Reduction of CO_2 emissions by using biogas as a fuel for small spark ignition engines

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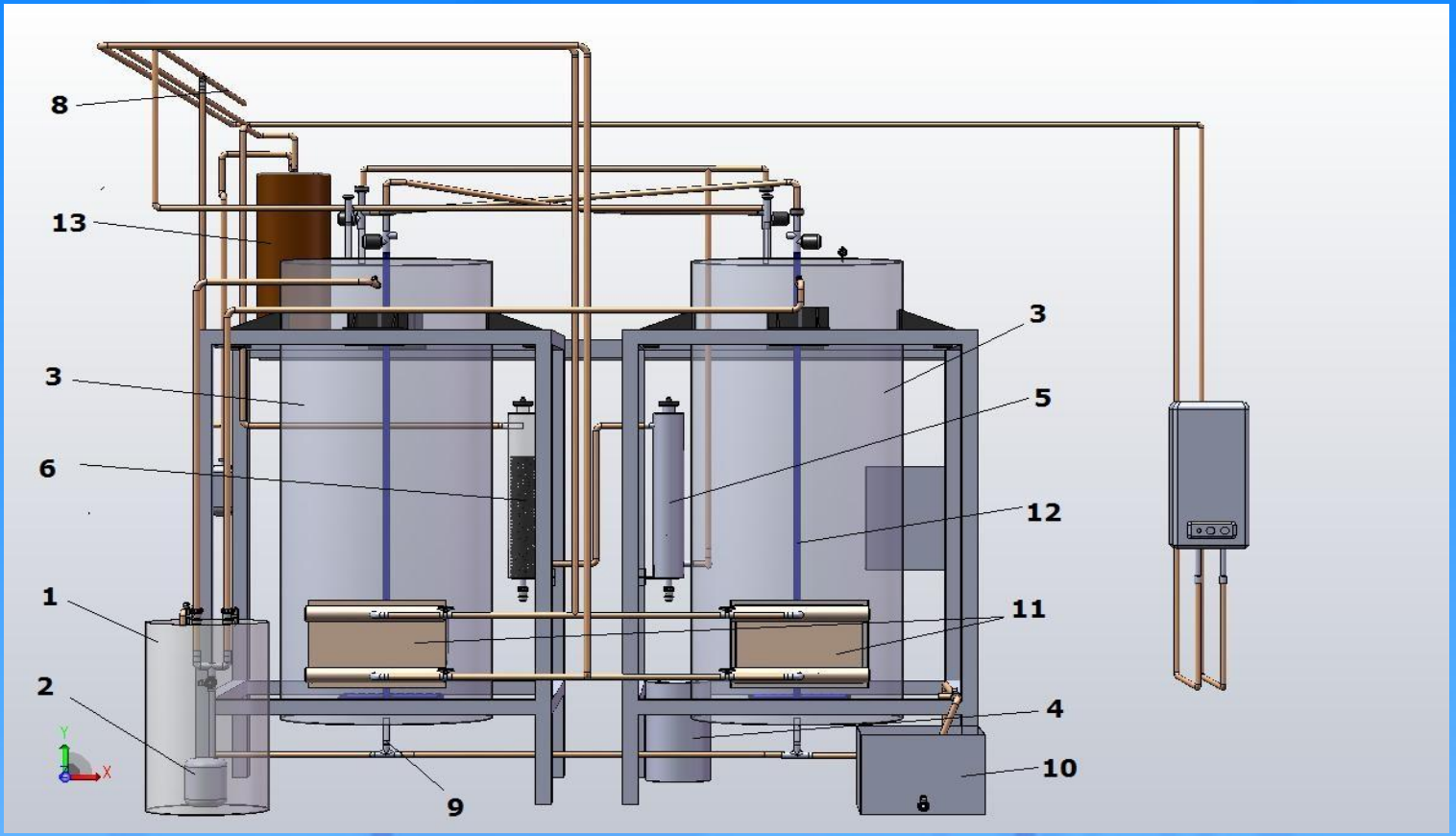
ABSTRACT

- One of the major advantages of using renewable energies is the reduction of CO_2 emissions which is one of the most important Greenhouse gases which is produced in large quantities in present times;
- Biogas can be a suitable fuel for different applications in small spark ignition engines;
- The paper presents a comparative study related with the reduction of CO_2 emissions from using biogas instead of natural gas or gasoline for a small spark ignition engine of 2.2kW;
- In the paper are also presented some of the characteristics (high and low calorific values) for different biomass batches used for obtaining biogas through anaerobic fermentation process.

