Use of Chemical Fractionation to understand Partitioning of Biomass ash constituents during Co-firing in Fluidized Bed Combustion

Paula Teixeira[1], Helena Lopes*[1], I. Gulyurtlu[1], Nuno Lapa[2]

1) LNEG-UEZ, Est. Paço do Lumiar, 22, 1649-038 Lisboa, Portugal

*Corresponding author: E-mail: helena.lopes@lneg.pt

2) Universidade Nova de Lisboa, Faculdade de Ciências e Tecnologia, GDEH-UBiA, Quinta da Torre, 2829-516 Caparica, Portugal

ABSTRACT

Since the nineties, environmental and economic problems, like the necessity to decrease greenhouse gas emissions encouraged the use of renewable energy sources. Directive 2001/77/CE relative to the promotion of electricity produced from renewable energy has set targets to the share of renewables in the energy consumption that are being reviewed in light of the growing concerns with the climate change evidences. However, coal still contributes to nearly 40% of worldwide electricity generation and will maintain an important role in the global energy supply. As a way to contribute to those targets and maintain competiveness in the energy market, co-combustion of biomass with coal in existing installations is being promoted, allowing the use of biomass without major needs for retrofitting. However uncertainty in supply of high quality biomass, like wood, has led to the use of residual biomass or agricultural biomass. Their properties and composition are highly variable and differ from coals, hence creating problems. For this reason, the behaviour of ashes during combustion is a challenge for trouble free use of biomass for energy.

Efforts to overcome these problems include the investigations of several aspects, as for example the type of associations of problematic elements in the fuels that may be responsible for ash related problems such has slagging and fouling.

The goal of this paper is to correlate the elements bound in biomass fuels with the partition of elements and their relative enrichment in the several ash streams produced by combustion and co-combustion tests of biomass with coal to verify to which degree the reactivity of the elements may dictate their behaviour during combustion. The chemical fractionating methodology applied to the fuels was based in previous studies developed by Zevenhoven and consists in consecutive use of three increasingly strong solvents; pure water (H_2O), 1M ammonium acetate (NH_4Ac) and 1M HCl. The chemical fractionating was performed in duplicate and based on duplicate precision, instrumental precision and trueness; the uncertainties of the results were estimated. Combustion and co-combustion tests (with 5, 15 and 25 %wt of biomass) were carried out on a pilot scale fluidized bed combustor (FBC). Two different coals were used and three types of biomass; wood pellets, straw pellets and olive bagasse were tested. The four ash steams obtained; bottom ash, first and second cyclone ash and stack flay ash were studied. Uncertainty of analysis was estimated based in the duplicate precision and the trueness was evaluated thought interlaboratorial tests performance conducted, which allowed to establish the elemental mass balances of the combustion system and the partitioning of elements through the ash streams. The relative enrichment of elements in the several ash streams was estimated, incorporating uncertainties for a better assessment of the influence of elements reactivity on ash behaviour.