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3,135,420

CONTAINER FOR CORROSIVE LIQUIDS

Filed June 22, 1962

2 Sheets-Sheet 1

FIG. 2

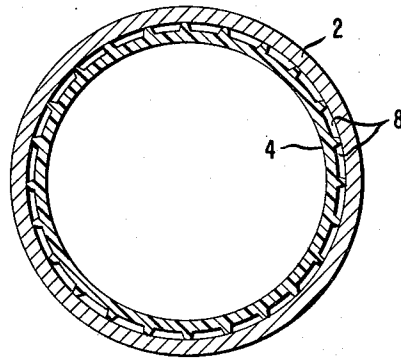
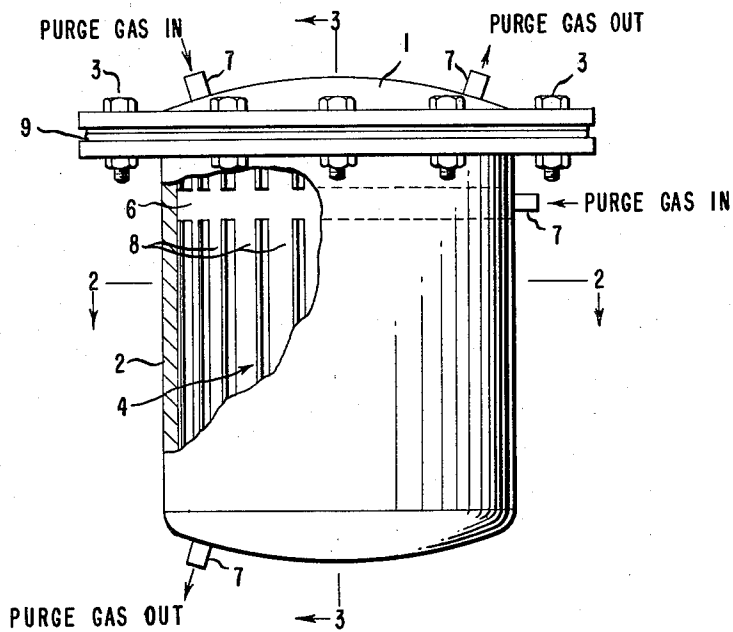


FIG. 1



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FIG. 6

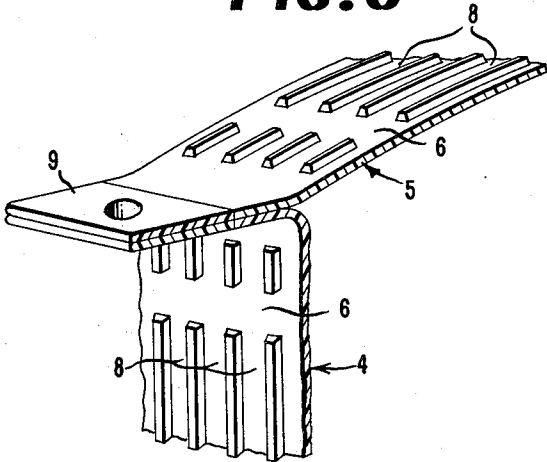


FIG. 7

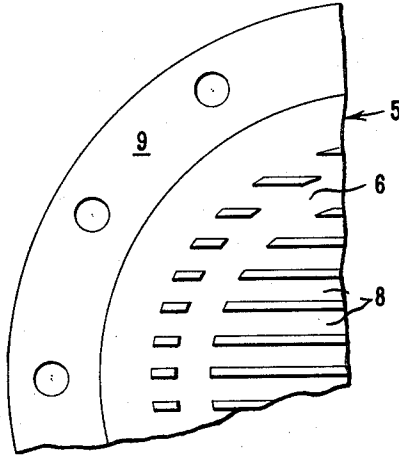


FIG. 5

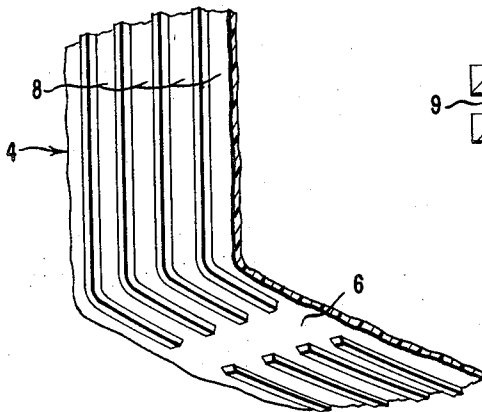


FIG. 3

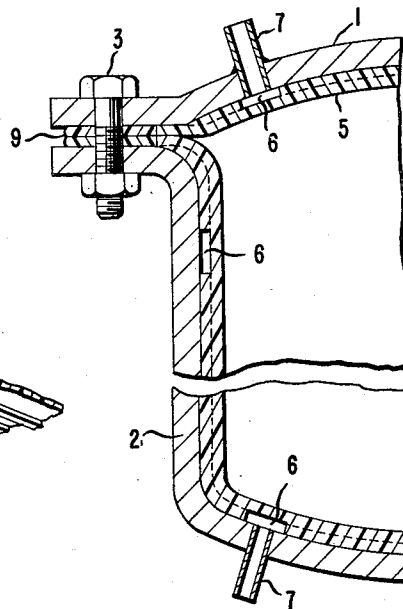
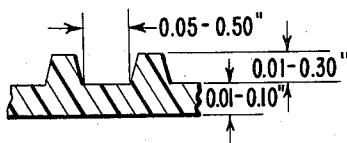


