-stage centrifugal compressor in the turbo compressor – turbo expander units and in the proposed vacuum and heat cogeneration system.

The single-stage centrifugal compressor can reach relatively high pressure ratio. If the dimensionless work coefficient is $\psi = 0.6$ and the compressor efficiency is $\eta_p = 0.8$, the dependence of the pressure ratio on the impeller peripheral speed is given in next table, for compressor inlet temperature $T_0 = 20$ °C.

u_2 (m s^{-1})	200	250	300	350	400	450	500	550
Π	1.3	1.5	1.8	2.1	2.6	3.2	4.0	5.0

The calculating relations for the centrifugal compressor pressure ratio Π, main dimensions of the centrifugal compressor flow field (impeller tip

diameter D_2 (m)), rotational speed of the impeller Π (s^{-1}) in functions of the compressor (vacuum pump) capacity V ($m^3 s^{-1}$) are given in the following text [3],

$$\Pi = (1+\psi(\kappa-1)M_u^2/\eta_p)^{\sigma}$$

$$D_2 = \sqrt{\overline{V}/\left(\pi \overline{b}_2 k_{v2} \tau_2 u_2 \varphi_2\right)},$$

$$n = \frac{u_2}{\pi D_2}.$$

The dimensionless work coefficient is ψ = 0.50 – 0.65, the dimensionless work coefficient is φ_2 = 0.25 – 0.35 and compressor polytropic efficiency η_p = 0.70 – 0.85, depending on centrifugal compressor flow field characteristics and operating conditions, Mach number, Reynolds number etc.[3]. The peripheral Mach number $M_u = u_2/a_0$ depends on peripheral speed u_2 and sound velocity a_0,

$$a_o = \sqrt{k\xi_o RT_o},$$

$$R = R_\mu/\mu,$$

$$\xi_o = p_o v_o/(RT_o).$$

Gas constant is R, universal gas constant is R_μ, compressibility factor ξ_0 is about $\xi_0 \approx 1$. The quantities of thermodynamic state at the compressor inlet are: pressure p_0, temperature T_0 and specific volume v_0. The coefficient $\sigma = \eta_p k/(k-1)$ depends on efficiency η_p and on isentropic exponent k. Correction factor of the specific volume at the impeller outlet is k_{v2}. The range of values of the impeller relative width is $\overline{b}_2 = b_2/D_2$ = 0.02 – 0.06; wider range is $\overline{b}_2$ = 0.01–0.08 [3]. Coefficient of reduction of the impeller outlet cross-section is τ_2.

The turbo compressor pressure ratio is determined by the intensity of the vacuum needed. For vacuum of 0.2, pressure ratio is Π = 1/0.8 = 1.25 and impeller peripheral speed is u_2 = 190 m·s^{-1}. For vacuum of 0.3, Π = 1/0.7 = 1.43 and u_2 = 240 m·s^{-1}. For vacuum of 0.5, Π = 1/0.5 = 2.00 and u_2 = 340 m s^{-1}. For vacuum of 0.7, Π = 1/0.3 = 3.33 and u_2 = 455 m s^{-1}. For vacuum of 0.8, Π = 1/0.2 = 5.00 and u_2 = 550 m s^{-1}.

The capacity (volumetric flow rate) V (m^3 s^{-1}) determine the compressor flow field dimensions (tip impeller diameter D_2). The small diameter D_2, determined by the capacity V, and the high peripheral speed u_2, determined by the pressure ratio needed Π, causes high and extremely high impeller rotational speed n (s^{-1}).

The high impeller peripheral speed causes high Mach number of the flow in the compressor flow field. Local supersonic flow, embedded at other subsonic flow, appears firstly at the impeller cascade inlet around the suction side of the blade. Appearance of supersonic flow at the cascade inlet causes shock wave and choking of the flow. This, along with appearance of separated jet-wake flow at the impeller cascade causes disorder at the flow field and decrease of the compressor efficiency [3].

CONCLUSIONS

A new thermal system for cogeneration of vacuum and heat in paper machines is proposed. A turbo compressor – turbo expander unit is applied in the new concept for generation of vacuum. The unit contains a single-stage centrifugal compressor directly driven by a single-stage turbo expander. The boiler steam firstly comes into the turbo expander, where it expands generating mechanical work to drive the turbo compressor. The steam exiting the turbo expander is used for heat generation in the drying cylinders for drying purposes. Directions for optimization of the cogeneration systems in case studies are given.

The characteristics of single-stage high pressure ratio transonic centrifugal compressors are determined and the possibilities for their application in the novel co-generative systems with turbo compressor – turbo expander units are estimated.

Complete or partial substitution of the electrical energy for vacuum generation can be obtained with optimal implementation of the new system for vacuum and heat cogeneration in paper machines. The proposed system has advantage in comparison with traditional thermal systems by technical, economical and environmental reasons.

NOMENCLATURE

a	Speed of sound (m s^{-1})
$\overline{b}_2$	Relative impeller width
D_2	Impeller tip diameter (m)
M_u	Peripheral Mach number
n	Rotational speed (s^{-1})
p	Pressure (Pa, bar)
R	Individual gas constant (J kg^{-1} K^{-1})

R_μ	Universal gas constant (J mol^{-1} K^{-1})
T	Temperature (K, °C)
u_2	Impeller peripheral speed (m s^{-1})
V	Volumetric flow rate (m^{3}s^{-1})
V	Specific volume (m^3 kg^{-1})

Greek letters

ΔT	Temperature difference (K)
η	Efficiency
κ	Isentropic exponent
μ	Molecular mass
ξ	Compressibility factor
Π	Pressure ratio
ψ	Work coefficient
φ_2	Flow rate coefficient
τ	Contraction of the flow cross-section

Subscripts

P	Polytropic
0	Compressor inlet
2	Impeller outlet

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Original scientific paper

ENERGY EFFICIENCY IMPROVEMENT OF PAPER MACHINE STEAM-CONDENSATE SYSTEMS BY APPLICATION OF EJECTOR THERMOCOMPRESSION

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A b s t r a c t: Application of ejector thermocompression in paper machines is investigated in this paper. The paper machines are very large consumers of heat energy. With optimal application of ejector thermocompression in the paper machine steam-condensate system the losses of the steam and condensate can be prevented and significant improvement of the energy efficiency can be achieved. Thermal characteristics of the open, cascade and ejector thermo compression steam-condensate systems are analyzed. Thermal-flow characteristics of steam ejectors are estimated and suggestions for optimization of the ejector flow field are given. Results of theoretical and experimental investigations are presented and discussed.

Key words: paper machine; ejector thermocompression; steam-condensate system; energy efficiency

ПОДОБРУВАЊЕ НА ЕНЕРГЕТСКАТА ЕФИКАСНОСТ НА СИСТЕМИТЕ ЗА КОНДЕНЗНАЦИЈА НА ПАРЕА КАЈ МАШИНИТЕ ЗА ХАРТИЈА СО ПРИМЕНА НА ЕЈЕКТОРСКА ТЕРМОКОМПРЕСИЈА

А п с т р а к т: Во овој труд се презентирани резултатите од истражувањата за оптимална примена на ејекторската термокомпресија во системите за кондензација на пареа кај машините за хартија. Машините за хартија се големи потрошувачи на топлинска енергија. Со оптимална примена на ејекторската термокомпресија во системите за кондензација на пареа кај машините за хартија загубите на пареа и кондензат можат да бидат спречени и да се постигне значително подобрување на енергетската ефикасност. Анализирани се отворените, каскадните и парнокондензационите системи со ејекторска термокомпресија. Оценети се термичко-струјните карактеристики на парните ејектори и дадени се сугестии за оптимално обликување на струјниот простор на ејекторите. Презентирани и дискутирани се резултатите од теоретските и од експерименталните истражувања.

Клучни зборови: машина за хартија; ејекторска термокомпресија; систем за кондензација на пареа; енергетска ефикасност

INTRODUCTION

The paper industry is large and significant consumer of heat and electrical energy. The production and consumption of paper in the world continuously increases. The concept of cleaner production and the energy efficiency improvement strategy have led to research and development of new combined thermal systems with utilization of low temperature heat, solar energy, geothermal enery and waste heat. Application of vapor ejector thermocompression in paper industry steam-condensate thermal systems and the improvement of the energy efficiency of these systems is the subject of investigations of this paper.

Steam-condensate thermal systems are applied in numerous industrial sectors. Traditionally, open steam-condensate systems are applied in thermal processing plants. Losses of the water va-

por flowing from the open condensate reservoir into the atmosphere are a common characteristic of the open steam-condensate systems. The quantity of these losses depends on the operating conditions (pressure and temperature) and on the management of the system, maintaining and servicing of the facility and system components.

Improvement of the energy efficiency of technological processes and plants has attracted many research activities over the past years. A study for alternative secondary heat uses to improve energy efficiency of a pulp and paper mill is presented by Ruohonen et al. (2010). A feasibility study on superheated steam drying of paper and textile is proposed by Van Deventer (1997), resulting in high improvement of the energy efficiency. An overview of the investigations and a retrofit analysis, using pinch technology/process integration methods, on the improving energy efficiency in plump and paper Kraft mills is presented by Savulescu et al. (2008), where a systematic procedure is given to extract and analyze the impacts of direct heat transfer on the overall energy efficiency of a Kraft process, with a specific focus on mixing along the pulp line and in the water tanks. An improvement of the energy management in a steam-condensate system used for corrugated board production is proposed by Bujak (2008). The system containing an open condensate tank is modernized installing a closed condensate tank to eliminate the energy losses due to secondary steaming. The technical and economic aspects of introduction of a closed condensate reservoir in the steam-condensate system of a tissue machine are analyzed by Gabbrielli et al. (2006). The modifications to the system make it possible to achieve consistent savings of natural gas, fresh water and CO_2 emissions through elimination of steam losses that were present in the open steam-condensate system. The tissue machine drying section contains a rotating Yankee cylinder which is supplied with steam via a regulated ejector. Recent development of the paper production technology and processes has resulted in reduction of heat energy consumption (Krgović and Jovanović, 2003). A comprehensive review of investigations on water (R718) ejector refrigeration and heat pump technology is presented by Šarevski and Šarevski (2016). Implementation of the ejector thermocompression technology is an effective way to prevent steam and condensate leakages (losses) into the environment and significant improvement of the paper production process energy efficiency.

A novel closed steam-condense system with ejector thermocompression has been proposed by Šarevski et al. (1997) and applied in various industrial technological and processing plants, including the paper industry (Šarevski and Šarevski, 2003); textile industry; chemical and pharmaceutical industries, among others. The improvement of the energy efficiency is significant, resulting in energy savings of 15% up to 45%.

The purpose of this paper is: to describe and promote novel industrial closed steam-condensate thermal engineering systems with ejector thermocompression; to estimate the energy efficiency improvement and performance characteristics of these systems applied in the paper industry; and to provide suggestions and procedures for their design.

CHARACTERISTICS OF OPEN STEAM-CONDENSATE SYSTEMS

A schematic of a simple open conventional steam-condensate system is given in Figure 1. The steam produced in the boiler house is transported via pipelines to the heat consumers (heat exchangers; heat apparatus), where the steam condenses. Pressure reduction control devices are usually installed before the heat consumers. At the exit of the heat exchangers, condensate separators (condensate batteries) are installed. There are various constructions of condensate separators. The condensate via pipelines goes into the open condensate reservoir and then is transported with condensate pumps to the boiler supply reservoir located in the boiler house.

The following disadvantages of the simple open steam-condensate system can be identified: losses of the water vapor flowing from the open condensate reservoir into the atmosphere; cavity operating conditions of the condensate pumps; mismatched operation of the condensate reservoir, condensate pump and boiler supply reservoir, resulting in condensate losses; technical problems with maintenance and servicing of the equipment.

When the condensate separators are functioning perfectly, part of the superheated condensate evaporates (secondary steaming) when it is throttled from high pressure (heat exchanger pressure) to atmospheric pressure in the open condensate reservoir. This part is the loss of water vapor which flows from the open condensate reservoir into the atmosphere,

$$x = (h_p' - h_{at}') / (h_{at}'' - h_{at}') \quad (1)$$

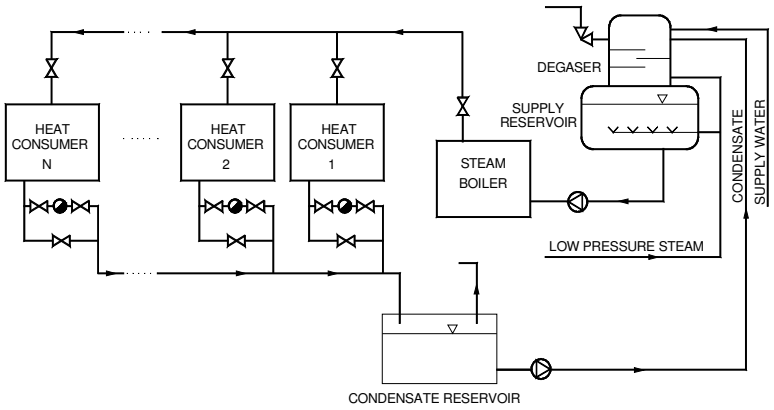

Fig. 1. Schematic of a simple open conventional steam-condensate system

The part (x) depends on the heat exchanger pressure, which determines the saturated liquid (condensate) enthalpy h_p'. The enthalpies of the saturated liquid and saturated vapor at atmospheric pressure are h_{at}' and h_{at}". The values of the loss of vapor (x) are 11–20 % depending on the heat exchanger operating pressure 5–16 bar.

If the condensate separators are not in technically correct conditions and/or the by-pass valve is open, then large quantity of vapor flows into the environment and the losses of vapor are extremely high. The losses are much larger than the thermal losses due to damaged insulation of the pipelines or/and any other thermal losses.

In some cases (rotating drying cylinders in paper machines, for example) the installations with classical condensate separators are typically the wrong technical solution, which cannot function properly. Therefore, the bypass valves must be opened and water vapor flows uncontrolled into the environment, resulting in extremely high energy losses.

If there are heat consumers at different operating pressures, then a cascade steam-condensate system can be applied (Figure 2). The vapor exiting the higher pressure heat consumers can be used in the lower pressure heat consumers, resulting in a decrease of the energy losses. However, compliance of the heat capacities of the various heat consumers working in different pressures is needed; very often this condition cannot be fulfilled.

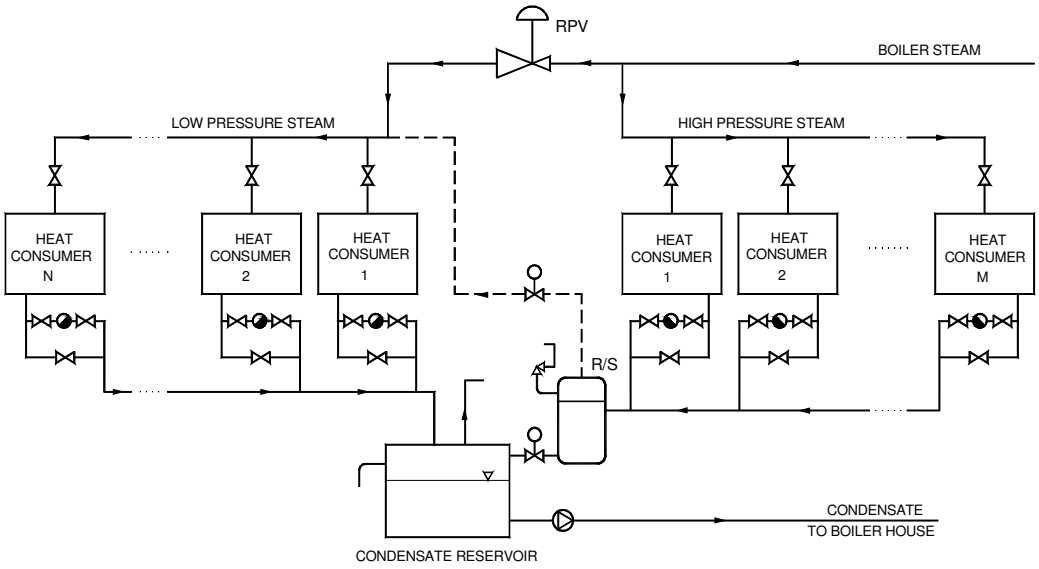

Fig. 2. Schematic of a cascade steam-condensate system

DESCRIPTION OF THE NOVEL STEAM-CONDENSATE SYSTEM WITH EJECTOR THERMOCOMPRESSION

A schematic of an original concept of a steam-condensate system with ejector thermo compression is given in Figure 3. Many heat consumers operating at the same pressure are supplied with steam via an ejector. At the exit of any consumer only a valve (balancing valve) and optionally a non-return valve are installed. All consumers are connected with a closed condensate-steam reservoir/separator. The steam is evacuated from the reservoir/separator with the ejector and as a secondary flow is compressed up to the consumer pressure, using boiler motive steam as a primary flow. The condensate, via the control valve, is transported to the boiler house with pipelines. The return condensate continuously flows in the boiler supply reservoir. The vapor appearing due to pressure drop is utilized for thermal preparation and degasification of the boiler supply water. If the pressure in the heat consumers is needed to be constant in variable operating conditions, then a control valve (RV) should be optionally installed, always in front of the ejector.

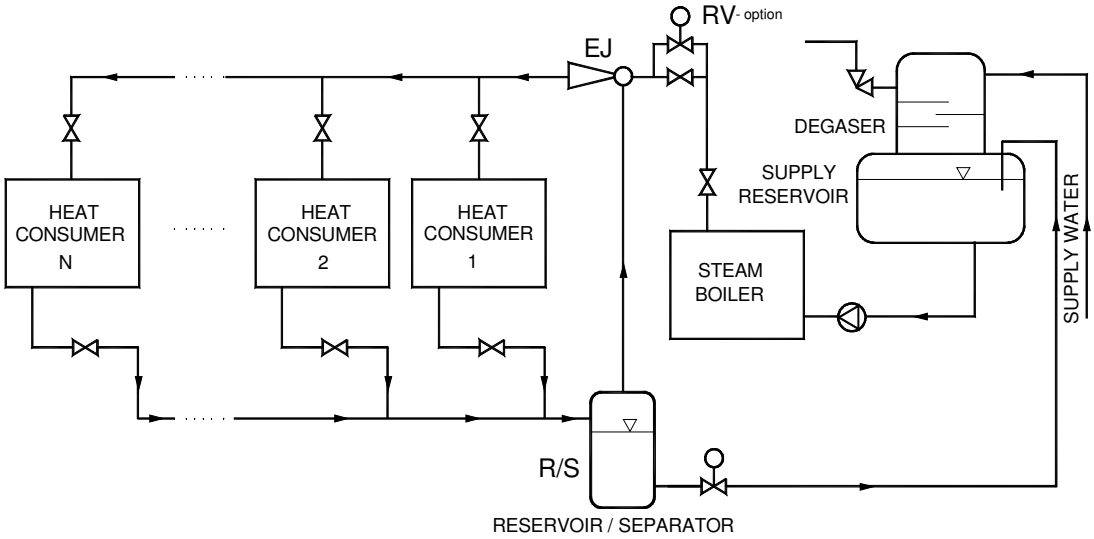

Fig. 3. Schematic of an original concept of steam-condensate system with ejector thermocompression

The boiler pressure is higher than the required pressure in the heat consumers. According to the value of the boiler motive pressure (ejector primary flow pressure) and the value of the required pressure in the heat consumers (ejector exit pressure), the value of the pressure in the reservoir/separator (return vapor pressure; ejector secondary pressure) can be determined. According to the experience with design, construction and commissionning of these systems, the recommended ejector entrainment ratio (secondary flow rate/primary flow rate) is $\omega = m_{sec}/m_{pr} = 0.2–0.3$. It means that 20–30 % of the supply boiler steam recirculates in the ejector-heat consumers-reservoir/separator circuit. Using these recommendations the steam ejector can be calculated and designed and the steam–condensate system can be constructed, concerning the operating conditions of the technological and/or processing plant.

A schematic of a steam-condensate system with ejector thermocompression suitable for application in thermal technological/processing plants and systems containing rotating drying cylinders (paper machines, for example) is given in Figure 4. An alternative scheme of a cascade steam-condensate system with ejector thermocompression suitable for application in the paper machines is given in Figure 5. The first and the last sections of the paper machine usually operate in conditions of vacuum. In these conditions, the condensate from the vacuum reservoir/separators should be transported by condensate pump, or by two-phase ejectors installed in the condensate pipelines, using high pressure condensate. A vacuum pump should be installed to achieve and maintain vacuum in the machine vacuum sections.

