

Modelling of melt on spinning wheels and the impact of scale up on the various parameters

Background

Thermal Ceramics produce a variety of different fibre compositions from a melt stream via the use of vertical spinning discs.

Standard production uses large contra-rotating wheels. Generally higher tap rates require larger diameter wheels. This process produces a lot of unfiberised material as well as the fibre required, which has a mean diameter of about 2 microns. Generally this unfiberised material is in the form of small spherical beads of glass which the industry refers to as shot. The shot particles of course can be anything in size from a few microns up to over 1000 microns in diameter. However in practice we find that there are few shot particles < 44 microns in diameter. For ease of measurement Thermal Ceramics therefore just measures the shot content as being all non fibrous material (shot) which has a diameter > 44 microns. The measurement is carried out by sieving and reported as the weight percentage. This number usually varies between 45–55% by weight. The majority of the particles, fall within the range 75–250 microns and will form up to 75% of the weight of shot measured. Recent work has demonstrated that it is feasible to reduce this shot content down significantly.

Importance of Shot

Shot is detrimental to the product in 2 major areas.

Shot increases thermal conductivity. If it wasn't there, the thermal conductivity would at the very least remain the same, but empirical data suggests that removing shot reduces thermal conductivity. Fibre is generally sold as a needled blanket with densities of the order of 100kg/m³. Less material could therefore be sold for the same insulating effect making costs lower and the price lower. One of the big advantages of using fibre over bricks is the savings on thermal mass and therefore any reduction in density will enable savings to be made by customers in their applications.

A growing area of fibre use is in the automotive industry, which requires clean fibre with zero shot. Costs can therefore be improved if the initial shot can be reduced. This maximises production of fibre for cleaning and will reduce the need for investment in new expensive cleaning equipment as the market increases.

Modelling work

We have demonstrated it is possible to reduce shot significantly in the process. We have proposed a set of parameter, which may influence shot content. We need to move towards production scale, where it is foreseen that there may be a problem in scale-up. Experiments to do this are expensive and time consuming as larger scale approaches full production and the problems associated with running trials in such an environment. Modelling could aid to reduce development time and understand potential problems early.

Some of the parameters proposed to be important include.

Melt temperature, spinner speeds & angles, air stripper design and melt stream drop height.

We need to explore how the melt transfers onto the spinners and what kind of melt layer exists on the spinners and then how this breaks up into droplets, which are flung off to become fibres. Then we can try to understand what happens as the spinners are increased in size and the melt tap rate is increased. Hopefully the model will show what parameters are important and whether there is a gradual decrease in effectiveness or a watershed.

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