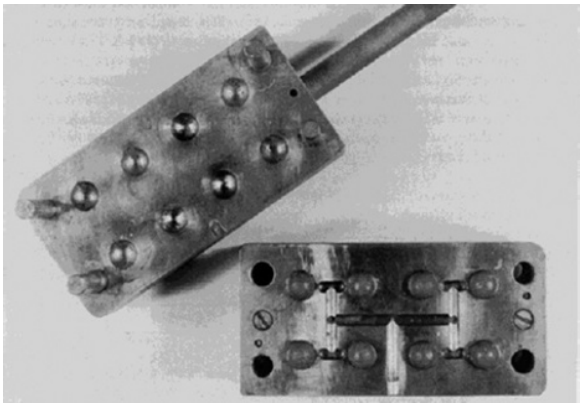

Figure 15.12 Photograph of injection mould used to make small balls (Beckett *et al.*, 1994).

at temperatures above 18 °C (64 °F) up to just below the melting range of the chocolate (about 30 °C, 86 °F), and so accurate temperature control was no longer required.

The surprising property of the extruded chocolate was that it remained in a plastic condition for a significant amount of time, enabling it to be twisted or even tied into knots. The actual period of this plastic state was found to depend upon the type of chocolate, the extrusion conditions and the post-extrusion storage temperature. In general it took from 30 min to several hours for the chocolate to return to its previous brittle form.

Many plastic products are formed by injection moulding. Because of the plastic nature of the cold extruded chocolate, this type of process was investigated. A mould capable of producing eight 12 mm (0.5 in) diameter balls (Figure 15.12) was attached to the Florin ram extruder. Once again the trials were carried out at room temperature. Eight balls were consistently produced, but their surface quality was variable, ranging from matt to glossy. The entrance gate to the ball was only 200 μm (0.008 in), showing that chocolate can be extruded through a very narrow opening.

This process (Mackley, 1993) can be carried out using single and twin screw extruders in addition to the original ram type machine. With skilful process control, therefore, it is possible for liquid chocolate to be tempered, solidified and extruded in a single extrusion–processing step.

15.6 "Single shot" depositors

15.6.1 Background

A substantial proportion of the chocolate confectionery market consists of moulded filled sweets, that is a chocolate shell containing a contrasting centre which can be praline, sugar fondant, peanut butter and so on. The advantages of

moulded products over enrobed ones (Chapter 14) are that they can be made in a much wider variety of shapes and that they have a higher gloss finish. The main disadvantage is the number of procedures required to produce a traditional shell moulded product, that is:

1 Mould warming;
2 Tempering of the chocolate;
3 Depositing the chocolate to fill the mould;
4 Shaking to remove air bubbles;
5 Cooling and inverting to remove the centre chocolate;
6 Vibrating to control shell thickness before inverting again;
7 Shell cooling;
8 Scraping to remove excess chocolate from mould;
9 Deposit the centre;
10 Vibrate and cool centre;
11 Re-heat the back of shell and the centre;
12 Deposit tempered chocolate to produce back (bottom) of sweet;
13 Scrape off excess chocolate;
14 Vibrate and cool;
15 Demould.

Although obviously complex, shell moulding works well and can be used with a wide variety of centres including whole nuts and cherries and the filling can be as much as 66% of the sweet.

Single-shot depositing is more limited in the types of centre that can be used, in that this must be in a form which can be pumped. In addition the centre is normally less than 50% of the sweet. It does however enable a very wide range of products to be made by a much shorter process. Cadbury Ltd. (now part of Mondelēz) in the United Kingdom has used the process for over 60 years, but it has only been available to the confectionery industry at large as ready manufactured plants since the 1970s (Jeffery, 1990).

15.6.2 Basic principle of single shot depositing

The basic principle behind this technique is illustrated in Figure 15.13. As can be seen, it relies upon carefully timed depositing through concentric cylindrical feeds and through a central nozzle. Tempered chocolate is fed through the outer ring and the centre is deposited down the inner tube.

The sequence starts with the chocolate being deposited through the outer nozzle hole. After a predetermined time the centre starts to flow, so that a ring of chocolate surrounding a rod of centre is being forced through the nozzle. Subsequently the centre stops and a plug of chocolate once again flows through the nozzle, to complete the sweet. Thus a chocolate "balloon" is formed containing the centre confectionery. This may be deposited on a belt to form a chocolate "kiss" (see Figure 15.14) or more usually falls into a mould, where it is vibrated to make the chocolate and centre conform to the required shape, which includes