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Experimental Research on Animal Fat Burning in Co-Combustion with Liquid Hydrocarbons

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Running title: **Animal Fat Burning in Co-combustion with Liquid Hydrocarbons**

Abstract
The research goal is to determine the possibilities to destruct animal fats by burning. The experimental research has defined the limits of application for the technology of animal fat co-combustion with liquid hydrocarbons. For that purpose a boiler has been used that is equipped with a specialized heater and a burner with mechanical pulverizing. The burning efficiency and the pollutant emissions were determined.

Practical applications
The actual possibilities to destruct animal fats by burning were studied as a means to achieve a higher efficiency of the destruction processes. Animal fats in various percentages were added to the liquid hydrocarbons of fossil origin to be used as fuel in specialized burning installations. The installation should comprise a specialized heater and a burner with mechanical pulverizing of the liquid state mixture of animal fats and of fossil liquid fuels. The research determined the pollutant emission levels and the efficiency of the burning installation.

Key words: animal fats destruction, liquid hydrocarbons co-combustion

Introduction

The research work done with respect to the animal fats combustion has derived from the environmental requirements from the tannery industry in Romania. In the manufacturing processes of the animal hides, proteins and animal fats result. The proteins, in 80% proportion to the fats, are currently researched in the bio-gas generation by anaerobic digestion processes.

The researches in the present paper are complementary to the fats burning in the diesel internal combustion engines, in researches performed also in the University Politehnica of Bucharest. The optimal dosage in that technology was 15%.

Experimental boiler description

Research and experimental verification were conducted on a boiler pilot, model Multiplex CL 50, the boiler being manufactured by the company Thermostahl with a thermal power output of 50 -55 kW and it is used for living spaces heating, that have a total volume of up to 1500 m^3.

The boiler installation includes a frontal enclosure, equipped with a burning grate, the flame of the pulverized liquid fuels being above the grate. The water heating is achieved using smoke pipes placed horizontally inside a convection heat exchanger that is placed above the furnace. The boiler has natural draft.

The boiler water temperature is directly controlled by the systems with which the control panel is fitted, namely: thermometers, thermostats and safety thermostat. When the water temperature reaches the desired level, the thermostat of the burner interrupts its operation. The optimum temperature is around the 80° C value, and that does not go below 60° C (see Figure 1).

The burner used is of the type:
GB – GANZ: ANYO – 12/R-2-1-0
Year 2007 Manufactured EN 29254 RO
Fuel: liquid fuel type C.L.U.
Connection pressure: 0,5 bar
Electrical connection parameters: voltage 230V; 50 Hz – 950W; IP20
Certification ISCIR CERT Nr. : 001E
Power PE=2000W for the electric heater for the fuel, in temperature range of (0°C – 200°C).

Because it is designed for burning of type M light liquid fuel, the burner has two stage pressure control for the pulverizing of the fuel. The burner is also fitted with an automated burning system, an ignition system and a flame monitoring system (Figure 3).

Experimental burning of animal fats dosaged in fossil liquid fuels

The dosage of the animal fat in the light liquid fuel was made for the mass ratios of 10%, 20% and 30%

The figure below illustrates the fat weighing operation to achieve those dosages (Figure 4).

The light liquid fuel mixture with the animal fat for the above mentioned proportions was homogenized by heating between 45°C and 50°C in the heater attached to the burner. This mixture was aspired by the burner pump through a system of flexible pipes.

The following figure shows the light liquid fuel mixture before homogenizing the mixing fat mass of 10%.

In Figure 6 the variation of pulverizing pressure for different dosages of animal fats is presented.

In Figure 7 is displayed the variation of the boiler efficiency for different animal fats dosage proportions.

The main pollutant emission levels were: $SO_2 \approx 2$ ppm; CO = 550 – 790 ppm; NO = 90 – 152 mg/m^3_N.

The air excess coefficient level was
$\lambda = 2.25\text{-}2.43$.

The stack flue gas temperature was:
t_{ev}=340 -378°C,
the resulting boiler efficiency being: 70.4-82%.

The elemental analysis for the light liquid fuel was:
87.8% C, 11.4% H, 0.0% S, 0.335% O, 0.04% A, 0.0% W,
with LHV=43277 kJ/kg.

The elemental analysis of the fat animal waste from tannery was:
68-74% C, 10-11% H, 0.0% S, 14.8-17.8% O, 0.18-0.25% N,
with calculated LHV range 33500 - 35000 kJ/kg.

Conclusions

The research proved the possibility of burning animal fats in mixture with fossil liquid fuel. Good performances were obtained for the actual burning process (flame length, smoke degree, pollutant emissions), and as well for the energy producing installation, that is the hot water boiler.

Unlike the burning in the diesel internal combustion engines, the burning of the mixture of animal fats with fossil liquid fuels allowed for the increase in the fats percentage. The present tests were stopped at the 30% value for the participation of fats in the mixture.

