frauscher motors

Research project:

Biomass gasification burner for a Stirling CHP

Project period: October 2018 to September 2020
Promoted by EFRE and the State of Upper Austria
Project Manager: Franz Diermaier

Project description

A new type of combustion reactor based on the principle of wood-countercurrent gasification with subsequent direct combustion of the wood gas was developed and tested for thermal utilization and conversion of solid biomass into electricity. In the form of a micro combined heat and power plant (CHP), the thermal energy obtained in this way can be converted into CO2 neutral electrical energy in combination with a Stirling engine. In particular, the formation of dust (fine dust, ash and unburned biomass) and gaseous tar should be reduced to a minimum through primary measures in order to prevent contamination of the Stirling heat exchanger in favour of long-lasting high efficiency and to reduce environmental pollution. Secondary air preheating has been integrated to further increase efficiency . The plant was also equipped with an automatic pellet feed and ash removal.

Results

When operated with wood pellets, the gasifier achieved a fuel heat output of 26.4 kW. The primary air ratio was at λ =0,32 and the total air ratio at 1.6. These are characteristic values for this type of carburettor.

Table 1: Mean gaseous emissions of individual test periods with and without air preheating

Date	Air preheating	O_2	CO	NOx	orgC	PM exhaust	PM Combustion chamber
[dd/mm/yyyy]	[-]	[Vol%]	[mg/Nm³]*¹	[mg/Nm³]*¹	[mg/Nm³]*¹	[mg/Nm³]*¹	[mg]
09.06.2020	without	8,0	145	243	<2*²	5,8 (55%*³)	2,2 (66%*³)
10.06.2020	with	7,9	110	372	3	7,1 (38%*³)	3,8 (46%*³)
*¹relating to 5% O_2, *²: Value is less than the detection limit, *³: Proportion of unburnt in %							

According to the measurements in Table 1, both gaseous and dust emissions are well below the emission limits applicable in Austria for combined heat and power plants in this performance class. .

Summary

After a total of 115 hours of operation, the initially problematic tar deposits were brought under control in addition to stable wood gas production and combustion. For this purpose, the usual low temperature above the fuel bed in this type of gasifier was increased by partial oxidation. This prevented condensation of the tar-containing product gas. By designing the system as a countercurrent gasifier, very low dust emissions (fly ash, unburned biomass) could be achieved due to the good filter effect of the fuel bed. Excessive dust could lead to fouling of the Stirling engine‘s heat exchanger, reducing performance and efficiency over time.

For more information on the research project, please contact Franz Diermaier (DW 8272)