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Analecta Technica Szegedinensia



**UNIVERSITY OF SZEGED
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CONTENTS

	PAGE
Tamás ANTAL, Benedek KERÉKES, László SIKOLYA MEASUREMENT OF QUALITY PROPERTIES OF DRIED PLUM VARIETIES	5
Róbert BAZSÓ, Jurik LUBOŠ, Tomáš VÁRADY HISTORICAL BASINS SEDIMENTS	12
Diána BÁNÁTI ETHICAL CONSIDERATIONS IN THE FOOD CHAIN	18
István BÍRÓ, Béla M. CSIZMADIA TRANSLATIONAL MOTIONS IN HUMAN KNEE JOINT MODEL	23
Olga BOROTA, Snežana SINADINOVIĆ-FIŠER, Milovan JANKOVIĆ, Mateja PRIMOŽIČ INFLUENCE OF DIFFERENT CATALYSTS ON TRANSESTERIFICATION OF SUNFLOWER OIL	30
József CSANÁDI, Zsuzsanna KÁRNYÁ CZKI, Ildikó BAJÚSZ, Ottilia BARA-HERZEGH, József FENYVESSY EFFECT OF LACTOSE HYDROLYSIS ON MILK FERMENTATION AND SOME PROPERTIES OF CURD	36
Andrea CSIKAI INTRODUCTION OF SIX SIGMA TOOLS INTO THE SUPPLY CHAIN QUALITY MANAGEMENT OF FEED PRODUCTION	43
Gordana DIMIĆ, Sunčica KOCIĆ-TANACKOV, Danijela TUČO EFFECT OF SPICE EXTRACTS ON THE GROWTH OF PENICILLIUM SPECIES	51
Ljubica DOKIĆ, Marija MILAŠINOVIĆ-ŠEREMEŠIĆ, Ivana NIKOLIĆ, Zita ŠEREŠ DSC OF RESISTANT STARCH PRODUCED BY DIFFERENT METHODS	58
Zoltán FABUYA MODELLING AND OPTIMIZING IN AUTOCLAVING	62
G. FICZEK, M. STÉGER MÁTÉ, B. NOTIN, E. KÁLLAY, S. SZÜGYI, G. BUJDOSÓ, M. TÓTH INNER CONTENT AND PROCESSING INDUSTRIAL CHARACTERISTICS OF NEW HUNGARIAN BRED SOUR CHERRY CULTIVAR CANDIDATE	68
Ildikó HORVÁTH GÁLNÉ, József GÁL, Ágota PANYOR TENDENCIES IN EATING HABITS CAUSED BY THE CHANGE OF HOUSING STRUCTURE IN HÓDMEZŐVÁSÁRHELY	74
Judit HÁMORI, Kinga HORVÁTH, Erzsébet SZABÓ, Diána BÁNÁTI INNOVATION – THE ACCEPTANCE OF NOVEL FOOD TECHNOLOGIES BY UNIVERSITY STUDENTS	82
Katalin HERBÁLY-HEKLI THE USE OF LOCAL VALUES FOR TOURISM AND RURAL DEVELOPMENT	88
Zsuzsa H. HORVÁTH, Sándor CSATÓ THE EFFECT OF GRAIN SIZE ON THE COLOUR CHARACTERISTICS OF DURUM SEMOLINAS	96
Endre IANOSI CONSIDERATIONS ABOUT FOOD SAFETY MANAGEMENT SYSTEM'S AUDITING	104
Gheorghe-Constantin IONESCU, Daniela-Smaranda IONESCU THE OPTIMIZATION OF ENERGY CONSUMPTION IN WATER SUPPLY SYSTEMS	110
Judit JANKO, Maria FEKETE BROILER CHICKEN: THE COMPARATIVE-EVALUATIVE ANALYSIS OF THE MANUAL SLICING TECHNOLOGY	114
Imre KALMÁR, Eszter VASS KALMÁRNÉ, Ferenc FARKAS, Valeria NAGY ENERGY NATURALLY – BIOGAS AND BIODIESEL	122
Judit KRISCH, Zsuzsa PARDI, Kitti KOVÁCS, Miklós TAKÓ, Tamás PAPP, Csaba VÁGVÖLGYI, Tserennamid RENTSKENHAND EFFECT OF ESSENTIAL OILS OF SELECTED SPICES IN FOOD SYSTEMS	128
Sunčica KOCIĆ-TANACKOV, Gordana DIMIĆ, Ilija TANACKOV, Aleksandra TEPIĆ, Biserka VUJIČIĆ, Jelica GVOZDANOVIĆ-VARGA MATHEMATICAL MODEL FOR COMPARISON OF THE INFLUENCE OF ESSENTIAL OILS AND HERBAL EXTRACTS ON THE MOULDS GROWTH	133
Marián KOTRLA, Martin PRČÍK USE PLANTS SPECIES OF TYPHA ANGUSTIFOLIA L. IN THE RESTORATION OF WETLAND ECOSYSTEMS IN AGRICULTURE LANDSCAPE	143