INTRODUCTION

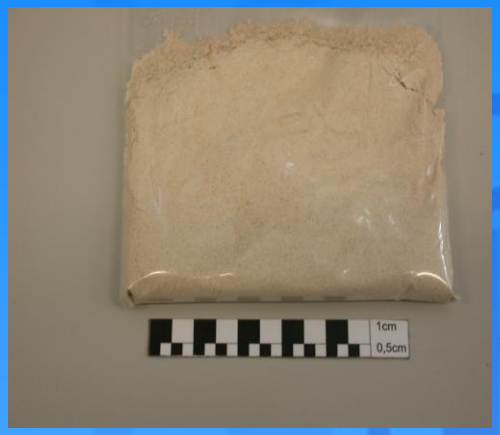
- The use of biomass has for millennia helped human society to fulfill many of its fundamental energy needs, such as for the production of goods, cooking, domestic heating and the transport of people and goods;
- One of the technologies used for energy recovery from biomass residues (practically considered waste) is the production of biogas through anaerobic fermentation;
- Biogas could become – according to its physical, chemical, and thermal characteristics - one of the most important alternative fuels, with CO_2 neutral emission, and can potentially replace natural gas and oil as it can contribute to maintain mobility, while other alternative sources of electrical energy and heat generation are available (wind, solar energy, etc).

PILOT PLANT DESCRIPTION



Pilot plant components : 1 – preparation tank, 2 – pump, 3 – fermentation reactors, 4 – correction agent tank, 5 - filter for retaining the H2S, 6 - system used for retaining CO2. 7 - adjacent system for CO2 desorption and compression, 8 – consumer , 9 - gravimetric system, 10 – system for neutralizing the resulting liquid, 11 – heating system, 12 - bubbling system, 13 - small tank for biogas samples.

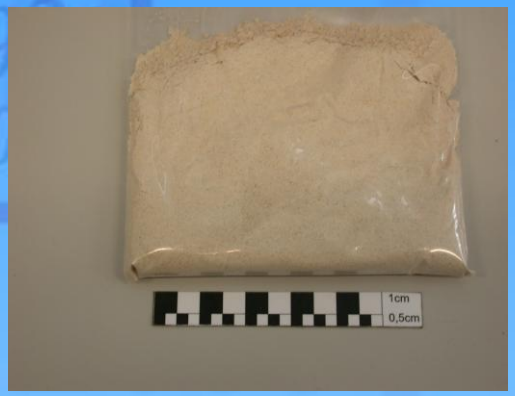
GENERAL PRESENTATION FOR DIFFERENT BIOMASS TYPES



