REVIEW OF FACULTY OF ENGINEERING

Analecta Technica Szegedinensia

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dean
University of Szeged Faculty of Engineering

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Innovariant Nyomdaipari KFT.
6724 Szeged, Textilgyári út 3.
Phone: +36 (62) 493-626

UNIVERSITY OF SZEGED FACULTY OF ENGINEERING
H-6724 Szeged, Mars tér 7.
Phone: +36 (62)546-000
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CONTENTS

ENERGY NATURALLY – BIOGAS AND BIODIESEL

Imre Kalmár[1] , Kalmárné Eszter Vass[1] , Ferenc Farkas[2] , Valeria Nagy[2]
[1]College of Nyíregyháza, H-4400 Nyíregyháza, Sóstói út 31/b, Hungary
[2]Szolnok College, H-5000 Szolnok, Tiszaligeti sétány, Hungary
e-mail: kalmi@nyf.hu; kalve@nyf.hu; farkas@mfk.hu; valinagy@mfk.hu

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.

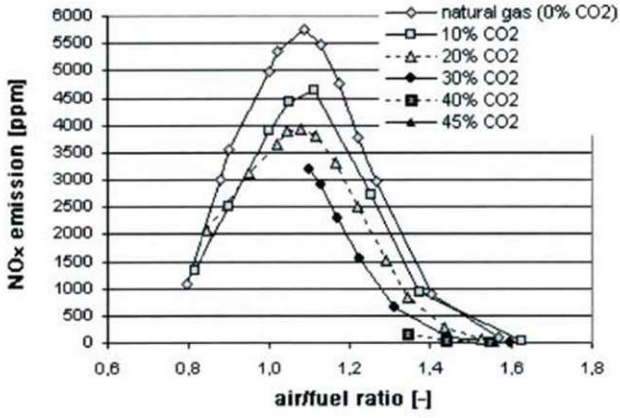

Figure 1. NO_x emission [Meggyes – Nagy, 2009]

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 $\lambda = 1.1\text{-}1.4$ 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 $\lambda = 1.1\text{-}14$ air access factors.

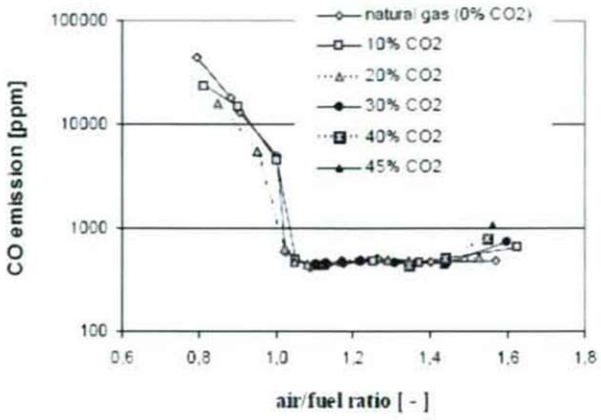

Figure 2. CO emission [Meggyes – Nagy, 2009]

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 λ=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 λ=1.1-1.4 air access coefficient.

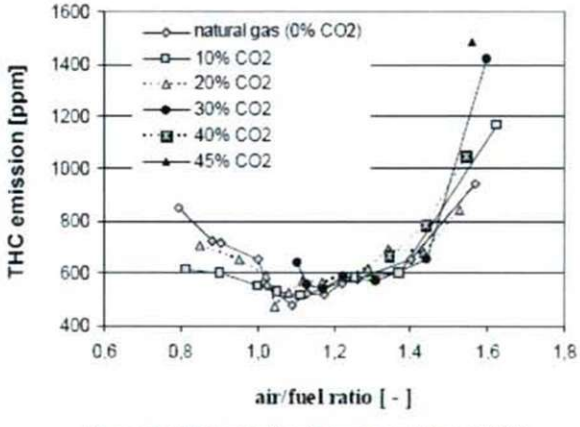

Figure 3. THC emission [Meggyes – Nagy, 2009]

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, CO_2 and O_2 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 4kinds of fuel fell back by 6.93 %-24.94 % compared to the CO value of diesel oil (*Figure 4*).

