compared with ones which were conched for a similar length of time but with a long liquid phase (Beckett, 2006).

When conching at a high temperature, additional time may be required to enable the chocolate to cool before the emulsifier is added, as some authors have found that lecithin is less efficient when added to chocolate hotter than about 60 °C (140 °F).

The conche is the last major processing stage before the chocolate is used for moulding, enrobing and so on. These processes require a consistent viscosity and some adjustment may be required. One approach is to place a viscometer in the discharge pipe from the conche and then make the necessary fat or emulsifier additions in the storage tanks. An alternative solution is to monitor the conche electrical power curves and use these to make fat adjustments into the conche during the liquid phase (Mars, 1994). Frisse provide a viscometer, which can be fitted inside a conche. This operates by measuring the damping of mechanical oscillations and can give continuous readings, which are recorded by the PC control system.

10.4 Conching machines

10.4.1 History

Conche development has gone through various inventive and innovative phases starting back in nineteenth century. In literature, the longitudinal conche of Rodolphe Lindt is cited as the first conche. Subsequently, rotary conches were developed and introduced onto the market. Initially the conching units were equipped with stone rolls and, later, with various mixing and shearing elements. The next development step was the vertical conches which preceded the introduction of horizontal conches. This was a revolutionary step change in the process of conching as it offered great opportunities in respect to volume capacity increase, production of masses with better flow behaviour and enhanced flavour/aroma profiles. In recent times, continuous concepts have also been generated, and automation (Chapter 24) contributes to the overall control of the conches and the conching process itself. In addition, add-on devices to standard conches have been introduced with the objective of optimising chocolate flow properties and also enhancing particular flavour profiles.

Irrespective of the conche concept or design, the energy intake or energy density (kW/t) is a key factor that is directly linked to the efficiency of the conching process. Currently therefore, machinery suppliers have been targeting their developments to intensify the energy intake within a short time period, whereas in the past a more gentle treatment was taking place in a longer processing time. This impacts significantly upon physical and chemical reactions such as reduction of moisture, degree of de-agglomeration, release of fat, wetting of particles with fat, stripping of unwanted volatiles, flavour redistribution and development and flow properties.

10.4.2 The first conche development

As already mentioned, Rodolphe Lindt is considered as the inventor of the very first conche, the so-called longitudinal conche (1878). The concept was based on a granite roll that was moving in a continuous manner backwards and forwards inside a trough. The conching process lasted up to 96 h and the maximum capacity was about 4000 kg (a four trough setup). Particles were heavily wetted with fat at the early phase of the process (due to mechanical limitations of the design), retarding the rate of moisture reduction and the stripping effects of unwanted volatile components. Furthermore, the longitudinal conche provided low energy input into chocolate, but had a very high energy consumption. Last but not least, the temperature control was focused on the cooling water and not on the mass.

In the following sections, various conche designs will be described and illustrated by commercially available machines. To start with, the different types of conches will be classified according to their design, type of mixing elements and number of shafts.

10.4.3 Classification of conches

Often conches are classified into vertical or horizontal types. In the first case, these are conches in which mixing, scraping and shearing paddles are attached on a shaft that is vertically oriented. Additional mixing elements may perform a planetary motion around the centrally driven paddles. The second case, with a horizontal powered shaft, is now the more widely used. Depending on the design and mixing volume of the paddles, the shearing zone being created between the conching paddles is an important parameter. This is related to the overlapping of shearing elements, which provides additional shearing zones inside the conche vessel. Last but not least, the number of shafts can be used for classification too.

10.4.4 Vertically oriented shaft conches

One of the most widely used vertically shaft conches is the Carle and Montanari-OPM Clover (Figure 10.8). This consists of a jacketed casing in which there are agitators, scrapers and tapered cone-shaped rollers. The chocolate mass is initially mixed in the outer compartment until it becomes pasty enough to be transported by a conveying screw into the inner part of the machine. Here tapered cone-shaped rollers apply an intensive shearing action, squeezing the chocolate mass against the conical inner surface and also throwing it back into the outer compartment. The scraping elements provide further homogenisation and shearing. Throughout the process a large proportion of the mass is exposed to air, resulting in low moisture levels and the removal of volatile aromatic components. The loading capacity is up to 6000 kg (e.g. Clover 30 at 3000 kg, Clover 60 at 6000 kg) and the power varies between 70 and 98 kW.