Ing. Barbora LIPOVSKÁ, Roberta ŠTĚPÁNKOVÁ	150
<i>THE SUSTAINABLE RURAL PUBLIC SPACES: THE IMPORTANCE OF HUMAN FACTOR FOR LANDSCAPE PLANNING PRAXIS</i>	
Csaba NÉMETH, Laszlo FRIEDRICH, József SURÁNYI, Csaba BALLA	159
<i>CALORIMETRIC STUDY OF CHANGES INDUCED BY PRESERVATIVES IN LIQUID EGG PRODUCTS</i>	
Csaba NÉMETH, Laszlo FRIEDRICH, Ildikó ZEKE, Csaba BALLA	165
<i>A NEW LIQUID EGG PRODUCT</i>	
Szilvia NÉMETH, Gitta FICZEK, László SZALAY, Magdolna TÓTH	171
<i>EVALUATION OF INNER CONTENT OF PROMISING APRICOT VARIETIES FOR PROCESSING IN INDUSTRIAL RIPENING TIME</i>	
Pavol OTEPKA, Katarína VIDOVÁ	177
<i>OFFERING OF ECO-AGRITOURISM SERVICES AND THEIR PLACE IN RURAL DEVELOPMENT</i>	
Biljana PAJIN, Ivana RADUJKO, Dragana Šoronja SIMOVIĆ, Julianna GYURA, Radovan OMORJAN, Sándor BESZÉDES, Bojana IKONIĆ	183
<i>QUALITY OF CREAM PRODUCTS WITH THE ADDITION OF EMULSIFIERS FROM DIFFERENT SOURCES</i>	
Žaneta PAUKOVÁ	189
<i>POPULATION DYNAMICS OF RAMETS ALLIUM URSINUM L. IN SOUTH-WESTERN SLOVAKIA</i>	
István PÉTER SZABÓ, Gábor SZABÓ	200
<i>DESIGN OF AN EXPERIMENTAL PCM SOLAR TANK</i>	
Cornelia PURCĂREA, Adriana CHIȘ, Nicolae CSEP	206
<i>INVOLVEMENT OF ACETYLSALICYLIC ACID IN SUNFLOWER (HELIANTHUS SP.) PLANT RESPONSE TO DIFFERENT ABIOTIC AND BIOTIC STRESS</i>	
József SÁROS, Sándor CSIKÓS	216
<i>POSITIONING OF PNEUMATIC ARTIFICIAL MUSCLE UNDER DIFFERENT TEMPERATURES</i>	
József SÁROSI, János GYEVIKI	222
<i>EXPERIMENTAL SETUP FOR THE POSITIONING OF HUMANOID UPPER ARM</i>	
Sladjana SAVATOVIĆ, Sonja DJILAS, Jasna ČANADANOVIĆ-BRUNET, Gordana ČETKOVIĆ	227
<i>ASSESSMENT OF ANTIOXIDANT ACTIVITY OF HEXANE AND ETHANOLIC TOMATO POMACE EXTRACTS</i>	
Zita ŠERES, Biljana PAJIN, Žana ŠARANOVIĆ, Ljubica DOKIĆ, Dragana Šoronja SIMOVIĆ, Zsuzsanna LÁSZLÓ, Aleksandar JOKIĆ	229
<i>SEDIMENTATION COMBINED WITH MICROFILTRATION FOR WASTEWATER TREATMENT IN WHEAT STARCH INDUSTRY</i>	
Gábor SZAFNER, Ottó DÓKA	237
<i>EFFECT OF THE FAT CONTENT ON THE THERMAL EFFUSIVITY IN FOOD PRODUCTS: AN INVERSE PHOTOPYROELECTRIC STUDY</i>	
Viktória SZŰCS, Diána BÁNÁTI	243
<i>RISK PERCEPTION OF FOOD ADDITIVES IN HUNGARY</i>	
Noémi VANDERSTEIN	248
<i>RULES OF DESCERNING FOOD FROM THE ASPECT OF BEING KOSHER IN THE JEWISH WORLD</i>	
Blaga VASILE, Carol DAROCZI	254
<i>THE CHARACTERISTIC FOR INJECTIONS TIMES</i>	
Blaga VASILE, Carol DAROCZI	262
<i>THE CHARACTERISTIC FOR INJECTIONS TIMES</i>	
Edina VINCZE-LENDVAI, Sára HODÚR	270
<i>ATTITUDE OF THE SMES IN THE SOUTH PLAIN REGION TO THE ACADEMIC INNOVATION</i>	
Jelena VULIĆ, Jasna ČANADANOVIĆ-BRUNET, Gordana ČETKOVIĆ, Sonja DILAS	278
<i>BEE TROOT POMACE - A GOOD SOURCE OF ANTIOXIDANT PHYTOCHEMICALS</i>	
Brigitta ZSÓTÉR	281
<i>SHOPPING HABITS OF THE INHABITANTS IN A TYPICAL SETTLEMENT OF THE SOUTH-EAST PLAIN</i>	

