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SULPHUR GRANULATING ROTOFORM PROCESS

DENIS RUD, SERAFIMA POKROVSKAYA
Polotsk State University, Belarus

Environmental regulatory agencies continue to promulgate more stringent standards for sulphur emissions from industrial sources. Many plants are still allowed to emit large quantities of SO_2 because of their remote locations and the high cost of mitigation, but those exemptions are running out as governments become more environmentally responsible.

With the renewed interest in high sulphur coal for power production and increased activity in the mining and metals sectors, it is necessary to develop and implement reliable and cost-effective technologies to cope with the changing requirements.

Sulphur dioxide is found in a many industrial gases emanating from plants involved in roasting, smelting and sintering sulfide ores, or gases from power plants burning high sulphur coal or fuel oils or other sulphurous ores or other industrial operations involved in the combustion of sulphur-bearing fuels, such as fuel oil. One of the most difficult environmental problems industry faces is how to control SO_2 emissions from these sources economically [1].

Sulphur is a basic chemical element widely distributed in nature. It's found in small amounts in all living creatures, including humans. Sulphur makes up 0.05 percent of the earth's crust and often accumulates in large amounts near volcanoes. Sulphur is also found, in varying amounts, in crude oil and natural gas. The crude oil contains "sour gas" that has a hydrogen sulfide content of about 14 percent. Oil refinery plant removes this hydrogen sulfide from the crude oil and associated gas and converts it into elemental sulfur. Elemental sulphur is a yellow solid substance that is not hazardous.

Sulphur has many uses. It's a key element in the production of paper, rubber and textiles and to make cosmetics, plastics and paints. It's used by the pharmaceuticals, mining and food industries and in the production of cement, asphalt, glass and steel. Its largest use is in making fertilizers and soil conditioners [2].

As further processing very often requires liquid sulphur (e.g. for the production of sulphuric acid and fertilizer), it is advantageous to transport and store sulphur in liquid form. However, temperatures of between 124–145°C mean that handling, transportation and storage could pose a problem from the point of view of safety and economics, so liquid sulphur is handled only if one or more of the following factors apply:

– Short distances.
– Short storage cycles.
– Availability of adequate storage system.
– Availability of adequate infrastructure for transport, be it road, ship or railway transport.

More often, for easier handling, storage and transportation, sulphur is formed into pastilles/semispherical granules. The pastilles are globally accepted as a premium quality product, delivering the following significant benefits:

– High purity (bright yellow colour).
– Low friability and high impact abrasion resistance (low visual dust generation).
– Good flow characteristics.
– Easy remelt (no agglomeration).
– Low moisture content.
– Stable properties over time.
– Consistent quality.

Based on steel belt technology, world company has developed an efficient and environmentally friendly process for the cooling and solidification of molten sulphur. The basic principle consists of a continuously running steel belt, which is cooled from the underside by spraying water through nozzles. A specially developed feeding system – the Rotoformer – deposits liquid sulphur in form of droplets onto the steel belt. These are cooled as they run with the steel belt and discharged in form of solid pastilles / semispherical granules at the end of the system [3].

Integration of the Rotoform in the complete system

The product is manufactured in a reactor or a mixing container and kept at the ready in an intermediate container, pumped via a filter and placed onto the steel belt cooler in droplet form. The high-quality pastilles produced by the cooling and solidification are transported to the finished product warehouse and subsequently packed (Fig. 1).

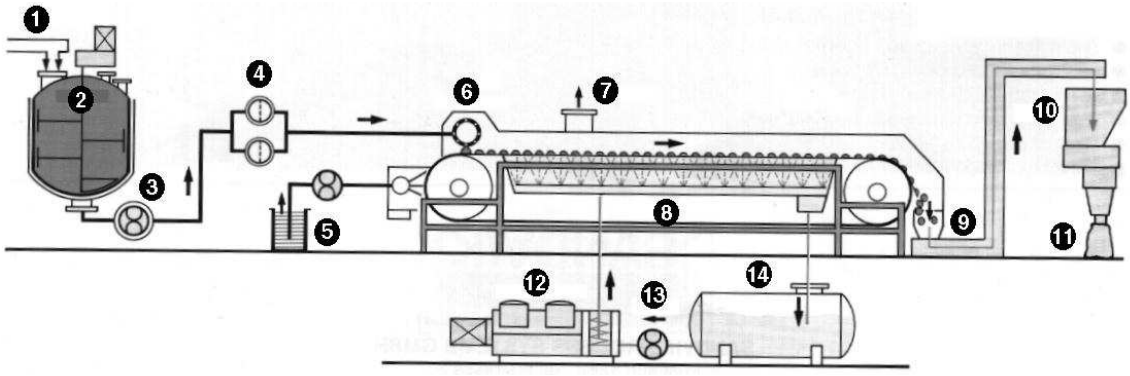

Fig. 1. Functional diagram of the Rotoform system:
1 – Additive raw materials; 2 – Mixer; 3 – Pump; 4 – Filter; 5 – Release agent applicator; 6 – Rotoform;
7 – Gas out; 8 – Steel belt cooler; 9 – Conveyor; 10 – Weigher; 11 – Packing; 12 – Chiller; 13 – Pump; 14 – Water tank

The sulphur pastillation unit consists of:

1. Sulphur Feeding Circulation Equipment

The liquid sulphur will be supplied from an existing sulphur pit by pumps via heated pipelines through liquid sulphur filters to the Pastillation Lines.

