Purification of monochloroacetic acid (MCAA)

End purification with suspension-based melt crystallization

Features

• High product purity – The ultra-pure crystal from the suspension crystallization process and the efficient separation of the GEA wash column provides the maximum purity possible. Organic impurities are removed to <100 ppm and metals essentially eliminated below detectable limits.

• Continuous operation – The suspension crystallization process operates as a continuous process. Operating turndown ratio of 50% and an immediate stop/hold (for upstream/downstream upsets) does not require a complete start-up.

• Feedstock – Variations in feed composition are absorbed by the system.

• Expansion and debottlenecking – The suspension crystallization process is ideally suited to end-purification and can be easily added to existing units to improve capacity and final product purity.

• Economics – Due to the inherent advantages of crystallization a single step process typically offers a significantly lower operating cost than other separation techniques providing the same final product purity. GEA can provide assistance in determining the optimum configuration and cost information for your specific circumstances.
MCAA or monochloroacetic acid is an important chemical intermediate in the organic synthesis of a wide variety of other chemical products. A large portion is used for the production of carboxymethylcellulose (CMC listed as E466) which is widely used as a thickening agent in many food and non-food applications (stabilizer in dressings, ice cream, gluten and fat-free products but also use in pharma and non-food applications such as 2,4 D, oil & gas extraction, paints, pulp & paper). Herbicides and laundry detergents might not benefit from the ultra-high purity quality provided by melt crystallization but the growing life science and pharma applications typically demand minimal impurities in their raw material. Melt crystallization is perfectly suited to meet these demands.

The main production process involves the chlorination of acetic acid with hydrochloric acid as a byproduct. Residual acetic acid and the di- and tri-chloro monomers are the main impurities that remain after reaction and initial distillation. All of the products and by-products are moderately to highly corrosive to normal steel and the entire process is typically carried out with exotic alloys, Teflon® (PTFE) or glass and enamel lined vessels. Some of the more critical impurities are difficult to remove via distillation and require complex multiple steps or additives to aid removal. Crystallization provides the possibility to make ultra-pure MCAA in a single step. Pure MCAA crystallizes at 63°C, it forms relatively large, strong crystals and the liquid has water like viscosity. All qualities required for separation and purification via suspension-based melt crystallization.

Crystallization is a highly specific separation technique. The MCAA solution (mixture of a MCAA and other impurities) exhibits eutectic type solubility and therefore will form pure MCAA crystals (see also phase diagram MCAA-DCAA). Below the equilibrium line the liquid solution composition is determined by the temperature of the solution. Cooling a solution of MCAA will result in the formation of completely pure MCAA crystals. When we cool a 95wt%MCAA solution the first crystals will form around 60°C. The impurities will remain in the liquid and the equilibrium temperature will slowly decrease. As the coolant temperature decreases we form additional crystal mass and the equilibrium follows the curve down to around 58°C where we have converted roughly 50% of the original feed to solid MCAA. When we can separate the crystals and remove all of the liquid (and the impurities) what remains is purified MCAA product. The GEA wash column is a highly efficient solid liquid separation device; basically a continuous filter that includes a unique internal wash mechanism that separates the crystal mass from the impurity rich mother liquor. The purified product is refluxed back through the crystal mass and allowed to reach a new equilibrium inside the column by recrystallization. This process occurs naturally without any additional energy or special control. The configuration of the wash column provides the residence time required and promotes the washing process. The end result is complete separation and recovery of the pure crystals formed in the crystallization section.

For more information regarding this technology and your specific configuration requirements, please contact us or get in touch with your local GEA contact on gea.com via the Application Chemical, Specialty & Fine Chemicals.