Mix of maize and corn waste

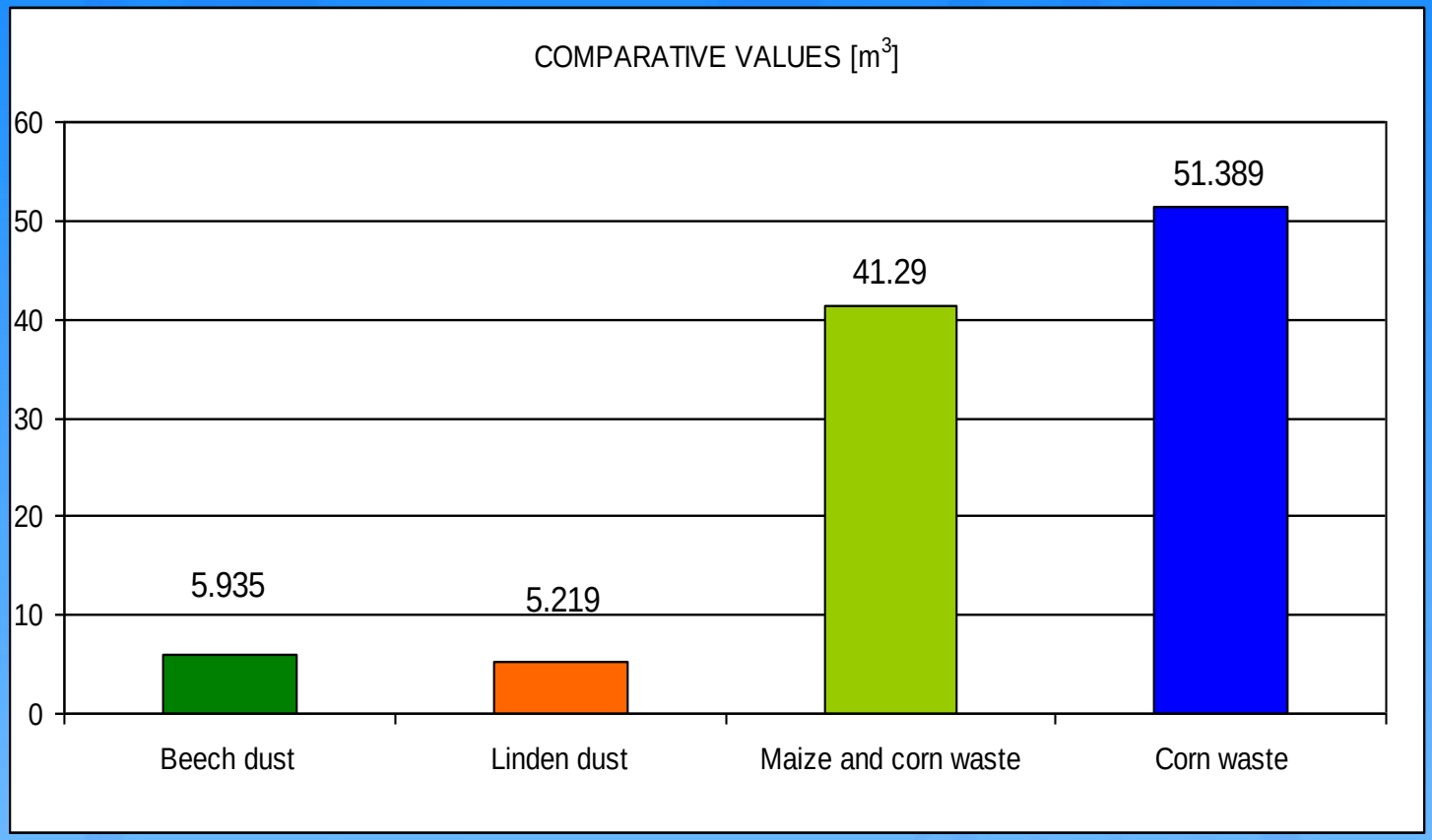
Grains of corn Waste

Beech dust



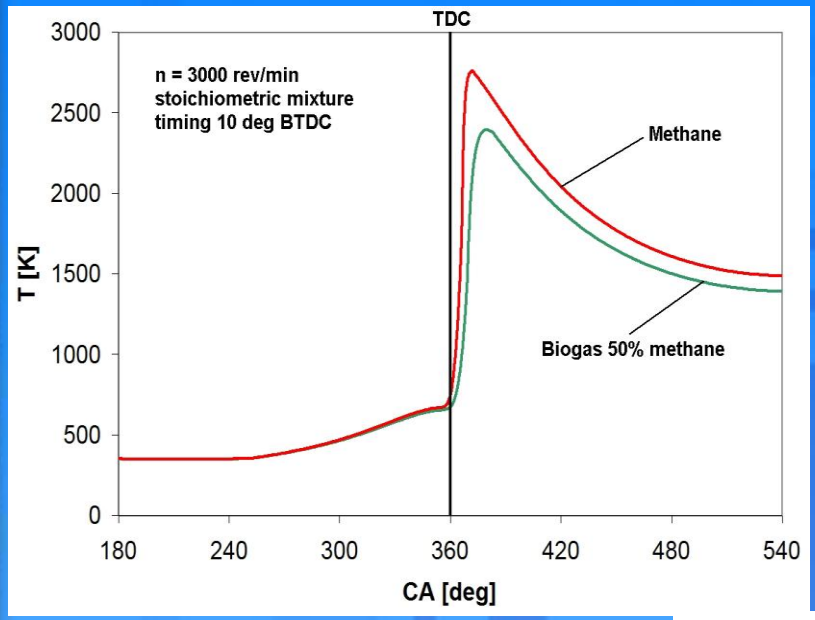
Linden dust

GENERAL PRESENTATION FOR DIFFERENT BIOMASS TYPES



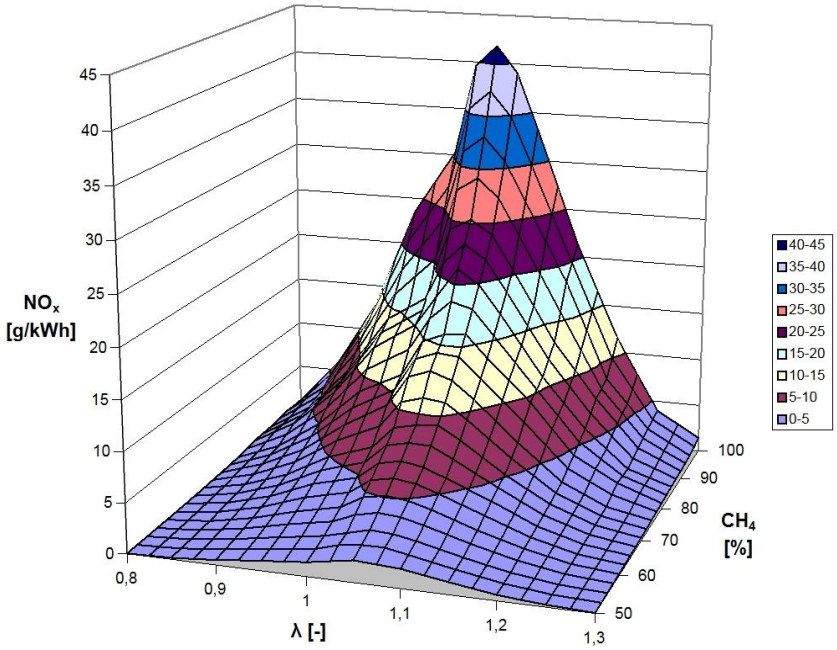
Comparative results regarding the biogas amount

STUDY AND DISCUSSION



Simulated temperature values vs. crank angle rotation for methane and biogas with 50% methane content during compression and expansion strokes

Calculated NOx emissions for different biogas quality values, engine speed 3000 rev/min



