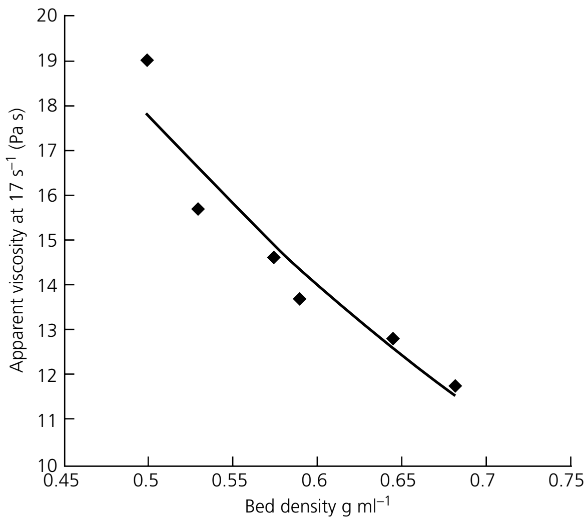

Figure 9.13 The apparent viscosity of a milk chocolate at a shear rate of 17 s^{-1} as a function of solids bed density.

Alternatively, batches of coarse and fine chocolate could be mixed, in theory even after conching. Bolenz *et al.* (2014) demonstrated the practical application of this technique.

9.7 Particle size and sensory properties

Particle size influences not only the sensory perception of coarseness, but also melt, flavour, colour and gloss. According to Niediek (1994), there was no published systematic research on the effect of particle fineness on the flavour of chocolate mass. A study of the effects of particle size on the flavour of milk chocolate has, however, been carried out using time-intensity methods and a trained sensory panel (Mongia, 1997; Ziegler *et al.*, 2001), and in a series of papers Afoakwa and co-workers have investigated the influence of particle size distribution on the rheological and textural qualities of chocolate.

Chocolate exhibits the unique property of melting from the solid state at room temperature to form a smooth dense suspension in the mouth at body temperature. The liquefaction of chocolate in the mouth is defined by the melting characteristics of the fat and facilitates the perception of taste and flavour attributes. The intensity of perceived taste and flavour changes dynamically over time as the chocolate is melted, manipulated and mixed with saliva. Time–intensity methods result in dynamic measurements of changes in sensory perception in the form of time–intensity curves, from which can be extracted attributes like maximum intensity, time to reach maximum intensity and duration of the stimulus.

Sweetness, chocolate flavour and the *effort* required to melt, manipulate and swallow chocolate samples varying in particle size distribution and flow properties were measured using time–intensity procedures. *Thickness* and *coarseness* were measured using traditional descriptive analysis procedures (Mongia, 1997). The mean diameter of the volume distribution (as measured by laser light scattering) ranged from 8.50 to 16.95 μm (0.3–0.6 × 10^{-4} in). This was achieved by varying the size of the sugar only; cocoa solids and non-fat milk solids were of consistent size in all samples. As the average particle size got finer and yield value increased, the time to maximum, intensity of maximum and duration of *effort* required to melt, manipulate and swallow the sample all increased, that is the finer chocolates had a greater residence time in the mouth. While the chocolates all had the same amount and size of cocoa solids, and therefore the *intensity* of chocolate flavour did not differ, the *duration* of chocolate flavour was influenced by the average particle size, with the *chocolate* flavour of finer samples persisting longer than that of coarser samples. This is directly related to the residence time of the sample in the mouth.

Kuster (1980) reported that cocoa mass is sensed organoleptically earlier than sugar or milk powder, and presumed that with lower surface values (greater particle size), the sweetness of the sugar could be diminished. We originally hypothesised that the finer the chocolate, the sweeter the taste, since small crystals dissolve more rapidly that do larger ones. However, the maximum intensity for *sweetness* was greater for coarser samples. As with the *chocolate* flavour, the *sweetness* persisted longer in finer samples. Increasing viscosity is known to reduce the perception of sweetness in solutions and gel products, but not the perception of chocolate flavour in desserts (Pangborn and Kayasako, 1981).

Thickness scores were highly correlated to the Casson yield value (r = 0.97) and to the mean diameter over the volume distribution (r = –0.99). As expected, the chocolates became lighter (tristimulus L value increased from 34 to 41) as the particle size became smaller. Multivariate regression analysis led us to conclude that yield value and mean particle size are more significant contributors to the sensory perception of chocolate products than, for example, plastic viscosity or the shape of the particle size distribution.

Conclusions

It has long been known that particle size reduction is critical to obtaining desirable liquid chocolate flow properties. However, as has been shown, the affects of particle size are much farther reaching and include influencing the taste and texture of the final product. Developments in engineering design and process control now enable chocolate manufacturers to manipulate the particle size and size distribution, should they wish to do so. However, it must also be remembered that size reduction is only one part of chocolate processing and that the actual grinding