Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

ERA-NET Bioenergy | IEA FORSCHUNGS KOOPERATION | FFG Forschung wirkt. | klima+ energie fonds

Highlights of Bioenergy Research 2020
January 24th, 2020, Messe Congress Graz, Austria

Abstract

Reduction of ash-related problems in large-scale biomass combustion systems via resource efficient low-cost fuel additives

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The incineration of waste wood is very often associated with ash-related problems (deposits, slagging and corrosion). This leads to short maintenance intervals, mainly needed to remove ash depositions, which result in significant power generation losses and high downtime costs. To avoid these problems, additives can be used, with particularly cost-effective additives being of great interest. On the one hand, the purpose of the additives is to reduce the Cl concentration in deposits on heat exchangers, which is the main cause for corrosion. On the other hand, the additives shall increase the ash melting temperature of deposits and hereby reduce deposit formation. In a first step the combustion behaviour of 3 different waste wood mixtures without and with the addition of various low-cost additives such as recycled gypsum, coal fly ash and iron sulphide with two different addition ratios were investigated in a laboratory reactor. Using the laboratory reactor allowed the determination of suitable additives and ratios of additivation for further investigations in the industrial plant. This approach represents a cost-effective and time-saving method for determining suitable additives and ratios of additivation. Based on the investigations carried out, the addition of 2% gypsum and 3% coal fly ash was recommended, since an improved ash melting behaviour can be expected with addition of gypsum and coal fly ash. These additives with the recommended mixing rates were then tested in a large scale CHP plant (a 40 MWth grate furnace with additional injection of wood dust above the grate). Extensive test runs were carried out without additive (as a reference), and with the additives focusing on dust formation (aerosols and total dust), deposit formation and the corrosion behaviour of superheaters. These investigations were accompanied by fuel and ash analyses (grate, cyclone and filter).

The additives increased the amount of total dust in the flue gas up to 195% and 262% for gypsum and coal fly ash respectively. The chemical analysis of the total dust showed that elements which have high concentrations in the additive can be found in the total dust. Aerosol measurements showed that the addition of coal fly ash minimised the amount of fine particulate matter, as less alkali metals (K and Na) were released from the waste wood into the gas phase during combustion. Gypsum addition increased the SO2 concentrations in the gas phase due to the decomposition of gypsum, as in the

combustion chamber about 900°C are present. Due to the excess of SO2 and preferred sulphation reactions (binding of S to alkali metals) less Cl is bound to alkali metals. Hereby, the Cl concentrations in the aerosols were decreased compared to the reference case.

This effect was also found in the deposits sampled at the position of the superheater. Without additives, the deposits contained significant amounts of Cl. With the addition of coal fly ash the Cl concentration in the deposits was reduced due to dilution by a strongly increased deposit built-up rate resulting from a larger total dust concentration in the flue gas. For the addition of gypsum, almost no Cl was found in deposits due to the sulphation of alkali metal chlorides. Deposit build-up rates were comparable to the reference case for gypsum addition.

The measurements carried out so far showed the influence of the additive application on chemical compositions and amounts of ash fractions, deposits and dusts. By taking a closer look at the change in chemical compositions of dusts and deposits, a first estimation of the extension of service intervals can be made. However, in order to quantitatively determine the possible extension of the uninterrupted operation intervals as well as the corrosion behaviour e.g. by using gypsum addition, the addition would have to take place over a longer time period (at least weeks).

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