The design, construction and operation of a 75 kW two-stage gasifier

Ulrik Henriksen[a,*], Jesper Ahrenfeldt[a], Torben Kvist Jensen[a], Benny Gøbel[a], Jens Dall Bentzen[b], Claus Hindsgaul[a], Lasse Holst Sørensen[c]

[a]*Biomass Gasification Group, Department of Mechanical Engineering, Technical University of Denmark, 2800 Kongens Lyngby, Denmark*
[b]*COWI, Parallelvej 15, 2800 Kongens Lyngby, Denmark*
[c]*ReaTech C/O CAT Post Box 30, 4000 Roskilde, Denmark*

Abstract

The Two-Stage Gasifier was operated for more than 2000 h. This paper will focus on the first tests (465 h). During these tests the gasifier was operated automatically unattended day and night, and only small adjustments of the feeding rate were necessary once or twice per day. The operation was successful, and the output as expected. The engine operated well on the produced gas, and no deposits were observed in the engine afterwards. The bag house filter was an excellent and well operating gas cleaning system. Small amounts of deposits consisting of salts and carbonates were observed in the hot gas heat exchanger. Analysis showed that the metal part of the reactor, where the char bed is located, was not corroded. The top of the reactor had to be reconstructed in some other material.
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1. Introduction

Development of processes for thermal gasification of biomass has been going on for many years. One of the main problems has been the presence of tars in the produced gas. Tars damage internal combustion engines, gas turbines and other machinery. Therefore gas cleaning and reduction of the produced tar has been the subject of many research projects [1]. Gasification processes producing only very low amounts of tars will have great potential as tar treatments can be avoided [2].

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* Corresponding author. Fax: +45 45 93 57 61.
  E-mail address: ubh@mek.dtu.dk (U. Henriksen).

Fig. 1. Picture of the Viking gasifier in operation.

At the Biomass Gasification Group, MEK, DTU the Two-stage gasification process has been developed during the last 14 years. The main advantages of the two-stage gasification process is, that contrary to most other gasifiers, tars are only present in very small amounts in the produced gas [3,4].

Test runs of up to a few days duration of different manually operate two-stage pilot plants have been carried out. After this, a small-scale demonstration plant for fully automatic operation for at least 1000 h was established at DTU. The small scale (75 kW thermal) was chosen for economical reasons. It was decided to use wood chips as fuel.

The gasifier called 'Viking' (see Fig. 1) is a traditional two-stage gasifier which means that the pyrolysis and char gasification takes place in separate reactors (see Fig. 2).

Between the pyrolysis and the gasification, the pyrolysis products are partially oxidised by means of air addition. Thus the tar content in the volatiles is reduced by a factor of 100 and thermal energy for the endothermic char gasification is produced.

When the partially oxidised pyrolysis products pass through the char bed in the char gasification reactor, the tar content is further reduced by a factor of 100.

The resulting tar content in the produced gas is less then 15 mg per Nm^3 [5].

2. The plant

The plant consists of a number of main components, which will be described briefly in the following

2.1. Feeding system

A container with a conveyer in the bottom feed the wood chips to a screw conveyer. A lock hopper system (two valves separated by a screw conveyer) secures that no gas escapes the system. After this