Glass crushing: The sharp end of cullet recycling

The use of cullet represents an integral part of glassmakers' ongoing challenge to lower costs while maintaining glass quality. Richard Sims* explains the importance of glass crushing in cullet preparation and how two crusher systems from EME help to streamline the process.

Certain aspects of the glass manufacturing process offer more attraction than others: The melter, for example, or the gob feeder, and in particular the forming process, where molten glass is transformed into a product. Other areas are less glamorous, yet still important. Cullet preparation is certainly one of the less critical parts of the manufacturing process, but it is nonetheless an integral part of the continuous challenge to maintain glass quality while limiting costs.

The use of cullet plays an important role in modern-day glass manufacture and in many sectors considerable quantities are returned to the melting process. There are various reasons for this. For instance, cullet produced in the factory represents a raw material, which is both cheap and reliable. This recycling process can also provide the manufacturer with a significant reduction in specific melting energy consumption.

Rejection levels

Although the generally high productivity levels achieved in container manufacturing often leave very little factory cullet available for re-melting, this is not the case in all sectors of the industry. Very high quality requirements for certain glasses can lead to significant rejection levels, and a typical example of this is the production of ultra-thin flat glass sheets for use in thin film transistors (TFTs) and liquid crystal displays (LCDs).

For these types of production, absolute freedom from glass faults is necessary and strict dimensional tolerances – especially the thickness are vital for the quality of the finished product. Compliance to these strictures automatically results in higher reject levels and the production of cullet.

Some production processes themselves can also lead to relatively high cullet availability. An example of this is provided by flat glass production, in which cullet is produced when the edge strips are cut off.

Crushing process

All cullet, whether factory-owned or foreign, must be treated before it can be added to the melting process. One of the most important parts of this cullet preparation is the crushing process, which is carried out in order to fulfil two major functions. Firstly, it serves to reduce the size of the material so that it becomes acceptable for the melting process, and secondly it is a method of simplifying the removal of contaminants such as metallic inclusions.

However, the crushing process is complicated and the solution needed depends entirely on the starting point – the type of cullet to be recycled. To illustrate this we will take two examples from opposite ends of the glass manufacturing spectrum. We will explain the problems that occur in the crushing process and offer the solutions to these problems.

The first example concerns the difficulties inherent in crushing the ultra-thin sheets produced for TFT displays. The typical glass thickness is less than 0.8mm and may even be as little as 0.2mm, whilst rejected sheets may be as large as 2000 x 2500mm. Pieces of glass of this size and thickness are remarkably flexible and will bend rather than shatter The problems for the crushing process can be compounded by the tendency of such sheets to stick together if stacked, as they inevitably are. The combination of large sheet size and relatively low throughput adds to the difficulty of handling this material effectively.

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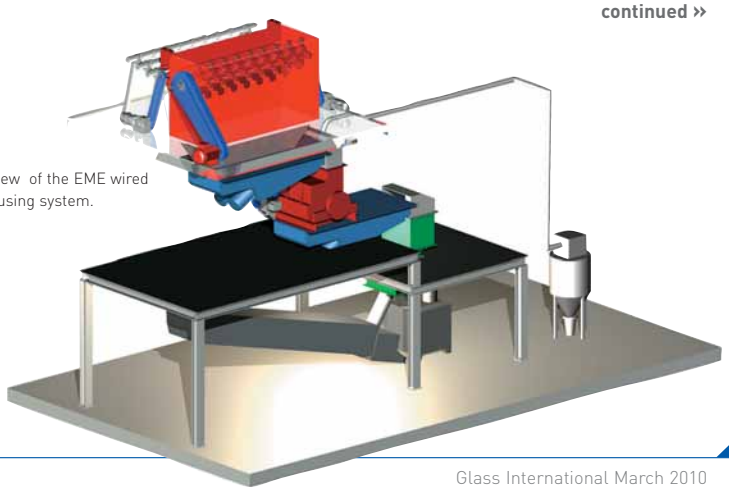

Overview of the EME wired glass crusing system.

