

The Melt System: Controlling a Change of State for the Processing Industries

The chemical, pharmaceutical, food, dairy and confectionery industries frequently use materials in the liquid state, materials that are solids at ambient temperatures and pressures. A variety of pharmaceutical products incorporate low melting solid ingredients and waxes, gums and gels are more readily formulated as liquids. In the chemical industry coatings are conveniently applied as liquids. Many food products involve the use of intermediate liquids or semi-solids. These processing industries therefore require melt systems, i.e., process equipment that is designed to provide controlled melting of a solid material and retain the material in the liquid state.

Thirty years of working with the processing industries has allowed A&B Process Systems to gain valuable experience in the design, fabrication and installation of such systems. Today the company is able to provide melt systems that are easy to maintain, reduce the labor involved, improve safety and can be efficiently cleaned. These benefits in the operation of the process system translate into economic advantages, e.g., lower operating costs and a shorter return on investment for the customer.

What is a Melt System?

A melt system typically includes stainless steel tank(s), a melt grate, agitators, pumps, heat transfer panels and an external heat exchange unit, interconnected by stainless steel piping. In most melt systems the stainless steel tank is fitted with hinged or lift off covers, agitation bridges and the melt grate. The heat transfer panels, required for control of the temperature of the liquid product, are attached to the walls of the tank, often in multiple zones. The sensitivity of many of the materials processed in the melt system demands that overheating be avoided and therefore the bulk of the liquid material must be stirred in a controlled manner. This agitation also eliminates any "cold spots" in the mass of liquid, which could result in localized solidification or crystallization, as well as providing turbulence to ensure that residual solid material dropping through the grate is fully melted before a product transfer cycle is selected. An external heat exchanger may be required to control the temperature of the heating medium circulated through to the melt grate.

Some Factors Important to the Design of the System

To design a melt system it is important to initially obtain specific information about the particular process and the plant site. For example;

- (i) The Physical Properties of the Material(s) Properties such as the density, specific heat, viscosity, latent heat of the solid(s), heat capacities and melting point(s) at normal pressures, are necessary to calculate the heat required for the melting process. Furthermore, this information may define the method of heating, the surface requirements and the type of agitator to be used.
- (ii) Material Throughput The amount of material required in the liquid state per unit time is a significant design factor.

- (iii) **Material Loading and Transfer** There are several approaches to loading material onto the melt system, each requiring different design characteristics.
- (iv) **The “Heat Source”** Knowledge of the type of heating utilities, e.g., hot water, steam, electricity or oil, is important information, together with their available capacities at the plant.
- (v) **The Available Floor Space** The footprint of the melt system can be dependent upon the available floor space at the site.
- (vi) **Accessibility** Information regarding shipping regulations/restrictions can determine the degree of pre-assembly. It is also important to obtain knowledge of the accessibility to the plant floor, such that the degree of pre-assembly can be determined prior to installation at the site

The Melt Grate and the Melting Process

The melt grate is the component of the system upon which the melting process occurs and it may be fabricated in several forms. A series of straight tubes, through which the heating medium flows, is a straightforward configuration that is often used. However, the proper arrangement of the stainless steel tubes is a key factor in achieving an efficient grate design. It is important to provide the maximum surface area, together with the appropriate velocity of the heating medium, to realize efficient transfer of heat to the solid material.

More complex designs may be fabricated. For example, the so-called “expanded metal grate” consists of stainless steel sheets laser welded at multiple sites and expanded by hydraulic pressure to give an array of smooth ridges and therefore a high contact area to enhance the rate of melting of the solid material. This perforated “dimple surface” design provides a more complete melting process. Another design is a 2-stage arrangement that, in A&B’s experience, realizes better performance with certain products. Here the grate has smaller tubes, wider gaps and a dimple sheet catch tray below. The 2-stage design can be an attractive option when floor space is at a premium.

As stated earlier, an important consideration in designing a melt system is the material throughput. A “table” melt system is usually recommended when a high throughput is involved, this being a design with a significantly larger melt grate that is part of a “table” located adjacent to the stainless steel tank(s). This allows easier accessibility to the melt grate, obviously simplifies the loading process and provides a significantly larger contact area for melting the solid material. The stainless steel tank(s), located below the level of the “table,” are fitted with agitators and heat transfer panels as described earlier.

The heating medium is typically heated water and it is not uncommon to find that the melt system requires an external heat exchanger, supplied with steam from the plant, to control the temperature of that heating medium. This unit may be either a shell-and tube or plate-and frame heat exchanger. When available at a plant, steam is always considered as a heat source, but the sensitivity of the material(s) to heat may limit its’ use. In some cases electrical power is the



preferred energy source at the customer's plant site and then the "heat exchanger" is simply a jacketed, immersion heater or a self-contained water/oil temperature control module.

The efficiency of the melting process is dependent upon the amount of the solid material conveyed to the melt grate. In many plants this is controlled by manually placing the melt blocks on the grate. This approach is labor intensive and health and safety guidelines will determine the height of the grate, the weight of a melt block and the frequency of lifting by individual operators. A&B Process Systems offer ergonomic designs for the melt system, with platforms, ladders and safety railings. Every effort is made to reduce the manual lifting and dumping, minimizing injuries and product contamination. The use of conveyor belts, hinged buckets or pallet lifts can be included in the design of the melt system to provide alternative approaches to the loading process.

Guidelines for Fabrication

A&B Process Systems design and fabricate the melt systems to meet the guidelines for the particular processing industry, e.g., the 3-A guidelines established for the food, dairy and confectionery industries or the ASME, ANSI and BPE regulations. These guidelines and regulations specify the materials to be used for the tanks, piping, pumps, seals etc and also the preferred designs. Within the various guidelines the surface condition is usually specified, particularly in weld ares, joints and seams. To provide the required levels of cleanliness and minimize product contamination, A&B Process Systems will design and fabricate a clean-in-place (CIP) unit that can be integrated into an existing melt system or include that unit in the design of a new melt process system.

Automation and Controls

The incorporation of controls in the melt system and its' CIP system is important and it is necessary to include a variety of instruments and devices to monitor the processes. A&B Process Systems has recognized the need to provide user-friendly controls and instrumentation with any system. The Automation and Controls group at the company works with the design engineers and with the customer to ensure that this objective is realized and that the proper level of operator training is provided.

Installation of the Melt System

Once fabricated the melt system may be assembled as a modular or skid-mounted unit at A&B Process System's facilities in Stratford, Wisconsin and fully tested prior to shipment. However, consideration of the size of the system and the accessibility to the site at the customer's plant may require assembly and testing at Stratford, but then disassembly to facilitate the shipping and installation. The field erected fabrication is completed by A&B's engineers, welders and fitters, providing the same high quality workmanship with minimal disturbance to existing plant operations.