Lecture 9.

Removal of tar and other impurities

Tar removal

High molecular weight compounds in the gas downstream of the gasifier begin to condense at temperatures less than 450^{o}C.The condensed material termed tar is partly deposited on the walls of the piping and partly remaining as an aerosol in the gas. The tar content hinders the removal of particulates from the gas and also causes problems with the subsequent utilization of the product gas. The type of biomass largely determines the nature of the tar produced which is also influenced by the gasification process and the operating conditions. Air gasification produces a low viscosity /low reactivity tar with a low molecular weight. High temperature gasification gives a tar with low oxygen content, consisting mostly of hydrocarbons. Research has shown the fixed bed down draft gasifier to be most capable of producing a low tar/tar free gas.

Two strategies can be applied to the removal of tar.

1. Improvement of the gasification technology so that no /little tar is produced.

2. Development of Tar removal processes.

Tar can be cracked into lower molecular weight compounds using either catalytic or thermal processes. Catalytic cracking takes place at 800-900^{o}Cand thermal cracking at 900-1100^{o}C. As gasification is usually in the range 800-900^{o}C, thermal cracking requires additional energy to heat the gas, which is usually achieved by introducing a small volume of air to enable combustion of part of gas to raise the temperature. While an effective method, thermal reducing the overall efficiency of conversion of biomass energy to gasification process. Catalytic cracking is therefore preferred, using catalysts such as dolomite, olivine and nickel compounds. A uniform and high temperature has been found to be the ideal combination to achieve the total cracking of tar.

Production of a very low tar content gas is best achieved by cooling the gas to 60-80^{o}C with water and using electrostatic precipitators to capture any aerosols. However, this approach collects water condensed from the gas during cooling, resulting in a waste water heavily contaminated with dissolved organic substances, which require appropriate treatment and/or disposal.

Trace impurities

The removal of N,S,Cl and other trace elements volatilized from the biomass during gasification is usually required for the most end users of the gas. Nitrogen compounds are mainly as ammonia, with some hydrogen cyanide being possible and can't be removed by filtration but require wet scrubbing with water or aqeous solutions, which cools the gas to about 50 ^{o}C. The

alternative to wet scrubbing is to leave the N compounds and to use low-NOx techniques during combustion, or selective catalytic reduction of the nitrogen oxides in the flue gas.

Chlorine content in the biomass is present usually as HCl in the gas from the gasifier, the concentration depending on the feed stock and gasification conditions. The removal of HCl is typically undertaken by wet scrubbing or absorption on active materials such as CaO/MgO.

The alkali components in the biomass particularly, Na and K compounds, are volatiles at high temperatures but it is uncertain which compounds are actually present in the gas. The alkali compounds cause corrosion of ceramic filters and turbine blades and the best way to reduce the concentration is to cool the gases to about 500 ^{o}C to condense the compounds and then filter the gas.