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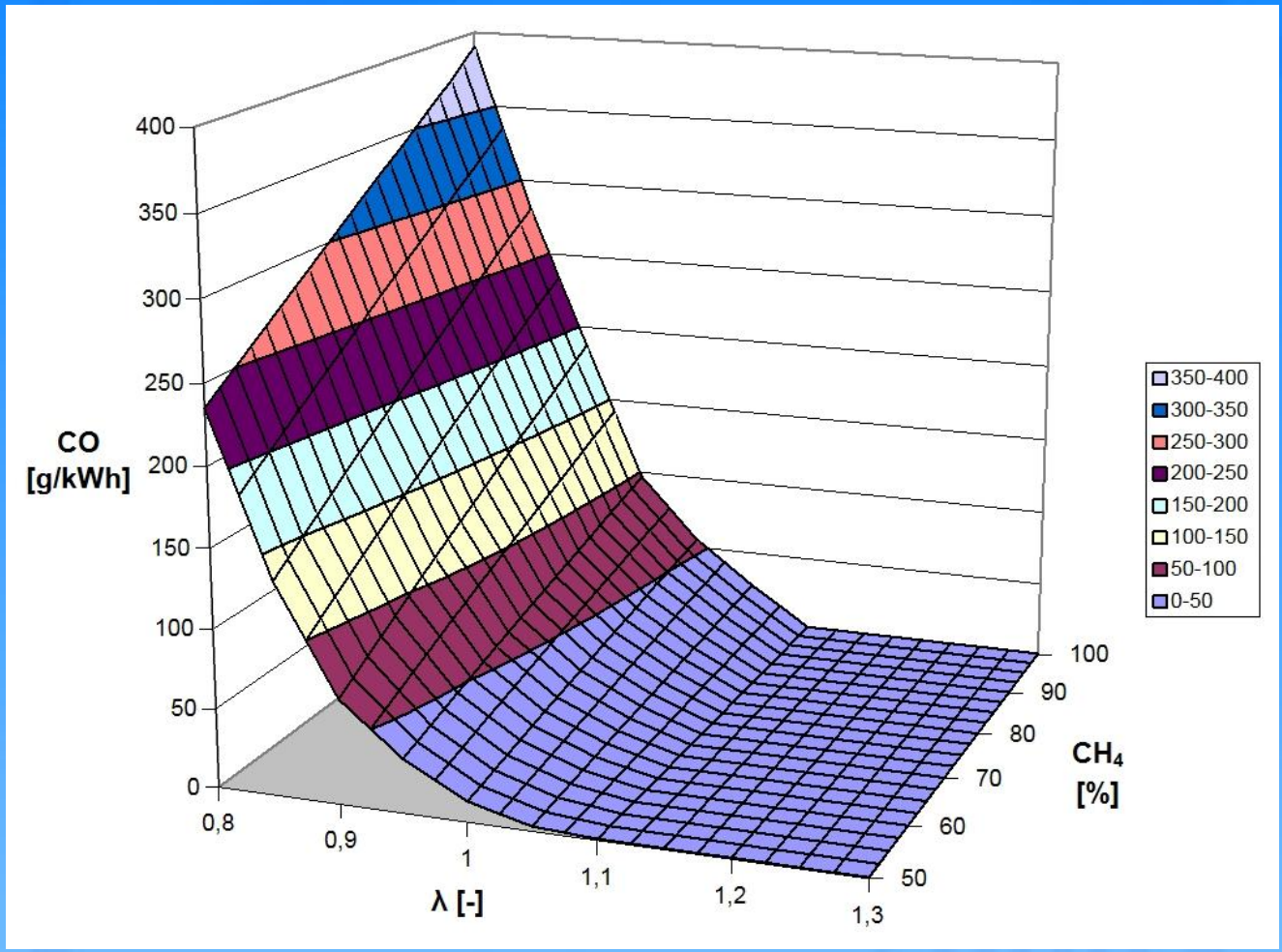
