24.2.13 Production monitoring

24.2.13.1 Five roll refiner technology

A typical five roll refiner and its monitoring sensors is illustrated in Figure 24.17. Some of the sensors (Figure 24.18) will be described later in more detail.

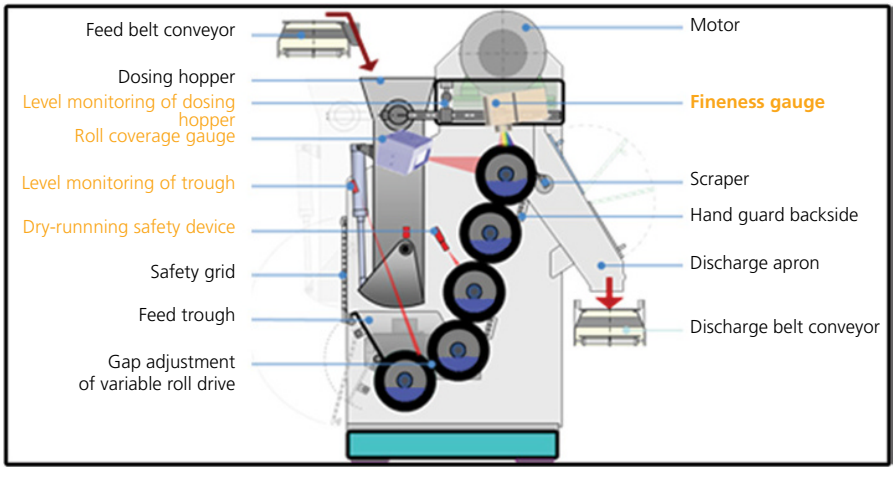

Figure 24.17 Overview of five roll refiner with its parts as schematic cross section view. Control elements are marked in red colour. Reproduced with permission of Bühler, Uzwil, Switzerland.

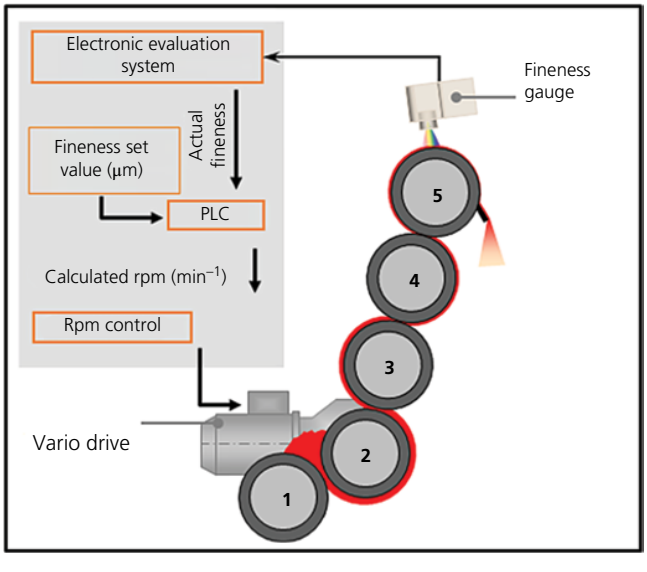

Figure 24.18 Refiner (schematic) with automatic particle size control (FineSense®). Reproduced with permission of Bühler, Uzwil, Switzerland.

Particle size control In state of the art chocolate production (dosing, mixing, refining and conching) the particle size of flakes after refining is an important quality criterion. Achieving the designated particle size is both important for the product quality as well as for economical production. Too coarse a particle size will result in rework, too low a particle size is lost throughput. An in-line thickness gauge combined with a refiner is able to adjust the particle size automatically and prevents such losses. Particle size is controlled by the product intake conditions varying with the masse consistency (the rest of the refiner remains fixed). The intake can be set either by adjusting the gap between roll 1 and roll 2 or the variable speed of the first or second roll within a certain speed range. Machines with variable speeds are preferred for automatic fineness adjustment.

The fineness of chocolate flake can be measured by different methods, which are summarised in Table 24.6.

Roll coverage control An uneven chocolate film coverage of the rolls reduces the throughput as well as increasing roll wear. Even more importantly, a uniform particle size distribution over the roll length is needed to produce a chocolate with consistent flow properties.

The roll coverage is influenced by the feed texture/plasticity and the refiner parameters such as roll temperature and pressure and the cooling intensity. A highly specialised machine operator is able to adjust the refiner parameters according to the type of pattern he sees on the rolls.

The coverage measurement of the fifth roll can be recorded by a camera with an in-line pattern detection system. The recorded pattern and its behaviour (stable, moving etc.) is compared with a data base and the necessary adjustments calculated and automatically reset by the machine.

The roll coverage can also be recorded with a laser scanner. The laser beam is used to detect the stripes and defining their position. This information is then transformed into a binary image as shown in Figures 24.19 and 24.20.

Before commercialisation of this technique, a pilot plant study (Figures 24.21 and 24.22) was performed to optimise the degree of coverage of the rolls in five-roll refiners and to investigate alternative automatic control systems. Figure 24.21 shows schematically the light source and the line camera. An incremental encoder on the fifth roll (not illustrated) synchronises the line camera with the aid of a frame grabber card. Automatic adjustment to optimal values in this way is much more frequent and accurate than would be possible even with the best machine operator.

Trough level control The discharge trough allows product to be deposited in the first roller gap. The trough should be filled with as little product as possible, but should contain enough product for the rollers to never run dry. The level is also important to produce a uniform film and therefore get a steady particle size