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PROCESS FOR MELTING SULFUR

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This invention relates to an improved method and apparatus for the melting of solid sulfur and the heating of the resulting liquid to temperatures above the melting point.

Sulfur is a solid at atmospheric temperatures, but is a liquid above 238° F. Its most important uses require elevated temperatures, and therefore that it be in the liquid state, although it is frequently received and stored in the solid state at atmospheric temperatures. For example, sulfur must be liquefied, heated and burned in the manufacture of sulfuric acid, of paper, and of certain chemicals. It must also be liquefied and heated for most of the purification processes which are applicable to it, e.g., sublimation for production of flowers of sulfur.

A widely used method of melting sulfur is to introduce the solid into a tank of liquid sulfur, kept heated somewhat above the melting point. Melting rate by this method is limited because it is not practical to heat the liquid sulfur above about 320° F. Above that temperature, the liquid becomes very viscous, reducing heat transfer rates. Furthermore, at high temperatures the crude sulfur of commerce deposits scale of carbonaceous material on the heating surfaces, insulating them, and seriously reducing their heat transfer rate. Because excessive temperature of the heating surfaces creates these difficulties, steam contained in coils is the usual, and most desirable heating medium since its temperature is readily controlled. Heating the coils by passing burner or flue gases through them is unsatisfactory because of the normally high temperature of these gases.

If, as is often the case, the solid sulfur contains moisture, this is converted to vapor during melting, and is entrapped in the liquid surrounding the solid, causing foaming and, possibly overflow. Agitation of the liquid in the tank, both reduces foaming and increases melting rate, greatly. But a mechanical agitator requires driving power and costly maintenance.

Another widely used method of melting sulfur is by direct contact of the solid with heated surfaces so shaped as to allow the liquid which forms to drain to a collection tank. This method overcomes the problems incurred in foaming and agitation of the liquid, but the temperature limitations apply, nevertheless.

It is an object of this invention to provide a new and improved method and apparatus for melting solid sulfur, and further heating the liquid so produced.

Another object is to provide a method and apparatus for melting solid sulfur, and heating the liquid so produced, at a high rate without using a mechanical agitator.

Another object is to provide a method and apparatus for melting moist, solid sulfur, and heating the liquid so produced with reduced foaming.

Another object is to provide a method and apparatus for melting solid sulfur, and heating the liquid so produced, which avoids heat-transfer surfaces with their inherent tendency to scale and corrode.

Another object is to provide a method and apparatus for melting solid sulfur, and heating the liquid so produced, which utilizes the efficient process of transferring heat directly from hot gases to the sulfur.

Other objects will be apparent to those skilled in the art from reading the present description, taken in conjunction with the appended drawings, in which:

FIGURE 1 is a flow diagram of the process of this invention;

FIGURE 2 is a schematic view of one embodiment of the apparatus of this invention;

FIGURE 3 is a schematic view of another embodiment of the apparatus useful in practicing the present invention; and

FIGURE 4 is a schematic view of an embodiment utilizing multiple submerged burners in the practice of this invention.

The objects of this invention are accomplished, as shown diagrammatically in FIGURE 1, by adding solid sulfur, which may contain moisture, to a body of molten sulfur which is maintained at a temperature between about 238° F. and 320° F. preferably between 270 and 300° F. The body of molten sulfur is heated by one or more submerged burners which burn air and fuel, preferably in stoichiometric amounts, in order to produce hot combustion products. Gaseous, liquid or solid fuel, such as powdered coal, may be used in the practice of this invention. The hot combustion products are released below the surface level of the body of molten sulfur and cause an agitation and thorough mixing of the molten sulfur body. The combustion products exchange their heat directly with the body of molten sulfur without the use of a heat exchanger and are themselves cooled, preferably to about the temperature of the molten sulfur body, and evolve from the body of molten sulfur. The solid sulfur is melted by contact with the body of molten sulfur and thoroughly mixed with it by the agitating action of the submerged gases. Molten sulfur is desirably continuously removed at about the same rate at which solid sulfur is added. Some of the advantages of the use of the method and apparatus of this invention are: (1) control of the liquid sulfur temperature within a narrow range, (2) the agitation of the liquid sulfur by the gaseous combustion products bubbling through it so that mechanical agitation is unnecessary, (3) high fuel efficiency that is obtained by having the temperature of the combustion products closely approach the temperature of the melted sulfur before leaving the molten body, (4) improved thermal efficiency as compared with heat exchanger systems, (5) the elimination of the coating of heat exchanger surfaces by insoluble contaminants, (6) removal of moisture from the molten mixture, thus reducing foaming and corrosion, (7) the use of smaller size equipment and (8) the portability of the apparatus which may permit it to be used in a number of locations.

The method and apparatus of this invention may be practiced using either a single submerged burner as shown in FIGURES 2 and 3 or with multiple submerged burners as shown in FIGURE 4. The apparatus of the invention in its general form is illustrated in FIGURE 2. Tank 1 contains liquid sulfur 3 which is kept heated to a temperature between about 238° F. to 320° F. by one or more submerged burners 4. Solid sulfur 2, at atmospheric temperature, is fed into the liquid sulfur 3 at a point as near the point of burner gas release as possible. The hot liquid sulfur melts the solid. The accumulating liquid flows into conduit 5 at a rate substantially equal to that at which the solid is introduced. Conduit 5 is located at a point as far removed from the point at which the solid is introduced as possible. Conduit 5 conducts the liquid sulfur to its point of use or storage, as desired. As shown in FIGURE 3, a screen 22 or other scalping device may be placed at the entrance to conduit 5 if it is desired to limit the size of any solids in the melted discharge. Temperature gauge 23 indicates the temperature of the molten sulfur.

The term "submerged burner," as used herein, and as widely used in commerce, refers to a burner so designed that the hot products of the combustion are discharged