FIG. 4



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CONTAINER FOR CORROSIVE LIQUIDS

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This invention relates to containers for corrosive fluids.

The handling of corrosive fluids often presents problems in chemical processes because of the deleterious effect which such materials have on metal equipment. This deterioration of equipment may be accompanied by an additional problem, namely, contamination of the process streams by the products of the interaction of metal and the corrosive agent. These difficulties have been overcome in part through the use of more costly metals having greater chemical resistance to the corrosive materials. Even more recently, it has been discovered that metal equipment can be shielded by means of liners or covers fabricated from high polymers which are substantially chemically inert to the corrosive substance. As a result of the aforesaid developments, corrosion problems have been reduced sharply, although not eliminated completely. For example, because of the tendency of corrosive agents to diffuse through polymeric barriers, a chemical attack of a metal exterior structure still may occur after diffusion of the agent through the liner. Furthermore, there may be either a chemical or solvent attack on the cement or adhesive normally used to bond the polymeric liner to the outer structure. The bonding agent may be attacked not only by the corrosive agent diffusing through the liner, but by other relatively inert materials, for example, moisture. Although this difficulty may be circumvented by fabricating the container solely from the inert polymer thus removing the need for an exterior structure and a bonding agent, such a remedy usually is precluded because of either the inherent lack of self-supporting rigidity in the polymer selected or the high cost of the quantity of polymer needed to achieve self-support. A still further difficulty often encountered when employing polymeric liners is blistering of the exterior surface of the liner, particularly at temperatures above 100° C. Such blistering, the origin of which is unknown tends to shorten the life of the liner.

It is an object of the present invention to provide a new and useful container for corrosive fluids. Another object is to provide a container which utilizes a high polymer membrane or interior member between the material to be contained and an exterior member or outer wall. A further object is to prevent blister formation on the aforesaid polymer membrane. A still further object is to hold said polymer membrane in place within the outer member without the use of a cement or bonding agent. Other objects will become apparent herein-after.

The objects of the invention are achieved by means of a dual-walled container comprising an exterior, rigid, supporting, enclosing member or wall containing therein an interior, supported enclosing member or wall having a loading or discharging passage leading therefrom through said outer member. The inner wall or liner is fabricated from a high polymer which is essentially inert to the corrosive fluid to be contained therein. Furthermore, the liner is substantially isolated from the outer wall by a vapor space through which flows an inert gas stream to purge out any fluid material diffusing through the inner polymer wall. The inner polymer membrane may be held in place and supported by a variety of means. If the inner polymer wall exhibits sufficient rigid-

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ity to be self-supporting, it may have affixed to its outer side suitably positioned studs which are held in place on the outer wall. The studs may be affixed to the inner wall, for example, by heat-sealing, or they may be formed concurrently during the wall fabrication step. The stud may be threaded on one end, the threaded end being extended through the outer vessel wall and suitably held in place. A metal rivet running through the inner wall and having its head protectively coated with an organic polymer, likewise, may be used to hold the liner in place. Variations of the above, particularly as to the number and location of the studs or rivets, may be employed. For example, the vapor space between the inner and outer walls may be maintained under a high inert gas pressure to aid in providing support for the fluid-filled inner member. In this case, the positive pressure of the inert gas may retard the diffusion of the corrosive agent through the inner wall. Especially suitable in this invention is the use of an inner member support means which consists predominantly of a plurality of parallel-spaced ribs extending peripherally about said inner member and integral therewith to increase the effective rigidity of the inner member by providing multiple support-points of contact with the exterior wall. Although the aforesaid ribs are predominantly parallel, i.e. a majority of ribs are parallel with each other, there may be a series of parallel ribs which is angular with one or more other series of parallel ribs depending upon the shape of the container. For example, the series of parallel ribs in the end sections of a cylindrical tank may be angular to a series of parallel ribs in the side. Furthermore, in a spherical container the ribs may become non-parallel as they converge at the poles. A particularly advantageous feature of using the ribbed construction is that the polymeric inner wall may be fabricated from sheeting having the ribs directly incorporated therein. Ribbed sheeting may be formed by standard extrusion techniques using a notched die to introduce the ribs, after which the ribbed sheet may be shaped to provide the interior member or wall of the container. For most applications, the nominal polymer wall thickness, i.e. the wall thickness exclusive of ribs or support means, may be 0.01 to 0.10 inch. When using ribbed liners, the outer wall may contain appropriately spaced ridges or indentations which serve to hold the liner in place. Peripheral spacing rings or strips which may be fabricated independently and affixed either to the inner or the outer wall, also, may be used to provide the same effect as the ribbed wall, namely, to substantially isolate the inner and outer walls while providing support for the inner wall. A still further variation in the present invention may be realized by filling the space between the inner and outer walls with a highly permeable inert material which provides structural support without materially impeding the flow of purge gas. Asbestos may be cited as an example of such a porous material. Regardless of which of the above structural variations are employed, an essential aspect of the invention is the positive flow of inert gas which purges out any material which is entrapped between the walls after diffusing through the polymeric inner wall.

