

Conditioning of a biomass gasification product gases for supplying a combustion engine

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The consequence of biomass gasification is generation of a gas mixture composed mainly of hydrogen, carbon mono and dioxide, and methane, called SNG (Substitute Natural Gas) which can be utilized as an alternative fuel for internal combustion engines. However, the product gas mixture cannot be directly supplied to the engine due to variability of its composition as well as its impurities. This brings the necessity to conduct a series of procedures of gas purification and conditioning before supplying the engine. This paper therefore deliberates a concept of gas conditioning method.

INTRODUCTION

Inasmuch the most common engine fuel is still fossil fuel, researches all over the world are working on alternative ones.. Recently, it is attempted to obtain alternative combustion engine's fuel as a result of the biomass gasification process. The composition of this gas indicates that it is possible to use it in an combustion engine. The reaction of biomass gasification produces gaseous mixture of hydrogen, carbon mono and dioxide, and methane. That mixture is called SNG (Substitute Natural Gas). The gasification process however, is burdened with formation of undesirable products like for example tar, particulate matter, light hydrocarbons, sulfur oxides, chlorine compounds, as well as nitrogen compounds like nitrogen oxides or ammonia. It is necessary to appropriately and accurately perform the process of gas purification and conditioning before supplying the combustion engine. Therefore in this paper concepts of gas conditioning method are presented.

THE TEST STATION AND THE EXPERIMENT

The laboratory gasifier was designed of metal container with volume of 1 dm<sup>3</sup>. It was equipped with the systems of gas conditioning and suction pump installed between reactor and the burner. The first step was the dolomite reactor. Each experiment assumed reactor operation within the range of temperature of 700-800°C. Moreover, the test station was equipped in a set of laboratory gas scrubbers with various filling materials for gas conditioning. When the experiment was completed, the content of gas scrubbers was subjected to chemical analysis in order to determine the contaminates removed from the gas by particular filling material. Each scrubber contained 150 ml of substance.

A total of 7 experiments in which always 200 g of wood pellet with humidity of 6% was gasified. The resulting syngas was directed to the system of gas conditioning.

Table 1. gas conditioning system configuration used in experiment 5

Gas scrubber 1	condensate prior to the catalyst reactor
Gas scrubber 2	condensate after catalyst reactor
Gas scrubber 3	rapeseed oil methyl ester (RME)
Gas scrubber 4	distilled water
Gas scrubber 5	aqueous solution Na <sub>2</sub> CO <sub>3</sub> (condens. 99,0%)
Gas scrubber 6	methanol
Gas scrubber 7	rapeseed oil
Gas scrubber 8	material (bandage)



Figure 1. Gasification and gas conditioning system, used in experiment no. 2

SUMMARY

- The basic pollution generated in the process of gasification include a large amount of tar (liquid pollutants) and gaseous pollutants, such as sulfur oxides, nitrogen oxides, and chlorine compounds
- the dolomite reactor is very effective in removing *inter alia* tar
- nitrogen oxides are removed by distilled water, sulphur compounds in aqueous solution, chlorides in aqueous solution of sodium carbonate, and with ammonia in distilled water or methanol (due to the low efficiency of contaminants removal the use of methanol scrubber is not necessary)
- The chromatographic analysis done in order to identify the volatile organic compounds (VOC) revealed only the presence of n-pentane which would suggest that during the process the hydrocarbons of lower order (alcohols, ketones) are formulated

CHEMICAL ANALYSIS

The colorless materials, or materials with minor coloration inside the gas scrubbers such as distilled water, aqueous solution of Na<sub>2</sub>CO<sub>3</sub>, or methanol was analyzed by method of spectrophotometry UV-VIS. For those sample a quantitative ion (SO<sub>4</sub><sup>2-</sup>, S<sup>2-</sup>, Cl<sup>-</sup>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup> and NH<sub>4</sub><sup>+</sup>) was used. Identification of those ions informed about reduction of for example sulfur oxides, nitrogen oxides, hydrogen sulfide, chlorines, etc. Tests were performed using a spectrophotometer cuvette tests HACH LANGE DR 3800.