ENERGY NATURALLY – BIOGAS AND BIODIESEL

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ABSTRACT

After our joining to EU the sustainable agricultural development, increasing the rate of renewable energy sources have become an actual economical problem. In the present economical environments the private sector from own sources can not solve in its complexity the environment protection and energetic problems.

We made different tests on renewable energy in frame of some project at Szolnok University College. In this paper we deal with the biomass, but also the biogas and biodiesel also because producing and utilization of biogas and biodiesel as energy source helps realization of strategic purpose and objects in the energy policy and the environment policy, too. Actually, our environmental obligations and supported tasks of renewable energy production came into view after our joining to the EU. In the European Union the share of renewable energy must reach 20 % till 2020. So we have to take advantage of prospects more and more in the renewable energy.

This paper introduces the realization and application of an energetically-based producing and utilizing model of renewable energy systems. The solution is realized in experimental conditions in scientific researches of bio-energy engineering processes. The European Union focuses on the promotion of renewable energy sources through its energy policy. In Hungary the total quantity of biomass is ~350-360 Mt which ~105-110 Mt reproduce annually. The biggest biomass producer is the agriculture that produces ~50-60 Mt a year. The quantity of biomass used for energetic purposes in form of biogas and biodiesel in internal combustion engines. Actually, the idea of the bio-fuels is as old as the engine itself.

1. INTRODUCTION

Application of renewable energy resources is both a need and a possibility in Hungary. It is necessary to find the most suitable solution in terms of environment protection, energy policy, agricultural, EU integration and national economic perspectives in order to decrease the overuse of fossil energies and Hungary's import dependence. Such a solution could be – together with increasing the energy's economy and efficiency – to increase the use of renewable energies. Our country has excellent agro-ecologic capabilities for producing biomass for energetic purposes.

2. EFFECTS OF BIOGAS OPERATION

In the surroundings of the biogas-works – that will be established – the available biomass potential can be more or less various and differing composition in the works. This fact also justifies that it is necessary to make increased scales experiments represented work conditions for to determination the optimal work technological parameters and recipes in every case. So there is a real demand of market to develop an instrument which is closer to work conditions, mobile, suitable to make representative, comparative experiments. In the

frame of an R&D project (EA_KFI_07-bioreakt) we worked the technical requirements of mobile bioreactor and measuring system development for technological experiments of biogas production on the spot.

We made emission tests on 24.6 kW power, 4 cylinder Wiscon Total TM27 type gas engine at Budapest University of Technology and Economics Department of Energy Engineering with biogases. Biogas was produced at Szolnok University College by a such instrument which is closer to work conditions, can be installed on the spot of the biogas plants, is suitable to make representative, comparative experiments with available sort of biomass.

