Optimisation of chocolate refining

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The size distribution of the solid particles in chocolate is a major factor in determining its mouthfeel, flavour and rheology. Particle size is largely controlled by refining[1], a size reduction and mixing process carried out in two stages by two-roll and five-roll press mills, respectively[2]. Refining transforms a coarse chocolate paste resembling wet sand into a smooth flaky powder, which is then liquefied by applying heat and shear in a process known as conching.

At present, there is limited understanding of the physical and chemical changes occurring in the paste as a consequence of the shear and compressive forces applied in the nip region between rolls. Also, in order to improve particle size control and refiner efficiency, there is a need to model the effects of input material variation and process parameters on refining capacity, size distribution, flow properties and the sensory characteristics of the end products. Very little quantitative and modelling information is currently available in the public domain for this particular type of pressure roller mill process.

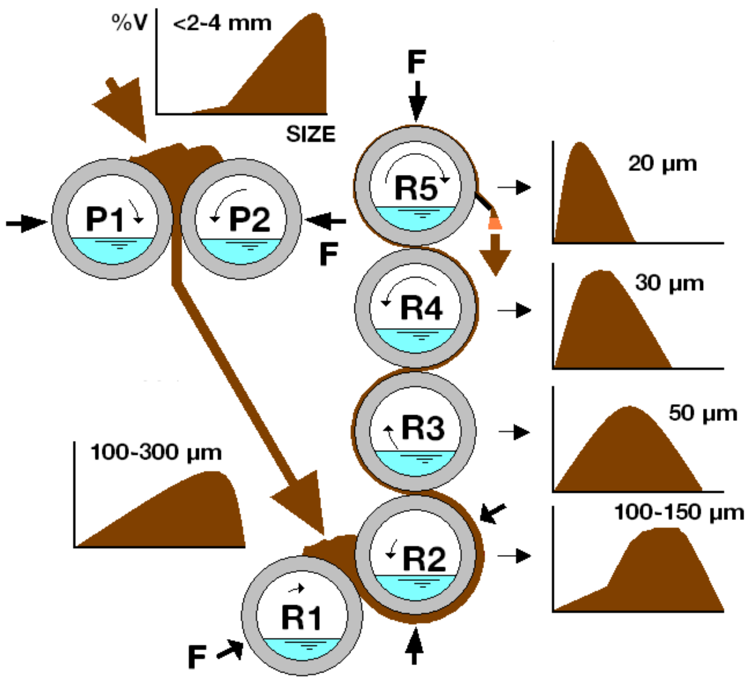

Figure 1: Schematic diagram of two stage roll refining

This work approaches the problem of improving product quality and reducing cost by building a higher level of scientific understanding on the following areas:

- Method development for the characterisation of input, intermediate and output material, e.g. particle size and shape, compressibility, specific surface area, moisture content, sugar crystallinity.

- Understanding and modelling the combined effect of roll compaction and shear forces[3], and evaluation of their effect on throughput and particle breakage probability. This includes the study of the tribo-rheology between paste and roll, particularly to account for the potential influence of changes in roll roughness due to wear.
- Development of a model for the prediction of chocolate viscosity based on particle size distribution and other relevant variables.
- Evaluate the impact on the flavour and texture of moulded bars.

Research has been carried out on the development of specific particle size measuring methods for the different fineness levels using laser diffraction and image analysis, a crucial aspect for this work. Also, initial experiments and modelling have led to more precise estimates of gap size and film thickness, using measurements of throughput, roll coverage and paste density. These variables determine the magnitude of the forces ultimately causing mixing and particle breakage. Figure 2 below illustrates how particle size changes with throughput, and therefore also with gap size and the magnitude of the comminution forces. In addition to this, an initial assessment of current performance suggests there is potential for significant productivity gains reducing throughput losses by adjusting to variations in raw materials.

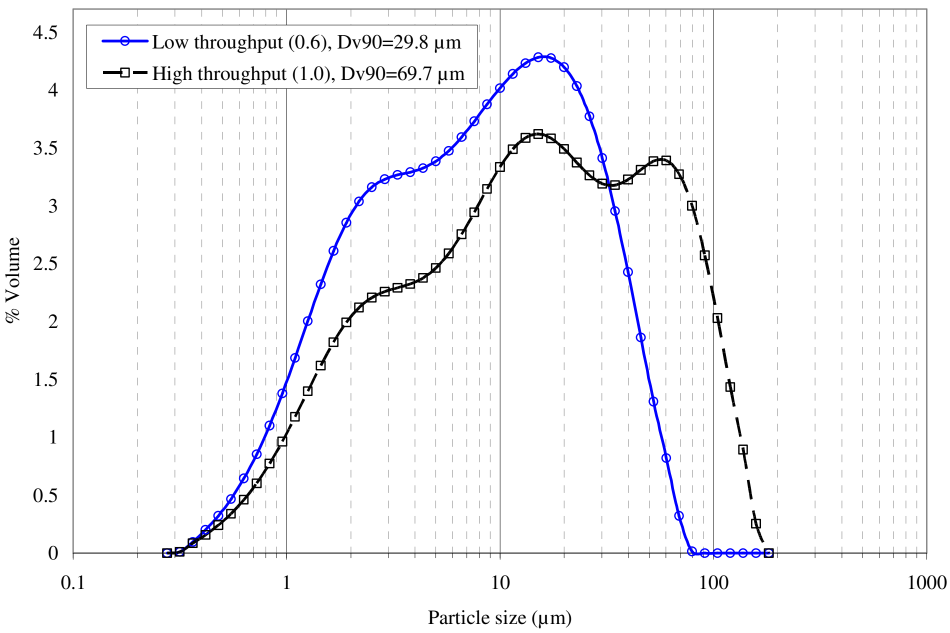

Figure 2: Example of particle size variation with throughput (µm)

References

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