Marcin LANDRAT[1] and Waldemar ŚCIERSKI[1]

POSSIBILITIES OF ALTERNATIVE FUEL (BIOFUEL) APPLICATION IN INDUSTRY

MOŻLIWOŚCI ZASTOSOWANIA PALIW ZASTĘPCZYCH (BIOPALIW) W PRZEMYŚLE

Abstract: Apart from the growing requirements related to environmental protection and imposed emission limits, the industry is encountering yet other difficulties. It regards, eg the increasing prices of fossil fuels, which are the key factor determining the production costs and the final price of the product. In these circumstances it appears to be reasonable to use alternative fuels, which could facilitate the achievement of lower level of harmful substances emission without lowering the quality of the obtained final product and reduce production costs. Moreover, the application of the fuels alternative to the typical fossil fuels used in industry could protect it from a probable situation where natural resources of the currently used fuels run out or their accessibility is hampered. In a technical process, fuel should comply with specific technical and economic requirements as well as possess necessary physicochemical properties. We also need to consider a number of factors which may limit the application of specific fuels due to the equipment operation conditions (eg furnaces), the permissible final plant emission and the required quality of the final product. These are mainly its fuel and physicochemical properties that determine the application of particular fuel.In the article laboratory test results of four possible alternative fuels (biofuels) and mazout treated as a reference substance are discussed and the compliance of each fuel with established requirements is specified.

Keywords: alternative fuels, biofuels, industry, mazout, fuel properties

Fuel applied in technical processes should comply with specific technical and economic requirements as well as possess necessary physicochemical properties. Moreover, there is a number of factors limiting the possibility of fuel applications which are the result of the furnace operation conditions, permissible final plant emission and required quality of the final product. Usage of alternative fuel should be economically justified - the costs of obtaining fuel resources should be reasonable and their producer (supplier) should ensure the continuity of supply. Applied fuel should, above all, meet the requirements of the plant where it is to be used. The behaviour of a specific substance in the process conditions should be known and it should be adjusted to those conditions [1]. These are mainly its fuel and physicochemical properties that determine the application of a particular fuel.

Alternative fuels under study

Laboratory tests were intended to determine the fuel and physicochemical properties of liquid fuels considered for the application in industry.

Five types of liquid fuels were used for tests:

- mazout,
- two types of petrol produced based on plastics - KTSF,
- technical glycerol,
- animal fat - Saria.

[1] Department of Technology and Installations for Waste Management, Faculty of Energy and Environmental Engineering, Silesian University of Technology, ul. Konarskiego 18, 44-100 Gliwice, phone 32 237 21 22, fax 32 237 11 67, email: marcin.landrat@polsl.pl, waldemar.scierski@polsl.pl

Mazout

Mazout is currently one of the basic liquid fuels used in industry. Its calorific and emission properties as well as its behaviour in the process conditions are known. In the conducted tests, mazout was treated as a reference substance.

Petrols produced based on plastics - KTSF

KTSF is a substance produced based on plastics. Raw materials used for its production include mainly polyolefines, that is polyethylene (PE) and polypropylene (PP) derived from wastes, usually packaging. The final product is applicable in petrochemistry for fuel production, household chemistry as raw material for the manufacturing of such chemical products as eg: paraffins, pastes, lubricants and dividing liquids [2].

Two KTSF samples were used for testing. The first sample contains 20% of the final product, the second sample contains 80% of the final product.

Technical glycerol

Glycerol is formed in the process of esterification of plant oils which results in the formation of methyl esters of higher fatty acids (biodiesel). Plant oils most commonly used for the process of glycerol production include: colza, sunflower, soybean, maize as well as palm and olive oils [3].

Technical glycerol is used as a substance for chemical syntheses and as a semi-finished product for the production of pharmaceutical glycerol in the process of low pressure distillation. Technical glycerol is not classified as a hazardous substance, it is biodegradable and does not pose a threat to human health. It is an inflammable substance, its vapours are heavier than air and it may form flammable mixtures with air [4].

The yearly growing processing capabilities of plants for biodiesel production result in the overproduction of glycerol in Europe to the extent which exceeds the demand of the cosmetic and pharmaceutical industry. Therefore, a gradual decrease of the price of this substance is predicted as well as the intensification of researches on the economic application of technical glycerol [5].

Animal fat - Saria

Saria is a fuel produced based on animal wastes derived from agriculture and food industry (slaughter houses, plants processing animal products). This substance is produced inter alia as the result of processing of the fat derived from dead animals or those slaughtered not for consumption purposes as well as from animal wastes derived from animals intended for consumption, including fish wastes [1].

Fuel and physicochemical properties testing

Fuel and physicochemical properties testing covered the evaluation of the content of:

- sulphur,
- carbon,
- hydrogen,
- measurement of the ignition temperature,

- chlorides,
- combustible particles,
- determination of gross calorific value,
- calculation of calorific value.