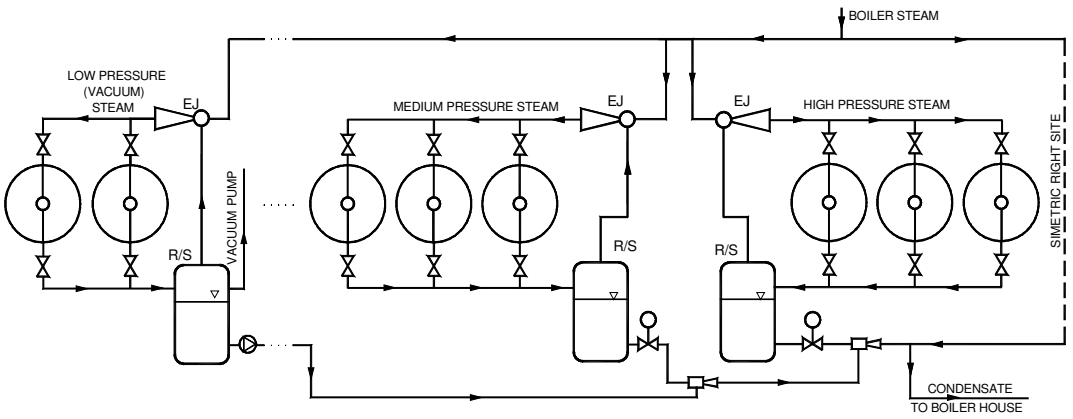

Fig. 4. Schematic of a steam-condensate system with ejector thermocompression applied on paper machines

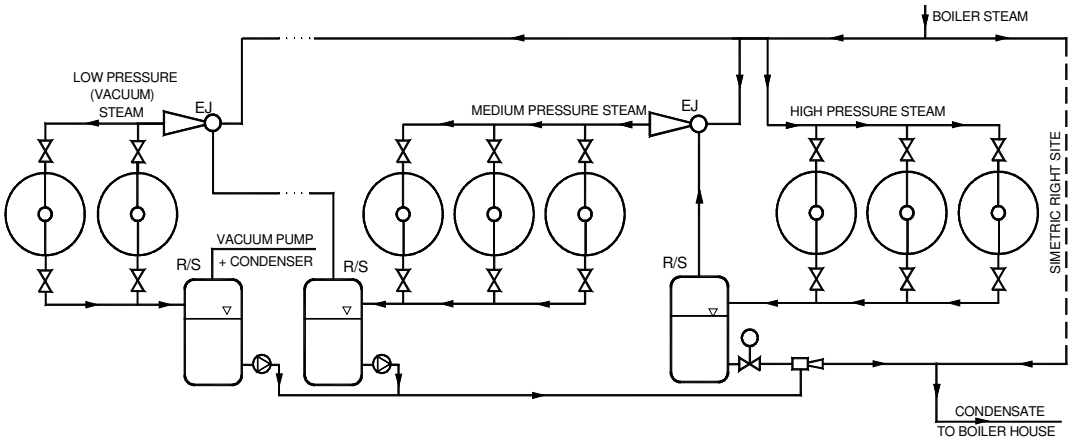

Fig. 5. Schematic of a cascade steam-condensate system with ejector thermocompression applied on paper machines

RESULTS OF IMPLEMENTATION OF CLOSED STEAM-CONDENSATE SYTEMS WITH EJECTOR THERMOCOMPRESSION

Experimental investigations were carried out on a prototype of the closed ejector thermocompression steam-condensate system applied on a paper machine ("KOMUNA" Skopje; Šarevski and Šarevski, 2003). Three ejector subsystems are installed: main drying rotating cylinder (Yankee cylinder, YC), with nominal design steam consumption of 2500 kg h^{-1} and steam gauge pressure 4.5 bar; two drying cylinders (TDC), with 600 kg h^{-1} and 3.0 bar; and convective air heater section (CAHS), with 750 kg h^{-1} and 4.5 bar. The nominal design boiler steam gauge pressure is 6.0 bar. The calculating nominal gauge pressure in the closed reservoir/separator is: YC, 3.7 bar; TDC, 2.0 bar; CSHS, 3.7 bar. The plant is equipped with calibrated industrial measurement instruments. Bourdon tube pressure gauges have been used with accuracy class ± 2% of span 0 to 6.0 bar and 0 to 10.0 bar. The primary boiler steam flow rate was estimated by the measured pressures and by geometrical characteristics of the ejector primary nozzle. The uncertainty depends on the uncertainty of the measured pressures, on the uncertainty of the nozzle critical cross-section diameter and on the uncertainty of the calculating procedure. All experimental runs were carried over at steady state conditions. The uncertainty of the measurements was evaluated according to ISO "Guide to the Expression of Uncertainty in Measurement", 1993. The comparison of the experimental results with the numerical estimations using the calculating procedure shows that the differences are within the accuracy of experimental investigation.

Prevention of the secondary steaming losses by implementation of the closed ejector thermocommpression steam-condensate system additio-

nally results in: significant reduction of the boiler fresh water consumption: after reconstruction 2 – 3 m^3 per day; before reconstruction 112 – 125 m^3 per day; significant reduction of the thermal losses from the boiler blow-off to prevent high concentration of salt in the boiler water; significant reduction of the expenses for chemical and technical preparation of the boiler supply water; improved operating conditions of the boiler, and other technical, economical and environmental benefits.

According to the global annual technical and economical indicators for the paper machine, the specific average annual consumption of natural gas per ton of paper is: after reconstruction 170 $m_n^3\,t^{-1}$; before reconstruction 305 $m_n^3\,t^{-1}$. The energy consumption has been reduced for 44 %. The measurement of the natural gas flow rate and natural gas consumption has been realized by calibrated turbine type flow meter. According to the legal metrology principles, the maximum permissible error is 1.5% (Directive 2004/22/EC Measuring Instrument Directive, ANNEX MI-002, Gas Meters and Volume Conversion Devices).

The concept of closed steam-condensate system with ejector thermocompression has been implemented on numerous technological and processing plants: paper industry (a paper machine 44% ES; a corrugated board production plant 29% ES); textile industry plants 27% – 35% ES; chemical and pharmaceutical industry plants 17% – 31% ES; a canning industry plant 33% ES; a dairy industry plant 28% ES; food and sweet industry plants 23% – 42% ES; a leather industry plant 41% ES; a leather processing and rubber industry plant 33% ES. The implementation results in energy savings (ES) which, depending on the conditions of the thermal systems before the reconstruction, are from 15% up to 45%.

The energy savings are established according to the global annual technical and economical indicators for the plant production, comparing the specific average annual fuel consumption per unit of product after the reconstruction and before the reconstruction. Additionally, the expenses for chemical and technical preparation of the boiler supply water are lower and pollution of the environment with combustion exhaust gases and CO_2 is reduced. Improvement of the energy efficiency, simplicity and reliable operation, easy maintenance and servicing and low capital costs are advantages of the novel steam-condensate system with ejector thermocompression, resulting in technical, economical and environmental benefits.

OPTIMAL DESIGN OF THE STEAM EJECTOR

The following geometrical parameters of the ejector flow field (Figure 6) have strong influence on the ejector performance characteristics: ejector primary nozzle converging angle (α); ejector primary nozzle diverging angle (β); profile of the secondary nozzle; primary nozzle exit position (NEP); mixing chamber converging angle (γ); mixing section length and diameter ratio (l_{mc}/d_{mc}); mixing section cross-section and primary nozzle exit cross-section ratio; diffuser diverging angle (δ). According to the based publications of the ejectors and analysis of numerous theoretical and experimental results of investigations of steam ejectors; different refrigerant vapor ejectors; CFD simulations and experimental verification; ejector flow field optimization, systematized by Šarevski and Šarevski (2016), the following recommendations for optimal geometric parameters can be exposed:

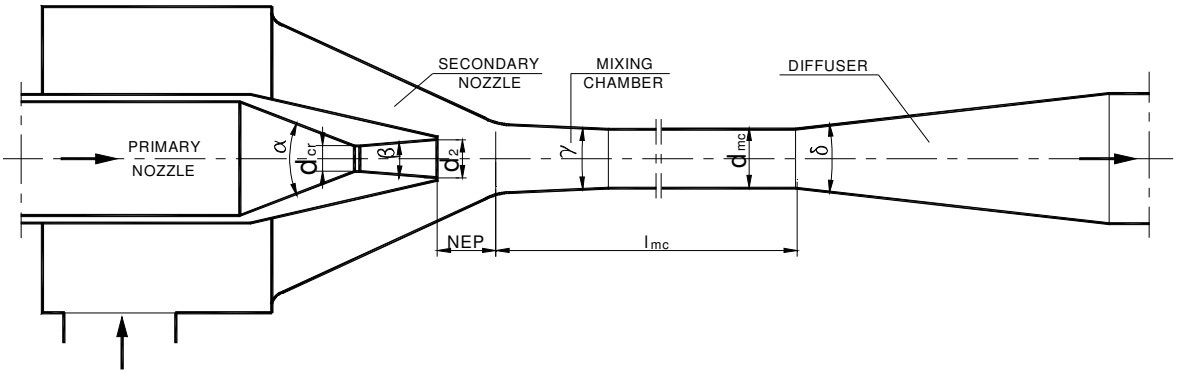

Fig. 6. Geometrical parameters of the ejector flow field

– $\alpha = 30°–40°$ and $\beta = 10°–12°$,
– NEP = (1–2) d_{mh},
– ejector secondary nozzle should be optimally designed,
– optimum mixing chamber converging angle (γ) depends on design concept of the ejector and on primary nozzle stagnation pressure; higher values correspond to higher stagnation pressure,
– $l_{mc}/d_{mc} = 7 – 9$,
– $\delta = 5°–7°$,
– mixing section cross-section and primary nozzle exit cross-section ratio depends on thermal system operating conditions; optimum ratio can be obtained using previously mentioned recommendation for ejector entrainment ratio

$$\omega = m_{se}/m_{pr} = 0.2 – 0.3.$$

Using calculating procedure (Šarevski and Šarevski, 2016) and recommendations given previously, the ejectors can be successfully designed and applied in the closed steam-condensate systems of various technological and processing plants.

CONCLUSIONS

An original concept of closed steam-condensate thermal systems with ejector thermocompression is exposed. Technical and operating advantages in comparison against traditional steam-condensate systems are discussed. Suggestions and recommendations for design parameters of the ejectors are provided.

According to the results of investigations and experience in design, construction and commissioning of these systems it can be concluded that: the ejector thermocompression can be successfully applied in paper industrial steam-condensate systems; significant energy efficiency improvement has been achieved; simplicity of the construction; reliable operation; easy and simple maintenance and servicing; and low capital costs are characteristics of the steam-condensate systems with ejector thermocompression and advantages in comparison against traditional steam-condensate systems.

The concept of the novel system has been implemented in numerous industrial technological and processing systems, including that in paper industry, resulting in energy savings which, depending on the conditions of the thermal systems before the reconstruction, are from 15% up to 45%. Additionally, consumption of boiler water is reduced, expenses for chemical and technical preparing of the boiler supply water are lower and pollution of the environment with combustion exhaust gases and CO_2 is reduced.

Introduction of the ejector technology in the industrial steam-condensate systems results in technical, economical and environmental benefits. The effects of the implementation can be significant in industrial sector of developing countries, resulting in global environment protection benefits.

NOMENCLATURE

d	Diameter (m)
h	Specific enthalpy (J kg^{-1})
l_{mc}	Mixing section length (m)
M	Mass flow rate (kg s^{-1})
m	Relative mass flow rate
T	Temperature (K, °C)

Greek letters

α	Ejector primary nozzle converging angle
β	Ejector primary nozzle diverging angle
γ	Mixing chamber converging angle
δ	Diffuser diverging angle
ω	Entrainment ratio

Subscripts

cr	Critical
pr	Primary
sec	Secondary
mc	Mixing chamber

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Original scientific paper

PHOTOVOLTAIC MAXIMUM POWER POINT TRACKING METHOD IMPLEMENTATION IN LabVIEW

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A b s t r a c t: In recent years, due to the rapid depletion of conventional energy resources and the ever-increasing energy demand, alternative energy sources and their optimal utilization have become a focal point in the field of power engineering. Photovoltaic (PV) power generation technology specifically, has seen major advances in the last decade, enabling its widespread use in both industrial and domestic applications. Maximum power point tracking (MPPT) is a technique used to maximize the power output of a photovoltaic system. This paper presents a maximum power point tracking (MPPT) algorithm for a photovoltaic system and its implementation as a virtual instrument in the graphical programming language LabVIEW. A theoretical outline of incremental conductance (IC) method for MPPT is presented with an analysis of its advantages and disadvantages. The virtual instrument is used to control and visualize the output power of the simulated model of the photovoltaic panel and to determine its most suitable resistive load.

Key words: maximum power point tracking; incremental conductance; PV system; LabVIEW

ИМПЛЕМЕНТАЦИЈА НА МЕТОДОТ ЗА СЛЕДЕЊЕ НА ТОЧКА НА МАКСИМАЛНА МОЌНОСТ НА ФОТОНАПОНСКИ ПАНЕЛ ВО LabVIEW

А п с т р а к т: Во последниве години, поради забрзаното исцрпување на конвенционалните извори на енергија и постојаното зголемување на побарувачката на енергија, алтернативните извори на енергија и нивната оптимална искористеност станаа фокусна точка во областа на електроенергетиката. Конкретно, фотонапонските системи за производство на електрична енергија бележат значаен напредок во последнава деценија, овозможувајќи нивна широка примена во индустријата и во домаќинствата. Следењето на точката на максимална моќност (MPPT) е техника која се користи за да се зголеми излезната моќност на еден фотонапонски систем. Во овој труд е претставен алгоритам за следење на точката на максимална моќност за фотонапонски систем и негова имплементација како виртуелен инструмент во графичкиот програмски јазик LabVIEW. Претставен е теоретски преглед на методот на зголемување на спроводливоста (incremental conductance) за следење на точката на максимална моќност со анализа на неговите предности и недостатоци. Виртуелниот инструмент се користи за да се контролира и визуелизира излезната моќност на симулираниот модел на фотонапонски панел и да се утврди најсоодветното оптоварување.

Клучни зборови: следење на точка на максимална моќност; метод за големување на спроводливоста; ФВ систем; LabVIEW

INTRODUCTION

Solar energy is one of the most important renewable energy types due to its availability, cleanness and cheap energy resources. Nowadays, there are a lot of different approaches for improving solar energy utilization. More attention is being paid to solar cells due to rapidly developing technology and potential applications to meet societal energy demands. A solar cell is a device which directly converts the energy from the solar radiation into electrical energy, in a process based on the photovoltaic effect [1]. PV cells are commercially available in a number of different semiconductor materials, mainly mono- or polycrystalline silicon. Mono-crystalline silicon (mc-Si) cells are made of

single continuous crystal lattice structure, with almost no defects or impurities. The main advantage of mc-Si cells is their high efficiency, typically about 15% [2]. Other advantages of mc-Si cells are their low maintenance cost, high reliability, low noise and being completely eco-friendly [1].

The overall performance of a mc-Si solar cell strongly depends on the environmental parameters such as light intensity or irradiance, cell temperature and tracking angle if the module is not fixed [1]. The PV cell I-U characteristic is non-linear due to the complex relationship between the output voltage and current, and it varies with temperature and irradiance. There is a single point on each I-U curve known as Maximum Power Point (MPP), on which the PV system operates with its highest possible efficiency and generates the highest output power. The main source of energy losses is the system's failure to track the MPP [2]. In order to maintain the system's operating point at its maximum output power, many different MPP tracking algorithms have been developed, with a practical implementation in the DC-DC converter used for adjusting the output voltage to a particular resistive load [3].

In this paper, a model of a solar module is developed using the LabVIEW (Laboratory Virtual Instrument Engineering Workbench) software environment, in order to simulate and analyze the operation of the PV module. The PV cell output current is calculated with an explicit equation developed by an approximation using a Taylor series. The influence of weather conditions on the operation of the PV module is analyzed through variations in cell temperature and solar irradiation. The incremental conductance (IC) method is used for MPP tracking and for calculation of a most suitable load at the MPP.

PV MATHEMATICAL MODEL

PV cell model

A photovoltaic cell consists of a p-n junction that emits electrons when exposed to light, which is known as photovoltaic effect. The solar cell can be modeled as a current source which represents the solar irradiation, in parallel with a forward biased diode. The most popular method of modeling a solar cell is the single diode model shown in Figure 1 [3], [4], [5].

In practice, a PV cell is not an ideal diode, so the energy losses are taken into account by the presence of the series resistance R_S and parallel resistance R_P. The series resistance R_S is very small, which arises from the ohmic contact between the metal and semiconductor internal resistance. On the other hand, the shunt resistance R is very large and represents the surface quality along the periphery. Leakage of current through the periphery is represented by I_P. Both the diode current I_d and shunt current IP are provided by the photocurrent Ip_h. Ideally, $R_S = 0$ and $R_P = \infty$ [3].

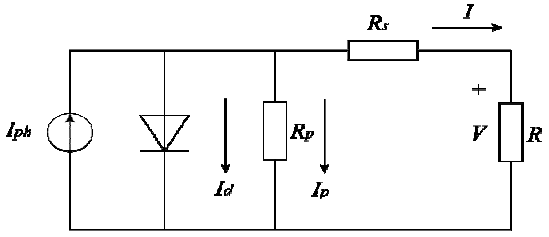

Fig. 1. Equivalent circuit of a silicon solar cell

From Figure 1, the output current of a solar cell is shown in Eq. (1):

$$I = I_{ph} - I_0\left(e^{\frac{q(V+R_S I)}{nkT_C}} - 1\right) - \frac{V + R_S I}{R_P}, \quad (1)$$

where I_0 is the cell saturation of dark current [A], V is the cell output voltage (V), $q = 1.6\cdot10^{-19}$ C is the electron charge, $k = 1.38\cdot10^{-23}$ J/K is the Boltzmann constant, n is the ideal factor of the p-n junction and T_c is the cell operating temperature (K), which can be calculated as shown in Eq. (2) [3]:

$$T_c = \frac{T_{noct} - 20}{0.8} G + T_a, \quad (2)$$

where T_{noct} is the nominal operating cell temperature (K), given by the PV module manufacturer, G is the solar irradiance (W/m^2), and T_a is the ambient temperature (K).

The photocurrent can be calculated using Eq. (3) [6]:

$$I_{ph} = I_{sn}\left[1 + \mu_{Isc}\left(T_c - T_{noct}\right)\right], \quad (3)$$

where I_{sn} is the nominal short-circuit current (A) which can be determined by Eq. (4). μ_{Isc} is the cell short-current temperature coefficient (A/K).

$$I_{sn} = \frac{G}{G_{nom}} I_{SC}, \quad (4)$$

where G_{nom} is the solar irradiation (W/m^2) at standard test conditions (STC: G = 1000 W/m^2, T_c = 25

°C, AM 1.5 reference spectrum, wind velocity 1 m/s [2]), and I_{SC} is the short-circuit current (A).

The reverse bias saturation current can be determined using Eq. (5) [6]:

$$I_o = \frac{I_{SC}}{e^{\frac{qV_{OC}}{nkT_cN_s}[1+\mu_{Voc}(T_c-T_{noct})]}-1}, \quad (5)$$

where V_{oc} is the open circuit voltage (V), N_s is the number of cells in series in the PV module, μ_{Voc} is the cell open circuit voltage temperature coefficient (V/K).

PV MODULE MODEL

Photovoltaic modules consist of a number of silicon based photovoltaic cells electrically connected in series and in parallel circuits, depending on the voltage or current requirements [2]. The equivalent circuit for the solar module arranged in N_p parallel and N_s series identical cells is shown in Figure 2. If the cells are connected in parallel, the total voltage remains the same as the voltage of one cell, but the output current is the sum of the values of the current of each of the cells. Since the current of a single cell can be more than 3 A, and the voltage is less than 0.7 V, a parallel connection is rarely applied [3]. When several cells are connected in series, the PV module output voltage increases, and the current remains the same.