The samples with active carbon which was used in experiments 6 and 7 was analyzed in terms of qualitative and quantitative content of volatile organic compounds in the gas, due to the fact that active carbon is excellent sorbent of those compounds. VOCs identification was performed by means of gas chromatography (GC) method.

RESULTS

Studies in which the method of UV-VIS spectroscopy was applied allowed to determine the content of analyzed ions in various scrubbers. This enabled the assessment of a particular substance ability to purify syngas. The amount of ions was also summed in order to obtain information about the total contents of impurities in the gas.

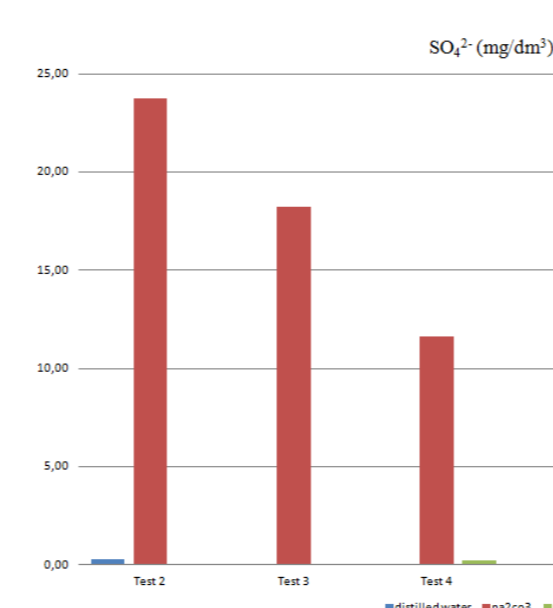


Figure 2. The amount of absorbed ions SO<sub>4</sub><sup>2-</sup> in the individual absorbers in subsequent experiments.

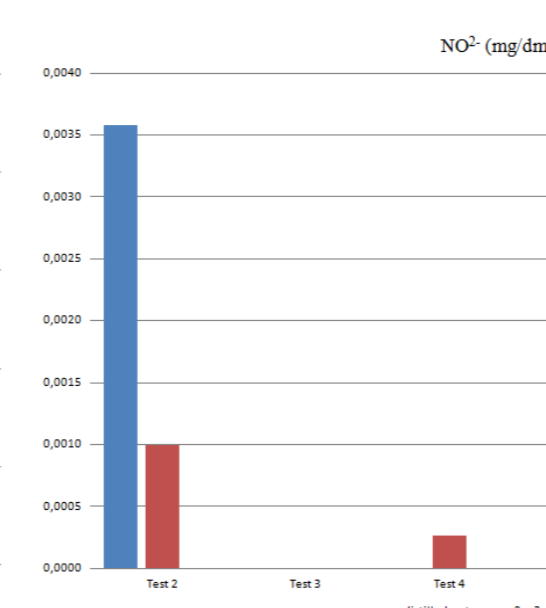


Figure 3. The amount of absorbed ions NO<sub>2</sub><sup>-</sup> in the individual absorbers in subsequent experiments.

