Reconstructed gasification technology

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Abstract: - The article describes the reconstructed gasification technology, which works in autothermním mode. The technology is housed in the complex VSB - Technical University of Ostrava at the Energy Research Center. Over the years, various modifications have been made to the technology, and the last modification that was made in 2016 is described in the article. Comparative tests of the same pellets were performed on the modified technology, followed by an RDF fuel test, a pellet and a mixture of these fuels. The monitored parameters of the assay, the chemical composition of the gas, the amount of generated dust and tar.

Key-Words: - gasification, autothermal generator, pellets, RDF, fuel mixture, chemical composition of gas.

1 Introduction

The Research Energy Center started to deal with gasification in 2006, when it began building the first version of the gasification technology. This technology utilizes autothermal gasifier fixed bed. The technology uses air as a gasification medium. Over the years, various modifications were made to the technology. Various gas purification apparatuses have been tested (dolomite reactor, high temperature filter and scruber). Also, it is changing the internal lining of the reactor and transport to the treatment reactor. Over the years, dozens of tests were performed agro different, different mixtures of fuel and recently conducted tests with fuel RDF.

2 Gasification technology

The technology is based on the generator autothermal traveling grate in two axes (horizontal and vertical). The generator has a heat output of 100 kW and can operate at temperatures of 750-1000 °C. This technology uses various types of fuels, such as chips, wood pellets, pellets from various agro materials, coal and RDF. The gasification technology works after all the refurbishments, with the same gasification mode, and this is an autothermal. [1-5]

The technology consists of a fuel tank, from which the fuel is conveyed via two screw conveyors. The first screw conveyor is horizontal and transports fuel to the edge of the generator where the second screw conveyor is. This screw conveyor is vertical and conveys fuel above the grate, from the generator core. In the generator there are fuel reactions with the medium (drying, pyrolysis, oxidation, reduction) in which syngas is formed. The gas thus produced is further passed through a high-temperature filter where solid pollutants are removed and the filter is operated at temperatures higher than 450 ° C. Subsequently, the gas is produced into the coolers and then into the exhaust ventilator. The last part of the technology is the combustion chamber where the gas is burned. Fig. 1. [1-5]

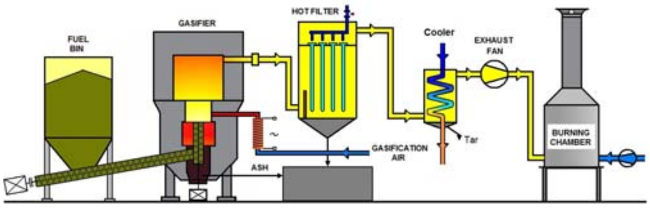

Fig. 1. Scheme gasification technology

2.1 Adjustment of gasification technology

To adjust the gasification technology was done because there were large heat losses. Another reason why it was decided to reconstruct, a large number of tests performed various fuels, and possible damage to the inner lining. These fuels have caused ash melting on the inside lining and grate. After the reactor was dismantled, it was found that the inner lining is on melts of different types of fuels. When precise prohlídnutí lining of cracks were detected, see Fig. 2. [1-5]

Fig. 2 Reactor lining with melted fuel parts and visible crack

Upon detection of cracks in the inner lining had to proceed with the reconstruction and adaptation of technologies. Modification was carried out in 2016. The reconstruction included: production of new inner lining, production of a new moving grate and adjusting the lower and upper part of the generator. [1-5]

Reconstruction started by adjusting the lower and upper part of the generator. The adjustment of the upper part of the generator consisted in fixing the upper part of the generator to three beams, Fig. 3. The lower part of the generator was mounted on a structure with mechanical jacks and mounted on the rails. The lower part of the generator was mounted on the rails to simplify the dismantling of the generator. This has resulted in quicker access to the inside of the generator and the possibility to inspect the inner lining after the tests have been performed. [1-5]

Fig. 3. generator on consoles

A new internal lining was built into the reconstructed generator and was fitted with an oscillating grate (Figure 4). The oscillating grates have been designed to allow movement in two axes (horizontal and vertical). Double Axis movement prevents the ash from fueling on the walls of the reactor lining. Also it makes it easier to fall through the ash from the generator to the ash blowing agent. This oscillating grate allows you to test fuels that have a problem with crushing ash. The grate has been awarded model No. 29866. [1-5]

Fig. 4. The new lining generator with oscillating grid

The visual comparison generator before and after the adjustments made, see Fig. 5.

Fig. 5. Generator before and after reconstruction

3 Comparison of monitored parameters before and after the generator is reconstructed

The tests performed were performed under the same conditions. The gasification temperature was 850 ° C, the gasification medium was air and the fuel used was pellets. For each test, an online measurement of the chemical composition of the gas took place.

Sampling tars, which were observed at the following parameters: chemical composition and quantity of generated tar pitches.

3.1 Comparison of produced gases

When comparing the gas produced, the gas produced before the reconstruction was in some components better. It is obvious that the gas before, had a higher hydrogen content and almost twice as large as it was after the reconstruction. It can also be seen that after the reconstruction the oxygen content in the gas has increased more than three times. This is why the gas is better than the reconstruction before reconstruction. After this comparison leakage was detected, the air intake point was at the screw conveyor. This leak was the reason for lower gas quality after the reconstruction. See table 1. [1-5]

	Compounds (% Vol.)						
	CO	CO_2	CH_4	C_nH_m	H_2	O_2	LHV (MJ/m^3_N)
Pellets - Before	25,8	9,6	3,8	0	10,7	0,7	5,5
Pellets - After	17,0	10,8	4,9	0	5,3	2,5	4,5

