Quantifying high temperature stability of stone wool fibres

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Stone wool is a widely used insulation material, which is not only sought for its insulating properties but also for its fire resistance due to high temperature stability (HTS). HTS is the ability of the stone wool product to maintain its geometrical shape at high temperatures (~1000°C), which is an important factor in protection against spread of fire. The origin of stone wool HTS is complex and is associated with several important factors including fibre properties, wool product properties (i.e. density, organic binder content etc.), product design and application.

In our work, we have investigated how the fibre properties influence the HTS of stone wool fibres with a special focus on fibre chemistry. Such an investigation involves a challenging question: How do we quantify the HTS of stone wool fibres. Previous descriptions of HTS have been based on qualitative comparisons of SEM images [1,2] or deformation temperatures measured by hot stage microscopy (HSM) [3]. The previous HSM methods are not suitable for quantification of HTS, while the characteristic deformation temperatures are determined based on the change of the arbitrary geometric values that are related to the fibre melting behaviour. Our method is based on characteristic temperatures determined by chemical and physical changes occurring in the fibres and is more suitable for quantifying and understanding the HTS at temperatures below the melting point.

Our method for quantifying the HTS is based on a combination of DSC measurements and HSM measurements. DSC is used to understand the origin of the geometric changes observed by HSM. DSC is used for investigating the crystallisation behaviour of the fibres, which is an important factor in controlling the HTS [1,2]. The change in geometrical shape of fibres is quantified by HSM with a special focus on the different changes in geometrical shape occurring well below the melting point, most notably the shrinking in the 700-900°C range (Figure 1).

In our method, we eliminate effects of product properties such as density by sieving the fibres and pressing them into pellets. The defining features of the shrinkage is the initiation temperature, end temperature, and the amount of shrinkage.

We have found that the amount of organic binder on the stone wool fibres has a significant influence on the HSM measurements (Figure 1). However, the organic binder does not seem to affect the characteristic features of the shrinkage mentioned above, at least using a steady heating rate of 10K/min.

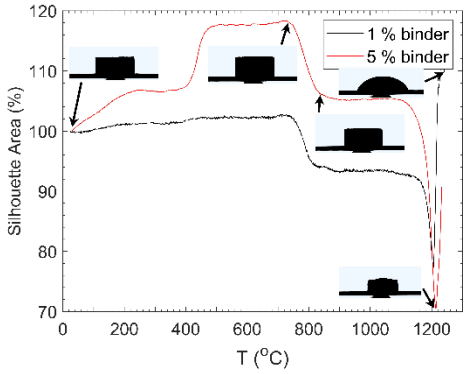

Figure 1. Silhouette area as measured by HSM in atmospheric air at a heating rate of 10K/min. Results shown for two stone wool fibre samples with low and high binder content. HSM images included for selected temperatures. The width of the pellets are 13 mm.

Using the described method, we are currently investigating how factors such as major and minor element chemistry and redox state, heating procedure, atmosphere, and fibre diameter affect the HTS of stone wool fibres.

References

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