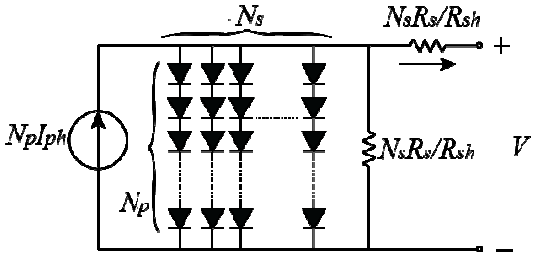

Fig. 2. Equivalent circuit of a PV module

The output current of the PV module is implicitly given in Eq. (6) [7]. The module's *I-U* curve has the same form as the cell's *I-U* curve, whereas the equivalent model parameters differ depending on the number of cells connected in the module: the photocurrent and the dark saturation current increase N_P times, the series and shunt resistances change according to Eq. (7), and the ideal diode factor increases N_S times.

$$I = N_p I_{ph} - N_p I_0 \left(e^{\frac{q\left(\frac{V}{N_S}+\frac{R_S I}{N_P}\right)}{kT_c n}} - 1 \right) - \frac{\frac{N_p V}{N_S} + R_S I}{R_p} \quad (6)$$

$$R_{S,T} = \frac{N_S}{N_P} R_S, \quad R_{P,T} = \frac{N_P}{N_S} R_P. \quad (7)$$

A problem arises because Eq. (6) does not have an analytical solution. Numerical methods such as the Newton-Raphson's method have been widely applied to solve this equation. In this paper, a different approach is made in order to establish an explicit form of the Eq. (6). When a Taylor series is utilized to represent the function $f(x)= e^x$ as a power series, the approximation is given in Eq. (8) [8]:

$$f(x) = e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots \quad (8)$$

If the same Taylor series representation is used for Eq. (6), taking into account only the first two parts of the series (first order approximation - FOA), the PV module output current can be determined by solving the linear Eq. (9), assuming that R_S is given by the PV module manufacturer or otherwise previously determined and $R_P = \infty$.

$$I = \frac{N_P I_{ph} - N_P I_o \left(e^{\lambda V} - 1\right)}{1 + R_S I_o e^{\lambda V}} \quad (9)$$

where $\lambda = q/nkT_cN_s$.

MAXIMUM POWER POINT TRACKING

The maximization of the output power has been discussed in the technical literature since the 1960s. The operation of PV arrays using MPPT can generate 17% of extra annual power, when compared to systems that use fixed output voltage [6]. The voltage that produces maximum output power (P_{max}) depends on the sunlight intensity level and on the PV panel temperature. Several techniques have been proposed for implementation of MPPT. The basic idea consists in setting P_{max} when $dP/dV = 0$. The control is achieved by adjusting the output current through changes in the equivalent load impedance.

The incremental conductance (IC) method utilizes the fundamental concept of hill climbing, in which the slope of the P-U curve is zero at the MPP, positive at the left side and negative at the right side of the curve, as shown in Figure 3 [9], [10]. In this algorithm, present and previous values of the PV module's voltage and current are measured and are used to calculate the values of *dI* and *dV* [4].

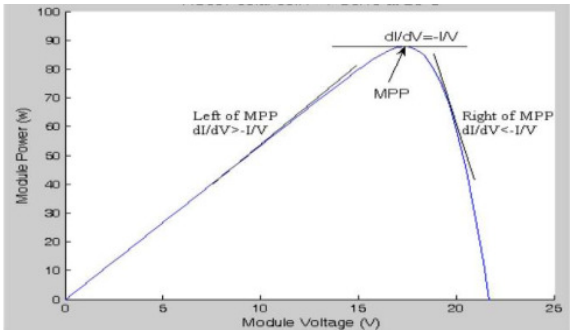

Fig. 3. Basic concept of the incremental conductance method on a P-U curve of a solar module

The mathematical description of the IC method is shown in Eq. (10), and the flow chart software design is shown in Figure 4 [9].

At MPP: $V = V_{mp}$,

$$dP/dV = 0 \Rightarrow \frac{dI}{dV} = -\frac{I}{V}. \qquad (10a)$$

Left of MPP: $V < V_{mp}$,

$$dP/dV > 0 \Rightarrow \frac{dI}{dV} > -\frac{I}{V}. \qquad (10b)$$

Right of MPP: $V > V_{mp}$,

$$dP/dV < 0 \Rightarrow \frac{dI}{dV} < -\frac{I}{V}. \qquad (10c)$$

The main advantage of the IC method, which is superior to the other MPPT algorithms, is that it can calculate and find the exact perturbation direction for the operating voltage of PV modules. Also it is easy to implement, has a high tracking speed and is highly efficient [4].

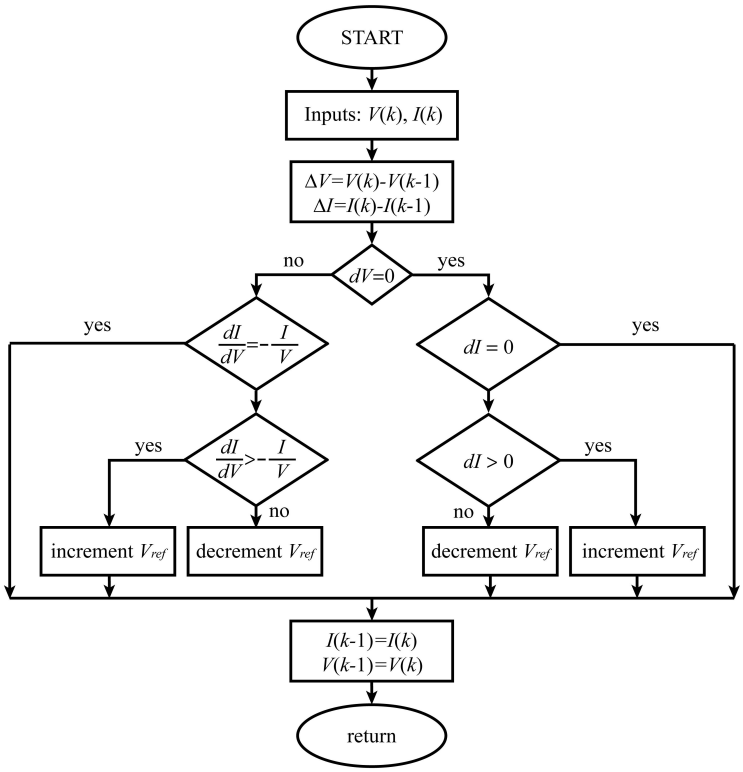

Fig. 4. Block diagram of the incremental conductance method used on a PV module

PV MODULE MODEL SIMULATION IN LABVIEW

A LabVIEW model of the PV panel is developed to calculate the output current, using Eq. (9). The electrical specifications of the module used in the Laboratory for Electrical Machines, Transformers and Apparatuses are given in Table 1 [10], the number of cells connected is N_S = 18 and N_P = 1, and the model implementation is shown in Figure 5.

The front panel and block diagram of the model's final implementation with MPP tracking are shown in Figure 6 and Figure 7 respectively.

Table 1

Technical specifications of the SPM030501200 PV module

Parameter	Symbol	Value	
Rated power	P_m	50	W
Maximum power voltage	V_{mp}	18	V
Maximum power current	I_{mp}	2.78	A
Open circuit voltage	V_{OC}	22.2	V
Short-circuit current	I_{SC}	3.16	A
Efficiency	η	15.03	%
Nominal operating cell temperature	$T_{c,noct}$	45±2	°C
Temperature coefficient of maximum power	μ_{Pm}	–0.24	W/°C
Temperature coefficient of open circuit voltage	μ_{Voc}	–0.07548	V/°C
Temperature coefficient of short circuit current	μ_{Isc}	0.001169	A/°C
Series resistance	R_S	0.83	Ω
Shunt resistance	R_P	8817.92	Ω

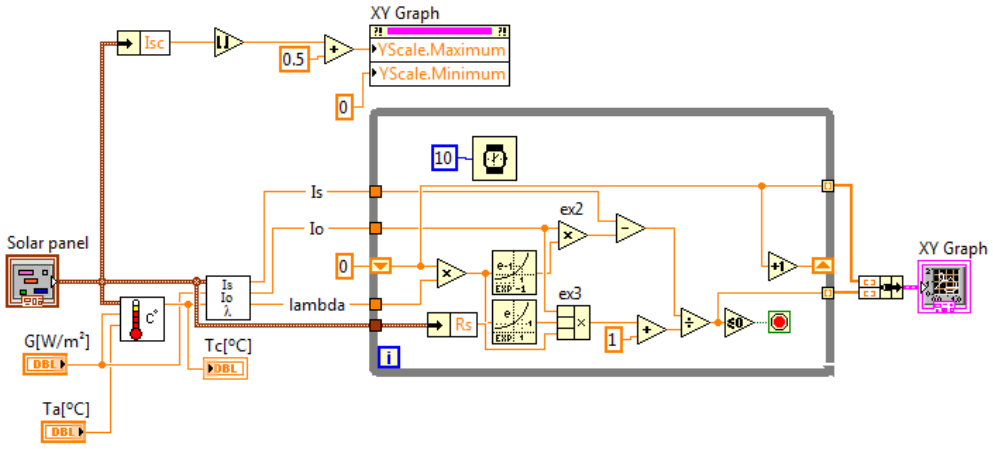

Fig. 5. Block diagram of the LabVIEW virtual instrument containing the solar panel model

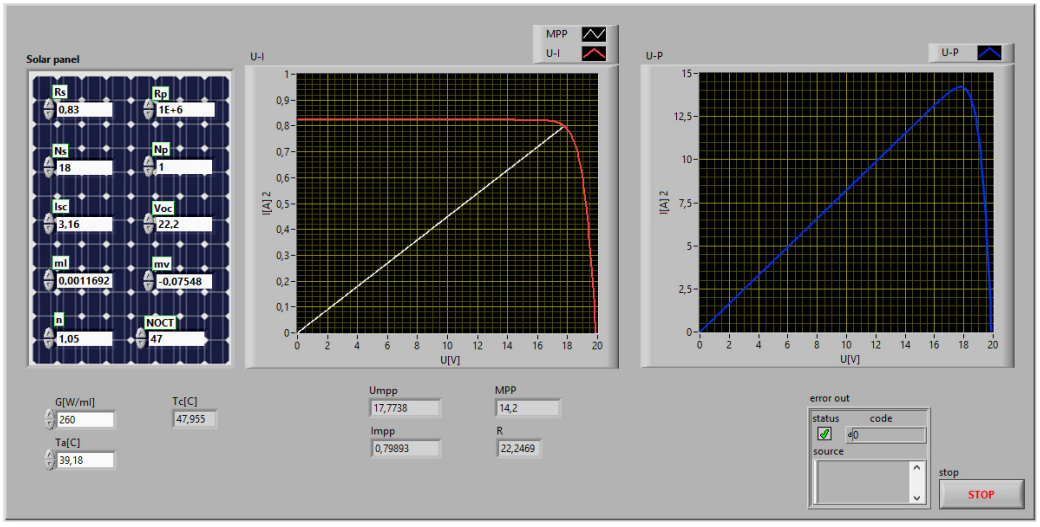

Fig. 6. Front panel of the virtual instrument used for MPPT of the solar panel model

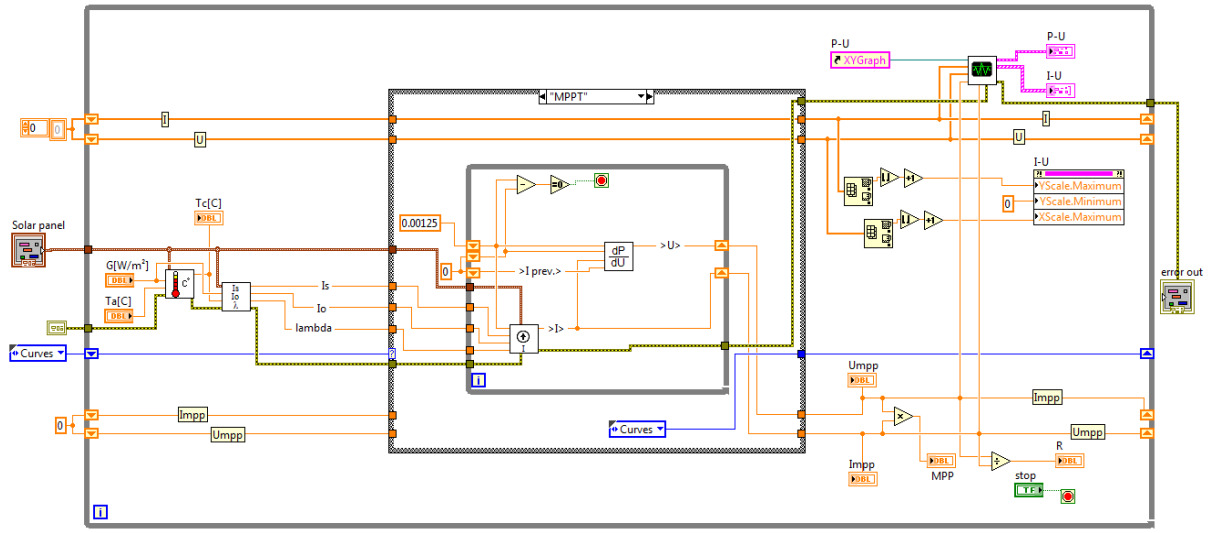

Fig. 7. Block diagram of the virtual instrument used for MPPT of the solar panel model

SIMULATION RESULTS

One of the main purposes of this paper is to compare the approximated I-U curve calculated with Eq. (9), and the curve provided by the PV module manufacturer, in order to verify the accuracy of the model. To quantify the matching between these two curves, a coefficient of determination (R_2) is used. It is a number that indicates how well certain data fit a statistical model: $R_2 = 1$ indicates that the regression line perfectly fits the data [11]. Basically, the method of least squares is utilized for comparison of the curves.

In this research, the coefficient of determination is $R_2 = 0.979$ and it verifies that the LabVIEW model gives an acceptable mathematical representation of the panel's characteristics. If the ambient temperature is T_a = 13.5 °C, and the ideal factor $n = 1.05$, the cell temperature is T_c = 47.25 °C, which is close enough to the nominal operating temperature. In order to increase the accuracy of the mathematical model, all of the relevant parameters and operating conditions have to be taken into consideration and implemented in the Eq. (9). For example, the wind velocity is not analyzed in the Eq. (9), but its influence can be regarded by increasing the ambient temperature, thus making suitable adjustments in the model.

Using the LabVIEW model, the influence of solar irradiation on the I-U and the P-U curves for a constant cell temperature T_c = 47 °C is presented in Figure 8. The system characteristics at different irradiances are shown in Table 2. These curves are plotted in Figure 9 for different cell temperatures and G = 1000 W/m^2, and the system parameters are given in Table 3.

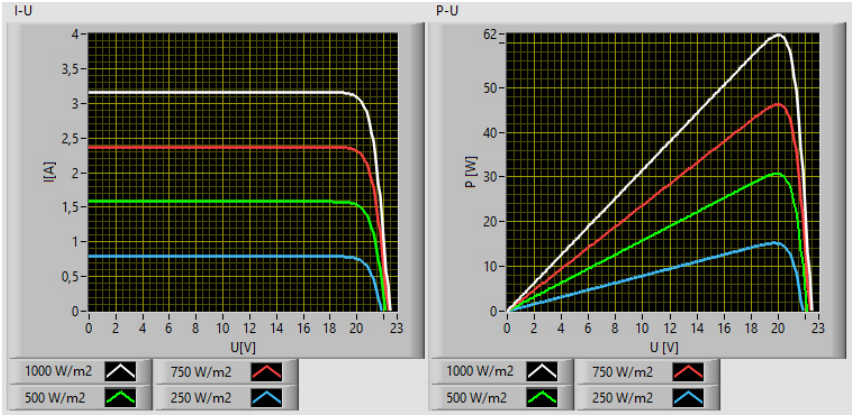

Fig. 8. *I-U* and *P-U* curves at constant cell temperature and variable solar irradiance

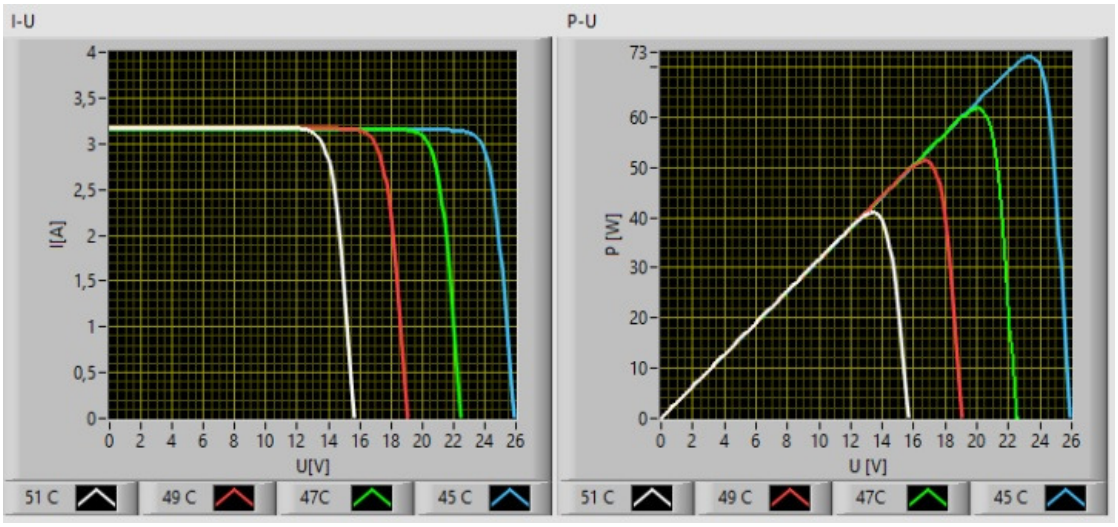

Fig. 9. *I-U* and *P-U* curves at constant solar irradiance and variable cell temperature

Table 2

System parameters at variable irradiance and constant cell temperature

G W/m^2	V_{mp} V	I_{mp} A	P_{max} W	η %	R Ω	T_a °C
1000	19.23	3.076	59.16	17.23	6.2529	13.5
750	19.09	2.307	44.02	17.09	8.2735	22.0
500	18.90	1.538	29.06	16.93	12.291	30.5
250	18.77	0.769	14.43	16.81	24.413	39.9

Table 3

System parameters at variable cell temperature and constant irradiance

T_c °C	V_{mp} V	I_{mp} A	P_{max} W]	η %	R Ω]	T_a °C
45	23.03	3.085	71.04	20.69	7.462	11.25
47	19.74	3.081	60.82	17.71	6.406	13.25
49	16.47	3.072	50.59	14.73	5.360	15.25
51	13.22	3.055	40.38	11.76	4.326	17.25

The module's efficiency can be calculated as a ratio between the electrical energy produced and the total energy of the solar irradiance [12]:

$$\eta = \frac{P_{max}}{P_{in}} = \frac{V_{mp} I_{mp}}{G \cdot S}, \qquad (11)$$

where S = 0.343 m^2 is the module surface which absorbs the solar irradiance.

The maximum output power is observed to be decreasing with the solar irradiance, due to the notable short-circuit decrease. The short-circuit current is proportional to the number of generated charge carriers and their mobility. It strongly depends on the generation rate of charge carriers and diffusion length. This causes decrease in the efficiency of the PV module. The solar irradiance only slightly affects the V_{oc}.

The results show that cell temperature also has a significant impact on the PV module's parameters and it controls the quality and performance of the solar cells. The open circuit voltage, maximum power and efficiency are found to be decreased with increasing the cell temperature, and a slight increment is observed in the short circuit current.

CONCLUSION

In this paper, a new mathematical model of a solar panel was presented, using the Taylor Series for linearizing the equation for PV module output current, as well as the incremental conductance algorithm for maximum power point tracking. The model was designed as a virtual instrument in LabVIEW to simulate a real solar panel and implement the MPPT algorithm on it. The verification and validation of the simulated results for the *I-U* curves included comparison of the data from the technical specification and *I-U* curve at STC of the panel provided by the manufacturer. Using the method of least squares, the accuracy of the model was calculated and it can be concluded that the

model gives an accurate representation of the characteristics of the real solar panel.

The environmental parameters strongly affect the PV module performance: solar irradiance mostly impacts short-circuit current value, while cell temperature has a significant impact on the open circuit voltage value. These parameters are related to the maximum output power and system efficiency.

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Original scientific paper

PRODUCTION OF ALTERNATIVE FUEL FROM WASTE POLYOLEFIN MIXTURE BY THERMAL PYROLYSIS

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A b s t r a c t: Pyrolysis of waste polymers to alternative fuels can be the most promising plastics "recycling" method. During the thermal pyrolysis waste plastic is converted into the liquid, gas and solid fuels. In this study the thermal pyrolysis of polyolefin waste plastic has been investigated in a stainless steel semi-batch reactor in order to produce a high yield of liquid product. The range of temperature was 400ºC to 550ºC and as a feedstock polyolefin mixture composed of high density polyethylene (HDPE) and polypropylene (PP) was used. Due to the low heat conductivity of waste plastics, a metal rings are putted into reactor. The amount of raw material was varied during the process of pyrolysis. The main product is a liquid fuel with yield higher than 73%. The obtained results showed that the yield of liquid fuel was dependent on the time of pyrolysis, as well as the amount of raw material. It is probably due to the different retention time of oil vapours into reactor. Characterization of the liquid fuel (density, kinematic viscosity, aniline point and refractive index) was performed using standard test methods.

