- Badly adjusted or damaged scrapers,
- Stickers being hammered out with metal or sharp objects.

Other causes of breakage could be due to a combination of moisture, chemicals, temperature and mechanical stresses. Too high a temperature during mould washing for example can weaken the mould structure. Also, a defective injection moulding process where optimum conditions were not followed could accelerate the stress cracking process.

Continuing to use cracked moulds is a false economy: they can distort under the backing-off knife and cause bad backs and over-weights, and they are likely to cause jams at turn-points by breaking or becoming distorted.

Moulds should be stored face to face, not just stacked, to avoid scuffing and scratching the upper surface.

14.2.17.3 Mould washing

The importance of mould washing is often overlooked until problems arise. These can often be water spots that transfer to the product or fatty specks that leave micro-pits in the product: both a sign of inadequate washing. There are five main factors in mould washing (Stuart, 2011):

1. *Water quality* Water needs to be soft. Hard water can cause deposits due to dissolved salts being left on mould surfaces after drying. Treatment options for hard water include softening and deionisation. Deionised water is best used for final rinse water in order to prevent the deposition of any residue on the mould. Reverse osmosis water can also be used as the final rinse water.
2. *Time* In a mould washer the conveyer speed and length of each zone defines the time element. The speed can be adjusted based on the type of mould (and residue) that is run. A shallow mould with a sugary residue might be able to be run at a faster speed than a large intricate PC chocolate mould with fats.
3. *Temperature* The optimal temperature is defined by the detergent specifications and the limits of the material being washed. The maximum recommended washing temperature for PC moulds is 60 °C (140 °F). Above this, moisture will be absorbed and weaken the moulds.
4. *Detergents* Detergents have mainly surfactants that help wet and penetrate the surface of the mould. They may also contain other additives to add alkalinity or acidity, defoamers and even enzymes to perform specific actions. Concentration and type of detergent is best defined by the detergent supplier after testing sample soiled moulds.

   Detergents must be neutral (pH ~ 7) to avoid chemical attack and it is most important that the product be specifically made to clean polycarbonate. Rinsing may be done at temperatures of up to 75 °C (167 °F) if the residence time is only seconds. A rinse aid should be used to help drying and prevent spots on the moulds. There are several types of rinse aids. The type needed depends on the quality of the water and the types of detergents and defoamers used.

5 *Mechanical force* Mechanical force is provided by the use of strategically aimed nozzles that direct the water to all surfaces and both sides of the mould. Powerful water pumps are required for this. Water is the central figure as it allows the transfer of mechanical force to aid lifting the soil, it applies the detergent and is the medium providing the necessary temperature for the process.

Typical mould washers have the same basic functions but may differ in design. A summary of the main washer zones and recommended conditions for washing and drying moulds is given in Table 14.1.

Solid chocolate must be removed from the moulds before washing, both to avoid contaminating the detergent solution and to prevent discharge of contaminated effluent which will be expensive to treat. There is a double cost saving, for lost chocolate and for effluent charges.

14.2.17.4 Mould innovations

Moulds made with BPA-free materials are available as a response to the escalating debate on the potential effect and exposure of this chemical on infants and children. These new materials offer the advantage of being BPA-free but may also compromise some of the key properties of the PC they replace (broad temperature usage, toughness, rigidity, gloss imparted on product, etc.). At the present time BPA-free moulds are still a rarity in the confectionery industry. Nevertheless, as the plastic industry improves the functionality of these new materials, they are likely to become more widely adopted.

Metal detectable moulds offer a solution for the removal of foreign bodies caused by mould breakage. The thermoplastic composition of these moulds includes a metal detectable agent in combination with PC or other more complex thermoplastic polymers. The metal detectable agent can be any ferrous or non-ferrous material having good magnetic permeability and/or good electrical conductivity. The amount of metal detectable material that can be incorporated in the mould is limited as it may potentially weaken the polycarbonate structure. Typically pieces of broken mould <5 mm will not be detected as there is not enough metal in the mould structure. Increasing the amount of metal in the

Table 14.1 Recommended washing conditions for polycarbonate moulds.

Wash type	Recommended temperature [°C (°F)]	Water type	Contact time (s)	Detergent
Pre-wash (heavily soiled moulds)	60 (140)	Soft	10+	None
Main wash	60 (140) maximum	Soft	15+	Detergent
Re-circulating rinse	60 (140) maximum	Soft	10+	None
Final rinse	60 (140) maximum	Deionised or reverse osmosis treated	Minimal	Rinse aid
Blowing off-air drying	105 (220)	—	As required	—