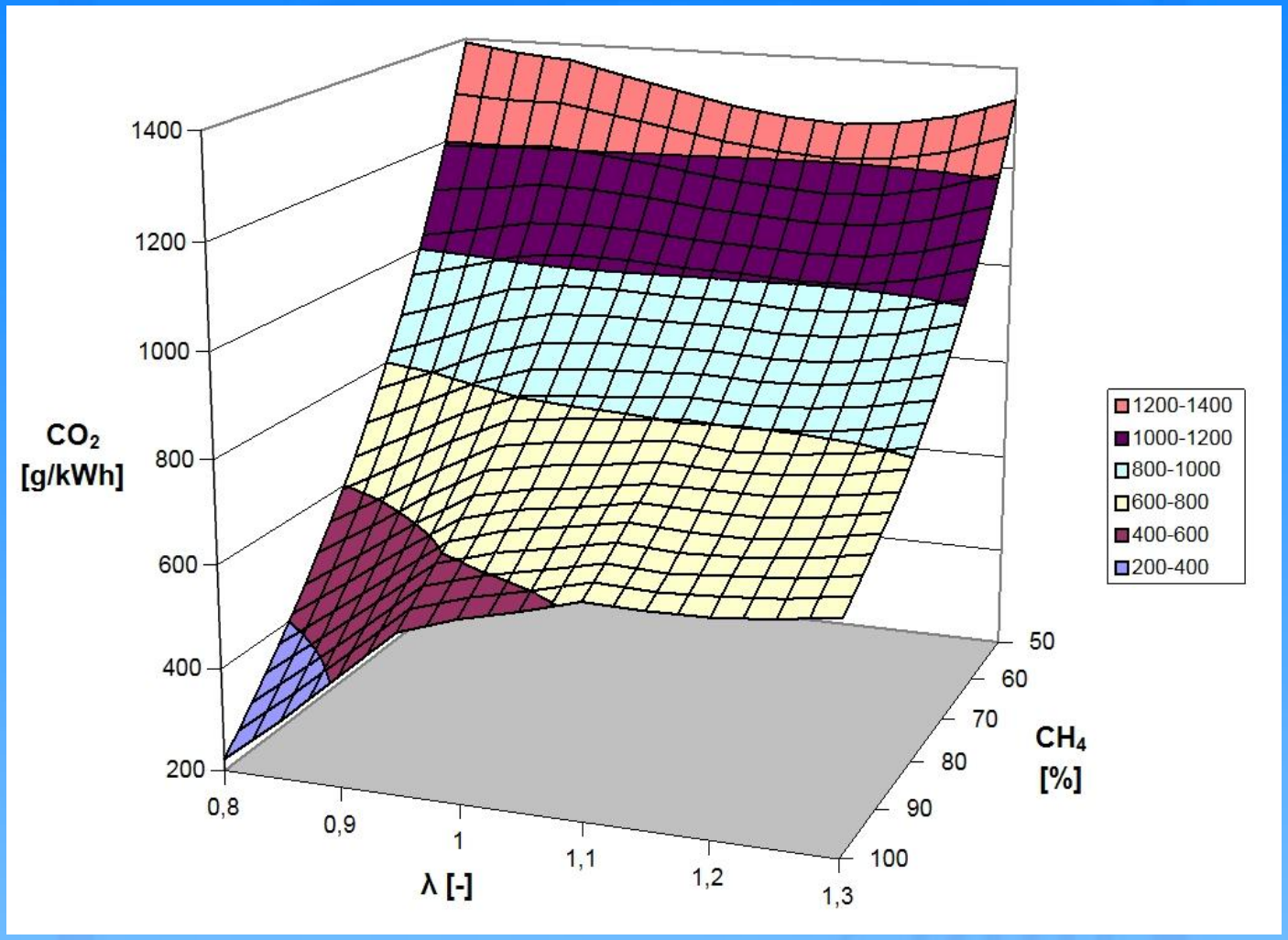
STUDY AND DISCUSSION