Key words: thermal pyrolysis; polyolefin waste plastic; liquid fuel; semi-batch reactor; physical properties

ПРОИЗВОДСТВО НА АЛТЕРНАТИВНИ ГОРИВА ОД СМЕСА НА ПОЛИОЛЕФИНСКИ ОТПАД СО ТОПЛИНСКА ПИРОЛИЗА

А п с т р а к т: Пиролизата на полимерен отпад до алтернативни горива може да биде метод кој најмногу ветува при „рециклирање" на пластиката. Во текот на термичката пиролиза пластичниот отпад се претвора во течност, гас и цврсто гориво. Во оваа студија термичката пиролиза на полиолефински пластичен отпад е испитана во не'рѓосувачки полушаржен челичен реактор со цел добивање висок принос на течен производ. Температурниот интервал се движеше од 400ºC до 550ºC, а како суровина се користеше полиолефинска смеса составена од полиетилен со висока густина (HDPE) и полипропилен (PP). Поради нискиата топлинска спроводливост на пластичниот отпад, во реакторот се стават метални прстени. Количината на суровина варира во текот на процесот на пиролиза. Главен производ е течно гориво со висок принос од 73%. Добиените резултати покажуваат дека приносот на течно гориво зависи од времето на пиролиза, како и од количината на суровината. Тоа веројатно се должи на различното време на задржување на пареите од горивото во реакторот. Направена е карактеризација на течното гориво (густина, кинематски вискозитет, анилинска точка и индекс на рефракција) со користење на стандардни методи за тестирање.

Клучни зборови: термичка пиролиза; полиолефински пластичен отпад; течни горива; полушаржен реактор; физички својства

INTRODUCTION

Polyethylene and polypropylene are very frequently used polymers and they are present in large amount in solid waste. Plastic waste can cause severe pollution problems [1]. Thermal or catalytic cracking of waste plastics is one of the possible methods of their utilization. The advantage of

thermal degradation (pyrolysis) of mixed plastics macromolecules in the absence of air compared to combustion is a reduction the volume of product gases by a factor of 5–20 which leads to considerable savings in the gas conditioning equipment [2]. The thermal degradation process at 400°C or higher results in the formation of products which can be used as fuels, gasoline and diesel fuel. [3]. Thermal pyrolysis needs higher temperatures and longer reactive time compared to catalytic pyrolysis. This kind of conversion of polyethylene (PE) and polypropylene PP) leads to a wide product distribution with poor economic value, which should be further upgraded [4].The pyrolysis of the polyolefin plastics high density polyethylene (HDPE), low density polyethylene (LDPE), polypropylene (PP), yields an oil product consisting mainly of alkenes, alkanes and alkadienes. The gas product consisting of hydrogen, alkanes and alkenes; and negligible char [5, 6]. Many researches proved that pyrolysis of polyolefin has produced only a little char, but the percentage of volatile products is high, so they can be largely converted to liquid oil [7].

Ingeneral pyrolysis processes, thermal or catalytic are high energy, endothermic processes [8]. In case of waste plastic mixture comprising polyethylene and polypropylene, thermal degradation proceeds mainly via a random chain scission mechanism to form intermediate species, which are further cracked to produce the final products [9]. Bockhorn et al. using thermal degradation found that formation of higher molecular weight compounds increased in the liquid oil as the temperature increased. They also found a higher yield of paraffins in the isothermal pyrolysis of polyethylene, but they observed that at low temperatures (430°C), the ratio of paraffins to olefins was constant over time, while at higher temperatures (480°C) the mole fraction of paraffins increased with time while that of olefins decreased [10].

The pyrolysis has many advantages because of its simplicity, the low pressure operation, negligible waste product and high conversion efficiency in the order of 83% [11]. A various factors have affected on the process of pyrolysis like temperature, retention time, type of raw material, presence of catalyst, type of reactor and etc. Various technologies have been used for conversion of plastic waste using thermal degradation [12–15]. All pyrolysis experiments were carried out in order to recover valuable products and energy.

The present work reports the results of non-catalyst, thermal cracking of waste mixture of HDPE and PP. The waste plastic mixture was decomposed in semi-batch stainless steel reactor. A better heat transfer through plastic material in the reactor is provided by metal particles. The amount of raw material was varied during the process of pyrolysis. The main product is a liquid fuel with yield higher than 73%. The obtained results showed that the yield of liquid fuel was dependent on the retention time of pyrolysis, as well as the amount of raw material.

EXPERIMENTAL

Materials

Waste samples of polyethylene and polypropylene were used as raw material in this work and mixture was supplied by a plastic recycling company which was a mixer of 75% PE and 25% PP, (weight) in the form of post-consumer plastic pellets. The samples were re-granulated by manufacturers. The polymer mixture pellets have maximum particle size of 5 – 6 mm. The melting temperature of HDPE+PP mixture, as determined by differential scanning calorimetry (DSC), was 127°C and 163°C, respectively.

Experimental setup

The thermal degradation experiments of waste polyolefin mixture were carried out in a stainless steel semi-batch reactor with 400 ml volume which was equipped with temperature measurement system (Figure 1). A PID (Unitronics V570) temperature controller was used to control the temperature and to maintain the constant heating rate 10°C/min in the reactor. The reactor was charged with different amounts of a sample, from 30 g to 100 g. Metal particles (M) were also added into reactor, mixed with the sample, in order to improve the heat transfer through the plastic sample.

The products of pyrolysis were collected through a deep pipe that reached down to the bottom of the batch reactor afterwards being let out to a system of condensers in order to condense the liquid products. The system of separators was composed of two water glass traps condensers. The first glass was hot trap, and the other glass was cold trap system. The first separator was maintained at 70°C to prevent wax formation by immediate condensation, while the second separator was kept at 0°C to condense low boiling point hydrocarbons (H.C. range C5-C8).

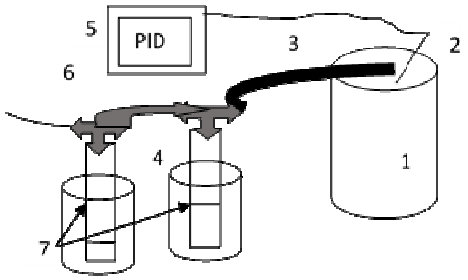

Fig. 1 Schematic flow diagram of the semi-batch reactor and the separation system:
1. Reactor, 2. Thermo-couple, 3. Effluent pipe, 4.Water cooler, 5. PID controller, 6. Exhaust for gases, 7. Condenser-separator (Cond. 1 and Cond. 2)

The reaction system was then purged with nitrogen and the reactor screws were closed at atmospheric pressure. The pyrolytic experiments were carried out under dynamic conditions using 10°C/min heating rate and different retention time on previously set temperature program. The condensed liquid products were formed in condensers when all samples were heated up over 410°C. The semi-batch reactor was heated up to the maximum reaction temperature of 550°C, for around 3 h. After finishing of the reaction cycle the batch reactor content was cooled to ambient temperature, the screws were opened and all contents (metal particles and solid residue) werere moved from reactor.

RESULTS AND DISCUSSION

The variation of the yield and the quality of the pyrolysis products are significant in the literature and it strongly depends of type of raw material and operating conditions. Obtained results (Table 1), clearly shown that yields of condensed products strongly depends from cracking temperatures and retention time.

Table 1

Liquid product yields and quantity

Sample No:	Raw mixture g	Liquid oil V cond. 1 cm^3	Liquid oil V cond. 2 cm^3	Y cond. 1 %
1	30.2	29	Trace	73.95
2	30.6	32	0.3	81.38
3	100.2	109	1.5	89.44

Changes in retention time at predetermined set temperature of the de-polymerization process have great effect on the final yield of the liquid product (Figure 2). HDPE with long linear polymer chain and low branching led to high strength properties and thus required more time for decomposition [15]. The influence of retention time is obvious (Sample No:1 and No:2) because obtained yields differs for both experiments with the same initial mass of sample. As can be observed from Figure 2 and Table 1, the generation of higher yields of liquid products were obtained when longer retention time is used at 380°C and 410°C.The obtained yield is 73.95 % for samples with shorter retention time versus 81.38% for samples with longer retention time at aforementionedset degradation temperatures.

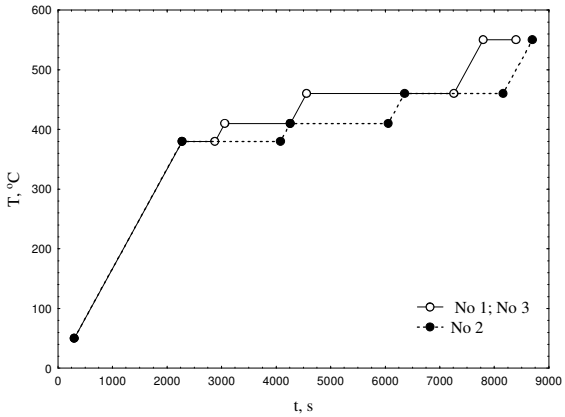

Fig. 2 Retention time as a function of temperature

The results of comparing the liquid product yields for samples with differential mass of waste mixture at same operating conditions (Table 1, samples No 1 and No 3) indicates that amount of raw material and free operating volume of reactor determinates the physical properties and the yields of obtained liquid products. The greater amount of initial sample improve the yield of liquid products because the free operating volume is smaller as well as retention time, so the large polymer molecules can't bereached of cracking to shorter molecules of gases (C1–C4). Secondary pyrolysis cracking occurs when residence time is long enough, which enhances the yield of gaseous product [16]. The production of volatile products starts to increase around 430°C. When the amount of gas products is large enough they, being let out to a system of condensers. The greatest amount of gaseous and condensed products are, form during the thermal degradation between 430 and 460°C. Because of a short retention time a big part of the liq-

uid yields are not fully cracked and were obtained waxy products. Samples with smaller initial mass have bigger contact area with the reactor surface space and higher retention time for cracking of a big polymers molecules. Also a free space is larger too, so the molecules have plenty of time to crack to the small gases molecules. Therefore the yield of liquid oil is 89.44% for sample with initial mass of 100 g versus 73.95% for sample with initial mass of 30 g. The obtained yields of liquid oil obtained with thermal pyrolysis for all experiments is high compared with literary data where the obtained yield is around 50% for thermal degradation of HDPE [17].

Physical properties of oil sample measured according specified ASTM test method are depicted in Table 2. The appearance of the oil is light brownish free from visible sediments. In the regulation for commercial diesels, the physical properties are very important. The quality of the liquid fuels and their properties from pyrolysis of plastics will vary with pyrolysis operation conditions, type of reactor and plastic feedstock [16].

Table 2

Physical properties of HDPE and PP pyrolytic oil

Sample No	Viscosity at 40°C mm^2/s	Density at 20°C g/cm^3	Aniline point °C	Index of refraction
1	1.0776	0.7704	60.8	1.4431
2	0.9973	0.7779	61.7	1.4404
3	waxy	0.8092	waxy	1.4435

It wasn't possible to measure the physical properties of sample No: 3, viscosity and aniline because the product is waxy. This indicates that aforementioned conclusions about the influence of operating conditions on obtained yield of liquid products are related with physical properties. The measured values for density show that obtained liquid fuel is in (first) diesel fraction – kerosene with density 0.78–0.81 g/cm^3. The aniline point for kerosene is in range of 60–69°C and index of refraction is 1.4408. All measured values confirm that obtained liquid fuel is diesel fuel – kerosene. The obtained results have proved that it is possible to control the yield and physical properties of the products by changing the operating conditions of de-polymerization reaction.

CONCLUSION

In the present investigation thermal pyrolysis of waste polyolefin mixture of HDPE and PP was performed in a semi-batch reactor made up of stainless steel at temperature range from 400°C to 550°C and at a heating rate of 10°C /min. The liquid yield is between 74 and 90%. The highly volatile products are obtained at temperature range 430–460°C. Obtained results show that amount of row material, free operating volume of reactor and correctly chosen temperature program (long enough retention time) improve the physical properties and the yields of obtained liquid products. All measured values confirm that obtained liquid fuel is diesel fuel – kerosene. The obtained results have proved that it is possible to control the yield and physical properties of the products by changing the operating conditions of depolymerization reaction.

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Original scientific paper

CHARACTERIZATION OF BIO-OIL OBTAINED WITH PYROLYSIS OF WHEAT STRAW

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A b s t r a c t: Recent few years due to the ecological problems with using fossil fuels there is increasing interest to find alternative and ecology friendly fuel. A good alternative which will partially substitute the fossil fuels is a bio-oil obtained from biomass. Pyrolysis is a thermo-chemical proceses of conversion the lignocellulosic materials to bio-oil, biochar and gas. Because the characteristic composition of bio-oil it can be use both as a fuel and as a feedstock for obtaining chemicals. Wheat straw is a biomass obtained from agriculture residue that could be used for conversion to bio-oil. In this paper, the composition of obtained bio-oil was analyzed using Fourier Transform Infrared Spectroscopy (FTIR) and the main constituents of bio-oil (water, alkanes, alkenes, alcohols, phenols and aromatics) were identified. The pyrolysis process was carried out in a semi-batch reactor and at optimized process conditions 52% bio-oil, 21% biochar and 27% gas were obtained.

Key words: bio-oil; wheat straw; Fourier Transform Infrared Spectroscopy; pyrolysis; semi-batch reactor

КАРАКТЕРИЗАЦИЈА НА БИО-МАСЛО ДОБИЕНО СО ПИРОЛИЗА НА ПЧЕНИЧНА СЛАМА

А п с т р а к т: Во последните неколку години, како резултат на еколошките проблеми со употребата на фосилните горива, постои зголемен интерес да се најде алтернативно и еколошки прифатливо гориво. Биомаслото добиено од биомаса претставува добра алтернатива како замена за фосилните горива. Пиролизата е термохемиски процес на конверзија на лигноцелулозните материјали до био-масло, био-јаглен и гас. Поради карактеристичниот состав на био-маслото, тоа може да се употребува како гориво и како суровина за добивање хемикалии. Сламата од пченица добиена како земјоделски остаток може да се употреби за конверзија до био-масло. Во овој труд е анализиран составот на био-масло добиено со користење на Фуриерова трансформирана инфрацрвена спектроскопија (FTIR) и идентификувани се неговите основни компоненти (вода, алкани, алкени, алкохоли, феноли и аромати). Процесот на пиролиза е изведуван во полушаржен реактор и при оптимизирани процесни услови се добиени 52% био-масло, 21% биој-аглен и 27% гас.

Клучни зборови: био-масло; пченична слама; Фуриерова трансформирана инфрацрвена; спектроскопија; пиролиза, полушаржен реактор

INTRODUCTION

Biomass is widely available energy source usually used as a domestic solid fuel. It is cost-effectiveness and renewable lignocellulose feedstock constitute from cellulose, hemicellulose and lignin. Every year tremendous amount of waste biomass comes from the agriculture residue which is not adequate used. Energy conversion of biomass is possible using three routes: combustion, gasification and pyrolysis. Process of pyrolysis is a thermo-chemical process conducted at high temperature, without oxygen and usually in presence of catalyst. Pyrolysis of biomass to liquid, solid and gas fuel is a promising process especially at this time when the fossil fuels are depleted. Also, there is an environmental problem with using fossil fuels due to the environmental pollution and global

climate changes. Wheat straw is a promising agriculture residue that can use as a feedstock in a lignocellulose biorefinery [1, 2]. During the process of pyrolysis bio-oil, bio-char and gas are obtained. Obtained bio-oil can be directly used or refined to safe fuel [3, 4]. Fuel properties of bio-oil are dependent by the oil constituents. The amounts of bio-oil constituents can be identified by Gas Chromatography and Mass Spectrometry [5] and Fourier Transform Infrared Spectroscopy (FTIR) [6].

EXPERIMENTAL

Materials and methods

Pyrolysis of wheat straw was carried out in inert atmosphere in a semi-batch reactor (volume of $0.4\ 10^{-3}$ m^3) in presence of commercial Al_2O_3 (BASF 92.7% Al_2O_3) and opalized silicate tuff (94.51% SiO_2) as catalysts. Heating rate varied from 5°C min^{-1} to 15°C min^{-1}, and temperature of the reactor was between 500 and 650°C. The composition of bio-oil was analyzed by Fourier Transform Infrared Spectroscopy.

Procedure

Air dried wheat straw material was finely chopped and putted into reactor together with mixed catalyst (ratio 1:1 biomass : Al_2O_3 and 1:1:1 biomass :Al_2O_3 : opalized silicate tuff) and heated at desired temperature. The process of pyrolysis was controlled using PID controller. Bio-oil was collected at three separators with constant temperatures (T_1 = 70°C, T_2 = T_3 = 0°C), than was filtered and analyzed.

RESULTS AND DISCUSSION

The wheat straw pyrolysis starts at 250°C to 290°C collecting bio-oil and water, than increase and intensification of pyrolysis process at 370 °C to 530 °C. At 550 °C process of pyrolysis finished. The biggest amount of bio-oil (52%) was obtained using both of catalysts, Al_2O_3 and opalized silicate tuff. Obtained bio-oil was dark brownish viscous liquid. Identification of functional groups of obtained bio-oil was carried out by FTIR spectroscopy (Figure 1). The biggest peak at 3354 cm^{-1} belongs to O–H vibrations of hydroxyl groups which and indicate the presence of alcohols, phenols, and water in the bio-oil. The second biggest peak with wave length 1639 cm^{-1} represents C=C stretching vibrations and presence of alkenes (methyl and methylene groups) and aromatics. The peak at 1383 cm^{-1} represents C–H stretching vibrations and belongs to alkanes between 1350 and 1470 cm^{-1} [6, 7].

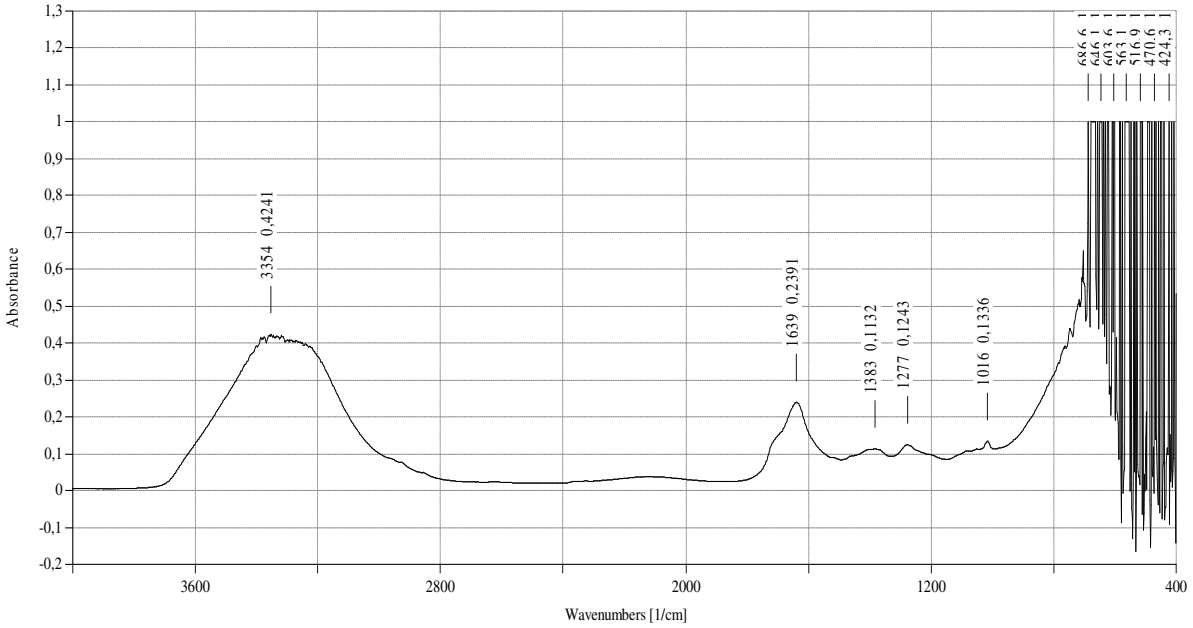

Fig. 1. FTIR spectral analysis for bio-oil obtained by pyrolysis of wheat straw

The standard test procedure for bio-oil quality was also conducted. Obtained results are depicted in Table 1.

Table 1

Density, d_{20} (kg m^{3})	Kinematic viscosity, v_{40} (mm^2 s^{1})	Refractive index, η	pH
1029,6	0,62452	1,6981	4

Wheat straw is a promising feedstock for bio-oil production. At optimal process conditions (heating rate 10°C min^{-1} and temperature 530°C) and combination of Al_2O_3 and opalized silicate tuff as catalysts the higher amount of bio-oil 52% was produced. FTIR spectroscopy is efficient rapid method for bio-oil components determination. The obtained bio-oil was with quality adequate for bio-oils obtained from pyrolysis of biomass with the presence of the main components of bio-oil: water, alkanes, alkenes, alcohols, phenols and aromatics.

