the sugar, forming a continuous skeleton. This also makes it possible to make very low fat products. The air bubbles are irregular and this type of product does not melt with heat like normal chocolate. It can however have a very low density (e.g. 0.2 g/cm^3) and it dissolves rapidly in the mouth, releasing a chocolate flavour. Two methods of manufacture have been described, both of which are based on evaporating water from chocolate ingredients (Section 15.7.4).

15.7.2 Vacuum aeration

When liquid chocolate is placed in a vacuum, it will rise into a foam. If this is then cooled and the fat allowed to set, it will retain its structure. Sometimes additional gas, usually carbon dioxide, is mixed into the chocolate before the vacuum is applied. The size and shape of the bubbles can be variable (see Figure 15.17) as they are affected by many factors, including the chocolate viscosity, the pressure, emulsifier type and the rate of set of the chocolate (Haedelt *et al.*, 2005). It is very easy to incorporate other large ingredients such as nuts and nougat within the aerated product. Vacuum systems however tend to be difficult to maintain in a hygienic condition and often need a relatively high labour rate to operate, so high pressure aeration systems tend to be more widely used.

15.7.3 High pressure aeration systems

These systems incorporate gas into tempered liquid chocolate under high pressure. Some of the gas dissolves and any remaining gas is dispersed as fine bubbles using a high speed beater. Sufficient cooling must be supplied to prevent the chocolate temper being destroyed by the process. The beater may be a separate unit, such as those manufactured by Haas-Mondomix or Asser Oakes, or integrated into the tempering unit such as the Sollich Turbotemperer® Airo (Figure 15.18). The pressure will also affect the product bubble size, as it is the release of this pressurised chocolate into normal atmospheric pressure that causes it to froth and form the bubble structure. Special depositors are needed to feed the chocolate into moulded shells or to extrude it as a continuous sheet.

Figure 15.17 Different sizes of bubbles in aerated chocolate.

Figure 15.18 Sollich Turbotemperer® airo (Source: Sollich).

There are several patents for these depositors but, as with single shot systems, it is very difficult for large pieces of other ingredients to be added.

The type of gas that is used is very important. For visible bubbles carbon dioxide is often used, although nitrous oxide is said by some workers to give a more intense cocoa flavour and a different texture (Murphy, 2005). If nitrogen is used however only very fine bubbles are formed and micro-aerated products are produced. This difference is believed to be due to the different solubility of the individual gases in chocolate.

15.7.4 Water evaporation methods

The earliest description of a process to make this type of product was in a patent by Cadbury (1975) and resembles one of the crumb-making processes described in Chapter 6. Sugar is dissolved in water before being emulsified with cocoa liquor and milk solids. The mixture is then concentrated to approximately 10–12% water in a scraped surface vacuum evaporator. The resulting paste is dried to less than 2% water in a continuous vacuum band drier. This type of aerated "chocolate" can be made with a low fat content, below that required to meet the legal definition of chocolate. It has a very low density (0.1–0.3 g/cm^3) and is able to be cut into pieces or granulated for use as inclusions in other products such as ice-cream or cakes.