Use of High-Thickness Outer Shells in Sulfur Pastillating Machines

L. LISCIANDRA, GL. VIRGILIO

SBS Steel Belt Systems S.r.l.

Venegono Inferiore (VA), Italy

SBS Steel Belt Systems Group of Companies, consisting of SBS Steel Belt Systems Italy, SBS Steel Belt Systems USA and Kaiser Steel Belt Systems in Germany, have been pioneers since the early 1960s in the development of pastillating units for different applications with viscosity from 5 up to 30,000 cP.

The unit applied for the sulfur industry is called Accudrop® and it was developed and is manufactured by SBS Steel Belt Systems USA. Figure 1 is a sectional view of the Accudrop® machine.

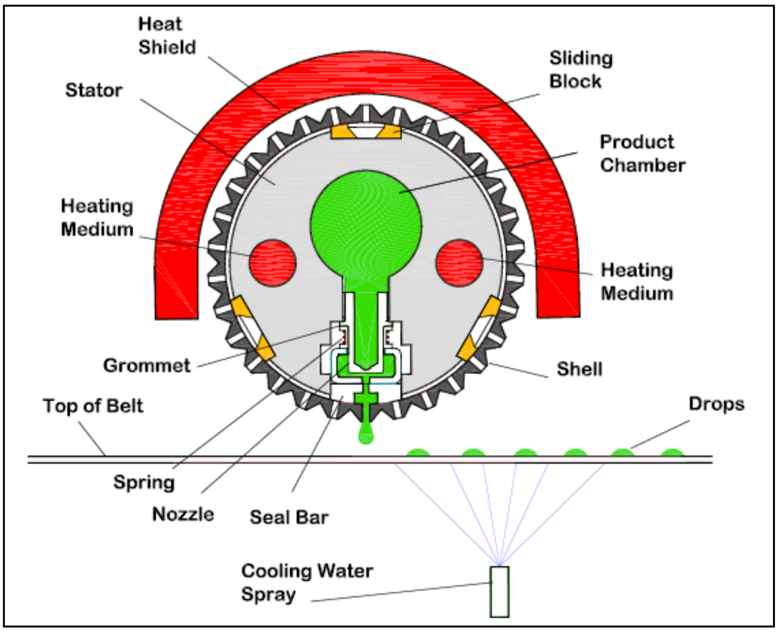
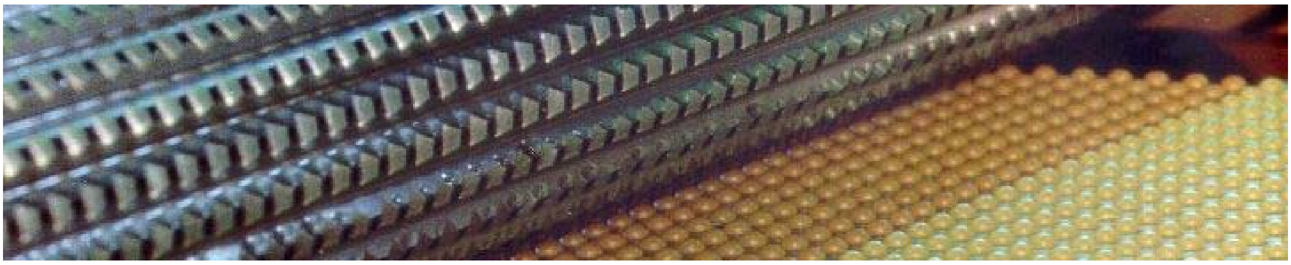


Fig. 1: Accudrop® pastillation system

A new outer shell with an innovative drilling pattern and high thickness (three times as thick as those commonly used in the market) has been developed for the sulfur industry, based on experience gained from SBS Steel Belt Systems Italy's most recent deliveries. The design of the drilling pattern of the shell allows the production of pastilles with a diameter of around 4 mm. The decision to use a 5.6-mm thick outer shell resulted from the following considerations.



Thicker pastillating drum with new drilling pattern

The study started from the premise that the diameter of the pastilles and their spherical shape depends on the surface tension. Approaching the surface tension from a thermodynamic standpoint, we deduced that any temperature variation of the liquid sulfur influences the diameter of the pastilles and their spherical shape. The lower the sulfur inlet temperature is, the higher the surface tension is.

The high thickness of the outer shell and the contour of its outer surface reduces the sulfur temperature by about 4°C on account of the longer residence of the molten sulphur inside the holes.

The definition of surface tension is the specific strength keeping closed a unit length of a conceptual cut on the material's surface.

Hitherto the relation between temperature and surface tension has only been empirical, but the following equation has been proposed by Eötvös for determining the possible values.

$$\gamma V^{2/3} = k(T_C - T);$$
$$\gamma = k(T_C - T)/V^{2/3};$$
$$\gamma = 0.058 \text{ N/m}$$

where:

γ is the surface tension value (mN/m)
V is the molar volume of the substance ($16.96.10^{-6}$ m³/mol)
T_C is the critical temperature (1314 K)
T is the actual feeding temperature (413 K)
k is constant for each substance (4.25 – 8 mN/m @ 413 K).

Values of surface tension under various temperature conditions are readable from the experimental curve of Fig. 2, reported from JCSA; it is from Rocco Fanelli with a contribution from the former Texas Gulf Sulphur Company, Inc.

Because more spherical pastilles are obtained the risk of having sharp corners is reduced and that means there will be less dust in the handling and bagging system. We have measured a reduction in dust of 10-12 wt-%.