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Original scientific paper

PROFESSIONAL DEVELOPMENT OF EMPLOYEES WOMAN-LEADERS IN FUNCTION FOR THE BUILDING OF COMPETENCIES FOR SOLVING THE BUSINESS CONFLICTS

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A b s t r a c t: This study is focused on women's leadership and the role of women in the process of resolving business conflicts by using alternative methods such as arbitration and mediation. In this sense, the policy of the companies to promote and support these processes through investments in professional development of staff is emphasized as a significant factor, particularly existing and potential women leaders in the field of women's leadership, mediation and arbitration. That will continuously create conditions for increased performance. Women's management style is built on the development of the individual-employee. Many studies show that women entrepreneurs and leaders, more than their male colleagues, support staff in their ambitions for further education, support teamwork, reduce hierarchy and strive for the quality of their offer to bein constant growth. Women spend more time on educating their employees, because they believe that it will allow greater competitive ability of the enterprise.

Key words: woman leader; business conflicts; alternative methods; arbitration; mediation

СТРУЧНО УСОВРШУВАЊЕ НА ВРАБОТЕНИТЕ ЖЕНИ-РАКОВОДИТЕЛИ ВО ФУНКЦИЈА НА ГРАДЕЊЕ КОМПЕТЕНЦИИ ЗА РЕШАВАЊЕ ДЕЛОВНИ КОНФЛИКТИ

А п с т р а к т: Во овој труд истражувањата се фокусирани на женското раководење и улогата на жената во процесите на решавање деловни конфликти преку примена на алтернативни методи – арбитража и медијација. Во таа смисла, како значаен фактор се потенцира политиката на друштвата да ги промовираат и поддржуваат овие процеси преку вложувања во професионалното усовршување на вработените, а особено на жените постојни и потенцијални раководители во делот на женското раководење, арбитража и медијација. На тој начин континуирано ќе се создаваат услови за зголемена ефикасност во работењето. Женскиот стил на раководење е изграден на развојот на поединецот – вработен. Истражувањата покажуваат дека жените претприемачи и раководител, многу повеќе од своите колеги мажи, ги поддржуваат вработените во нивните амбиции за дополнително образование, ја поддржуваат тимската работа, ја намалуваат хиерархијата и настојуваат квалитетот на нивната понуда да биде во постојан пораст. Жените трошат повеќе пари за школување на своите вработени, бидејќи веруваат дека тоа ќе овозможи поголема конкурентска способност на претпријатието.

Клучни зборови: жената раководител; деловни конфликти; алтернативни методи; арбитража; медијација

INTRODUCTION

In recent years the world has a tendency of exceptional increase in interest on leadership. Leadership or leaders are resource with the highest price since they successfully run businesses in any field to function successfully and achieve superior performance. That is the logical consequence resulting from growing changes in the environment, and therefore will not be wrong if we say that has

never been a greater need for the leaders as today. Leadership in modern organizations is bound to change.

Strong leadership begins with the manifesttation of the ability to form a group of individuals – who may have nothing in common – and will embrace the vision of themselfs as a team which can achieve above-average results. Today the Macedonian economy needs brave, innovative, expert and positive individuals and companies who will motivate and encourage women in Macedonia, with the aim of increasing participation in decision-making processes, working with people, care for their development and resolution conflict situations. The characteristics of the woman leader indicate that they can successfully cope with this challenge and in that the management should find understanding for adequate support whose forms are processed in this paper.

Certain studies have shown that mostly "common" qualities, as always nice and very understanding are feminine qualities, while mostly "organizational" qualities such as self-confidence and competitive spirit are qualities associated with men. These organizational features are considered crucial to successful leadership.

The paper developed two theses:

(1) investment organization specialized training in leadership, mediation and arbitration employees and existing and potential women leaders will create competencies to effectively solve business conflicts and adequate management in achieving organizational goals and objectives, and

(2) the impact of employee participation – existing and potential women leaders, training on leadership, mediation and arbitration directly on the reduction of business conflicts.

For this purpose, there are many studies who show how investment managers in specialized training and mentoring of existing and potential women leaders in the organization will result in efficient achievement of organizational goals and objectives. In addition, studies have focused on investment management in professional development and career advancement, or what level of employee participation, especially women and women leaders of these trainings on leadership, mediation and arbitration.

This paper is concentrated on a issue that is close to the public. Of great importance is the research which helps gathering information about the situation in the world and here in Macedonia, and the factors and barriers to greater involvement of women in leadership positions and tasks to solve business conflicts through alternative methods, such as arbitration which is presented in this paper and made a solid theoretical development of key terms related to the treated problem, and what is even more important and useful through the processing and analysis of the responses of the surveyed target groups – managers and staff, presented a certificate of advance and set these.

CONCEPT, MEANING AND CHARACTERISTICS OF LEADERSHIP

Leadership in the company is understood as a process of influence and inspiring employees to achieve common goals, by providing necessary power and freedom of employees to act in that direction.

Today it is considered that without true leadership, companies can achieve above-average performance – on the contrary, they would have stagnated at the level of mediocrity or would sunk to-below average. New technological change is significantly changing the way people work, such as communications of people inside the company and outside it, and change the relations in the sphere of competition. All these changes have a significant reflection on the leadership, the leadership of the companies.

For entrepreneurship are important leadership and vision, both for the individual and for the team. Entrepreneurs have a vision around which they try to gather other people and inspire them with their example, energy, dedication and determination. Leadership does not necessary mean that entrepreneurs have formal authority, especially when it comes to so-called corporate entrepreneurship, which is important for individuals to be motivated to solve problems that will recognize the opportunity, at the same time identifying the success of the firm in which they work.

Although the definitions of leadership differ among themselves, they include important elements that mutually bring them closer, as follows [11]:

- Leadership is process.
- With the leadership is accomplished influence.
- Leadership occurs in the context of a group.
- Leadership exists in terms of achieving the goal.

According to the same source, conducting (leading) is a set of processes aimed at attracting members of the organization work together to achieve the interests of the organization, which consists to the following four groups [11]:

- Activities aimed to motivate employees.
- Oriented activities for keeping employees.
- Activities of interpersonal relations, group behavior and conflicts within the organization.
- Communication activities.

Leadership is one of the key factors influencing the development of the company, whether it is about a business entity whose product or material goods is a company with a service activity. The dynamic development of society requires leaders with high performance and emphasized the ability of motivation and achievement of daily positive impact on effecting employees of the company.

The impact on others, the leader has achieved thanks to the characteristics that distinguish and which include love for the work and for people, honesty, self-confidence, know how, intelligence, confidence, adaptability, communication, objectivity, ability for team coordination, sanity, compliance and other real lasting value. This impact on the rest is the influence which the leader has achieved without coercion or influence employees in a manner that creates trust, respect and implementtation of effective actions aimed at achieving development all changes and achieving the established objectives.

The organization needs leaders who are able to lead the process of change, which is one step ahead of the others, who always bear in mind the long-term successful functioning (and not minor successes shortness of breath), with particular sense of adaptation and definite view that efforts to preserve the 'status quo` position is usually fatal in times of turbulent change.

This profile of an individual, no matter how capable, can independently achieve the result needed to associates / supporters / followers who will take their role, purpose and manner of unquestioned implementation of the plan of the leader and his intentions – the benefits could be achieved in favor of the enterprise, to ensure that they trust, who will be motivated to selfless and full commitment to work commitments and achieve planned objectives for a successful operation and development of the business entity.

"Leaders sometimes do not want to admit that their followers will always weigh the advantages and disadvantages of the change in terms of personal gain or personal loss, not from the standpoint of the organization" [8]. According to the same source, "People do not want to be managed. They want to be led".

Running is an impact, that it is the ability to get the title. However, keeping it defines as the ability to obtain a certain position.

According [9], there are four levels of vision in humans:

1. Some people never see (they are stray);
2. Some people see but never set out alone in its implementation (they are followers);
3. Some people see and set out in its implementation (they are successful);
4. Some people see it, they start bringing in and help others to see (they are the leaders).

The level of success of the leader have a decisive influence from those who are closest. Therefore, the most important lesson of leadership is developing staff [8].

The bright side of becoming a leader in work and private life is that you can practice the skills of influence and persuasion of others towards a common goal. They can promote the principles of outstanding teamwork values and objectives to determine their activities and conduct planned action. They can be improved by continuous assessment of their performance compared to its standards.

Successful leaders are recognized for their willingness and determination to go to change when necessary. The need to adapt to the new changes is key, so in contemporary literature [3] speaks of these approaches to leadership:

- transactional approach – marks leader that sets reasonable goals, effectively organize the work of followers and gives them all necessary assistance and resources that are necessary to achieve the objectives set,
- charismatic approach – marks leader who has the ability to motivate subordinates to accomplish the tasks above normal expectations,
- transformational approach – marks leader who is able to modify the tenets of subordinates in order to increase their commitment to the organization,
- interactive approach – a style characteristic of women. It is thought that women use different style of running than men. For men bound aggressiveness, initiative, hierarchy and competition, while the interactive leader prone to inspiration. Of course, many men also implement an interactive style.

Many experts argue that women entrepreneurs and leaders, more than their male colleagues, support employees in their ambitions for further education, support teamwork, reduce hierarchy and tend to the quality of their offer asin constant growth. Studies at Boston University showed that "women are more cooperative, informal, their leadership behavior build mutual understanding". In contrast, men tend to competitive leaders, formal and systematic management. In other words, women all their lives were also raised to feed and support others. This natural trait, along with hard work used in entrepreneurship also like in working with people: they support the ambitions of their collaborators.

CONFLICTS

The literature brings together a number of definitions of conflict. Some emphasize the behavior of the participants in the conflict, others concentrate on the sources of conflict, while others relate to the attitudes and feelings that arise in the conflict.

Definition that would unite all the important aspects of the conflict should indicate its three components [7]:

- sides of the conflict,
- conflict behavior, and
- conflict interests.

Each organization is bringing together people in order to achieve personal and common goals by working together. Each one has its own personality, and accordingly their own needs for personal, community, and social goals. Because there are no organizations without people, there is no organization without conflicts. In fact, conflicts are accompanying and inevitable occurrence of any organization. Conflicts arise from the contradiction of appearances. So contradiction is the hallmark of the outbreak, and the conflict is characteristic of the system or the organization. On the other hand, conflicts arise conflict, although there are conflicts which do not cause conflict.

Absence of contradictions means stagnation of ideas and phenomena. Absence of conflict means stagnation of the system. Absence of conflict means tolerating hazards.

The conflict is a social phenomenon and it can be: temporary, local, illusory, paltry, insignificant, admissible and inadmissible needed, necessary, constant, progressive, declining, conditions, impending, objective and subjective.

In issues of organization, the conflict is always a combination of several of its features. Therefore, the resolution of the conflict is a very complicated thing. The complexity of solving the complexed problems directs organizers using subjective and alternative methods (arbitration and mediation).

SAMPLE SURVEY, TECHNIQUES AND MEASURING INSTRUMENTS

The survey was conducted on a representative number of 130 respondents from the public and private sectors [10].

Target groups: managers (52 respondents) and employees (78 respondents).

The research used the following research techniques: surveys, interviews and content analysis.

Methods used in this research are as follows: Method of survey; Method of analysis and synthesis; Method of abstraction and concretization; Comparative method; Descriptive method.

Measuring instruments used in this research: A questionnaire (for each target group of respondents); Scale views.

RESULTS ANALYSIS

Thesis 1 treats the impact of the investment of the organization in specialized training and mentoring for leadership, mediation and arbitration for the employees and existing and potential women leaders to create competencies to effectively solve business conflicts and adequate management in achieving organizational goals and objectives.

According to the survey, attitudes of managers and employees in terms of the investment the organization in appropriate training is (independent variable) in Table 1 covers the issues or statements 1, 2, 3 employees and managers 1,2,3 the questionnaire.

The outline of a continuum for the independent variable is 2.820512821, indicating insufficient results and shows that employees and managers are still not sufficiently invested in training , it is a real reflection of the situation.

The dependent variable refers to the views of employees and managers about how training for professional development increases the competence of efficiency in operations. The dependent variable in the same table is presented with questions

or statements No. 4, 5, 6 for employees and 4, 5, 6 managers of the questionnaire. The line of the continuum is 3.83974359, that is the scale of values is seen as a good result (presented in Table 2 and Figure 1).

From the above it can be concluded that the independent and dependent variable on the scale of values ranging between 3 and 4, which means they have relatively overlap and provide adequate, good results which prove the thesis 1:

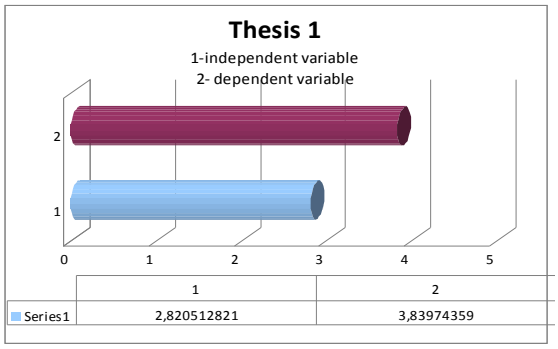

Fig. 1. Qualitative changes of the independent and dependent variable

Table 1

Questionnaire for managers and employees

No.	QUESTION / STATEMENT
1	Whether to effectively resolve disputes and conflicts, your organization employ alternate methods – arbitration and mediation?
2	Does your organization invests in specialized training and mentoring for leadership?
3	Does your organization invests in specialized training and mentoring for arbitration and mediation?
4	The application of alternative methods – arbitration and mediation results in efficiency of resolving disputes and conflicts, or in the effective realization of organizational goals and objectives.
5	Specialised training and mentoring for leadership competencies to increase efficiency in operations.
6	Specialised training and mentoring for arbitration and mediation increase the competence of efficiency in operation

Table.2

Qualitative analysis of hypothesis 1

Type of respondents	Question number	Yes	Sometimes	Not	Number of respondents	Yes×5	Sometimes×3	Not×1	Total	Points
1	2	3	4	5	6	7	8	9	10	11
Independent variable		Establishing criteria for the advancement of woment's leadership								
Employees	1	49	19	10	78	245	57	10	312	4
	2	14	19	46		70	57	45	172	2,20512821
	3	10	26	42		50	78	42	170	2,17948718
Managers	1	33	11	8	52	165	33	8	206	3,96153846
	2	9	14	29		45	42	29	116	2,23076923
	3	11	13	28		55	39	28	122	2,34615385
								A set of points:		16,9230729
								A set of points / number of questions:		2,82051285
Dependent variable		Effective management and operation								
Employees	4	42	23	13	78	210	69	13	292	3,74358974
	5	41	25	12		205	75	12	292	3,74358974
	6	50	16	12		250	48	12	310	3,97435897
Managers	4	32	12	8	52	160	36	8	204	3,92307692
	5	31	12	9		155	36	9	200	3,84615385
	6	30	13	9		150	39	9	198	3,80768231
								A set of points / number of questions:		23,0384615
								A set of points / number of questions:		3,83974359

Source: Mirjana Markovska, *Leader role of women in the process of resolving business conflicts by applying alternative methods,* Master thesis, Skopje, 2014,

The investment of the organization in specialized training and mentoring for leadership, mediation and arbitration employees and existing and potential women leaders will create competencies to effectively solve business conflicts and adequate management in achieving organizational goals and objectives.

Thesis 2 treats the participation of employees – current and potential women leaders, training on leadership, mediation and arbitration, and direct how it affects reduction of business conflicts.

According to the survey, attitudes of managers and employees regarding employee participation in training is in the field of leadership, mediation and arbitration (independent variable) in Table 3 covers the issues or propositions 7, 8 and 9 employees and 7, 8 and 9 managers of the questionnaire.

The outline of a continuum for the independent variable is 4.286324786, which means excellent results and shows that employees and managers have a high degree of employee participation – existing and potential women leaders, training on leadership, mediation and arbitration.

The dependent variable refers to the views of employees and managers about how participation in training resulting in reduced business conflicts and effectively address the current.

The dependent variable in the same table is presented with questions or propositions 10, 11 and 12 for employees and 10, 11 and 12 for the managers of the questionnaire. The line of the continuum is 3.155982906, or in the scale of values is seen as a good result (presented in Table 4 and Figure 2.) the independent and dependent variable on the scale of values ranging between 3 and 4, which means they have relatively marked overlap and give good or excellent results which prove the thesis 2.

Participation of employees – current and potential women leaders, in training on leadership, mediation and arbitration, will directly affect the reduction of business conflicts, and effectively address the current by applying alternative methods – arbitration and mediation.

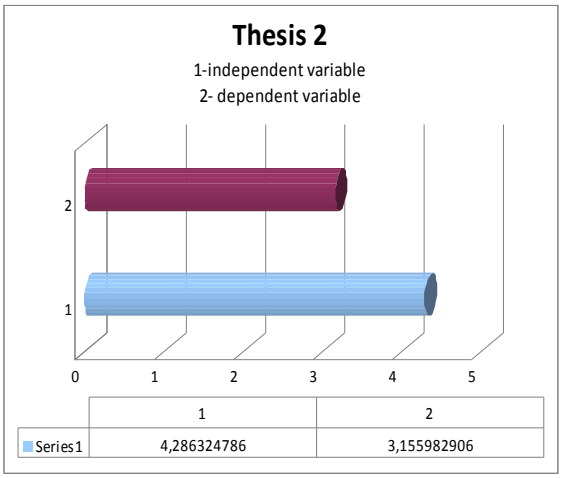

Fig. 2. Qualitative changes of the independent and dependent variable

Table 3

Questionnaire for managers and employees

No.	QUESTION / STATEMENT
7	Do you think that the share of training of employees, i.e. existing and potential women leaders, the basic principles of leadership, to increase their capacities?
8	Do you think that the share of training of employees, i.e. existing and potential women leaders, mediation and basic principles of arbitration and mediation will increase their competences?
9	Do you think that training for mediation are useful in relations / disputes and conflicts between workers and employers?
10	Training for professional development of women will contribute them to increase their capacity for career advancement.
11	Judiciary, mediation and arbitration are complementary.
12	Mediation training will increase the competences of the participants in the reduction of business conflicts and effectively address the current.

Source: Mirjana Markovska, *Leader role of women in the process of resolving business conflicts by applying alternative methods*, Master Thesis, Skopje, 2014.

Table 4

Qualitative analysis of hypothesis 2

Type of respondents	Question number	Yes	Sometimes	Not	Number of respondents	Yes×5	Sometimes×3	Not×1	Total	Points
1	2	3	4	5	6	7	8	9	10	11
Independent variable					Establishing criteria for the advancement of woment's leadership					
Employees	7	48	20	10	78	240	80	10	310	3,97435897
	8	51	19	8		255	57	8	320	4.1025641
	9	63	10	5		315	30	5	350	4,48717949
Managers	7	40	7	5	52	200	21	5	226	4,34615385
	8	39	8	5		195	24	5	224	4,30769231
	9	63	5	4		215	15	4	234	4,5
								A set of points :		25,7179487
								A set of points / number of questions:		4,28632479
Dependent variable					Effective management and operation					
Employees	10	62	15	1	78	310	45	1	356	4.56410256
	11	17	50	11		85	150	11	246	3,15384615
	12	57	14	7		285	42	7	334	4,28205128
Managers	10	45	5	2	52	225	15	2	242	4,65384615
	11	7	38	7		35	114	7	156	3
	12	30	14	8		150	42	8	200	384611585
								A set of points / number of questions:		23,5
								A set of points / number of questions:		3,91666667

Source: Mirjana Markovska, *Leader role of women in the process of resolving business conflicts by applying alternative methods,* Master Thesis, Skopje, 2014,

CONCLUSION

Any company, to create the conditions for increasing the efficiency of operations, should be continuously practiced building and strengthening leadership capacities as a policy to solve business conflicts by applying alternative methods – arbitration and mediation.

Survey focused primarily on the role of a woman leader in the process of resolving business conflicts using alternative methods of arbitration and mediation. The survey was conducted in 24 public and private companies, which surveyed 52 leaders and 78 employees. The research showed:

- For the effective resolution of business disputes and conflicts should no longer apply alternative procedures – arbitration and mediation.
- Need to increase the involvement of women leader in the process of resolving business conflicts of internal and external level.
- Necessary greater involvement of the woman leader as a decision maker, or its participation in the work of the management companies.
- Continuously working to strengthen women's leadership.
- Leadership is a key factor in the development of the company.
- The dynamic development of society requires leaders with high performance and a pronounced ability to motivate and effecting employees of the company.
- Requires motivated and satisfied employees as a basic prerequisite for efficient operations.
- Continuously investing in appropriate training and mentoring women in leadership, arbitration and mediation.
- Need to strengthen the efficiency of networking among Macedonian women – business leaders.
- It is necessary sharing and use of foreign experience to overcome the social barriers to the development of women's leadership.
- It is necessary to motivate women and their focusing on positive examples for strengthening the capacities of women's leadership in the Republic of Macedonia.

