

Mop Fan and Electrofilter: an innovative approach to cleaning product gases from biomass gasification

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Abstract from the report

The results of the EMF project showed that proper gas cleaning and conditioning in smaller gasification plants can be achieved by combining innovative components. All of proposed components of the innovative gas cleaning and conditioning system including the gascooler, the mop fan cleaning unit and the electrostatic precipitator (ESP) have been tested individually and collectively with biomass fluidized bed gasifiers. The mop fan cleaning unit has been thoroughly characterised at University of Nottingham (UNOTT), whereas the gas cooler, the ESP and the integrated system of the gas cooler, the mop fan and the ESP have been tested at Berlin Institute of Technology (TUB).

The mop fan cleaning unit was successfully applied to the cleaning of the product gas from the laboratory-scale (2 ~ 3 kg biomass/hr) biomass fluidized bed gasifier at UNOTT. Different fan rotating speeds and different flow rates of spray water were tested to optimise the performance of the mop fan gas cleaning unit. The particle removal efficiency with the tested mop was in the order of 50% without spraying water and as high as 90% if a small amount of water was sprayed on the mop fibres. The mop fan also showed a promising potential in removing water soluble species, e.g. N-species (ammonia etc.) in the product gas, with the removal efficiency of more than 80% achievable.

The gas cooler with structured tubes provided by ERK Eckrohrkessel GmbH has greater efficiency in heat exchange compared with the straight tube design. Preliminary qualitative analyses of residues in the heat exchanger indicated some minor deposition of tar compounds on the internal tubes. To quantify the fouling of the gas cooler, more operational time with the gas cooler on stream is needed.

Quench and ESP from Beth Filtration GmbH showed their capability for tar removal from the gas. The condensation of heavy tars takes place mainly within the Quench, whereas aerosols (droplets of water, tar and from the quenching medium (Rape Methyl Ester (RME)) or small particles are separated in the electric field of the ESP. Compounds which are present in the product gas in gaseous form or as vapour are almost unaltered by the electric field of the ESP. The quenching/washing unit before the ESP is necessary to bring down the temperature to a point where tar substances will condense on condensation nucleus. The removal of benzene, toluene, and xylenes (BTX) and parts of the naphthalene is strongly dependent either on a low temperature in the system or on an adequate washing medium. It seemed that not all RME was removed by the ESP. Improvement in the Quench design (nozzles, size and flow regime) and adaption of the gas velocity and residence time in the subsequent electric field could lead to better performance.

The testing of the integrated system has been carried out with the originally proposed component sequence (Gas Cooler, Quench, ESP and Mop Fan) with TUB gasification plant. The mop fan cleaning unit which uses a fine spray to enhance gas cleaning had led to problems with the pilot burner (which

burns off the cleaned product gas) at the TUB plant. The amount of the fresh water used by for the mop fan cleaning unit had to be reduced significantly.

The results obtained with the project show that the originally proposed setup should be modified: following the gas cooler, the quenching unit is used to further reduce the gas temperature. In accordance with earlier findings in literature, a quenching system with oil or a tarry fraction of the collected quenching medium could be used to separate heavy tars from the gas. The waste water generated in the mop fan cleaning unit was an oily light coloured liquid with a strong solvent-like smell and could be used as the quenching medium. The mop fan cleaning unit can then be used for the removal of lighter tars by applying a compact device rather than large washing columns and finally the ESP is used to remove droplets of water and condensed tars from the gas.