The general layout of the burning process points out to the conclusion that the proportion of animal fats in the mixture with fossil liquid fuels could be evidently enhanced.

Acknowledgements

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Figure 1. The experimental pilot boiler, mounted to the water delivery system and to the flue gas evacuation

Figure 2. The preheating system of the fuel

Figure 3. The liquid fuel burner

Figure 4. The animal fats in the dosage phase

Figure 5. The mixture of 10% animal fats in the light liquid fuel

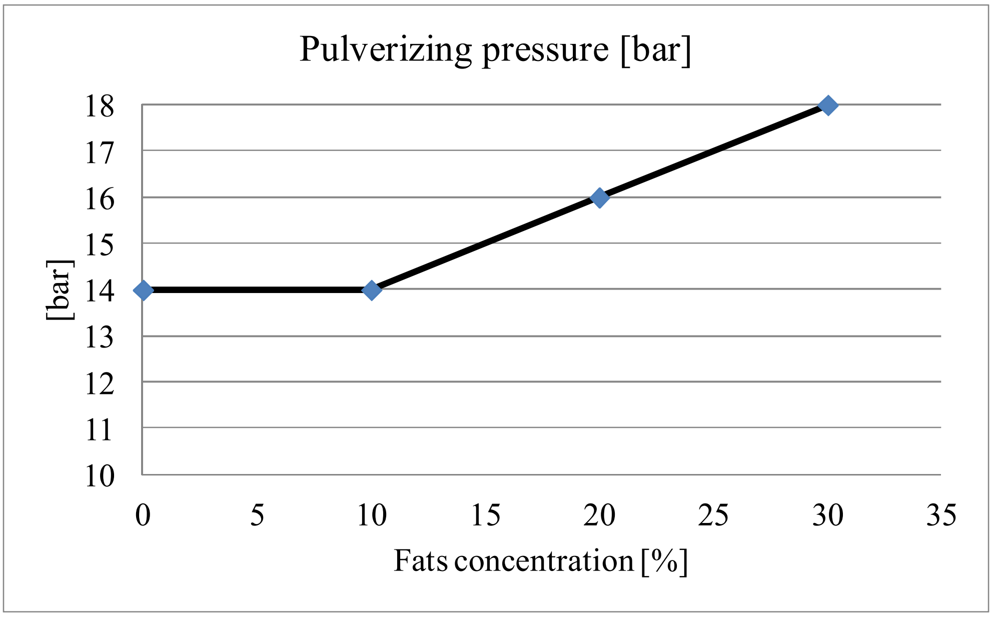

Figure 6. Pulverizing pressure

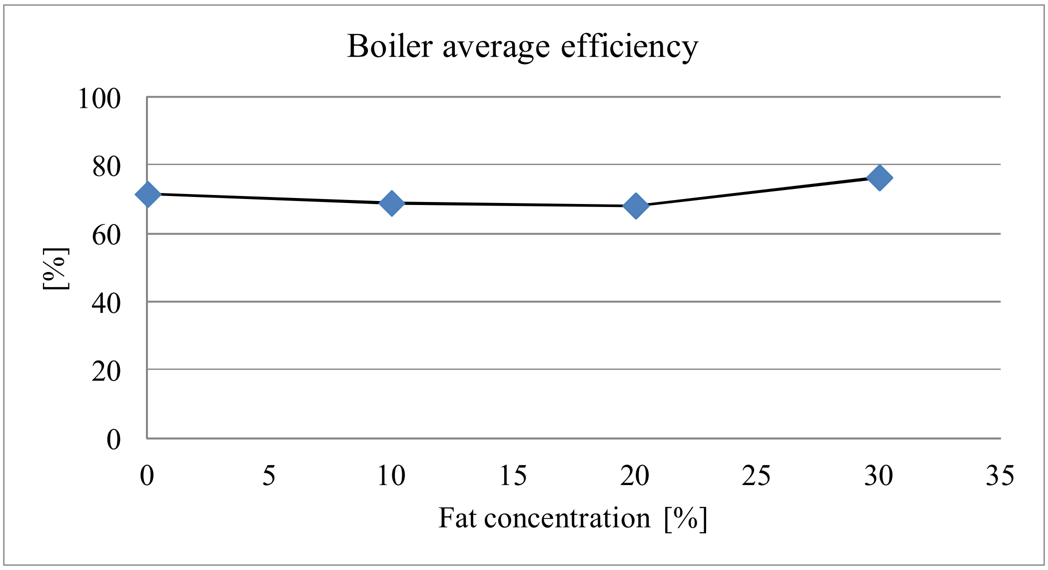

Figure 7. Boiler efficiency variation as a function of the animal fats concentration in the fossil liquid fuel