In *Figure 1* it can be seen that in case of $\lambda > 1.1$ air access coefficients the cooling effect of the surplus air results lower NO_x emission, however, NO_x formation depends on the temperature. The engine operation with increasing carbon-dioxide content of gas mixture – by reason of drawing-off of combustion and cooling effect of carbon-dioxide – results further decreasing.

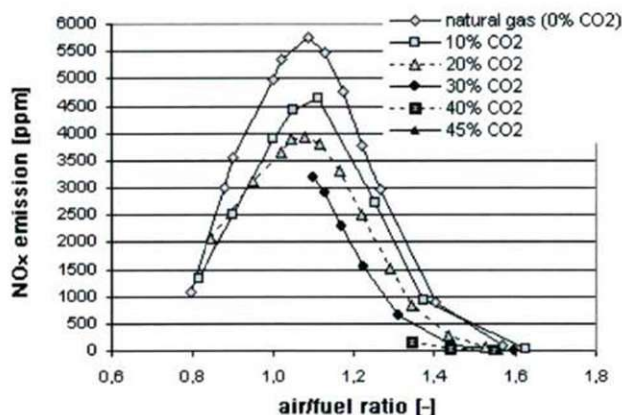


Figure 1. NO_x emission [Meggyes – Nagy, 2009]

With increasing of carbon-dioxide rate of the applied energy-carrier, the circumstances of the combustion are getting worse which result increasing CO emission and higher quantity of unburnt hydro-carbons. *Figure 2* illustrates the CO emission plotted against the air access coefficient. In case of $\lambda < 1.0$ air access coefficients CO emission increases by leaps and bounds, which can be explained by the increase of adiabatic flame temperature and production of getting rich mixture. However, in range of $\lambda = 1.1-1.4$ air access coefficients CO emissions – independently of carbon-dioxide content of gas mixture – stabilized on lower values. In the case of $\lambda > 1.4$ air access factors the dragging-on of combustion results increasing CO emission. In terms of CO emission, unambiguously, it can be determined that the traditional gas engine is operated with gas mixture with low methane content, there is no effect on CO emission if the gas engine operates permanently in range of $\lambda = 1.1-1.4$ air access factors.

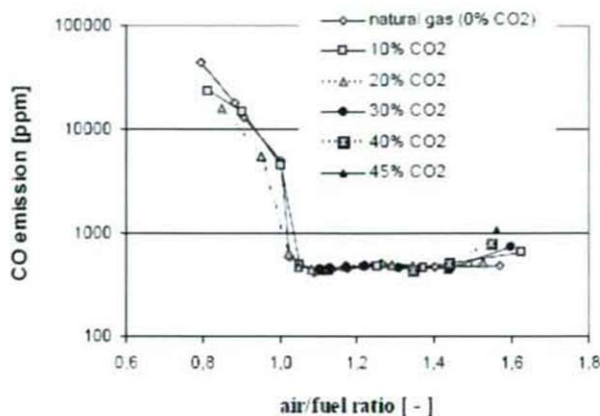


Figure 2. CO emission [Meggyes – Nagy, 2009]

Measuring of the methane content in the exhaust gas can give points of reference on the goodness of combustion process. Increasing the air absence and dragging-on of the combustion result similar tendencies considering the unburned hydrocarbons emission, too. In Figure 3 it can be discovered that considering the incombustible hydrocarbon content of the exhausted gases there is no significant deviation present between the operation of natural gas and gas mixtures with a higher carbon-monoxide content in the range of $\lambda=1.2$ -1.4 air access coefficient. The operation with low methane content of gas mixtures does not influence CO emission in the range of $\lambda=1.1$ -1.4 air access coefficient.

