Figure 10.8 Vertically oriented shaft conche, CLOVER, Source: Reproduced with permission of Carle and Montanari-OPM.

Petzholdt-Heidenauer (Hamburg Dresdner Maschinenfabriken GmbH) also developed vertically oriented conches. Their first concept was the PVS design, which was based on the traditional circular container with horizontal mixing elements. An innovative development was the integration of spraying systems in order to produce a thin film of chocolate, whose large surface area is in contact with the air and where enhanced removal of volatiles takes place. Their next generation of vertical shaft conches were PIV machines. These usually consisted of two or more 1000 kg conching vessels which were able to give a semi-continuous conching process. The diameter of the circular container was smaller than the PVS and extruder-like screws were added to the main mixing element. This configuration was designed to deliver the two different types of shear (see Section 10.2.3). The mixing took place in both vertical and radial directions.

The PIV-HLC model is based on the PVS design combined with two of the PIV extruder-like screws, which are positioned inside the conche beside the main mixing element.

Generally speaking, the limitations of the vertical shaft conches are capacity, temperature control and motor overload. The mixing efficiency is relatively poor as there is limited circular movement of the mass (depending on its consistency), unless extruder-like screws are incorporated. Removal of unwanted volatiles also tends to be slow without thin film or similar devices.

10.4.5 Horizontally oriented shaft conches

Horizontal shaft conches tend to dominate the mass production of confectionery. In general, this class of conches is capable of delivering a better end-product specification (low moisture level, better de-agglomeration, improved flow properties etc.). Increased volume capacity and shorter processing times are often possible due to more efficient mixing, drying and shearing. The design concept mainly consists of a double jacketed vessel in which there are one, two or three processing areas depending upon the number of shafts and the rotational area of the paddles.

Single shaft conches are typically based on a circular shaped vessel in which mixing and shearing elements are attached to a horizontal shaft. Depending upon the design of the paddles, a fluidised powdery mass can be produced with significantly improved drying properties (moisture reduction and stripping of undesired volatiles such as acetic acid). This type of conche has relatively good mixing but this is limited due to shearing only taking place between the paddles and the wall of the vessel. This means that the design of a "smart" shearing element that both mixes and shears is critical. In addition, the vessel may be inclined in order to improve the discharging of the chocolate.

Otherwise, depending upon its flow properties, this mass residue may be as much as 2%.

With two shaft horizontal conches a relatively good drying efficiency can be achieved since air is either drawn into or expelled from the mass. The drying effect is improved due to the rotation of paddles "sprinkling" the powdery mass from top to bottom, ensuring a large surface area of particles in contact with the air. Nevertheless the mixing efficiency is rather low in the horizontal direction. In some designs, the shearing occurs between the paddle and the wall of the vessel, whereas in other designs an overlapping zone between the paddles creates an additional shearing zone. This feature ensures better de-agglomeration performance and consequently, optimum flow properties (Figure 10.9).

The three-shaft conche is however normally considered to have the best drying efficiency since air is passing continuously and simultaneously in and out of the mass (Figure 10.10). This action results in the so-called "breathing" effect as

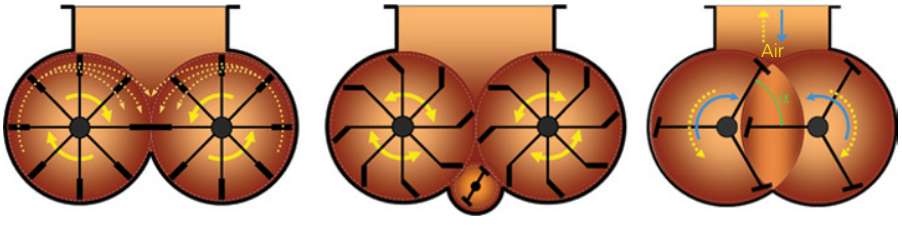

Figure 10.9 Illustration of horizontally oriented shaft conches depicting the movement of mass inside the conche vessel and the direction of the air flow. Source: Reproduced with permission of Bühler AG, Switzerland.