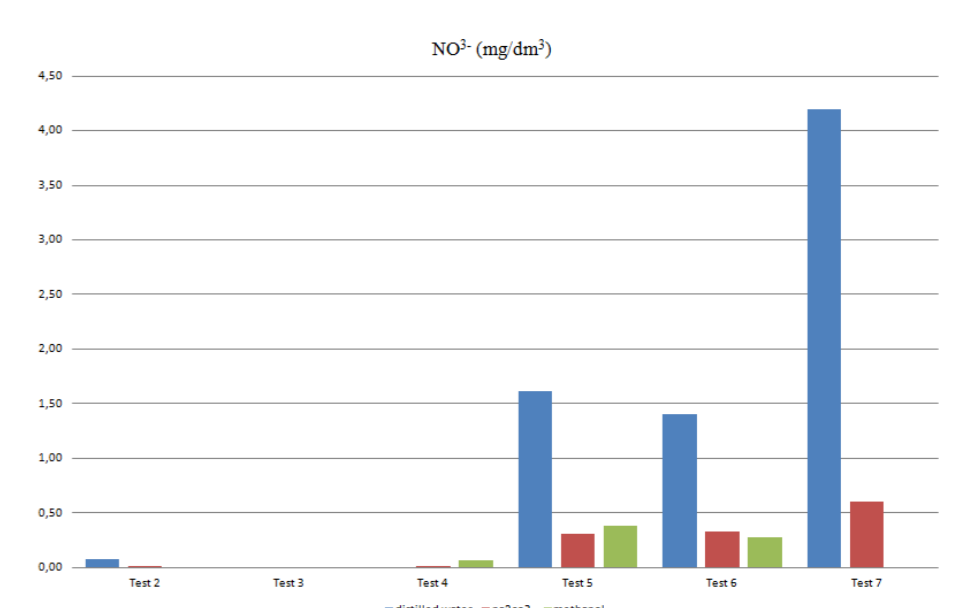


Figure 4. The amount of absorbed ions NO<sub>3</sub><sup>-</sup> in the individual absorbers in subsequent experiments.

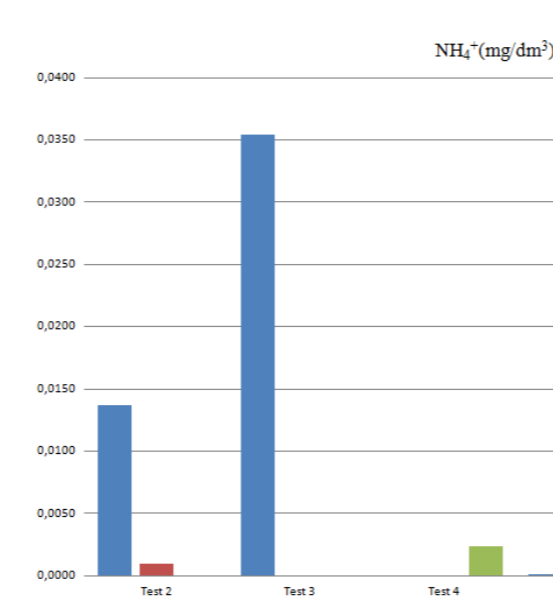


Figure 5. The amount of absorbed ions NH<sub>4</sub><sup>+</sup> in the individual absorbers in subsequent experiments.

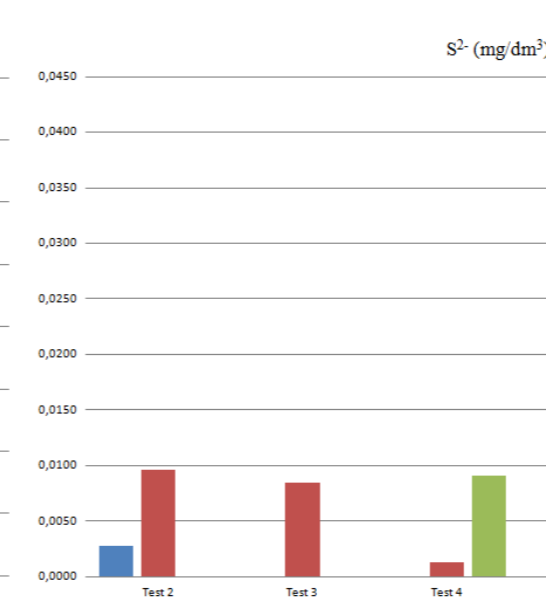


Figure 6. The amount of absorbed ions S<sup>2-</sup> in the individual absorbers in subsequent experiments.