- Organizing educational events through which individual will learn about the experiences of professionally accomplished and successful people – who will share their experiences, difficulties, ways of bridging.
- Should be the role of women in the business, or developing the potential of women as leaders.
- Strengthening the capacity of women with a set of specific skills that will bring an even higher level in the business community or business that stretch.
- Business networking through the development and expansion of businesses, new contacts, connections, lobbying and support for the growth of an entrepreneurial spirit.
- Increasing the number of women decision makers, and to improve the position of women entrepreneurs in the company hierarchy.
- Increasing the impact and the willingness of businesses to practical actions in favor of the development of women's leadership.

The findings from the survey show the importance of investment and support for companies in the professional development and career advancement of employees, especially working women, then they will be proactive to operate effectively and solve business conflicts. In that sense, today, a growing aspect is placed on employee participation in training for professional development and career advancement will create conditions for building leadership capacity and skills to solve business conflicts by applying alternative methods – Arbitration and Mediation or effective achievement of organizational goals and objectives.

New technological changes significantly change the way people work, communications of people inside the company and outside it, and change the relations in the sphere of competition. All these changes have a significant reflection on the leadership or the leadership of the companies. Today it is considered that without true leadership, companies can achieve above-average performance – on the contrary, they would have stagnated at the level of mediocrity or would sinking to below average. A mid the turbulent changes of each organization needs leaders who are able to lead the process of change.

In times of transition and democracy, women entrepreneurs are an important force increasing, although their overall role in business and public policy arenas is often difficult because of lack of understanding, legal obstacles and the traditional role of birth. However, the future of the modern woman is entrepreneurship, i.e. the possibility to choose its economic independence, the establishment of a private enterprise – separate. Thus, it is the woman entrepreneur is one of the generators of successful family businesses and new jobs.

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Original scientific paper

INFLUENCE OF THE COOPERATION BETWEEN THE FRANCHISOR AND THE FRANCHISEE ON FRANCHISING BUSINESS SYSTEMS IMPLEMENTATION AND DEVELOPMENT IN THE REPUBLIC OF MACEDONIA

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A b s t r a c t: Good business cooperation with the franchisor is the most crucial element for a successful implementation of the franchising system and realization of successful performance. Without this cooperation, the success is brought into question. Constant cooperation and support by the franchisor implies a complex package of interrelated services with the aim to help the successful business management and profit realization. The goal of the cooperation is to decrease the possibilities of failure, to provide successful targets and to avoid the mistakes characteristic when starting up a business via realizing efficient business relations. Advantages from working with this business model, from the viewpoint of the provider of the franchise – the franchisor, and especially its user – the franchisee, shall provide determination of the basic directions of how an entrepreneur could start a small business with a franchised business model. The potential franchisor can make a right decision to start his business with a franchise, and especially later for the business development, if he had previously analyzed and arranged the business relations that are to be established and built between the franchisor and the franchisee. The research which had been conducted through surveying and interviewing of around 30 franchisees in the Republic of Macedonia had for its goal to scan the real situation of the cooperation between the franchisor and the franchisee.

Key words: franchise; cooperation; small business; franchisor; franchisee

ВЛИЈАНИЕ НА СОРАБОТКАТА МЕЃУ ФРАНШИЗЕРОТ И ФРАНШИЗАНТОТ ВРЗ ИМПЛЕМЕНТАЦИЈАТА И РАЗВОЈ НА ФРАНШИЗНИТЕ БИЗНИС-СИСТЕМИ ВО РЕПУБЛИКА МАКЕДОНИЈА

А п с т р а к т: Добрата бизнис соработка со франшизерот е најбитен елемент за успешно имплементирање на франшизниот систем и остварување на успешно работење,. Без оваа соработка, успехот е доведен во прашање. Постојаната соработка и поддршка од франшизерот подразбира сложен пакет меѓусебно поврзани услуги со цел да се помогне во успешно водење на бизнисот и остварување профит. Целта на соработката е низ остварување ефикасни бизнис релации да се намалат шансите за неуспех, да се овозможи успешност на целите и избегнување на грешките карактеристични при почнување на бизнис. Предноста од работењето со овој модел на бизнис, од гледна точка давател на франшизата (франшизер) и, особено, корисник на франшизата (франшизант), е детерминирањето на основните насоки како еден претприемач да започне мал бизнис со франшизен модел. Потенцијалниот франшизант може да донесе правилна одлука за почеток на својот бизнис со франшиза, а особено подоцна и за развојот на бизнисот, доколку ги има анализирано и подоцна договорено бизнис-релациите кои се воспоставуваат и градат постојано меѓу франшизерот и франшизантот. Истражувањето кое беше спроведено преку анкетирање и интервјуирање на триесет франшизанти во Република Македонија имаше за цел да ја слика реалната состојба на соработката помеѓу франшизантот и франшизерот.

Клучни зборови: франшиза, соработка, мал бизнис, фрашизер, франшизант

1. INTRODUCTION

One of the basic advantages of the franchise as a business model is providing an application of previously developed business plan which has been developed through practice. This business plan is operational and is already profitable. The franchising system which had developed this business plan, conditionally had had pulled through all obstacles related to starting up and managing a business. This business system learnt from its mistakes, found the answers, solved the problems and marked a continuous upgrade. Now, all the knowledge and know-how experience is becoming part of the franchising package and provides the small business to lower its learning line and start up its business from an advanced starting point. This starting position saves time while making a profit.

In a technical sense, the small business gets an operative manual with a detailed activities' plan which in great degree covers the part of the everyday business performance.

2. REQUIRED INFORMATION FOR COOPERATION

When an entrepreneur finds a franchise, which he would like to work with, he gets in contact with the franchisor-owner of the specific franchise that he has interest in and starts the negotiations of the franchised business. The first contacts are actually information exchange between contractors.

When the franchisor gets a request from an entrepreneur for the franchise, he would like to have the following information from the potential franchisee:

- If the requestor has had an experience with the same or similar business;
- Which are the motives for requesting a franchise and if the requestor is informed of the method of franchising performance;
- If the requestor finds this a long-term investment or he expects a fast return of the capital;
- Questions about the readiness for further education and trainings;
- If the requestor is an enthusiast and capable to bring a success for the franchisor invests in the entrepreneur by giving the franchise;
- Information on the financial condition of the requestor, as well the whole family;
- Preview of a bank statement in order to check the financial condition;
- References from bank institutions;
- If he is a member of a franchising organization and on which level.

The potential franchisee shall request some information and data on the franchising system which he is interested in, such as:

- The franchising system, that is the constant franchising units and information on their performance;
- Insight in the contract which is to be signed.

3. SUPPORT FROM THE FRANCHISOR

Constant support which the small business gets before, during and after the business startup relates to a complex package of interrelated business services whose aim is to provide successful management of the new business and realizing profit with the bought franchising model [1].

The constant support includes basic and advanced training, constant promotion and improving the product's quality, consulting system (daily and monthly meetings with franchisor's experts), research and development, marketing and sales, accounting systems, financial support, etc.

The type of support is greatly related to the phase in which the small business is in, that is the amount of its development. In the beginning, support is often being connected to providing training (for the product), business system, marketing and establishing an accounting system. While the small business grows and develops, the support focus is changing too. In the later phase of the small business development, the franchise provides support in the employees' training, promotion of the accounting system, cooperation and netting with other franchisees for realizing the general purposes of the franchise and experience exchange.

Most common forms of support known by the contemporary franchise are the following: training, marketing and sales, brand development, purchasing power – favorable supply, easier access to finance.

4. ADVANTAGES AND DISADVANTAGES FROM FRANCHISOR'S POINT

The advantages which the franchisor gets by putting a concession on his franchised business model to the franchisee are actually the main driving force of the franchisor. These advantages could

be very significant and could generate disposable economical advantage for the franchisor. Those are the following:

Using foreign capital. For the franchise uses his own capital for starting up a business, the franchisor has no expenses to the level of franchising unit. This enables him to efficiently use the funds and their real location for other business activities [2].

Investment return. Relatively low level of investment per franchise shall enable the franchisor to have a high and fast return of investment.

Low risk. Using foreign capital greatly reduces the risk in franchisor's performance for in case of bad management of the franchising unit, franchisee's invested capital is in direct risk.

Limited/decreased responsibility. Technical specifications around the organization of the franchising unit are in franchisee's responsibility and authority. It means that franchisor's responsibility in that part of business is limited. The franchisee primarily maintains the high profitable performances of the franchisor and he is not included in the daily operational activities around managing the franchising unit. This business model enables the franchisor to be excluded in eventual problems and conflicts related to human resources management.

Greater growth. Using franchisee's time and spent efforts, the franchisor could increase the speed of his growth without employing new people and engaging additional workforce.

Improved performances of the franchising unit and quality control. As practice has shown, in the beginning franchisees are preoccupied with the operative condition of the franchising units much more than franchisor's employed managers. The basic reason for this is the sense of ownership of business over the franchising unit, and not only administrative business management.

Management consistency. As a result of the constant investment in the franchisee's and other employers' training, one could get a management to a higher level of consistency due to the feeling of ownership which prevails at the franchisor.

Efficient brand building. Due to low incomes in the area of development of franchising units, the franchisor finds it much easier to spread, develop and strengthen the brand. Market representativeness is increased (for example, retailing) and positioning of the brand is much easier.

Advertising. The franchisor shall get support and contribution regarding advertising by the franchisee. Of course, these local campaigns are created, managed and controlled by the franchisor.

Internationalization. The franchisee, as a local partner, with his knowledge of economics, law, social, political and other conditions, shall provide easier risk management of internationalization and easier adjustment of the franchisor to the local working conditions.

The basic disadvantage for the franchisor is the constant possibility of incorrect review of the business capacity of the future franchisee in realizing the contracted conditions. However, it could be the case that despite the thorough evaluation of the franchisee that he cannot realize the required working standards.

This could produce the so-called "domino effect" and to develop a new disadvantage for the franchisor. This disadvantage for the franchisor, which stems from the direct relation of the franchisor to the franchisee, is a reflection of the franchisee's bad management on the franchisor's management. The franchisor also has disadvantages in the area of franchisee's performance control [3]. The franchisee always has a certain independence (related to the need of initiative and creativity) in his performance which is not controlled by the franchisor. The franchisee could take actions that are not in accordance with the franchising brand and which "destroy" the business reputation of the franchisor.

5. METHODOLOGY

The subject of this paper is the analysis of the importance that cooperation between franchisor and franchisee has.

The problem of the research is:

- Insufficient representativeness of franchise as a method to establish a new business or to develop already-established business, and
- Low level of successfully organized access to information for potential buyers of the franchise (franchisees) about the available companies – franchise sellers (franchisors), information on establishing contacts and a method of starting up a business.

Research sample, techniques and measurement instruments

The research included 30 franchising systems from all over the country and their owners were surveyed.

Target groups: managers and employees.

The methods used for this research are the following: Survey Method; Method of Analysis and Synthesis; Method of Abstraction and Concretization; Comparative Method; Descriptive Method.

Measurement instruments used in this research are: survey questionnaires (for each target group of respondents); views scale.

6. RESULTS

The questionnaire consisted of 25 questions. The following text highlights the results from the answers in the questionnaire.

In the Republic of Macedonia there is a high level of attraction of the franchise as a business model for starting up a small business. The surveyed respondents, 70%, think that the franchised business model is quite attractive for starting a new business, and only 10% consider it as an unattractive model (Figure 1).

The greater part of the surveyed franchisees were entrepreneurs when they had made the decision of using this business model and who recognized the franchise advantages [1].

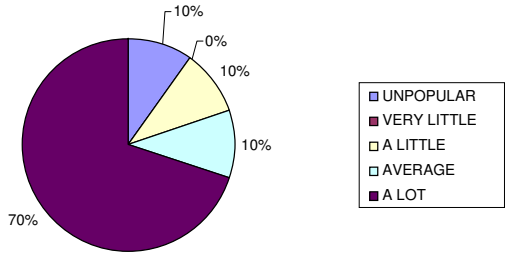

Fig. 1. Popularity of the franchise in the Republic of Macedonia.

Especially indicative are the results about finding ways to the working information required for making this decision (Figure 2). Of the respondents, 73% found the needed information for potential franchises in the foreign business areas. They had already used their already-established business relations with foreign partners and these contacts often arise from long-term relations with foreign business partners. This method of finding information is quite useful for it increased the security level due to knowing the information source.

Anyway, 20% of respondents got information via direct offers from franchisors, but yet the established foreign business contacts had their part here. The others 7% of the respondents got the required information through researching various media with the purpose to find a franchise which they are interested in.

Analyzing the results one could conclude that in the Republic of Macedonia there is no established information system on franchising as a possibility for starting up a business.

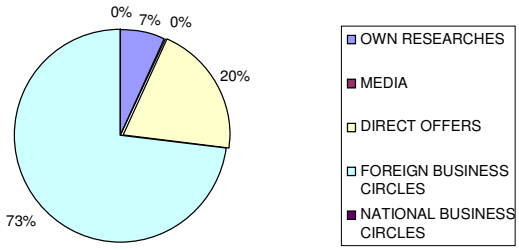

Fig. 2. Information sources on franchise

Finding information greatly depends on the business profile of the franchisee-to-be, i.e. if and to what degree is it involved in the export-import transactions and if and what kind of relations does it have with foreign partners. We would add that according the franchisees, in the Republic of Macedonia there is no official franchising union, nor is there some sort of association which would provide information exchange between the interested potential national franchisees and foreign franchisees.

Figure 3 represents the determination of motives for starting a franchising business. The greatest percent, 87%, of the surveyed franchisees highlighted the expansion of the already-established business as a main motive to start this franchised business. This leads to the conclusion that these are already experienced entrepreneurs who have their mind on this sort of business model because they can recognize the franchise's advantages.

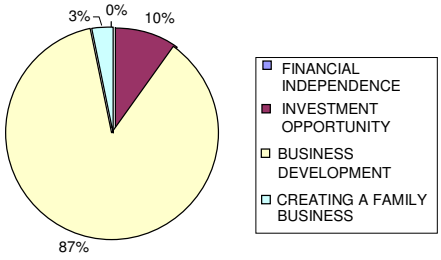

Fig. 3. Reason for starting a business

This conclusion is even more reliable if one adds the results that neither one of the respondents

had started his business with a franchise due to the financial independence or unemployment. 10% of respondents started their business as an investment opportunity, and only 3% of them see the franchised business model as a chance for opening a family business.

Figure 4 presents the data related to the quality of support that the franchisee gets from the franchisor. A general conclusion of 63% of respondents is that the support they get from the franchisor is very good. 27% claimed that the support was good, and 3% said that it was satisfactory. 7% of the surveyed franchisees think that the support was unsatisfactorily which still being considered as somehow tolerable percent. One can notice that the percent of not getting any support is 0, which is totally understandable having in mind that support is one of the basic elements and advantages of franchising.

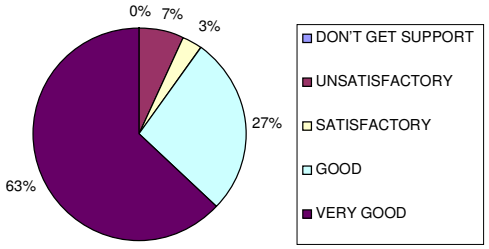

Fig. 4. Franchisor's support

In close relation with the previous data are the data presented in Figure 5 that imply on training as a kind of support. From the surveyed respondents, 71% pointed out that the support in the training area was very good, 13% of them said that the support in this area wasn't good, and another 13% of the respondents clarified that the support is unsatisfactory. Quite symptomatic is that 3% of the surveyed franchisees stated that they are not getting any kind of support in the areas of training and practice, which is completely contrary to the concept of the franchise.

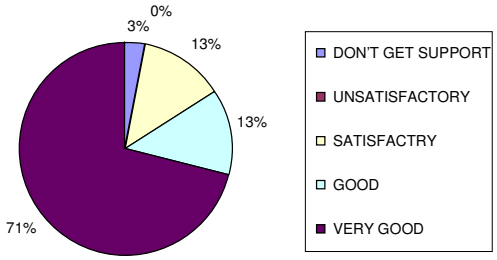

Fig. 5. Support in the area of training and practice

To the question how one could describe the support by the franchisor in the management area, 50% of the respondents answered that it was on satisfactorily level, 16% thought that it was good, 20% were very satisfied, as for the rest 14% they said that they are not satisfied (Figure 6).

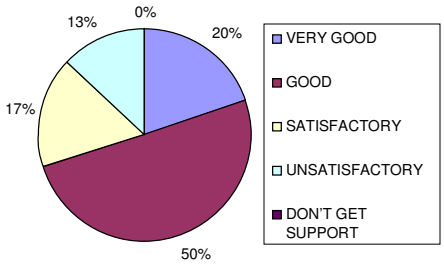

Fig. 6. Support in the management area.

One could conclude that franchisor's support in the management area is on satisfactory level but also, part of the respondents are not satisfied due to the difficult access and the strict procedures by the franchisor [5].

Results to the answers regarding support of the franchisor in the business development lead to a data that 83% of the answers belong to the answers group: very good, good and satisfying, which implies that the franchisor supports the franchised business (Figure 7).

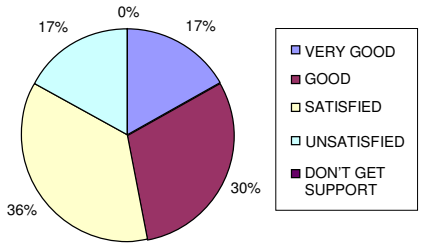

Fig. 7. Support in business development

7. CONCLUSION

Franchising as a business concept, although it is relatively new in these areas, it is not new to the world; on the contrary, it is quite often being used by companies as a strategy for business development, more precisely for the so-called non-capital expansion on the one hand, and it is being used by lots of entrepreneurs and young companies as a way of opening a business on the basis of already proven and successful concept on the other hand.

Franchise as a term in economy practice marks the tremendous development of time and geographical perspective.

With the appearance of globalization and the need for expansion outside the local markets, companies use this business format for expansion of their businesses in a relatively easy way without having to invest much finances, and they mainly use their knowledge and experience when it comes to internationalization and the knowledge of their local partners.

On the other hand, increasing number of entrepreneurs want to start their own business, and conditionally speaking, they have enough real resources and finances, but do not have knowledge and experience, identify franchise as an opportunity for opening their own business with objectively decreased risk of failure due to the support by the franchisor and using his know-how and his successful business concept.

When all the relevant data are ready and elaborated, the following step is preparing an action strategy and making contacts with the franchisor in order to define the contracting conditions regarding taking the franchise. This area too requires exceptional alertness. Lots of laws, especially when it comes to international franchises, do not arrange franchising as a separate area. The most typical form it takes is a classical obligatory relation or contracts are based on more legal provisions from different laws. Therefore, one needs an expert help about negotiating a contract and precise determination of the rights and obligations of the contracted parties in order to create conditions for a successful business.

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Original scientific paper

DIGITAL MARKETING – TOOL FOR EXTENDING PRODUCT LIFECYCLE

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A b s t r a c t: The development of new technologies constantly brings changes in the performance of companies. Product Lifecycle Management implies monitoring of market dynamics and quick adjustments of strategies to achieve their goal. Digital technology brings new features to the marketing concept and a completely different approach to the market. The goal of every brand is to gain market growth and extend the product lifecycle. Knowledge of social media enables companies to create digital marketing campaigns that will strengthen customer relationships. Social media are powerful analysis tools that can track marketing campaign results, customers' needs and competition performance. This allows for the creation of marketing tactics, which in turn makes the marketing strategy subject to change. Digital marketing requires an innovative and continuous approach by the companies to attract and retain customers. Customer loyalty is the key in achieving competitive advantage and long-term customer relationships means extending product lifecycle.

Key words: new technologies; management; lifecycle; product; strategies; brand; social media; market; digital marketing; customers

ДИГИТАЛЕН МАРКЕТИНГ – АЛАТКА ЗА ПРОДОЛЖУВАЊЕ НА ЖИВОТНИОТ ЦИКЛУС НА ПРОИЗВОДИТЕ

А п с т р а к т: Развојот на новите технологии постојано внесува промени во работата на компаниите. Менаџментот на животниот циклус на производите подразбира следење на динамиката на пазарот и брзо приспособување на стратегиите за остварување на нивните цели. Со дигиталната технологија, маркетинг-концепцијата добива нови функции и еден сосема поинаков пристап на пазарот. Целта на секој бренд е да остварува раст на пазарот и да го продолжи животниот циклус на производи. Познавањето на социјалните медиуми им овозможува на компаниите да создадат дигитални маркетинг-кампањи, со што ќе го зацврстат односот со купувачите. Социјалните медиуми наедно се и алатки за анализа со која се следат резултатите од маркетиншките кампањи, барањата на купувачите и настапот на конкуренцијата. На тој начин се согледуваат следните маркетиншки тактики кои треба да се преземат, со што маркетинг-стратегијата ќе подлежи на промени. Дигиталниот маркетинг налага иновативен и континуиран пристап на компаниите за привлекување и задржување на своите купувачи. Лојалноста на купувачите е клучна за остварување конкурентска предност, а долгорочните односи со купувачите подразбираат продолжување на животниот циклус на производите.

