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INSULATED SHIP HULL

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This application relates to insulated tanks and, more particularly, to insulated tanks for transporting molten sulphur.

A large proportion of the sulphur mined in the United States is mined by the Frasch process. In such process, water, at elevated temperature and pressure, is pumped into the deposit to heat the sulphur to a temperature where the sulphur becomes liquid. Once liquid, the sulphur is pumped from the deposit to the surface with compressed air. This process of mining is well known and has been used extensively for a number of years. Sulphur mined by the Frasch process is relatively pure, that is, there is little, if any, contamination in the sulphur. Thus, as mined, the sulphur is in condition for commercial use.

For many years it has been the practice to cool and solidify the sulphur as it is mined and to ship the sulphur to customers in cold, dry bulk. Many of such customers use the sulphur in a liquid or molten state. Thus, where the sulphur is received in cold, dry bulk, it is necessary for the customer to re-heat the sulphur to a temperature where it is liquid before it is used. Since, when mined, the sulphur was initially heated to a liquid temperature, the cooling, solidifying, handling and subsequent re-heating of the sulphur constitutes an unnecessary expense. In addition, even in those instances where the sulphur is to be used in cold bulk, shipment and handling of the sulphur in its liquid form is much more economical.

Hot, liquid or molten sulphur may be stored in insulated tanks without any great difficulty. Such tanks are conventionally provided with external insulation and, where desired, may contain heaters to maintain the liquid sulphur content at the required temperature. Such tanks, while adequate for storage purposes, have numerous disadvantages when used for transportation of hot, liquid sulphur especially when such transportation is by barge or ship.

When conventional storage tanks are placed on a boat or barge, a considerable amount of dead weight is added to the boat or barge. To support the tanks and, at the same time, allow relative thermal expansion between the tank and vessel, reinforcement of the vessel is required, adding additional dead weight. In addition, substantial sulphur storage space between the tank and vessel hull is lost. To offset this lost sulphur storage space, especially on barges, it has been the practice in some instances to extend the tank above the barge deck. Such extension prevents use of the deck for cargo space and does not permit the barges to be deck loaded with a return cargo after the sulphur has been unloaded.

One means of overcoming the deficiencies of externally insulated tanks is to build the tanks into the hull and rigidly frame the tanks in the hull. Such practice would substantially reduce dead tank weight and would substantially increase ship and barge capacity. This practice would also permit flat deck design and allow deck loaded pay-loads on the return trip, where desired. However, when molten sulphur is loaded and unloaded into tanks rigidly framed to the hull, extremely high stresses are produced. These stresses are superimposed on the hull plates of the ship through the rigid frame connections between the tank and hull. It is estimated that, when handling sulphur at 280° F. at an atmospheric temperature of 60° F., the combined longitudinal and transverse stresses in the material of the tank walls are in the order of 12,000 to 20,000 p.s.i. In the tank bottom, which is more rigidly confined and where the water more readily cools the hull plates, longitudinal stresses may approach a magnitude of 26,000 p.s.i. These stresses would, of course, be transmitted to the hull through the rigid frame and exceed practical stress loads.

To relieve these stresses in such construction, an attempt was made to line the inside of the tank with an insulating material and to load the hot, liquid or molten sulphur directly into the tank against the insulation. In this attempt, foamed or cellular glass insulation was applied, as an insulated liner, to the inside of the hull. When hot, liquid sulphur was loaded into the hull the liquid sulphur penetrated the surface of the cellular glass insulation. When the molten sulphur was unloaded from the hull, a portion of the sulphur which had penetrated into the insulation remained. With the balance of the hot, molten sulphur removed, the sulphur remaining in the insulation cooled and contracted. As the sulphur cooled, voids were created in the insulation. These voids were filled when hot, molten sulphur was again loaded into the hull. However, in addition to filling the voids, the hot sulphur re-heats and re-expands the sulphur already in the insulation. Because the voids have been filled, this re-expansion tore and damaged the insulation and resulted in rapid insulation deterioration. Such deterioration not only contaminates the sulphur but completely destroys the insulation after but a short period of use. As a result of these experiences with foamed glass and similar types of insulation, internal tank insulation construction was abandoned.

It is an object of the present invention to insulate the inner surface of a vessel to provide a tank for transporting molten sulphur.

It is a further object to apply such insulation in a manner wherein the surface of the insulation can be repeatedly contacted with hot, liquid or molten sulphur without deteriorating the insulation.

It is still a further object of the invention to provide a vessel for transporting molten sulphur wherein sulphur storage is accomplished below deck permitting the deck to maintain flat for deck storage.

Still a further object of the instant invention is to provide such a vessel in an economical manner through the conversion of existing tank vessels.

A still further object is to provide such a vessel which can be used over an extended period of time and in which the tank insulation is relatively inert to the sulphur, does not readily become impregnated and, where impregnation does occur, is of sufficient resiliency to withstand repeated expansion and contraction of the sulphur.

While the instant invention has application to ship and barge constructions in general, it has particular application to ships conventionally employed as tankers for the transportation of oil and similar liquids. For purposes of illustration in the following description the invention is described as applied to a conventional oil tanker.

In the attached drawings:

FIG. 1 is a side elevational view partly in section, of a tanker embodying the instant invention;

FIG. 2 is a top plan view, also partly in section, of the tanker of FIG. 1;

FIG. 3 is an enlarged sectional view along the line 3—3 of FIG. 2;

FIG. 4 is a sectional view showing, in enlarged detail, a portion of the construction according to the instant invention;

FIG. 5 is a view taken along the line 5—5 of FIG. 4; and