Peat as a co-combustion fuel/fuel additive to biomass for reduced ash related problems in heat and power generation plants – A state of the art report

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Torv som sameldningsbränsle/additiv till biobränslen för att minska askrelaterade problem i värme-/kraftvärmeverk – En sammanställning av kunskapsläget

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Summary

In Sweden and Finland, a relative large number of combined heat and power (CHP) plants are today using or have recently used co-firing of peat- and biomass fuel blends. Operational experience and earlier research has shown that such co-combustion of woody fuels and peat considerably extends the life of super-heaters and minimizes the occurrence of bed agglomeration in fluidized beds. In addition, it has been shown that it also can reduce fine particle emissions in small- and medium scale fixed bed applications.

The objective of the study was to summarize the state-of-the-art based on research carried out regarding the use of peat-biomass co-combustion as a measure to reduce/avoid ash-related operational problems (deposit formation, bed agglomeration and high temperature corrosion), and particle emissions. The report is based on a summary and synthesis of both scientific literature, from state-of-the-art databases, as well as technical reports from previous research projects (mainly Swedish & Finnish).

It is generally well established from previous research that co-firing peat with ash rich wood based biomass (e.g. bark, forest residues, Salix, willow), in most cases, have positive effects on preventing ash related operational problems, like bed agglomeration and deposit formation, as well as reducing the release of alkali from the fuel bed and fine particle emissions. Results from well documented long-term effects on the positive co-combustion effects is though relatively scarce in the literature especially regarding the effect of reducing deposit formation and high temperature (super-heater) corrosion.

To significantly reduce ash related problems in combustion of high alkali (> 0,5 wt-% d.s.) containing agricultural biomass (e.g. straw and energy crops) with peat co-firing, would require such high levels of admixture (> 40 wt-% of d. s.), which implies that it probably is of less relevance for implementation in practice, i.e. that peat could be referred as fuel additive/co-combustion fuel. In addition, for energy crops and agricultural residues no co-combustion results could be found in the open literature from full-scale experimental campaigns.

The results shows that admixing a typical carex based peat into wood based biomass, other than pure stemwood (e.g. bark, logging residue, forest residues, Salix, willow) gives positive effects on reducing ash related problems at levels of less than 30 wt-% d.s. For low ash containing peats, i.e. sphagnum based peats, higher levels are probably needed for reducing bed agglomeration and fine particle raw gas emissions. For some carex peats admixing levels as low as 5 wt-% d.s. have given significant positive effects on reducing the bed agglomeration risk in fluidized beds. However, due to the significant variation between different peatlands regarding their inorganic content and composition, the admixing levels that prevent ash related problems can differ considerably.

According to the literature the general and most governing ash chemical mechanisms behind the positive co-combustion effects is transfer and/or removal of potassium from the gas phase

to a less reactive solid particular form via sorption and/or reaction with the reactive peat ash (e.g. Si, Al, Ca) and/or sulphation of gaseous KCl via the sulfur in the peat.

In the choice of peat, a general recommendation can be made that peat with relatively high ash content (carex based peat), preferably also with high sulfur content is desirable. This is specifically relevant for reducing bed agglomeration and deposit formation/high-temperature corrosion. For fixed beds and grate fired boilers, a carex based peat is also preferable, although a peat with a relative high Ca/Si ratio is here recommended (a wt-ratio $\geq$1 is desirable) to avoid slagging, while reducing other ash related problems (i.e. deposits and high-temperature corrosion) as well as fine particle emissions.