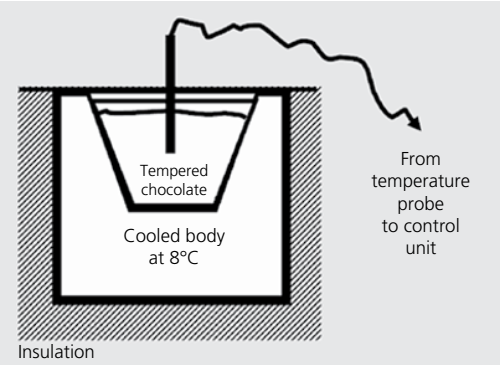

Figure 24.12 Schematic diagram of measurement head of tempermeter.

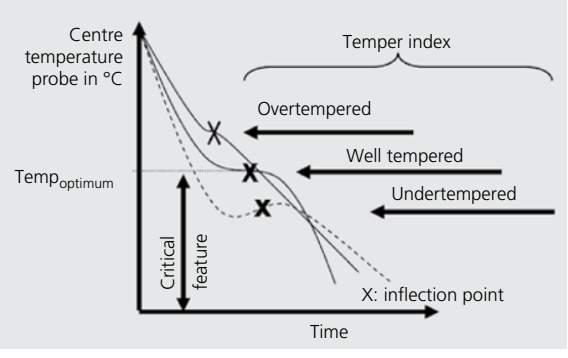

Figure 24.13 Typical temper curves from tempermeter.

Although such systems can quantify the degree of temper, the information is limited. It cannot for instance determine if certain crystal modifications are taking place and it can be distorted when an incompletely decrystallised masse is present.

24.2.9 Pressure measurement

Pressure sensors usually operate by converting the movement of a diaphragm into an electrical signal. They can be used, for example, for checking the masse pressure for aerated masses, the air pressure of the compressed air supplied to the infrastructure and the pressure in hydraulic drive. Within the confectionery industry they are particularly important to ensure a minimum pressure when providing cooling water to mills, roll refiner, tempering machines and conche units. Without this cooling flow, the output and quality are reduced and wear increases. In addition pressure sensors are often placed in closed circuit flow systems, for example the masse within a circuit of ball mills, the hydraulic circuits to the rolls in roll refiners, cocoa presses and hydraulically driven depositing systems, the reactor contents in alkalising units, refrigerant circuits in chillers

and refrigeration equipment with direct evaporators, pneumatic systems and pressure relief valves in pump systems. They can even be used as a means of determining the fill level of storage tanks. Examples of different pressure measurement applications are summarised in Table 24.5.

24.2.10 Measuring moisture/relative humidity

Water content of cocoa beans/cocoa nibs: In order to optimise the yield it is important to measure the moisture content at regular intervals. As a natural product, the composition of cocoa beans can vary. This applies to the fat and water content as well as to the attainable yield. Under production conditions, the water content of cocoa beans and cocoa nibs can be determined by halogen moisture analysers. These heat samples uniformly and the moisture present is determined from the loss in weight.

Water content of cocoa mass: When adjusting cocoa masses to a specific fat content, the moisture content must first be measured. This can be determined by measuring the adsorption/reflection of infrared radiation at the surface; the typical accuracy of measurement is 0.3–1.0%. This method requires a special calibration regime.

Air relative humidity: Water in the gas phase (air) is often recorded as relative humidity (%) or as a concentration (g/kg). In combination with the air temperature, it is then possible to determine the dew point, that is the temperature below condensation sets in, see Figure 24.14. Every time condensation forms on the product's surface there is a danger of mould growth or sugar bloom.

24.2.11 Recording flow characteristics

Flow characteristics of chocolate and filling masses are described in simplified form by means of the term "viscosity" (η). This is obtained by determining the interactions involving the shear stress (τ) at different shear rates (D). Viscosities are often measured either in separate laboratory rooms close to production or directly in the laboratory. Various models exist for describing curves mathematically; see Windhab *et al.* (2008), Tscheuschner (2004) and Chapters 11 and 12. Single-point measurements are not suitable when determining the viscosity of non-Newtonian fluids such as chocolate. Measurements should be made at least at two shear rates, with great care being taken with the sample preparation and in using the viscometer according to standardised procedures.

Flow characteristics depend on the condition of the material (texture) and the processing conditions (such as temperature, shear etc.). If production conditions are being adequately controlled, when manufacturing chocolate masses for making tablets it is not necessary to conduct viscosity measurements on a continuous basis. It is, however, common to record related variables, such as the power consumption of a conche shaft, to draw conclusions about the condition of the masse during processing, thereby permitting automation of the process