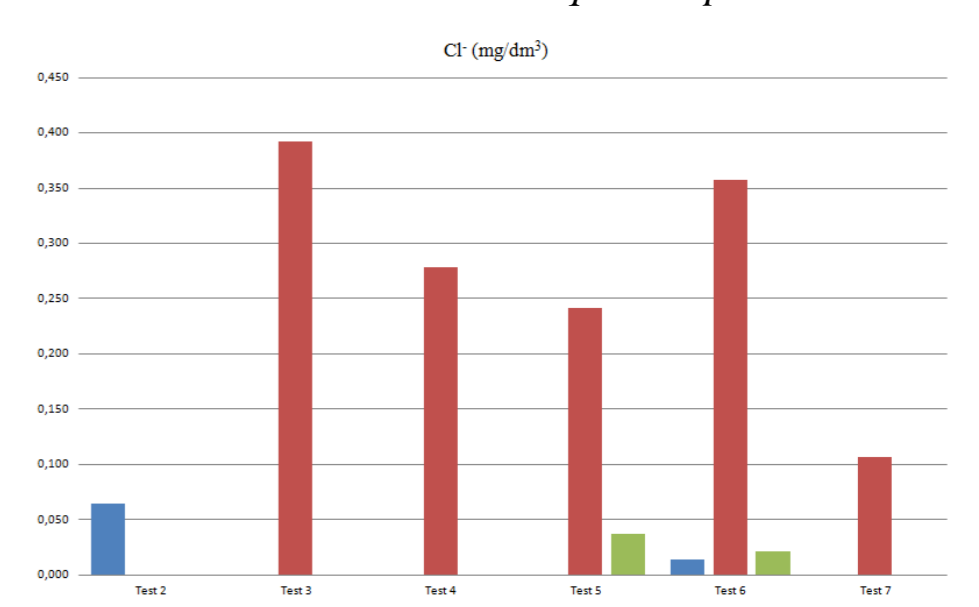


Figure 7. The amount of absorbed ions Cl<sup>-</sup> in the individual absorbers in subsequent experiments.

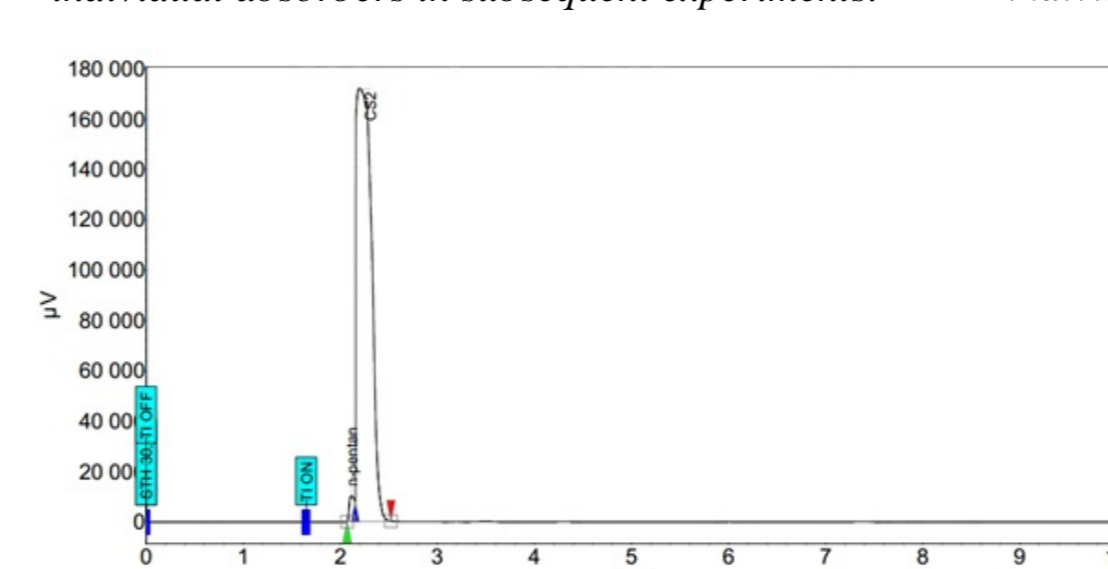


Figure 8. The chromatogram obtained from the GC analysis of the experiment 6

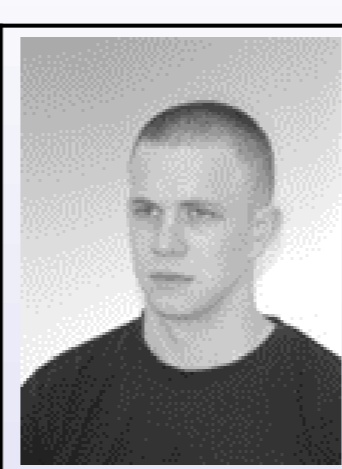
Table 2. The values of the concentration of hydrocarbons in the samples of experiments 6 and 7 ( mg/dm<sup>3</sup>)

Exp. 6		Exp. 7	
Sample 1	Sample 2	Sample 1	Sample 2
1075,2	1083,8	3118,1	3230,9

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