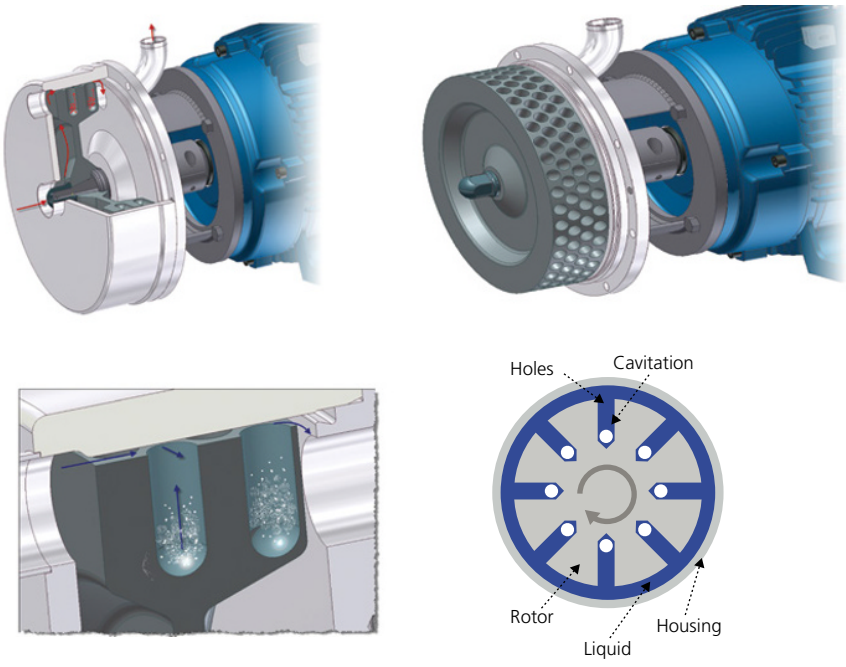

Figure 5.12 A cavitator unit with four rows of holes in the rotor (above) and visual cavitation occurring in the holes (below). Source: Pedersen (2014).

Installing the cavitator downstream of the evaporator and before the high pressure pump to the spray dryer allows for an increase in feed concentration of up to 7% without affecting the feed viscosity. Alternatively, maintaining the dry matter in the feed increases the output from the dryer by up to 10%, due to the reduction in feed viscosity (Pedersen, 2014).

5.3.2.2.6 The effects of spray drying processing parameters on milk powder functionality in chocolate

The difference between inlet and outlet temperature, ΔT, for the dryer sets the drying capacity for the plant. The lower the ΔT the lower the viscosity of the chocolate. Particle size and occluded air increase with ΔT, causing a higher chocolate viscosity, therefore a high drying capacity has a negative influence the performance of the powders in chocolate (Hansen and Hansen, 1990).

The outlet temperature had the highest influence: outlet temperatures above 95 °C result in lower bulk densities and increased occluded air, whereas outlet temperature from 70 to 95 °C lead to smaller particle sizes and lower occluded air (Aguilar and Ziegler, 1993). Sharma *et al.* (2012) reported that higher outlet temperatures led to higher free fat levels, but they did not refer to any beneficial effect in chocolate.

Table 5.8 summarises the processing parameters needed to optimise milk powder characteristics for use in chocolate.

Table 5.8 Spray-dried milk powder properties importance for lowering chocolate viscosity and how to achieve the properties during spray drying of whole milk powder.

Milk powder characteristic	Milk powder properties wanted	Milk powder parameters achieved during spray drying
Free fat	High	Pre-addition of crystalline lactose High pressure homogenization Smaller nozzles higher pressure
Bulk density	High	High viscosity – high dry matter in feed Outlet temp 70–95 °C Low ΔT in dryer Pressure instead of centrifugal nozzle
Particle size	Low	High pressure on atomizer High dry matter in feed
Occluded air	Low	High pressure on atomizer Outlet temp 70–95 °C Low ΔT in dryer Pressure instead of centrifugal nozzle
Fines	Low content	Fluid bed, separation
Lactose	Amorphous	Storage dry and low temperature

5.3.2.3 Whole milk powder

Whole fluid milk is first standardised in order to reach a minimum 26% milk fat content after drying and then pasteurisation at 80–95 °C to meet legal requirements and inactivate the lipolytic enzymes that cause deterioration of milk fat during storage. The fluid milk is normally homogenised between evaporation and spray drying because, if the milk is homogenised prior to evaporation, the free fat content will be lower (Burma, 1971). After concentration to 40–50% the spray drying typically happens in stages; evaporation of the free water in the first step is relatively easy to accomplish, whereas the last stage demands more energy and time.

5.3.2.4 High free fat milk powders

High free fat (HFF) milk powders were developed to fulfil demand from the confectionery industry; there are several factors impacting the degree of free fat in milk powder, with the drying process conditions being the key.

Techniques aiming to provide physical disruption of the milk fat globule membrane during liquid processing have also been used to achieve high free fat levels in WMP. The use of high homogenisation pressure before evaporation is one technique that has been used successfully. However, the highest level of free fat can be achieved in adding pre-crystallised lactose prior to the spraying, since the hard lactose crystals will penetrate and open the fat globules during processing (Aguilar and Ziegler, 1993). The free fat can also be influenced during spraying by using smaller nozzles and higher nozzle pressure. Figure 5.13 shows scanning electron microscopy pictures of the three different whole milk powders described above. The particle shape of roller-dried powders and the spray-dried powder with HFF are equally dimensioned as platelets, whereas the low free fat spray-dried powder are spherical in shape (Attaie *et al.*, 2003).