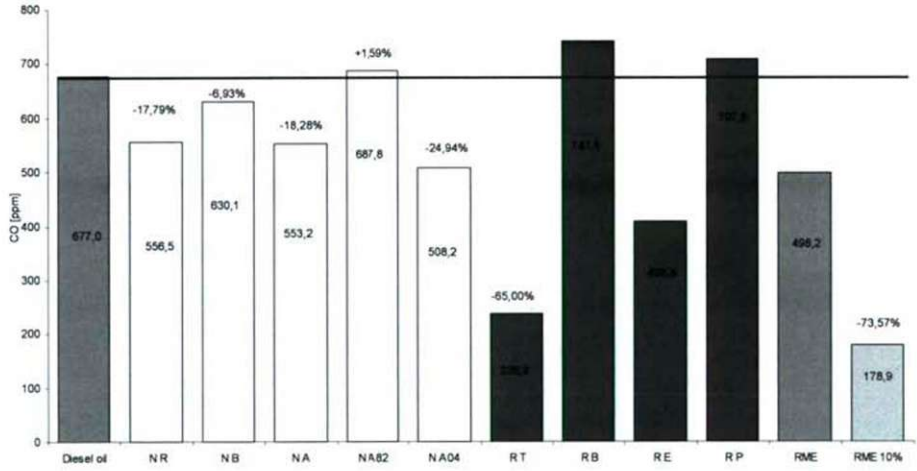

Figure 4. CO emission values [Farkas, 2009]

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*).

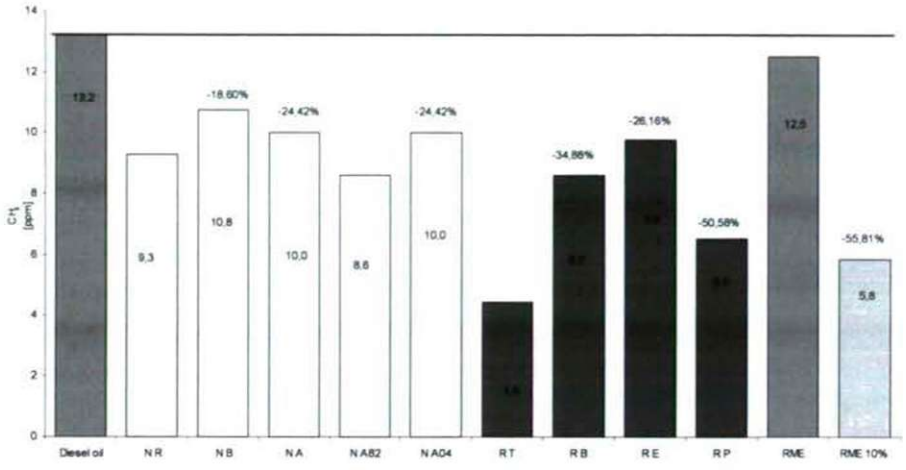

Figure 5. CH emission values [Farkas, 2009]

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*).

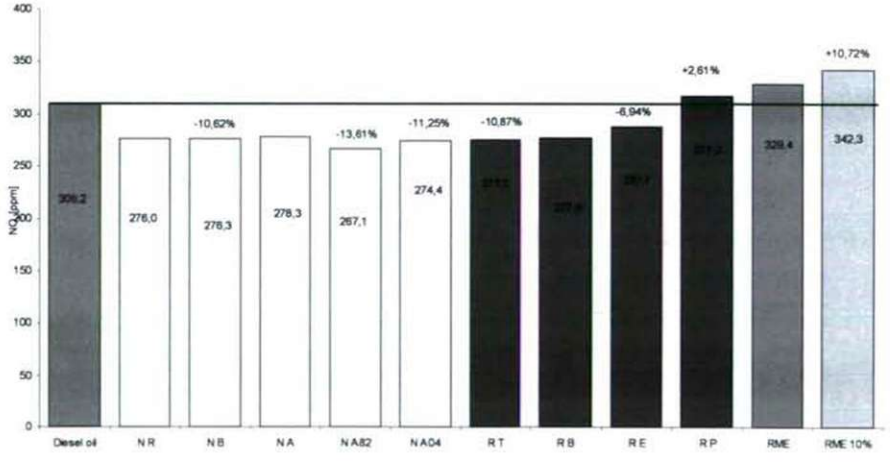

Figure 6 NO_x emission values [Farkas, 2009]

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 derivates tested by us are suitable for use as diesel engine fuel.

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