Converting non-reactive biomass ash into environment friendly cement

The combustion of biomass for electricity and heat production is increasing worldwide, and consequently the amount of fly ash produced from biomass combustion is increasing. Fly ash disposal causes a financial and environmental burden. Renotech Oy from Finland has developed a concept where non-reactive biomass ash can be transformed into reactive cement, which then can be used in civil construction or for fire protection materials.

THE CHALLENGE

The process of this new concept involves modifying the biomass ash in situ by using combustion additives which is already challenging. Along with it the second challenge is the transition of this process from lab and pilot plants to an industrial level production. Here a quality control system needs to be implemented. The goal of this study is to use different analytical methods to gain further insight into the effect that the modification of the biomass ash has. This is then done for several different additives and for different process parameters. The result then will be compared with traditional methods of cement modification.

In addition, trial runs were carried out at a pilot biomass combustion unit to study the ash modification. As a result, the modified ashes showed increased compressive strengths. Unfortunately, the compressive strength is not sufficient yet and more insights into the mechanisms of the strength development are required to formulate a more concrete business concept.

METHOD

The experiment included the ash modification trial runs which were carried out at a pilot biomass combustion unit. These were done for sustainable binders made of three different biomass ash types. The ash samples have been prepared in different dehydration states. First a thermogravimetric analysis (TGA) was applied on the samples. This was done at the University of Turku, Finland. After that synchrotron-based X-ray diffractometry (XRD) has been used to analyse the composition of the phases in the samples in more detail. These measurements have been done at beamline P02.1 (powder diffraction and total scattering) of the synchrotron PETRA III af the Deutsches Elektronen-Synchrotron DESY in Hamburg, Germany with an X-ray energy of 60 keV.

INSIGHTS & ANALYSIS

The thermogravimetric analyses gave a first insight in the composition of the phases in the different ashes. The X-ray powder diffraction measurements together with a Rietveld refinement of the diffraction results opened a deep insight in the composition of the different phases in the ashes. Three different ashes with two different treatments have been studied. The results of the measurements helped to understand the mechanisms of strength development during the ash modification trial runs.

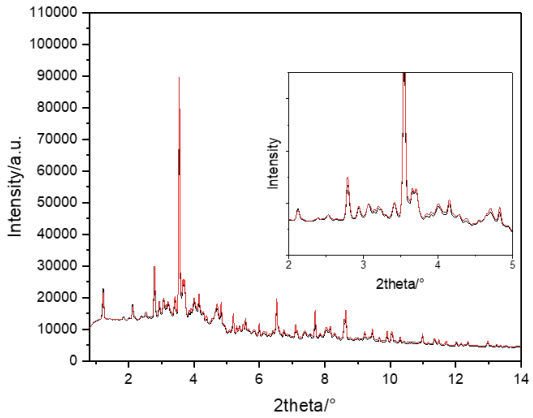

Figure 1 | XRD Spectrum measured at P02.1

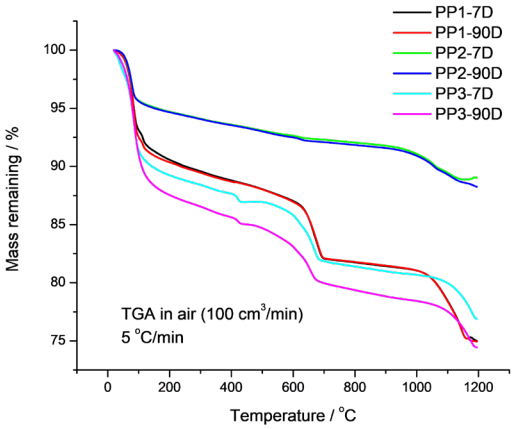

Figure 2 | Thermogravimetric analysis graph of different kinds of biomass ashes, measured by University of Turku

BENEFITS

This study helped to understand the details of the chemical processes that occur during the transformation of nonreactive biomass ash into reactive cement. With this it will be possible to optimize the process and to help to make a step in the transformation from a pilot plant to industrial production level. Along with the benefit of saving the costs for the disposal of the ashes, this solution also helps to reach the sustainability goals that have been set for the future.

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