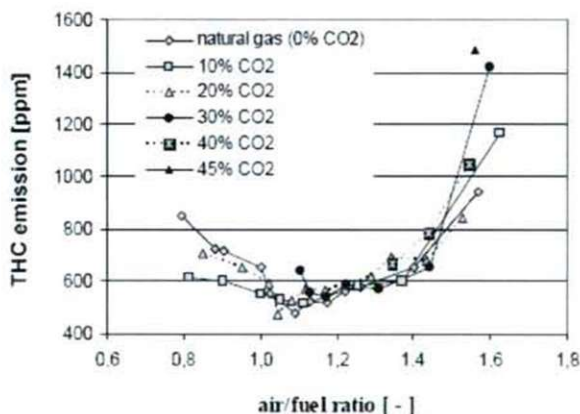


Figure 3. THC emission [Meggyes – Nagy, 2009]

3. EFFECTS OF BIODIESEL OPERATION

We had another project (NKFP4-063/2004) so we could test 10 types of vegetable oils which are suitable for use as diesel engine fuels. Application of mixtures of vegetable oils as fuels in the internal combustion engine resulted different power and torque values than diesel oil, it can be explained with different heat values and viscosity, cetane number of vegetable oils.

Nowadays we investigated emission components used with as well 5 kinds of sunflower oils mixed with diesel oil, and 4 kinds of rape oils mixed with diesel oil and RME. Our tests were performed by taking into account the requirements of EU 49 standards with PERKINS 1104C engine type at Szolnok College. In the course of our we established the amount of CO, HC, NO_x, CO₂ and O₂ components of exhaust gases and determined the rate of smoking too.

Our measuring system realized the certification cycle which contain operating conditions like speed (idle speed, maximum torque speed, maximum power speed), load (10, 25, 50, 75, 100 %) and load factors. R49 regulation requires a thirteen-step engine brake bench test in steady operation. The emissions are measured step by step, and they are registered as a specific mass emission (g/kWh) per performance. The issue is an average number that is calculated per polluting components and also per operation modes. Among the thirteen measuring points (operation modes) the sixth and the eights measuring points are high load working points. This means high average exhaust temperature.

After the emission tests it was stated that among the 5 kinds of sunflower oil mixed with diesel oil the effect of 4 kinds of fuel fell back by 6.93 %-24.94 % compared to the CO value of diesel oil (*Figure 4*).

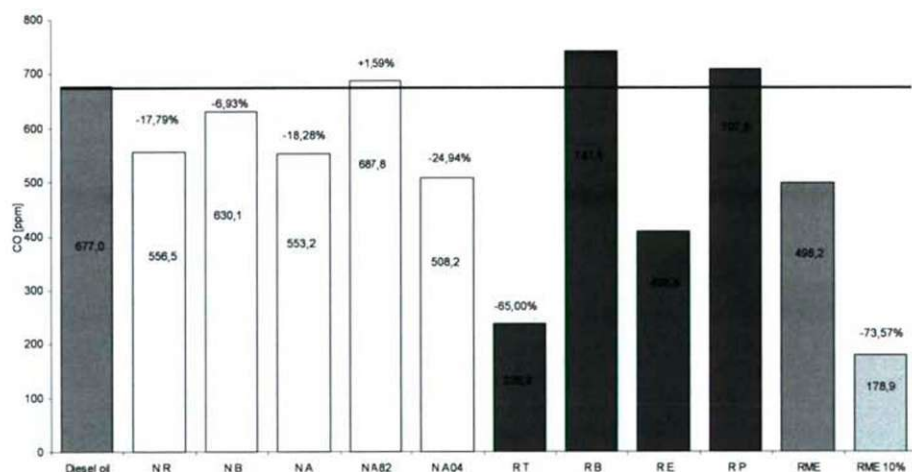


Figure 4. CO emission values [Farkas, 2009]

Among 4 kinds of rape oil mixed with diesel oil we noticed substantial falling (65 % and 39.61 %) in two cases and rising (9.52 % and 4.56 % twice). The pure RME showed 26.42 % less CO emission the mixed fuel containing 10 % RME decreased by 73.57 %.

CH emissions of all the vegetable oil-diesel oil mixed fuel remained under CH values of diesel oil (*Figure 5*).