Клучни зборови: нови технологии; менаџмент; животен циклус; производ, стратегии; бренд; социјални медиуми; пазар; дигитален маркетинг; купувачи

INTRODUCTION

With digital marketing, traditional media are replaced by social media. The marketing function is changed – from the process that has certain duration, becomes a continuous process whose effects reflect on the product lifecycle. Digital marketing allows companies to interact with customers on a daily basis and long-term communication strategy contributes to long-term use of the product. The purpose of this paper is to show the role of digital marketing in the product lifecycle and to show its influence as a tool for extending product lifecycle.

THE DEFINITION OF DIGITAL MARKETING

Digital marketing [1] is an umbrella term for the marketing of products or services using digital technologies, mainly on the Internet, but also including mobile phones, display advertising, and any other digital medium.

Digital marketing activities are search engine optimization (SEO), search engine marketing (SEM), content marketing, influencer marketing, content automation, campaign marketing, and e-commerce marketing, social media marketing, social media optimization, e-mail direct marketing, display advertising, e–books, optical disks and games, and any other form of digital media. It also extends to non-Internet channels that provide digital media, such as mobile phones (SMS and MMS), callback and on-hold mobile ring tones.

Digital marketing with social media

Social media are Internet tools by which people and companies create, share and exchange information, photos and videos in virtual communities. Unlike other digital activities where approach to customers is limited, social media enables companies to keep constant communication through the user's profile and establish strong customer relationships that lead to brand loyalty.

The research of GlobalWebIndex [2] published in January 2015 shows the twenty most used social networks in the world where the top five are Facebook, YouTube, Twitter, Google + and Instagram. Acording to eMarketer [3], by 2017 when US digital display ad expenditure will reach $37.36 billion, Facebook and Twitter together will account for 33.7% of the market. *Young people* across the *world's largest advertising markets will spend more time accessing* the *Internet via* mobile *than via* all *other devices.* This is the key finding from a new global insight study into changes in mobile behavior conducted by Zenith Optimedia and Global WebIndex. [4]

In the study entitled *The Mobile Imperative*, presented at dmexco 2015, Zenith Optimedia and GWI found that across all 34 markets surveyed, 41% of Mobile First users – defined as those with 90% internet access via mobile handsets – are from the 16–24 age group. A further 31% of Mobile First users are aged between 25 and 34. Mobile First users spend a significantly large amount of time on the mobile web, on average 3.59 hours per day, and 23% said they had bought a product via mobile in the last month. The most popular mobile web activity for Mobile First users is using a social networking service, coming in at 44%. This is closely followed by checking the weather (38%) and watching an online video (22%) – which has significant implications for marketers investing in content programs.

In Macedonia, 1,281,000 citizens use the Internet or 61.2% of the total population, the data published by the specialized statistical website Internet World Stat show [5]. An account on Facebook social network have 963 000 Macedonians. There are between 7000 and 10000 Twitter users of which 70% are using it as a source of news and information according to research agency Rating [6] and there are 120 000 Instagram users [7].

Internet divided media into old/ traditional media (television, radio and print media) and new media (digital devices – desktop computer, laptop, smart phone and tablet). One of the ways in which the Internet has become so central to contemporary media is trough the way in which its symbiotic relationship with media culture has offered audiences participatory opportunities [8]. This is the key element of digital marketing with social media were customers are included in many aspects of the marketing campaign trough interactions.

BENEFITS OF SOCIAL MEDIA MARKETING

In the 7th annual study Social Media Examiner 2015 [9] more than 3700 marketers provided insight for benefits of social media (Figure 1). Most participants (52%) are from United States, followed by United Kingdom (9%), Canada (6%) and Australia (5%). The top two benefits of social media marketing are increasing exposure and increasing traffic. A significant 90% of all marketers indicated that their social media efforts have generated more exposure for their businesses. Increasing traffic was the second major benefit, with 77% reporting positive results. Most marketers are using social media to develop loyal fans (69%) and gain marketplace intelligence (68%). More than half of marketers who've been using social media for at least 2 years report it helped them improve sales. More than half who spend 6 or more hours per week find the same results and 73% of those who spend 40+ hours per week earn new business through their efforts.

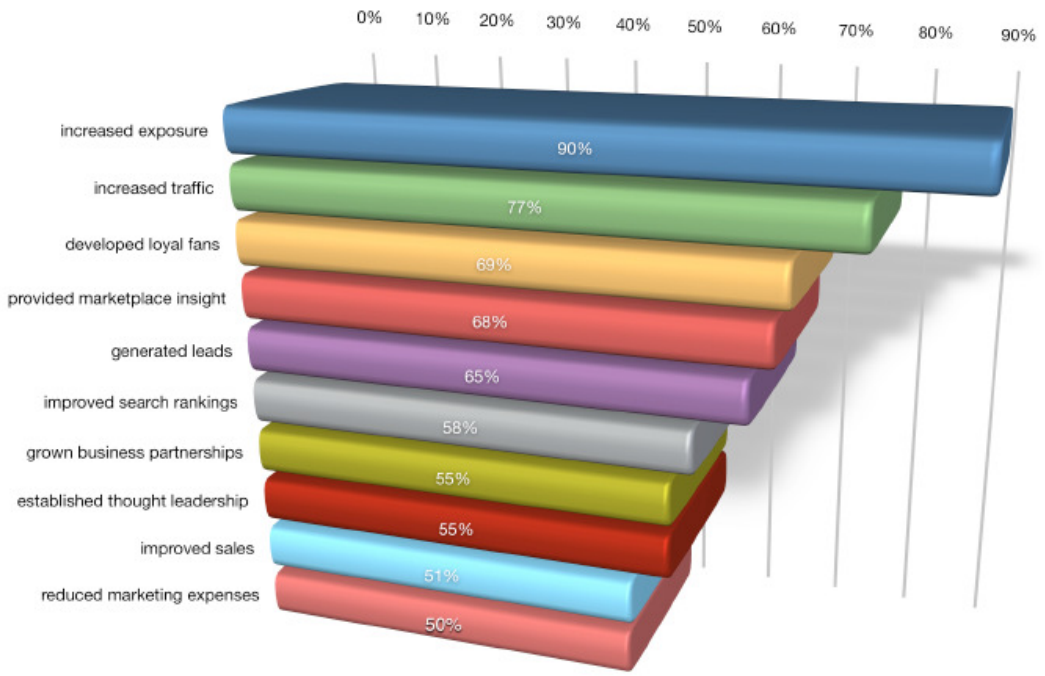

Fig. 1. Benefits of Social Media marketing

More than half of marketers who've invested at least 2 years in social media marketing report that new partnerships were gained. More than half of those investing as little as 6 hours per week in social media were able to build new partnerships. By spending as little as 6 hours per week, 66%+ of marketers see lead generation benefits with social media. More than half of those who spend at least 6 hours per week on social media efforts saw a benefit of reduced marketing expenses. Improved search engine rankings were most prevalent among those who've been using social media for one year or longer, with 54%+ reporting a rise. Improved search engine rankings were most prevalent among those who've been using social media for one year or longer, with 54%+ reporting a rise. At least 61% of those investing a minimum of 6 hours per week in social media marketing saw improvements in search engine rankings. More than half of marketers who have been using social media for 2 or more years (57%+) have been able to establish thought leadership. Most marketers (56%+) gained thought leadership with at least 6 hours per week.

DEVELOPMENT PROCESS OF INTEGRATED MARKETING CAMPAIGN

Integrated marketing campaign is the best way for attracting and retaining customers. It involves constant use of offline and online activities and it is equally important at each lifecycle stage.

Integrated marketing [10] is a marketing strategy that stresses the importance of a consistent, seamless, multi-dimensional brand experience for the consumer. This means that each branding effort – across television, radio, print, Internet, and in person – is presented in a similar style that reinforces the brand's ultimate message.

On Figure 2 development process of integrated marketing campaign has been presented.

Depending of the product lifecycle stage, company develops the marketing strategy:

1. In the Client Services Department, a client meets account and he sets demand with defined time frame and budget. The account makes market research and defines a strategic plan which is used as a basis for the marketing campaign. Some marketing agencies have Strategic Planning Department where this kind of research is made by the strategic planner. The research is completed by Media Department which submits data of product media coverage and data of competitors' performance.

2. Based on the research, the account creates brief that is delivered to Creative Department. The brief consists of: client's data; campaign goal; target group; customer profile; competitors' data; request of elements for the campaign and timeframe.

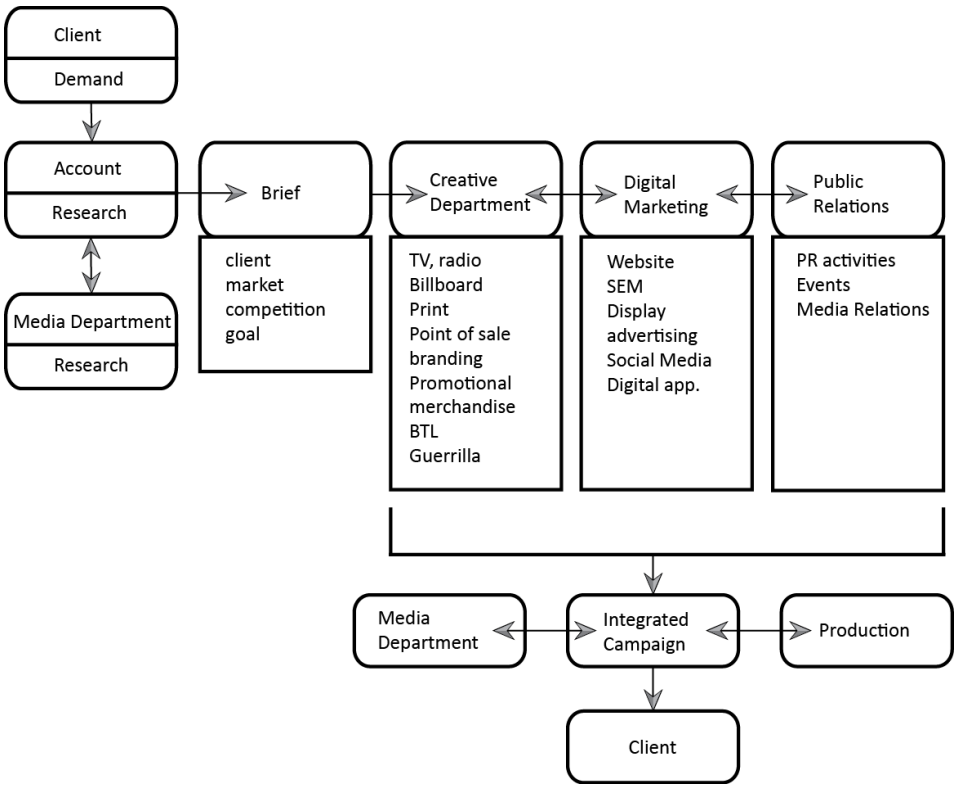

Fig. 2. Development process of integrated marketing campaign

3. Creative Department develops creative concepts. Concept developer and copywriter suggest 2–3 concepts that are visually defined by the Art Director and Creative Director and executed by graphic designers. A creative concept consists of: screenplay and storyboard for TV commercial; screenplay for radio commercial; billboards and print solutions; point of sale solutions; promotional merchandise materials; BTL and guerrilla activities. All activities through marketing departments are coordinated by the account that controls whether a marketing campaign is developing according to the strategic plan.

4. Based on the creative concepts, Public Relations and Digital Marketing departments submit proposals for PR activities and digital marketing strategy. PR activities include: PR content for print and digital media; organizing and sponsoring events; various promotional materials and activities etc. Digital marketing strategy consists of creating website and maintenance; search engine marketing; display advertising; social media and digital applications.

5. Before final concepts are sent to the client, they are revised by Production and Media Department. Media Department makes media plan for media displaying and Production Department revise the elements of the campaign if they are according to budget.

6. The final solution of the integrated marketing campaign is delivered to the client. If the client has requirements for change, changes should be made. When campaign is approved the execution process begins.

Before the advent of social media, marketing activities had a short duration with limited market reach. Today with social media, marketing activities run longer and for significantly lower costs. When TV promotion is over, video commercials continue their broadcast on YouTube and social media. Social media unites all digital activities: website, videos, digital applications, educational, informative and entertaining content with a main goal to increase interaction with customers. Facebook and Twitter give back to businesses in the form of real-time feedback. Companies can see for themselves when their lackluster advertising or weak marketing gets panned or ignored, and how their creative, engaging, authentic campaigns get praised and passed along [11].

Social media Facebook, Twitter and Instragram are crucial for digital marketing and their functions provide unique opportunities:

– Reaching a large number of users for a very short time;

– Sharing different types of content;

– Targeting users according different parameters;

– Fast feedback of digital campaign;

– Instant insights of interactions with users;

– Providing data of users behavior (when they are online, how they reach company profile, providing information toward customers needs);

– Providing data of users profile (gender, age, location, interest);

– Implementation of digital application;

– Monitoring global and local trends;

– Monitoring competitors' activities.

Brand Equity

Digital marketing has big influence in strengthening the elements of brand equity system [12]. As it can be seen from the proposed scheme (Figure 3), the brand value depends on factors such as favorable associations in the mind of the consumer who may be influenced by the brand through the marketing mix and a consistently constructed identity.

Knowledge related to quality is based on previous experience of the customer with the production of the brand and recommendations received from the closest circle of people, and associations for reliability are a result of the enduring relationship of the consumer with the brand.

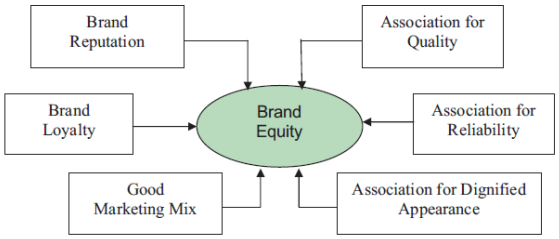

Fig. 3. The elements of brand equity system

DIGITAL MARKETING IN THE STAGES OF PRODUCT LIFECYCLE

At each stage of product lifecycle (Figure 4) [13] digital marketing plays an important role in the implementation of marketing strategies:

– Social media in the planning stage can be used for market research for creating product/services, co-creation and marketing-mix research for product that is already developed.

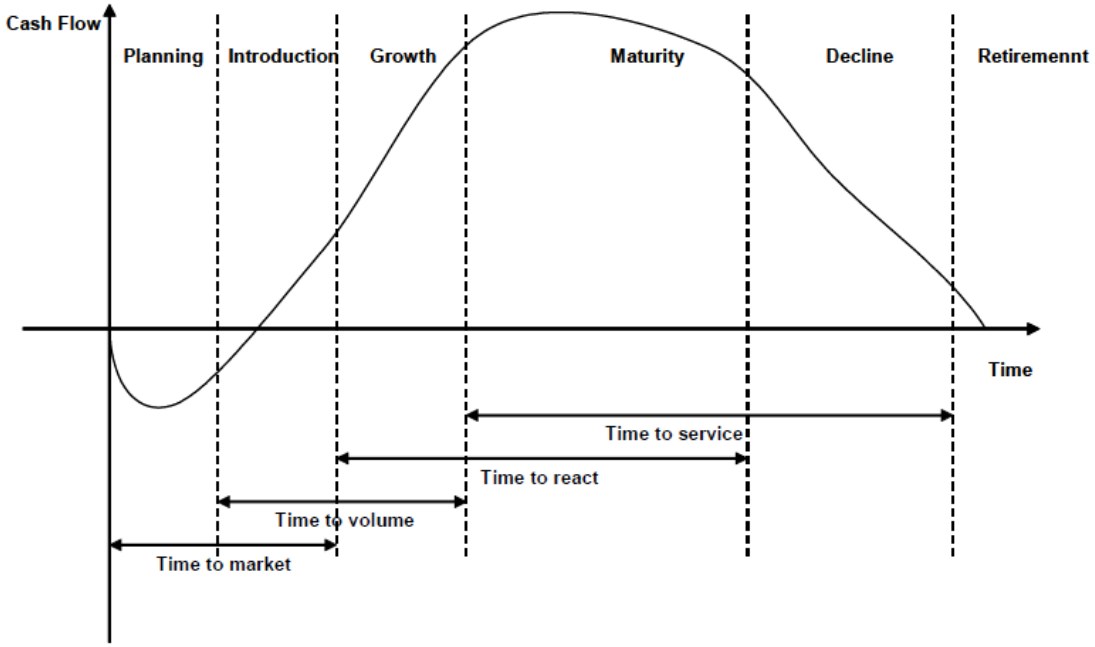

Fig. 4. The generic lifecycle model with appropriate PLM metrics for measuring the business performance in each lifecycle phase

– In the introduction stage, the role of social media is to familiarize customers with the product (brand awareness). Promotion includes YouTube videos and web banners. Customer relationships are built and depend on social media activities. With the functions of social media for choosing different marketing objectives and defining target audience, companies can reach a large number of users for a very short time and create a customer database.

– Digital marketing makes product differentiation in the growth stage. Integrated offline and online activities will increase the number of customer and sales. The main goal is constant communication and online presence that can be achieved through digital applications, marketing activities, support of online community, influential marketing etc. which reinforce favorable association and brand loyalty.

– In the maturity stage, companies should be maintaining online communication and observing competitors' marketing strategy in order to take actions toward their customers. To maintain customer loyalty, innovations in digital marketing strategies should be made especially when extension strategies are applied. With the digital marketing strategies, customers are included in the process of changing/ improving the product or in the process of co-creation.

– In the decline stage, the unique digital campaigns toward loyal customers will reinsure market presence of the brand.

RESEARCH ON THE IMPACT OF DIGITAL MARKETING ON SOCIAL MEDIA USERS IN MACEDONIA

To determine the impact of digital marketing on social media users in Macedonia research was conducted with questionnaire with Google Forms, in the period from 1.4.2016 to 30.5.2016 in which 98 people responded. Of the respondents 65 are women and 33 are men. Most of the respondents - 61.2% are between the ages of 31 and 40 years, 2% are over 51 years old, 25.5% are between the ages of 21 to 30 years and 11.2% are between the ages of 41 to 50 years.

Regarding the use of social media, only 3 respondents do not use Facebook, but in terms of other social media 40.8% do not use Instagram and 56.1% do not use Twitter.

In terms of time spent on social media, 57.1% of respondents said they spent more than two hours a day, 26.5% spend one to two hours a day and 16.3% spend about an hour a day. On the social media 43.9% of respondents follow 1 to 4 brands, 24.5% follow 5 to 10 brands, 31.6% follow over 10 brands and 72.4% of respondents said that digital marketing has influence on their purchasing decisions.

As the most important type of content in digital marketing 70.4% of respondents indicated informative content, 55.1% indicated educational content, 34.7% indicated entertaining content, 20.4% indicated contest games and 11.2% indicated gifs/videos. Even 78.6% respondents agree that digital marketing affects customer loyalty. More than a half of respondents (65.3%) think that Macedonian brands have good social media marketing strategy. Of those who don't share this opinion stated that Macedonian brands lack creativity, originality, innovation and professionalism. They also stated that companies shouldn't use identical communication as in their brochures and leaflets and shouldn't copy foreign campaigns that are not corresponding to local lifestyle.

THE IMPACT OF DIGITAL MARKETING ON PRODUCT LIFECYLE MANAGEMENT

Digital marketing has big impact in the areas of Product Lifecycle Management such as Innovation, Research and Development, Customer Experience Mapping and Customer Relationship Management.

Involving customers early in the product lifecycle reduces development time and costs. It brings new ideas and potential problems to light quickly, avoiding expensive rework. Involving customers throughout the lifecycle helps avoid the discovery of problems when it's too late to avoid their effect. Customer Surveys are carried out to discover what customers are thinking about existing products and future products. And, using technologies such as RFID and the Web, information is exchanged directly with customers using the product. Getting feedback from a customer at the actual time of use provides even more valuable information than a survey form [14].

Social media effects Customer Experience Mapping which consist of points of interactions (touch points) that customer has with the product, service, brand or organization, starting from brand

awareness, purchase, use, building relationship and sharing experience. With social media, Customer Relationship Management turns into Social Customer Relationship Management [15].