Stage by stage

Crushing is a process that brings the glass into contact with metallic surfaces and there is obviously the risk that the glass will be subject to some iron contamination as a result of this. In a modern installation typical iron addition contamination values would be in the region of 60ppm. When this is compared with a target level of only 30ppm in the melted glass for this particular product, the scale of the problem becomes clear.

During the first stage of the multi-stage crushing process a hammer impact crusher is used. This equipment features free-swinging hammers attached to its main drum. The glass sheet is inserted horizontally into the crusher, such as would be the case at the end of an inspection line. As the drum rotates the free-swinging hammers are brought down against the glass sheet and crush it against stationary horizontal bars, which are located between them. This step reduces cullet piece sizes to approximately 100 – 300mm.

A second hammer impact crusher is provided as an intermediate stage before the material is passed to a special version of the EME ZWB double roller mill which completes the crushing process. The resulting product is then sieved and any remaining oversized material is returned to the roller mill, while the acceptable material continues through the system.

In the final processing stage the material passes a magnetic drum separator where ferrous contaminants are removed and this is followed by an all-metal separator where other metallic impurities are eliminated.

All parts of the system that have glass contact are manufactured in special steel alloys to limit iron and nickel contamination of the glass that is being processed. Practical experience gained on existing installations has already shown that the use of this arrangement makes it possible to maintain the maximum level of 30ppm iron that is permissible in the finished glass.

Wired glass application

A second example of the application of EME crushing technology involves wired glass production. Wired glass is esentially rolled plate with a typical thickness of approximately 8mm, where a steel wire mesh is encased within the glass to provide additional mechanical security. Incidentally, the same EME crushing equipment can also be used to treat conventional rolled plate up to a thickness of 30mm.

▲ A close-up of the EME hammer impact crusher used for thin sheet processing.

In addition to the normal processing stage of reducing the cullet particles to sizes acceptable for re-introduction to the melt, when wired glass is recycled it is also necessary to separate the glass from the wire, so that the latter can be removed. As in the previous example a multi-stage process must be used in order to produce the best results.

Once again a hammer impact crusher with horizontal feed is used as the first stage crusher, but in this case this unit provides the main crushing effect. Considerable power is needed to crush sheets 30mm thick and, in the case of wired glass processing, even more power is needed to ensure that the glass is adequately separated from the wire. A feature of the EME crusher is its particularly robust design.

A high level of separation of glass from metal must be achieved in order to ensure the efficient removal of all metal parts whilst maintaining a minimum loss of glass. Therefore, a secondary crusher in the form of an impact crusher is used to complete the job. The crushing process is followed by the first of two on-line magnetic separators that are used to remove all traces of the wire mesh.

The wired glass crushing system from EME can accept sheets up to 2600mm wide and is capable of handling up to three tons per hour.

Filtering equipment

Glass crushing is a potentially noisy and dusty business and environmental regulations apply to this process in the same way as they do to other areas of glass production.

On a typical EME installation all units are provided with extraction equipment. Wherever the location of the individual items of equipment allows, all extraction units are connected to a central filter unit. This has filters that are equipped with sintered filter elements which are capable of clearing the exhaust to a remarkably low level of > 1 microgram per m^3. This value amounts to only 5% of the maximum level currently specified by the German TA-Luft.

If equipment locations do not allow the use of a central filter unit, then individual units are provided with filters of this same type. Thus, irrespective of how the individual units may have to be located in order to take specific factory space availability into account, the same low particulate emission levels can be achieved.

Noise absorbency

Despite the fact that modern EME crushers are designed to limit noise as far as possible, there is no doubt that glass crushing leads to relatively high noise levels.

In order to reduce noise emission to a minimum, all individual parts of EME crushing systems, such as casings, funnels and chutes are lined with noise-absorbent matting. However, the best practical solution to this problem can be achieved by installing the complete crushing system at a single location and constructing a noise-absorbent wall around the whole crusher installation.

The widespread use of cullet recycling has increased the need for equipment that will meet the differing requirements of various branches of the glass manufacturing industry. The two examples given in this article illustrate how EME has addressed the problems. ■

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