Calculated CO emissions for different biogas quality values, engine speed 3000 rev/min

STUDY AND DISCUSSION



Calculated CO_2 emissions for different biogas quality values, engine speed 3000 rev/min

STUDY AND DISCUSSION

Fuel	P_e [kW]	η_e	η_g	η_t	m_{fuel} [kg]	CO_2 emission [t/year]
Gasoline	2,2	0,3	0,98	0,76	7131	22329
Natural gas					6203	17058

Calculated CO_2 annual emissions

CONCLUSIONS

- **Biomass represents an inexhaustible energy resource that can be used for biogas production, both by anaerobic fermentation and other processes (aerobic fermentation, gasification), a state of art technology for anaerobic fermentation process being presented;**

- **Through experimental determinations it was determined that the agricultural residues produced much more biogas than the woody material and because of this, it is very important to find different solutions to solve the problem of the difficult degradation of the ligno – cellulose chains;**

- **Reported to the applications that biogas may have for combustion process, using biogas to produce electricity and heat in a co-generation plant can reach high levels of efficiency and might support the development of so called green chain for energy transformation;**

CONCLUSIONS

- **Taking into account the conversion of engines from gasoline to biogas, a proper assessment of the emission values should highlight the best strategy to exploit the engine. The quality of biogas is an important factor, with an important impact on efficiency and emissions level. A high methane content increases combustion efficiency and temperature values are correlated with higher emissions of NOx and sometimes also the CO concentration are altered;**

- **Engines operated with low quality biogas have high CO_2 emissions, simultaneously reached with high levels of unburned hydrocarbons, which are eliminated in the atmosphere, due to the limited development of the combustion process in the presence of CO_2 content in biogas.**

- **As general conclusion, the authors consider that biogas is to be taken into consideration for fuelling small cogeneration systems working with spark ignition engines, as clear benefits versus the CO_2 reduction of fossil origin are demonstrated and other negative impacts (such as supplementary pollutant emission or loss in efficiency) might be properly solved**

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