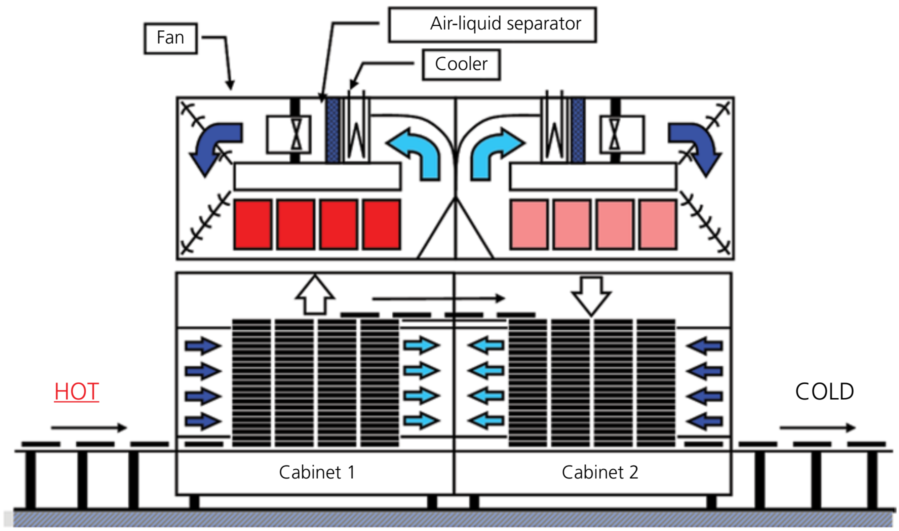

Figure 24.25 Schematic drawing of a paternoster-type cooling tunnel. Reproduced with permission of Kraft Foods R&D Inc. Munich, Germany.

fat bloom and dull surface appearance). All of these are the result of uneven line speed, which gives an inconsistent residence time of chocolate products in the cooler.

Paternoster-type cooling tunnels (Figure 24.25) are often part of continuous moulding lines. Another monitoring option exists in addition to traditional technology based on temperature data loggers. This involves viewing mould/product surfaces by infrared cameras just after leaving the cooler. The quality of the data sets can be improved if the images are synchronised so that all products appear at the same position, have identical size and the images are ready for further analysis. Besides making surface temperature pattern visible, (Figure 24.26) differences between different positions can be quantified over time (Figure 24.27). The possibility to combine the thermal history of a product with surface temperature data can be utilised for example in shelf life studies, see Figure 24.28, which shows three sets of data.

1 Taken at the outlet of cooling tunnel, the results in the lower part of Figure 24.28 show a typical cooling tunnel design-related surface temperature pattern. Patterns can be observed for some machine designs, which result from transient heat exchange conditions during transit through the cooling tunnel. The heat transfer conditions changes spatially along the layer of the moulds while travelling through the 75 stages of the two-cabinet elevator. Selected simulation results of temperature distributions whilst travelling through a cooling tunnel are illustrated in Figure 24.29.

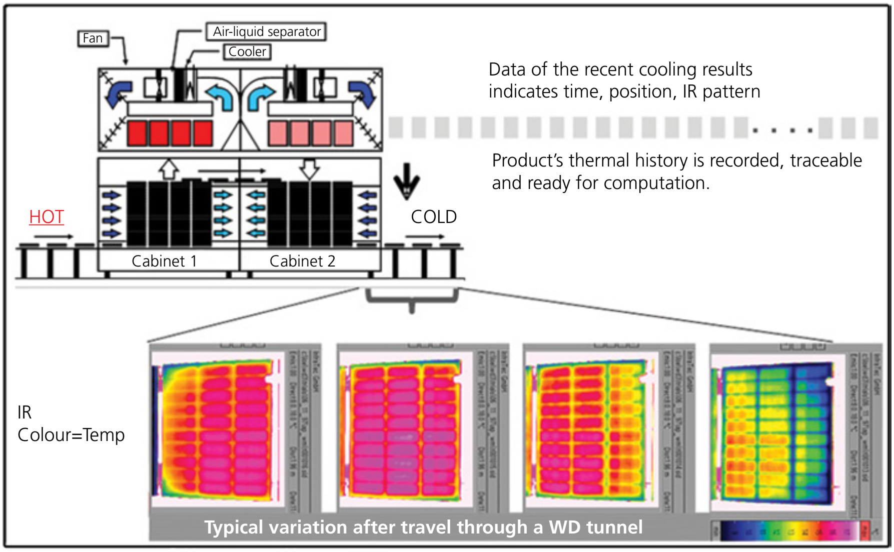

Figure 24.26 Schematic of IR imaging of moulds containing product, four moulds per stage, 75 stages. Below there are seen the individual mould patterns. Reproduced with permission of Kraft Foods R&D Inc. Munich, Germany.

2 For sensitive products, especially filled chocolates, some areas of the surface distribution pattern show the position of early and intensive fat bloom formation (see Figure 24.30).
3 In parallel to a traditional sensory test, this approach gives proof of concept for chocolate fat bloom assessment by computer. Results are visualised in Figure 24.28.

An alternative approach to the problem of sub-optimal heat transfer is described by Rocklage *et al.* (2012). Windhab *et al.* (2008) are also developing the so-called DETACHLOG principle. Using this approach it is possible to determine the exact time that the product will release from the mould cavity in a given cooling tunnel. This means that the minimum time for cooling can be determined. In addition this technology will enable the chocolate manufacturer to determine cooling profiles tailored for individual products and recipes together with performing shelf life studies.

24.2.14 Detecting foreign matter

External matter removal is vital in ensuring the safety of food products (Chapter 25). It involves not only control of foreign matter, but is also part of the processing guidelines for chocolate, filling masses and rework. Depending upon the processing stage, foreign matter can be removed manually or by equipment such as metal detectors, separators, magnets, filters, screens, traps and optical detectors.