FROM RECOVERY TO REMELTING

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USA, OUTLINES INFRASTRUCTURE CONSIDERATIONS FOR GLOBAL DRY SULFUR LOGISTICS.

Sulfuric acid – the most commonly used chemical in the world – is a primary feedstock in the production of fertilizers, as well as in the manufacturing processes of many other products.

Today, more and more sulfur is being generated as a result of increased global oil and gas production and environmental regulations that demand lower sulfur content in transportation fuels. The result is an evolving need for efficient sulfur storage and transportation logistics, which has, in turn, led to increased reliance on the production and transportation of dry formed sulfur that can be carried in bulk collier ships. Concurrently, large new facilities that have the capacity to form over 1000 tpd of sulfur

Figure 1. Wet prilled sulfur being conveyed from a sulfur prilling unit to a pile for open storage.

Figure 2. Material handling system including marine structures and shiploaders designed to handle either molten or prilled sulfur.

Figure 3. A 1 million tpy sulfur remelter with lime silo, external heat exchangers and a scrubber.

are being constructed in Canada, India, Iran, Kuwait, Malaysia, Mexico, Turkey and Vietnam.

From recovery of molten sulfur, to dry bulk solid, and back to molten sulfur, this process requires specialised technology and infrastructure to ensure safe handling, transportation and storage. This article focuses on those processes and infrastructure.

Degassing units

Sulfur that has been degassed to lower hydrogen sulfide (H_2S) results in a higher quality and much safer formed dry sulfur prill. Claus liquid sulfur contains 250 – 350 ppmw of dissolved H_2S/H_2S_x. With a long logistic supply chain, dangerous H_2S is released during storage, handling and transportation. This is particularly dangerous due to potential H_2S buildup in a ship's hold during ocean transportation.

Key drivers for sulfur degassing are safety, health and environmental improvements. Degassing units that include contactor, cooler and mechanical systems are readily available in vertical modular packages.

Sulfur forming units

Products that can be handled as dry bulk solids are formed by either dry pastillation, granulation, or wet prilling. The objective is to solidify molten sulfur into a product with a shape and integrity that will create the minimum amount of fine sulfur particles during transport, transfer, storage and reclamation. Sulfur dust is both a health hazard and presents potential for explosion if collected in a confined space with an ignition source.

Pastillation units spray water under a steel belt on which sulfur drops are deposited to produce pastilles. Meanwhile, granulation units use water sprayed into a rotating drum for cooling the liquid sulfur that is sprayed onto a seed curtain to form granules.

Prilling introduces liquid sulfur at the top of a forming tank for direct countercurrent heat exchange with water to produce prills that are withdrawn from the bottom of the forming tank via screens. Unlike a pastillation or granulation unit, prilling units are readily adaptable for modular construction. Major components include the forming tray, fume hood and scrubber (if required), forming tank, dewatering screen and dry product conveyors. Mechanical equipment includes the process water and cooling tower supply pumps and cooling tower with fan units.

This wet formed prill also benefits from modern process improvements for moisture control (2%), size uniformity, high capacity and ability to meet international commercial specifications. Apart from in very cold climates, process building enclosures are not required.

Dry sulfur material handling

A major advantage of dry sulfur in the global logistics chain is the ability to store, handle and transport it as a dry bulk product. Depending on facility owner preferences, it is acceptable to store dry sulfur in open storage stock yards. However, these yards are subject to windborne contamination (such as sand) and increases in free moisture due to rain. While dry storage in buildings will protect the sulfur from the elements, it also requires greater dust management.

Wet prilled sulfur (Figure 1) is less dusty from the time it is produced. There are also a number of commercially-available dust suppression products that work effectively if properly distributed at transfer

points along the material handling conveyor system.

Control of acidity is an important consideration for protecting material handling equipment and facilities. While total stainless steel construction would be ideal, it tends to be more expensive than most facilities can justify. Experienced providers of sulfur material handling systems understand this and will generally be able to offer a more cost-effective solution. That said, regardless of whether open or dry building storage is used, sulfur acidity will biologically increase over time. The use of additives before a material is placed in ship holds or at ports of storage for periods of over a few weeks can slow this activity.

Figure 4. Three modular pressure leaf filter units at a 1 million tpy sulfur remelting facility.

Shiploading and unloading

Being able to load ships with dry sulfur at the origin or unload ships at the consumption destination is greatly enhanced if existing dock facilities are available (Figure 2). The capital expense for basic new dock construction in the US starts at over US$30 million, excluding the cost of material handling conveyor systems, stockpiles and shiploading/unloading equipment.

Co-location of sulfur handling ship facilities at an existing dock can lower capital construction costs. However, berth occupancy minimum times and potential per diem ship costs for a shared dock must also be considered.

Large heavy longitudinal travelling shiploaders/unloaders provide the greatest flexibility for working vessels at rates of over 3000 tpd. These machines also have the highest installed capital cost, requiring substantial existing and new dock structure to support. In many cases, smaller fixed-arm shiploading equipment will have the lowest capital cost, but will also mean lower unloading rates (approximately 1000 tpd) and, unless one hold is being loaded for small cargo, the ship must be repositioned during loading/unloading.

Ships can be loaded/unloaded with dry sulfur using basic cranes and ships gear. While these simple systems have low capital costs, they require more manpower and have higher operating costs over the life of the facility.

Land transportation

If the sulfuric acid plant and associated melter is a distance from the ship dock, dry sulfur can be transported by rail or truck. The capital and operating costs of rail or truck loading/unloading facilities need to be taken into account accordingly. Often, only the cost of transportation is included in a business model, with truck and rail facilities easily overlooked or underestimated.

Sulfur remelting facility

A sulfur remelter is required to transform dry sulfur to molten sulfur, to then feed the sulfuric acid plant. Single melter vessel systems using external heat exchangers (Figure 3) can be provided with a capacity of well over 4500 tpd, which adds heat to the melter system through the use of external heat exchangers, without the use of internal coils in the melter vessel. External heat exchangers are much more efficient to maintain and operate than systems that include internal coils.

Dry sulfur is added to the melter vessel at a controlled rate. Heated molten sulfur is also added at the top of the melter. Properly designed mixing and the creation of a controlled vortex facilitate the highly efficient melting of the dry sulfur. Molten sulfur then flows from the melter vessel into an elongated pump tank. The pump tank and associated vertical shaft pumps circulate the molten sulfur through the heat exchanger/melter vessel system. Importantly, the pump tank also allows for non-meltable contaminates and any foam to settle out.

Filtering and molten sulfur storage

The last step before molten sulfur can be stored is post-melting filtering. This is typically completed using pressure leaf filter units at the remelter facility (Figure 4). These units use filter leafs that are pre-coated with filter media, such as diatomaceous earth. As filter efficiency decreases, the filters are taken offline, opened and the filter cake removed.

These properly sized and designed leaf filter units are readily adaptable to modular fabrication away from jobsite and transported as complete units by truck, barge or ship. Polishing cartridge filters can also be provided depending on the acid plant ash specification in cases where adequate filter screens and pre-coat is not available.

Molten sulfur is then pumped from the filter system to the molten sulfur storage tanks that provides feed to the sulfuric acid plant. Molten sulfur storage tanks require proper design and construction in order to maintain uniform heat and temperature control, as well as proper and safe venting.

Conclusion

Taking note of the necessary considerations and requirements for the production of dry sulfur, global ocean transportation and remelting is an important factor as decisions are made regarding changes in markets, new facility locations and type. WF

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