Laboratory tests were conducted in the laboratory of the Department of Technologies and Installations for Waste Management, pursuant to the applicable methods and standards.

Analysis of the obtained results and alternative fuel selection

As regards the calorific value of tested fuels, KTSF petrols based on plastics showed most advantageous results. They have the highest calorific value (44 151 kJ/kg and 44 963 kJ/kg), greater than mazout (42 150 kJ/kg) and Saria (37 317 kJ/kg). Technical glycerol had the least advantageous results, since its calorific value amounted merely to 16 450 kJ/kg.

Carbon and hydrogen content reached similar levels in all fuels (77.44÷88.78% carbon and 9.42%÷11.09% hydrogen), only in case of glycerol the content of these elements was significantly lower (35.03% carbon and 5.09% hydrogen). Sulphur content was highest in mazout (1.48%). In other fuels it did not exceed 0.5% and for KTSF petrol of the 2nd sample it amounted to 0%.

In case of aggressive compounds which include chlorides, all tested fuels demonstrated their content within the following range: from 305.4 mg/kg (mazout) to 601.5 mg/kg (KTSF petrol of 2nd sample) calculated to HCl. All tested fuels have high content of combustible matter - in all cases it amounted to over 99%.

The ignition temperature value, depending on the type of fuel, reached various levels. For KTSF petrol, the ignition occurred already at 26 and 27ºC. The ignition temperature of mazout was 86ºC. The highest ignition temperature was discovered in case of Saria (244ºC) and technical glycerol (256ºC).

Summary and conclusions

Based on the analysis of the conducted tests, technical glycerol and KTSF petrols were excluded from the considerations about using them as alternative fuels. Technical glycerol was rejected due to its too low calorific value, while KTFS petrols were eliminated due to the very low ignition temperature, which poses a threat to the process safety. It was concluded that only animal fat, Saria, may be qualified for the application in a thermal process.

Conduction of a combustion process with the usage of alternative fuel without co-combustion with mazout would be difficult to perform both due to technological reasons (Saria's parameters are less stable than those of mazout and its properties may differ depending on the supply) and due to the strict emission standards for fuels produced from wastes. Therefore, it is suggested to co-combust Saria with mazout in the proportion of 40% of Saria to 60% of mazout.

However, the application of additional fuel in the form of Saria is connected with expenses for the assembly of a required continuous monitoring system of gas impurities in the plant as well as with other difficulties resulting from the environmental regulations. Namely, the plant where co-combusted fuels are produced from waste animal fats must

comply with the regulations on waste co-combustion plant, and consequently, with much more strict emission standards for specific substances emitted from the plant.

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MOŻLIWOŚCI ZASTOSOWANIA PALIW ZASTĘPCZYCH (BIOPALIW) W PRZEMYŚLE

Katedra Technologii i Urządzeń Zagospodarowania Odpadów
Wydział Inżynierii Środowiska i Energetyki, Politechnika Śląska, Gliwice

Abstrakt: Poza zwiększającymi się wymogami związanymi z ochroną środowiska oraz nakładanymi limitami emisyjnymi przemysł napotyka na coraz to inne utrudnienia. Dotyczy to m.in. wzrastających cenach paliw kopalnych, które są kluczowym czynnikiem determinującym koszty produkcji oraz cenę końcową produktu. W tej sytuacji uzasadnione wydaje się być zastosowanie paliw zastępczych, dzięki którym można by osiągnąć niższy poziom emisji substancji szkodliwych bez obniżenia jakości otrzymywanego produktu końcowego oraz obniżyć koszty produkcji. Ponadto stosowanie w przemyśle paliw alternatywnych dla typowych paliw kopalnych mogłoby chronić go przed trudnościami spowodowanymi wyczerpywaniem się zasobów naturalnych używanych obecnie paliw lub też dostęp do nich stałby się utrudniony. W procesie technicznym paliwo powinno spełniać określone wymogi techniczne, ekonomiczne oraz mieć odpowiednie właściwości fizykochemiczne. Należy również mieć na uwadze szereg czynników, które mogą ograniczyć zastosowanie określonych paliw ze względu na warunki eksploatacyjne urządzeń (np. pieców), dopuszczalną emisję końcową z instalacji oraz wymaganą jakość produktu końcowego. O zastosowaniu danego paliwa decydują głównie jego właściwości paliwowe i fizykochemiczne. W artykule omówiono wyniki badań laboratoryjnych czterech potencjalnych paliw zastępczych (biopaliw) oraz mazutu, traktowanego jako substancja odniesienia, a także określono zgodność każdego z paliw z wyznaczonymi wymaganiami.

Słowa kluczowe: paliwa zastępcze, biopaliwa, przemysł, mazut, właściwości paliwowe