STEAM GASIFICATION PROCESS ENHANCEMENT WITH ALKALI AND ALKALINE EARTH-RICH WASTE MATERIALS

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INTRODUCTION

Among various methods to resolve the problem of process optimisation, the enhancement by use of catalytic materials seems to have noticeable potential in the field. The addition of various elements in their compound of metallic form in low amounts is reported to influence such process parameters as the process kinetics and syngas composition. Among all possible elements from which several like noble metal[1] s and alkali or alkaline earth metals[2] have been already confirmed to have such influence, the latter seems to be the most promising due to not only to resulting high process efficiency[3] but also due to their lower prices. This work aims to adjust this discovery into the application-ready product by proposing a cheap waste-based additive for steam coal gasification. A comparison between the use of the additive and the process without it have been presented.

EXPERIMENT

The experiment was performed with bituminous coal obtained from Janina mine. Rich in potassium, sodium and calcium waste material was obtained from industrial sector that in normal utilisation procedure performs its onsite incineration. Both samples were air-dried and ground 0.2 mm in diameter size. The proper fuel blend of coal and waste material was prepared based on data on best possible alkali presence with sodium and potassium as a priority due to their best influence[4]. As a result, fuel blend with waste addition no bigger than 10% was created (labelled as JB).

Both samples were steam gasified in laboratory scale gasifier in two different temperatures (800 and 900°C) and under the stable pressure of 10 bars. The gasifier used argon as a carrier gas with a flow of 2l·min^{-1} and distilled water as a steam source with intake of 0,3 ml/min. The composition of resulting syngas was measured by NDIR flue gas analyser. Total syngas yield was determined by calculating the yield of each product from the area under curve dV·dt^{-1}=f(t). The carbon conversion degree was also evaluated with use of the volume of carbon-based gaseous products with given equation (1):

$$X(t) = \frac{(V_{co}(t)+V_{CO2}(t)+V_{CH4}(t))\cdot M_C}{V_{mol}\cdot m\cdot C^{daf}} \cdot 100\ \% \qquad (1)$$

where:

$V_{CO(t)}$, $V_{CO2(t)}$, $V_{CH4(t)}$ - volume of released gas component at standard conditions as a function of time, dm^3*g^{-1}
V_{mol} - volume of one mole of gas at temperature of 273 K and pressure of 101325 Pa, dm^3*mol^{-1}
M_c- molar mass of carbon, g*mol^{-1}
m – sample mass, g
C^{daf}- dry ash free carbon content, -

RESULTS AND DISCUSSION

The results have shown a noticeable increase in carbon conversion degree after addition of the additive. Depending on the temperature its conversion degree rose from 60.7% and 74.7 to 73.5 and 94.3%. Such results mean that the presence of additive increased the selectivity of the process into gaseous products instead of undesired tar side products. Fig 1. Also shows that hydrogen and carbon oxides which are the most important constituents of syngas were recorded to have the highest yield increase after utilisation of the additive.

Carbon to syngas conversion [wt%]		
RT[°C]	**Coal**	**J blend**
900	74.7	94.3
800	60.7	82.8

Table 1 Degree of carbon conversion to gaseous products

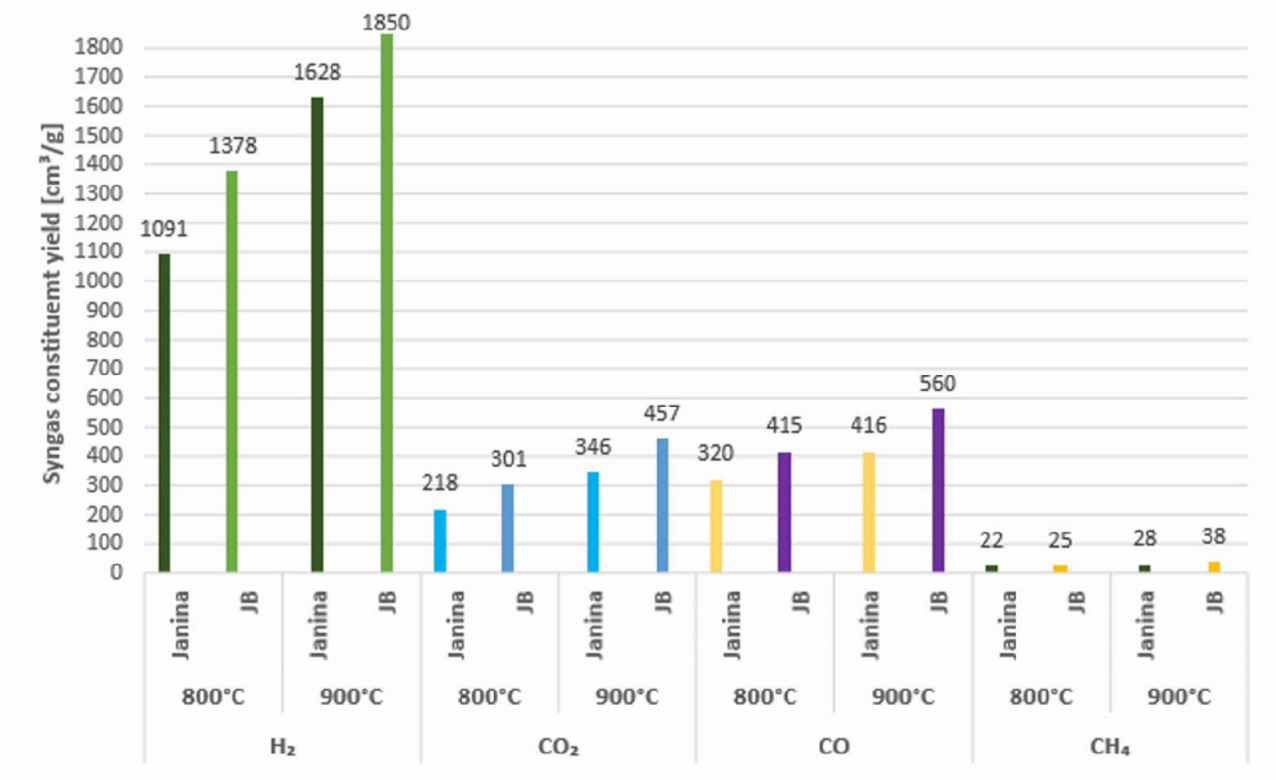

Figure 1 Yield of syngas of syngas produced from additive-free coal and from tested fuel blend during steam gasification process in different temperatures

CONCLUSION

This experiment has proven that it is still possible to greatly enhance already well-researched processes like steam gasification with both simple and cheap approaches. The next step in the popularization of this method will be an analysis of additive influence on low-quality hard coals, which are main feedstock of choice for this type gasification processes.

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