Table 1 The produced gases before and after the reconstruction

3.2 Comparison of tars

When comparing the tar formed by gasification of wood pellets, the reduction of the tar yield by one-third, after the reconstruction, is evident. Decreasing the tar is attributed to the oscillating grate, because the oscillation and forfeiture of the used fuel into the ashtray. Consequently, there is no further fuel response in the generator. [1-5]

	Before	After
	[mg/m^3_N]	
Naphthalene	1171	884
Benzene	5366	2667
Toluene	2313	1794
Xylen	353	189
Styren	783	594
Total tar	9986	6129

Table 2 The resulting tars and dust

4 Characterization of fuels used in new testing

4.1 Refuse Derived Fuel (RDF)

RDF can mean all types of incinerable waste. Among these wastes we can count on municipal, industrial and commercial waste. RDF fuel is an already sorted waste, which can consist of non-recyclable plastics, cardboard, rubber, various fabrics, wood. RDF is a fuel for which there is no precise classification, specification, and even legislative authorities have not provided any precise guidance on the composition of this alternative fuel.

This test used Palozo II fuel from OZO Ostrava s.r.o. Palozo consists of municipal and industrial waste and its percentage composition is: 61% plastics, 20% wood, 11% paper, 8% textiles. The basic properties of fuel are evident from the chemical analysis of the fuel Tab 3. and fig. 6. [2]

	Chemical composition Paloza II (%)						HHV (MJ/kg)	LHV (MJ/kg)
	A^d	S^d	H^d	C^d	Cl	U	Q_s^r	Q_i^r
Palozo II	12,63	0,03	7,95	59,51	0,18	±0,07	25,49	23,7

Table 3. Paloza II analysis

Fig. 6. Palozo II

4.2 Pellets

Pellets are made of dry softwood. These are granules with a diameter of 6 mm in length 10-20 mm, they have high calorific value, low ash content. See table 3. [2]

Chemical composition (%)			HHV (MJ/kg)	LHV (MJ/kg)
	A	W	Q_s^r	Q_i^r
Pellets	0,24 ≤ 0,48	5,92 ≤ 7,01	≤ 18,47	≤ 17,05

Table 4 pellet composition

5 Evaluation of the test

Each fuel was gasified separately and subsequently gasified in a 50/50% mixture. The test of these fuels was carried out at 850 ° C and air was used as the gasifying medium. During the test, the following parameters were observed: chemical composition of the gas, amount of dust, amount of tar and tar composition. [2]

5.1 Comparison of produced gases

The chemical composition of the gas produced is in the following table. Most carbon monoxide (16,9%) was produced during the gasification of pellets, but carbon monoxide (11,8%) was produced in the mixture of pellets and RDF. By gasification of pure pellets, most of the hydrogen was produced (5,3%), while at least hydrogen (4,4%) was produced in pure RDF. By measuring the composition of the gas it was found that the highest calorific value of the produced gas had clean pellets (4,5 MJ / m^3_N) and the lowest calorific value of the gas had a fuel mix (3,7 MJ / m^3_N). [2]

Fuels	Compounds (% Vol.)						
	CO	CO_2	CH_4	C_nH_m	H_2	O_2	LHV (MJ/m^3_N)
Pellets 100%	16,9	10,8	4,9	0	5,3	2,5	4,5
Pel/RDF 50/50%	11,8	10,8	4,8	0	4,9	2,8	3,7
RDF 100%	12,8	7,8	5,7	0	4,4	2,7	4,1

Table 5 the composition of the gases produced

For a more detailed picture, the methane formation was inserted into the chart below. It can be seen from the chart that most of the methane originated from the pure RDF gasification. In contrast, the formation of methane from fuel pellets and the mixture is almost the same. See chart 1.

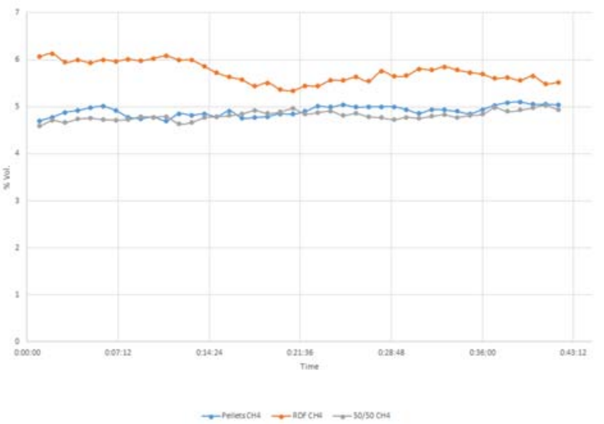

Chart 1 Methane formation

5.2 Comparison of the amount of dust and tar

The following table shows the amount of dust generated and the amount of tar produced. The least tar results from the combustion of pure RDF and most of the gasification of the pellets. Totally the opposite result came from the dust, most of the dust was generated by the gasification of RDF and at least the pellets. See table 6.

	Pellets	50/50	RDF	Units
Tar	970	400	330	mg/sample
Dust	0,68	1,22	1,10	g/sample
Chemical composition of tar				
Naphthalene	221 000	297 600	260 100	µg/sample
Benzene	121 720	299 200	443 700	µg/sample
Toluene	73 610	103 200	154 530	µg/sample
Xylene	22 270	14 176	23 103	µg/sample
Styrene	123 590	187 200	348 840	µg/sample

Table 6 Summary amount of tar, dust and tar composition

6 Conclusion

After a reconstruction of the generator and subsequent tests. Some shortcomings have been identified and subsequently removed. Comparative test and result comparison were found to reduce the formation of tar.

Subsequent implementation of the RDF test, pellet and fuel mixture. It confirmed the possible use of RDF as a fuel for gasification and thus gas production. This gas could be used in cogeneration units to achieve better gas utilization and also to generate electricity and heat.

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