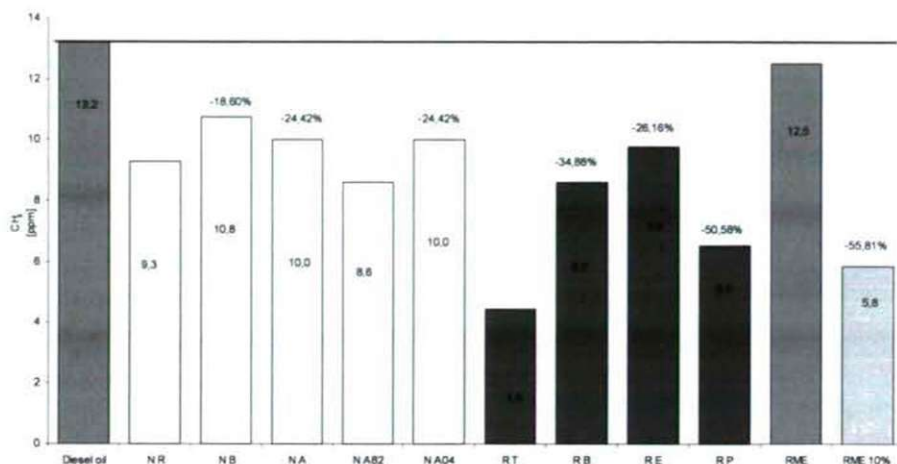


Figure 5. CH emission values [Farkas, 2009]

To compare the values of mixed fuel with sunflower oil that of there was a diesel oil, drop of 18.6 % - 34.88 % and also a fall of 26.16 % - 66.28 % mixed fuel was used with rape oil. The pure RME resulted 5.23 % less CH values, while the mixed fuel containing 10 % RME dropped by 55.81 %.

During the application of the 10 kinds of vegetable oil-diesel oil mixed fuel we measured higher NO_x values only on two cases than that of near diesel oil. (Figure 6).

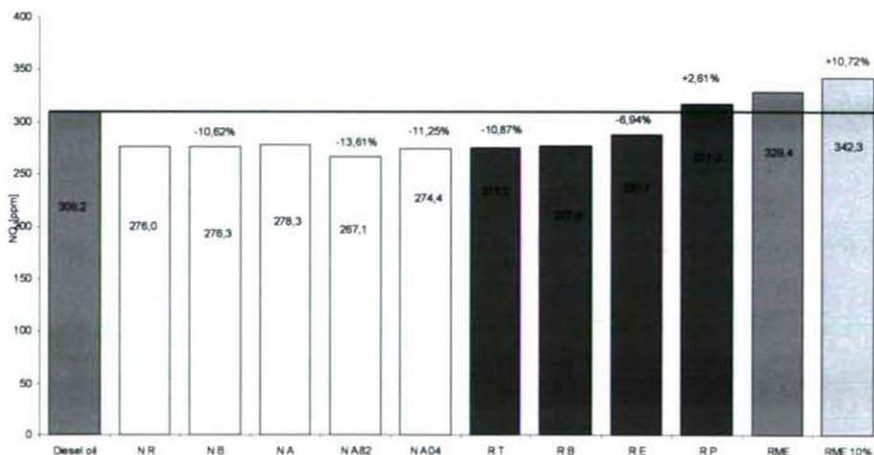


Figure 6 NO_x emission values [Farkas, 2009]

The samples with sunflower oil were slightly more favourable, than rape oil samples. Nine samples remained below the diesel fuel by 6.94 % - 13.61 %. Our further remark is that the values of pure RME exceeded the NO_x limit of diesel oil with 6.54 % and the mixed fuel containing 10 % RME also exceeded by 10.72 %.

4. CONCLUSION

The preservation of the state of our environment and the effective, economical expectations of the energy needs can be solved with the harmonized application of the traditional and renewable energy sources. That is why in nowadays the best perspectives are hidden in the energetic utilization of biogas as a universal renewable source of energy, which is among the mostly pressed tasks. Carbon-dioxide content (~25-60 %) of the biogas can be variable, depending on the organic material and the production technology. The combustion takes longer time on the effect of the carbon-dioxide, which brings forth changes in performance, efficiency and emission.

Today, all over the world, impacts of energy resources on the environment are global problem. Spread of energy carriers of biological origin can be promoted by continuous innovative activity.

Reinforcing the findings in the literature, it can be stated unambiguously that the 10 types of vegetable oil derivatives tested by us are suitable for use as diesel engine fuel.

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