The liquid sulphur which is not used by the Rotoform system circulates back to the sulphur tank.

The sulphur feeding circulation equipment allows by constant pressure a flexible production performance (33…100%), and is consisting of:

- steam jacketed pipes and valves
- pressure control valve and pressure transmitter for control the sulphur pressure in circulating piping on constant value.
- liquid sulphur filter with pressure transmitter for estimation of pressure droop (dP) across filter. The filter consists of 2 bucket filter; one in operating the other one as stand by. By pressure droop High alarm (approx. 0,5bar) the operator should manually switch the bags and clean by steam the dirty filter (possible during production).

The sulphur pressure and temperature in circulation line have relevant influence on production capacity and pastilles quality.

2. Pastillation Lines

With Steel Belt Cooler and Rotoform unit.

The liquid sulphur is transported via a steam heated product pipe through a filter station to the Rotoform. The flow rate to the Rotoform unit can be adjusted by means of a manual needle valve on Rotoform or by supply pressure. On/Off–valve with steam heated jacket cuts sulphur feed to Rotoform by disturbances or malfunctions.

To avoid the solidification of sulphur in the Rotoform and the sulphur piping, these units are also heated by steam. Rotoformer temperature is monitored by temperature transmitter. The rotation speed of the Rotoform unit can be adjusted. According to the speed of the Rotoform unit the steel belt velocity must be adjusted for the steel belt cooler drive accordingly.

Cooling water is sprayed on the underside of the steel belt in order to solidify the sulphur pastilles along their way on the steel belt cooler. Cooling water flow is monitored by flow transmitter. The steel belt cooler is equipped with a rotation "zero" protection via zero speed sensor (fig. 2).

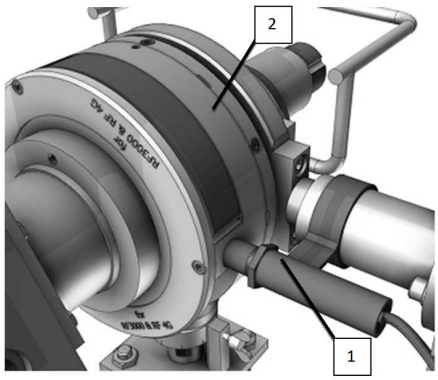

Fig. 2. Zero speed sensor

This provides a stop of the belt drive incase of a broken steel belt or chain. During operation a zero speed sensor constantly checks that the outer shell is rotating. The zero speed sensor is positioned in front of the service side bearing unit. A proximity sensor (1) detects a segment (2), installed in one of the three openings of the service side bearing unit. The zero speed sensor is a proximity switch. The proximity switch is adjusted so that it switches once per revolution of the bearing housing. This alternating signal is evaluated as a rotation signal by a separate controller and indicates that the outer shell is rotating.

Also two emergency pull rope switches are installed in case of emergency stop of the pastillation line is required. On the discharge and of the steel belt cooler a pneumatic discharge device disposes the pastilles from the belt. Pneumatic spray unit sprays release agent on the steel belt before RF in order to improve pastilles shape and discharging from the steel belt.

3. Cooling water system

The internal cooling water circuit for all pastillation lines consists of:

– Cooling Water Pit;
– Cooling Water Pumps.

The cooling water spray on the underside of the steel belt then flows from the collecting pans below steel belt back to the Cooling Water Pit by gravity.

The cooling water is cooling down by heat exchanger.

4. Release Agent System

The release agent system consists of a release agent tank with Mixer, Release Agent Pumps and circulation piping. This equipment is common for all pastillation lines.

The release agent tank is filled up with a mixture of 12% Tegopren and water. This mixture is put on the steel belt by means of spraying unit. The release system is required to easier remove the pastilles from the belt after solidification and improve pastilles quality.

5. Exhaust Fans

The pastillation lines are equipped with Exhaust Fans which transports the sulphur vapors from the Rotoform area out of the stainless steel hood outside of the shelter. It has to be in operation during the solidification to avoid dangerous concentration of poisoning gases.

6. Downstream

The Downstream (down to Pastillation Lines) performs the transport of produced sulphur pastilles via conveyor system to one of silos.

7. Railcar Loading

Loading of Railcars from Silo consists of:

– Pneumatic gate valve;
– Movable & Reversible Conveyor;
– Discharge Chutes fixed at both ends of conveyor.

8. Truck Loading

Loading of Trucs from Silo consists of:

– Pneumatic gate valve;
– Movable & Reversible Conveyor;
– Discharge Chutes fixed at both ends of conveyor [4].

Conclusion

This process is the ideal solution for oil refineries, something that is clearly demonstrated by the fact that all major oil refineries in the world, where sulphur production has increased substantially over the last years, are equipped with this system. This versatile process – which is supported by an efficient and global service network – provides a reliable and environmentally friendly solution to the issue of handling sulphur in the most efficient way possible.

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