Substantially dust-free discharge

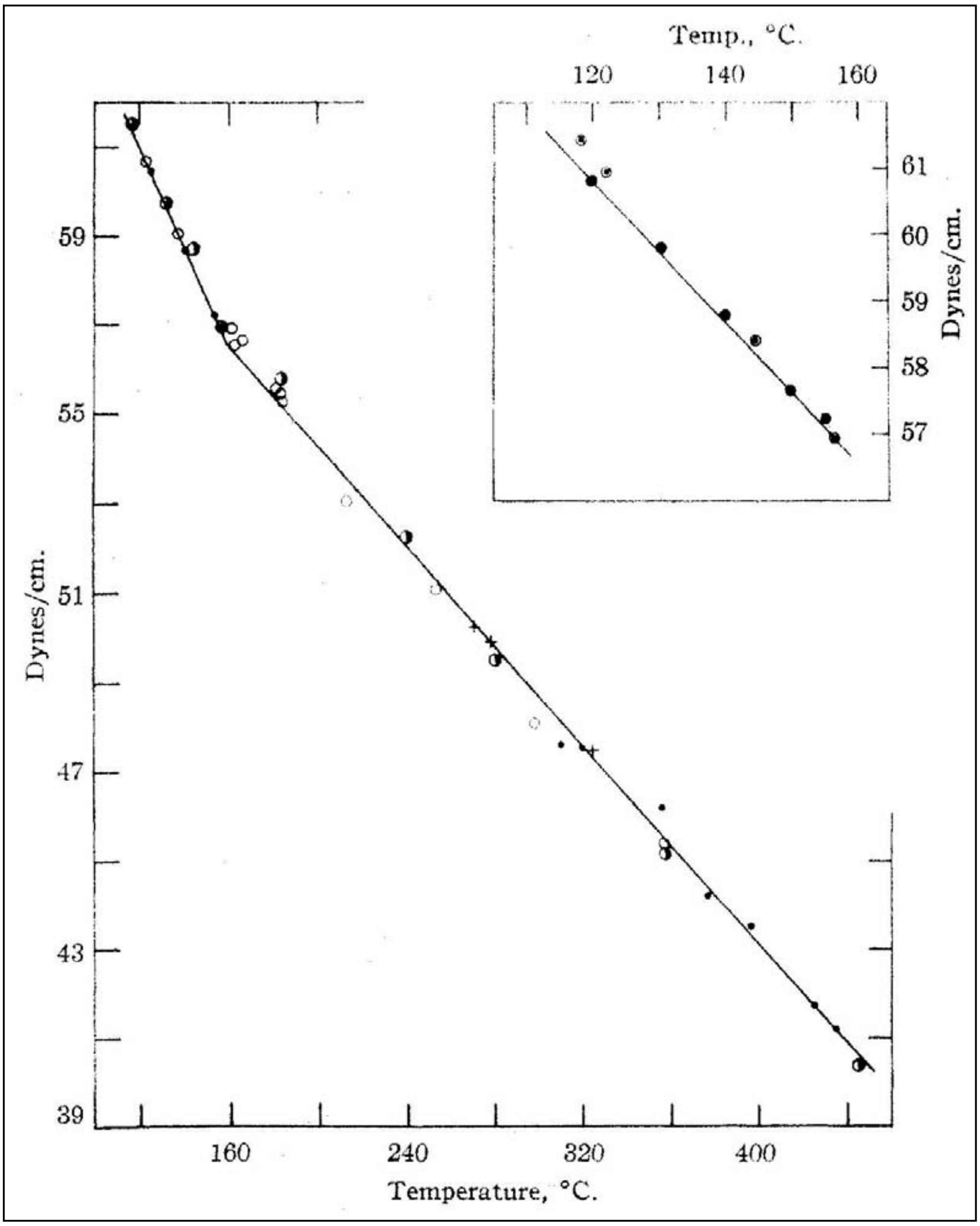


Fig. 2: Temperature-dependence of the surface tension of molten sulfur

Using a high-thickness shell also allows the liquid sulfur inlet temperature to be increased (trials have been done in which it was increased from 130°C to 140°C). That reduces the sensitivity of the system during the solidification process, avoiding extra downtime and the need for highly sophisticated temperature control.

Subsequent trials revealed that with a high-thickness shell it is also possible to operate with a higher cooling water temperature (from 20°C up to 32°C). The evidence of the related energy saving is given by the calculation of the thermal balance of the system. (Table 1).

Usually, for correct pastille formation, a water temperature of 20°C is required. In many cases that can only be achieved under the ambient conditions by providing a water chiller and an allowance of 60 kW for its power requirement. In contrast, when the high-thickness outer shell is used, well shaped pastilles can be made at water temperatures up to 32°C, which can usually be achieved with regular local tower water. That gives important savings in both investment and operating costs.

Thus the use of a high-thickness outer shell in the sulfur pastillating process is environmentally friendly because there is less dust in the final product and less energy is needed for cooling purposes.

Table 1
Thermal Balance of Sulfur Pastillation System Using High-Thickness Outer Shell

	Symbols	Values	Units
Quantity of liquid sulfur	G	5 300	kg/h
Inlet temperature of liquid sulfur	Tf	140	°C
Solidification temperature of liquid sulfur	Ts	119	°C
State change temperature of sulfur (from rhombic to monoclinic)	Tm	112.8	°C
Outlet temperature of sulfur	Td	60	°C
Solidification heat of sulfur	Qs	11	kcal/kg
Crystallization heat (from rhombic to monoclinic)	Qm	9.4	kcal/kg
Average specific heat of sulfur	c	0.18	kcal/kg°C
G.[(Tf-Ts).c+Qs+(Ts-Tm).c+Qm+(Tm-Td).c]	Q	184 440	kcal/h
Thermal requirement		214.46	kW
Total water flow	W	31000	kg/h
Water temperature increase	Δt	5.9	°C