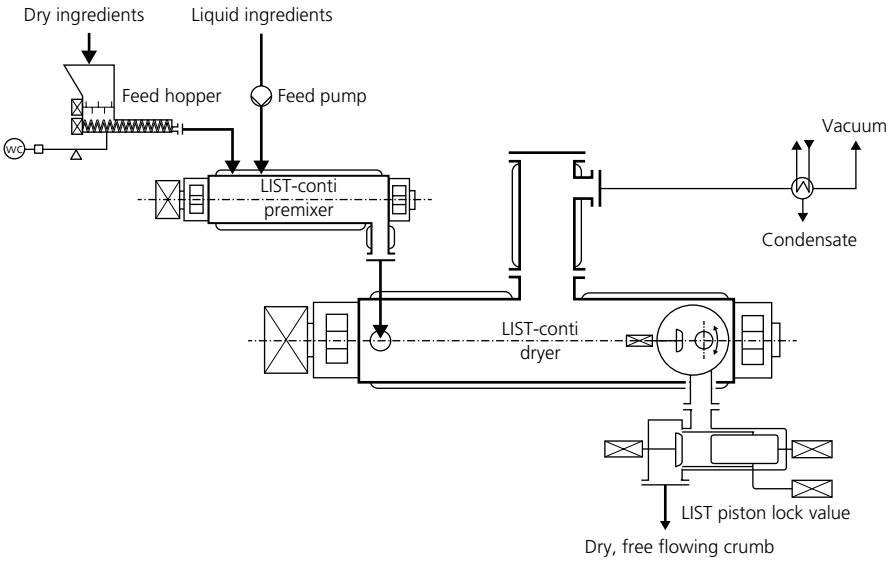

Figure 6.12 List crumb process flow diagram.

annular gap. Rapid cooling is encouraged by the dry ambient air that passes through the annulus and the water cooling. Sensible (specific) and latent heat of sugar crystallisation are removed in this way and the crumb pieces drop at the base onto a continuous air band dryer.

Although the process described was developed for atmospheric pressure, the Groen DR series of scraped surface evaporators are also available for vacuum operation. In addition crystallisers have been designed to operate with less viscous material out of the first dryer.

6.7.2.4 Stirred mixer vacuum process

A number of batch mixers have been designed to operate as semi-continuous crumb making machines. Typical of such processes is that offered by the company List AG. The process flow diagram is shown in Figure 6.12.

The core of the process is the second List dryer which is a heated single shaft mixer operating under vacuum and with sufficient power to convert an incoming paste of 88% solids, through the point of maximum viscosity and beyond to the point where the material becomes a flowing powder. At the correct flow rates it is possible to dry the final powder to around 1% moisture content. Figure 6.13 shows the List single shaft mixer/dryer.

In the early 1990s this type of equipment was being used to make white crumb in a number of companies. Similar semi continuous vacuum mixer/dryers have been used to make milk crumb by one of the major confectionery companies throughout the world.

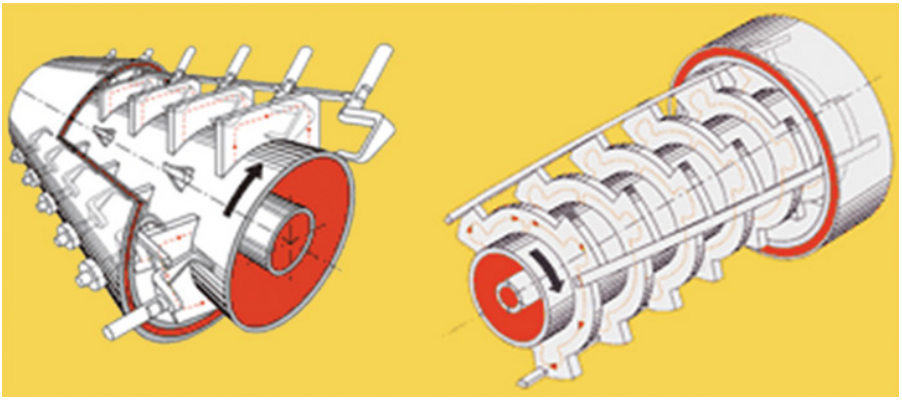

Figure 6.13 Illustration of List single shaft mixer/drier.

Table 6.4 Effect of process upon crumb properties

Process	Level of caramelisation	Degree of crystallinity	Aeration	Fat availability	Lumps/dust
Groen	Very high	Medium to high	Low	Medium to high	Small lumps
Batch oven	Medium	Low to high	High	High	Large lumps
Vacuum band dryer	Medium	High	High	High	Large lumps
Vacuum roll oven	Low to medium	Very high	Medium	Very high	Lumps and dust
Stirred mixer	Medium to high	Medium to high	Low	High	Dust

6.8 Effect of the crumb process upon the crumb properties

The choice of process has a major influence on the flavour and processing characteristics of the finished crumb. Table 6.4 summarises the major differences.

6.9 Changes to crumb during storage

Although originally crumb was chosen as a stable alternative to milk powders, there are limits to its stability in certain aspects.

The fat system in crumb is not in its final stable form immediately after manufacture. Crystallisation of the fats occurs slowly, with a tendency for the fat to migrate to the surface of the particles. It has been found that very fresh crumb requires more energy in later refining and conching, and it is undoubtedly the slightly lower fat availability on particle surfaces which accounts for this.

Crumb has a very low equilibrium relative humidity (ERH, the relative humidity at which moisture is neither taken up nor given out) at normal moisture contents as Figure 6.14 demonstrates.