Based on a survey of more than 3000 senior executives across industries, geographies, and functions, a resent McKinsey report indicated that companies qualified as "networked" (those that used collaborative Web 2.0 technologies intensively to connect internet efforts of employees and extend the organization's reach to costumers, partners, and suppliers) outperformed other companies in terms of market share, profitability, and market leadership (Bughin & Chui 2010). The car manufacturer Audi creates a "Virtual lab" for customers to contribute to the innovation process. This is folowed by 1662 participants who are chosen among online Audi communities to support the development team of Audi by developing ideas. Ducati and Harley-Davidson use social media communities for the purpose of developing new products. Nike allows customer to desing their own shoes and choose the features that they wish to see in company products by means of online portals. Apple iPod also benefits from the improvements made to exsisting company products by online communities who, in addition, also give ideas for new designs. In the study on the usage of social media, Naylor, Lamberton & West (2012) have found that the use of different form of social media by top companies for the purpose of connecting with customers is around 83% [16].

One of the many cases were company use social media for product development is Vitamin Water which is part of the Coca-Cola Company [17]. Nivea used social media for product innovation. Their Social Product Innovation process resulted with a revolutionary deodorant to the market. Invisible for Black & White became the company's best-selling deodorant in the company's history. This success story encouraged the company to use the co-creation process in other product lifecycles [18].

CONCLUSIONS

Companies must use digital marketing because we are living in the digital era and most of our daily communication takes place online. The function of digital marketing significantly facilitates marketing strategy implementation in each stage of product lifecycle and provides information of customer behavior which directs the work of the company. The aim of digital marketing is to attract customers and make them share their experience online. Constant use of digital marketing especially as a part of integrated marketing campaign increase sales and strengthens customer relationships which directly affects on extending of the product lifecycle.

RECOMMENDATIONS FOR FUTURE RESEARCH

Global companies use social media for market research and new product development. The features of digital marketing and analytics functions can be used as a base for creation of new application for connecting companies and customers for monitoring their behavior and collecting significant data for the innovation and new product development. In a similar way, customer relationship management should be improved.

The gained knowledge of the use of digital marketing points out the need for new additional futures that will improve customer service approach.

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Review

THE FUTURE PERSPECTIVES OF EUROPEAN UNION ENVIRONMENTAL LEGISLATION

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A b s t r a c t: The European Union as one of the largest communities in the world is strongly dedicated to the protection and improvement of the environment. The Treaty on the EU and The Treaty on the functioning of the EU, as fundamental legal acts create preconditions for common activities and legislation in field on the environment. The contemporary EU has built a comprehensive system of environmental legislation. This legislation has placed a high level of environmental standards. It is a legal base of the EU common environmental activities. Directives are the most frequent part of this legislation. The EU environmental legislation faces with a number of challenges. The main goal of this paper is to analyze the existing EU environmental legislation and to highlight its future perspectives.

Key words: European Union; environment; legislation; institutions; perspectives

ИДНИ ПЕРСПЕКТИВИ НА ЗАКОНОДАВСТВОТО НА ЕВРОПСКАТА УНИЈА ВО ОБЛАСТА НА ЖИВОТНАТА СРЕДИНА

А п с т р а к т: Европска Унија како една од најголемите заедници во светот силно е посветена на заштитата и унапредувањето на животната средина. Спогодбата за ЕУ и Спогодбата за функционирање на ЕУ, кои се фундаментални правни акти на ЕУ, создаваат предуслови за заеднички активности и заедничко законодавство во областа на животната средина. Ова законодавство постави високо ниво на еколошки стандарди и претставува база за заедничко дејствување на ЕУ. Директивите се најголем дел од ова законодавство. Законодавството на ЕУ во областа на животната средина се соочува со низа предизвици. Главна цел на овој труд е да се анализира постојното законодавство на ЕУ во областа на животната средина и да се расветлат неговите идни перспективи.

Клучни зборови: Европска Унија; животна средина; законодавство; институции; перспективи

INTRODUCTION

European Union as one of the largest communities in the world has been developing common policies and activities in many spheres. At the beginning the EU was created as a community which harmonized a part of economic activities of the member states. Today the EU is community of 28 member states with more than 500 million citizens which has developed common policies and activities in many spheres such as economy, custom and financial policies, social issues, foreign policy, defense and security, health and consumer protection, environment etc. The EU citizens have an opportunity to use the numerous of benefits. High level of environmental standards is one of the most important benefits for the citizens. According to the Treaty on the European Union, the Union shall establish an internal market, which shall work for sustainable development of Europe, based on balanced economic growth and price stabilities, a highly competitive market economy, aiming to make full employment and social progress and a high level of improvement and protection of the quality of the environment [1]. This Treaty to-

gether with the Treaty on the functioning of the European Union has a constitutional importance. The Treaty on the functioning of the EU stipulates the main objectives and principles of EU common environmental policies and activities [2]. It promotes principle of subsidiary which means that in the areas where the EU does not have an exclusive competence, the responsibilities are shared between the EU and the member states. In addition the European Council has agreed that subsidiary is to be taken into account at every stage of legislative process [3]. The need for the harmonization of policies, legislation and activities in the area of the environmental is clearly recognized in these treaties and they provide that the environmental legislation shall be adopted by the European Parliament and Council of the EU with the ordinary legislative procedures after consulting the Economic and Social Committee and the Committee of the Region, which demonstrates respecting the diversity in the regions. These treaties together with the numerous of other treaties and international conventions are the primary source of the EU environmental law. The EU environmental legislation as a secondary source of this law consists on directives, regulation and decisions and the tertiary part of this law as legally non-binding acts consists on recommendations, conclusions, opinions etc.

The EU as one of the world leaders in the area of environment has built a high level of environmental standards, which are regulated in the common environmental legislation. The main aim of this paper is to analyze the EU environmental legislation and to research its importance, challenges and to highlight its future perspectives.

THEORETICAL BACKGROUND AND EXPERIMENTAL

Within the preparation of this paper there were analyzed the main EU strategic documents and legal acts. The paper makes efforts to synthesize the main characteristic from different sectors of EU environmental legislation. There were analyzed the EU treaties. Also there was analyzed and classified the secondary sources of EU environmental law: directives, regulations and decisions as a most represented part of the EU environmental law. Finally there were analyzed tertiary sources of EU legislation.

The paper presents a historical development of the EU environmental legislation. Also it is analyzed a decision making process in adopting of this legislation. There were used statistical data both of the EU and Macedonia. It was reviewed a relevant published literature. Also, it was made a SWOT analysis which tends to determine strong and weak sides, and opportunities and threats for the future perspectives and challenges of EU environmental legislation.

RESULTS AND DISCUSSION

History of EU environmental legislation

The roots of European Union are in European Economic Community which was established by Treaty of Rome in 1957 [4]. Before it in 1951 was adopted Treaty of Establishing the European Coal and Steel Community – ECSC Treaty signed by Belgium, France, West Germany, Netherlands, Luxemburg and Italy [5]. These six countries also signed The Treaty of European Economic Community – Treaty of Rome. Since then European Union, from 6 member states has grown to the Union of 28 member states.

The Treaty of Rome did not content the clear legal provisions about environmental protection although it contents provisions for the importance of quality of human life. It creates a Community as economic union. The first amendment of Treaty of Rome was performed by Single European Legal Act. This legal act has a strong importance for further common environmental policy and has accelerated developing of the EU environmental legislation. The next phase was adoption on Treaty on European Union and Treaty of the functioning of the European Union, incorporated in Maastricht Treaty's in 1992, which transformed the Union into a wider community with common activities in many new spheres. Since then there were amended by Treaty of Amsterdam in 1997, Treaty of Nice in 2000 and Treaty of Lisbon which entered into force in 2009 [6].

Changing in Treaty of Maastricht opens the new perspectives of further development of common EU environmental legislation which was marked as a legal base for developing of environmental standards. The Amsterdam Treaty and the Treaty of Nice continues to strengthen the EU environmental measures which accelerated the development of environmental legislation. The Treaty of Lisbon makes a significant step toward building the higher environmental standards. The EU environmental policy and activities received an international dimension and the Union undertakes

the responsibility for global environmental threats. This Treaty involves the stronger cooperation between the EU and a member state in the environment and solidarity in the spheres of environment and energy. It shows that the EU has gone a long way in the development of the system of common environmental legislation [6].

Development of EU environmental policies and legislation is closely related with the framework of the common activities which are determined in the EU environmental action programs. These programs determine the priorities and dynamic of the common activities for harmonization of EU environmental legislation. First action program covers the period 1973–1976 and determines that environment belongs to the essential task of the Community and underlines the most important environmental objectives. Since then seven EU environmental action programs have been adopted. The Second program (1977–1981) is focused on water quality, industrial pollution and risk management. This program emphasizes a need for strengthening of common environmental legislation. The Third action program (1982–1986) explores benefits of environmental policies to the common internal market. It promotes that the environmental emission standards should be harmonized in aim to provide equal position on the EU market. The Fourth program (1987–1992) promotes creation of high level standards and risks prevention from trans- boundary pollution. It designs a stronger links between the environment and economy. For the first time economic instruments such as eco taxes are promoted. The Fifth program (1993–2000), underlines negative effects on the environment from agriculture, transport, energy and industry and the need for reduction of emissions from these sectors. The Sixth action program (2001–2010) promotes effective implementation of the EU environmental policy and legislation. The last adopted program is Seventh environmental action program which covers the period 2013–2020. It is a guide rule for the EU environmental policy and legislation until 2020, but also stresses the limits of the planet and potential conditions of the planet until 2050. This program highlights the need of harmonization and completely implementation of the environmental legislation.

The EU environmental action programs have a significiant role in the creation, development and enforcement of the common environmental policy environmental legislation. The programs have posted precise objectives and priorities of the EU and they have accelerated building a comprehensive system of common environmental legislation. In the Table 1 there is presented the development of the common EU environmental activities and environmental legislation.

Table 1

Development of EU Environmental Law

Year	Treaty / amendment
1957	Treaty of Rome (EC treaty). Treaty is concentrated on designing of common economic policy and has no provisions directly dedicated to the environment
1972	Meeting of leaders of member states in Paris. Promoting the importance of environmental protection and its relations with living conditions.
1973 – 1976	First Environmental Action Program
1977 – 1981	Second Environmental Action Program
1982 – 1986	Third Environmental Action Program
1986	Single European Act, involving the separate environmental chapter
1987 – 1992	Fourth Environmental Action Program
1992 – 2000	Treaty on European Union (Maastricht Treaty): establishing common environmental legislation and underline the importance of EU environmental legislation for the development of common activities.
1993 – 2000	Fifth Environmental Action Program
1997	Treaty of Amsterdam : environmental protection has to be integrated in all community policies and promoting harmonization of EU environmental legislation
2000	Treaty of Nice : promoting further development of the common environmental activities and legislation
2001 – 2010	Sixth Environmental Action Program
2009	Treaty of Lisbon: strengthening the common environmental activities and promoting the advantages of common environmental activities and the importance of common harmonized legislation for building a high level of environmental standards and promote international role of the EU in the environmental issues.
2013 – 2020	Seventh Environmental Action Program (2013 – 2020).

The main principles of the EU environmental Legislation

The EU environmental legislation produces a high level of environmental protection and provides a high level of standards which are based on

the fundamental principles: precautionary principle, principle of prevention; polluter pay principle and principle of liability for environmental damages.

The precautionary principle promotes that all subjects which are involved in any process which produce negative impacts on the environment could should be considered and predicts all possible environmental risks and undertaking measures for elimination or minimization of the risks. This principle promotes that in conditions where the environmental risks exist, the project and other activities that could produce the risks should be stopped. It suggests a need of precautionary measures even in case of suspicion of some environmental threats which is visible in many directives, for example in Directive 2000/76 [7], and Directive 2010/75 [8]. The principle of prevention is similar with the precautionary principle but also there are some differences. It signs preventive approach in all projects activities and insists on strict procedures and detail information about negative consequences on the environment during the performance of different public and private projects. This is determined in Directive 2011/92 [9] where are regulated the procedures for performing of certain projects and in Directive 2000/13 [10], which promotes consumer protection. However there are a lot of similarities between precautionary principle and preventive principle. The precautionary/prevention principle is overriding importance in every serious environmental policy, since it allows or requires action to be taken at an early stage [11].

The principle of liability promotes a liability for environmental damages, which is regulated in detail in Directive 2004/35 [12]. The main point of this principle is that the operators and other subjects whose activities caused environmental damages or imminent threat are financially responsible. It promotes full compensation for all direct and indirect damages. The polluter pay principle is one of the most important principles for designing the EU policy and legislation, which promotes that subject who produced pollution, has to pay for pollution and degradation of the environment. All cost spent in combating with the pollution should be submitted by the polluters. This includes the cost of prevention, monitoring, elimination, reducing and rehabilitation of negative impacts of pollution. The main goal of the principle is to discourage all types of pollution. The polluter pay principle is closely link with establishing of eco taxes. The eco taxes are deeply involved in the environmental and fiscal policies of the EU and the member states. In the future strengthening of these principles will be a big challenge for the further potentials and perspectives of the environmental policy and legislation on the EU and member states level.

In addition to the above mention principles also there are a number of other principles, such as principle of public participation, principle of transparency, principle of decentralization and principle of planning. It has to be considered that all principles are deeply related to each other and they are in the interactive relations. All principles have preventive, precautionary, planning elements and all of them have a goal to minimize and to reduce all types of environmental risks.

Sources of EU environmental legislation

Generally the sources of the EU environmental laws are classified in three groups the primary, secondary and tertiary. Treaty on the EU and Treaty on the functioning of the EU are the most important treaties with a constitutional importance. These treaties, as a primary source of the EU environmental law present the general orientation of the EU in the field on the environment. As a part of primary law also it should be mention the international conventions in the field on the environment which are signed and ratified by the EU and the treaties that are concluded between the EU and the third countries and the decisions of the Court of Justice of EU.

Regulations, directives and decisions are secondary source of EU environmental law and they are the most presented part of environmental legislation. Regulations have direct effect into the national legislation of the member states. They are directly applicable in the member states and there is no need for member states to adopt national legal acts for transposition and they provide uniformity of the part of environmental legislation. Some of them have an administrative function for establishing the EU common administrative structure, such as establishing European Environmental Agency [13]. Other regulations establish environmental financial instruments such as the EU LIFE instrument [14]. Some regulations have an aim to transpose the obligations from the environmental international convention. Additionally there are regulations which regulate collecting, classifying, and analyzing statistics data in separate sector of the environment. This is a case with Regulation 2002/332 which stipulates methods for establishing

waste statistic on generation, recovery, disposal and other types of waste treatment, as well the export and import of waste in a way which enables comparable results on the EU level [15].

Directives are the most frequent legal acts of the EU environmental legislation. They are flexible legal instruments that determine environmental standards and goals which have to be achieved from the member states. Member states can make a choice of methods and forms how to achieve the goals and they are obliged to transpose the provisions from the directives into the national legislation in determined terms. Sometimes the period for transposition of the obligation from the directives is different for different countries, mainly because of the differences of their economic, environmental and other potentials. The member states are obliged to implement the minimum standards which are determined in the directives and they can provide higher standards into the national legislation. This means that member states play a large part in the implementation of EU Environmental Law [16]. Some directives in general way regulate a particular environmental sector such as Directive 2000/60, which sets out a framework for the EU activities in field of water policy that apply for all water sections [17]. Separate waste sections such as drinking water, bathing water, industrial and waste water etc. are regulated in separate directives. The same situation is in waste section where Directive 2008/98 on waste regulates general principles and standards [18] which are applicable for all waste sections, while the separate waste sections such as packaging waste, hazardous waste, electrical and electronic waste etc, are regulated in separate directives. Decision supplements regulations and directives with some technical details. They are directly applicable and do not require any implementation.

The future perspectives of EU environmental legislation

Regulations and directives as the most frequent part of the EU environmental legislation are adopted in a complex procedure. This legislation is adopted by the European Parliament and the EU Council (Council of ministers) in procedure of co – decision, where both institutions have an equal role. Proposals of the legislation are performed by European Commissions in cooperation of 33 general directorates that are functioning in the framework of the Commission. The role of the Directorate General for Environment and Directorate General for Climate Action is the most significant. In the process of adoption of the legislation consultations with Committee of Regions and European Economic and Social Committee are mandatory. After the amendments of the EU treaties which have done by Lisbon Treaty the role of national parliaments are strengthened in the process of adoption of the legislation. Monitoring of the enforcement of the common environmental legislation is obligation of Commission, which prepares the reports for the enforcement of environmental legislation to the European Parliament and to the Council of EU. In case of failure of the obligation from the member states the Commission has a power to initiate the procedure in front the Court of Justice of EU.

From the above mention it can be concluded that the cooperation between the different EU institutions and between the EU and member states institutions in adopting and enforcement of the common environmental legislation is very important. Permanent improvement of this cooperation is one of the biggest challenges for the future perspective this legislation. Also the enforcement of the environmental legislation and enforcement of the decisions of Court of Justice of EU is very important for the practical effectiveness of the legislation. Additionally it has to be considered the supremacy of EU law versus law of the member states, which is not directly determined in the EU treaties and it has been introduced by the decisions of European Court of Justice.

The EU environmental legislation covers all environmental sectors, including air, nature, waste, water, chemicals safety, and other cross sectors environmental issues, such as environmental impact assessment, environmental information and public participation, liability for environmental damage, risk management, integrated preventive pollution control and other environmental issues. But it is very closely related with the many other spheres such as economy sphere, social, health, agriculture, energy, transport and other spheres. This shows its complexity and depth. Taking into account the diversity of the numerous of differences in the member states harmonization of environmental standards is not easy task. The member states such as Sweden, Denmark, Finland, Germany, Austria and Holland have a bigger progress than the other states, especially the member states which joined the Union after 2004. The equalization of the environmental standards in all member

states is one of the main challenges and tasks of the common environmental legislation. Orientation for gradually and progressively equalization is a real answer for the overcoming the differences between the member states and it is also a big challenge for the future perspectives of the environmental legislations. The EU has adopted more than 300 legal acts in the sphere of the environment which clearly shows the complexity of the EU environmental legislation. The EU legal regulation is aimed to determine high standards [19].

Lisbon Treaty which amends the basic EU treaties opens new perspectives for the common EU legislation. This treaty generally has introduced a more coherent legal structure which affects also the environmental sphere. EU assumes a greater responsibility for global environmental protection. Environmental policy is stronger integrated with other common policies. This produces stronger relations between the environmental legislation with other parts of common legislation. It means further building of a high level of environmental standards. The Treaty promotes legally binding of Charter of Fundamental Rights of the European Union [20], which strengthen the environmental rights as one of the most important human rights. Stronger respect of regional conditions and diversity is also a big future challenge of the common environmental legislation. The provisions of Lisbon Treaty promote strengthening the polluter pay principles which will have a strong future impact on this legislation.

Within the activities of the preparation of this paper it has been performed a SWOT analysis which presents strong and weak points, opportunities and threats for the future perspectives of the EU environmental legislation. The main strong points are: providing the concentration of the human and financial resources on the EU level; establishing a high level of environmental standards; protection of common market; involving strict and precise procedures and criteria in environmental sectors and promoting health protection and quality of life. The main weak points are: slow transposition in some member states; disparities of potentials between the member states; complicity of the legislation; exiting of different obstacles for enforcement of the decisions of the EU institutions and relatively slow procedure for adoption of the legislation. The main opportunities are: further capacity building of the EU and national institutions; enhancement of the environmental economic instruments; simplification of a part of the legislation and further strengthening of public participations in the process of adopting of the legislation. The treats are: still low level of public awareness in some member states, resistance of a part of involved stakeholders, especially of some polluters and still low institutional capacities in some member states. However this analyzes shows a number of potentials for the future perspectives of the common environmental legislation.

CONCLUSIONS AND RECOMMENDATIONS

European Union as a community of 28 member states is strongly committed to the protection and improvement of the environment, which is clearly emphasized in the EU treaties. The main legal framework of common environmental activities is determined in the EU environmental legislation. The EU has built a comprehensive system of environmental legislation which is a legal base for establishing of high level of environmental standards. More than 300 legal acts have been adopted in the field of the environment. This legislation is based on a number of principles. Directives as a flexible legal instruments are the most frequent part of this legislation. The variety of economic and other potentials is a main obstacle for more efficient practical implementation of the legislation in some member states. In the future the EU should continue with the efforts for development of the legislation which will provide equalization of the environmental standards in all member states. This legislation has to provide strengthening of the financial instruments for building a high level of environmental standards. Enhancement the international role of the EU in the global environmental issues opens the new perspectives for environmental legislation which should produce wider positive effects. Besides some obstacles in the practical implementation of the environmental legislation, there are the big potentials for the further development of the standards which will produce the benefits for the EU citizens. This is a good example for the other states.

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