Although it is preferable to minimize contact between the inner and outer walls of the container, structural features must of necessity include contact between the two at the studs, ribs, and the like because of the need for supporting and positioning the interior member. On the other hand, in order to maintain a purge flow adequate for removing the deleterious corrosive agent, a minimum free volume must be provided between the inner and outer walls. In the present invention, it is required that the gas purge space between the walls be maintained at 50 to 97% of the total volume between the inner and outer

members. A particularly useful range of percentage purge space is 70 to 75%. Conversely, it may be stated that the support means can occupy 3 to 50%, and preferably 25 to 30%, of the total volume between the inner and outer members. When the ribbed-type inner wall is employed, this percentage free volume may be achieved by adjusting the ribbed spacing, i.e. the distance between adjacent ribs on the inner wall, to 0.05 to 0.50 inch and the rib height, equal to the distance between the walls at the non-ribbed surface of the inner wall by a path normal to both walls, to 0.01 to 0.30 inch. The rib itself may have various shapes depending upon the method of fabrication. For example, the plain surfaces forming its sides may meet the inner and outer walls normal to their surfaces. The ribs, also, may be saw-tooth or truncated triangular in cross section, normally having their greatest thickness at the juncture with the inner wall.

In order to supply and maintain a positive flow of inert gas between the dual walls of the above-described container, suitable inlet and outlet valves must be provided. Likewise, baffles or a deflecting means must be installed between the inner and outer members to deflect the gas and ensure effective purging. When the ribbed inner wall construction is employed, a suitable manifold must be included so as to divert the flow of gas uniformly to all channels between the ribs. The flow of purge gas may be varied depending upon the rate at which the corrosive material being contained diffuses through the polymeric wall. When this diffusion rate is low, intermittent gas flow may suffice. Suitable monitors may be installed at the purge gas exit port to determine optimum flow rate. The purge gas preferably employed may be any gas which is inert to the materials of construction as well as to the agent being removed by the purge. For most operations dry air or nitrogen is used because of its ready availability.

The inner wall in the present invention may be fabricated from any organic polymer which is resistant to the corrosive agent being contained therein. Particularly useful are film-forming polymers, and especially those which have a high degree of rigidity. As examples of polymers useful herein may be cited the hydrocarbon polymers, especially high density polyethylene, polypropylene, polystyrene, and the like, the halogenated hydrocarbon polymers, such as polyvinyl chloride, the fluorinated hydrocarbon polymers, and the like, the polycarbonates, polyoxymethylenes, polyamides, and the chlorinated polyethers. The fluorinated hydrocarbon polymers are generally the most useful because of their inherent chemical inertness. Polymers prepared from tetrafluoroethylene, tetrafluoroethylene and hexafluoropropylene, vinylidene fluoride and chlorotrifluoroethylene are representative of this type of polymer.

The outer wall of the dual-walled container frequently is fabricated from a metal which provides both rigidity and mechanical strength. Since the use of expensive corrosion-resistant metals is unnecessary as a result of the present invention, greater latitude in the selection of the material used for the outer wall has been achieved. For many uses, the outer wall may be constructed from a polymeric material which possesses the requisite structural characteristics of an outer or protective member. Moreover, the selection of a polymeric outer wall is further enhanced because of the absence of any necessity to consider its chemical reactivity with the corrosive agent being contained. Especially suitable as polymeric outer walls are the thermoplastic resins such as the hydrocarbon polymers, e.g., polyethylene, particularly the high-density variety, polypropylene, polystyrene and copolymers of styrene, the polyoxymethylenes, polycarbonates, polyamides, and the like, as well as thermosetting resins and reinforced plastics.

The term "container" as employed herein refers to a structure which is used for the confinement and retention of a fluid within a given spatial limitation and neces-

sarily includes structures for confining not only essentially stagnant fluids but moving fluids as well. Containers useful in the latter application include pipe and tubing used in transferring fluid process streams, raw materials, products, and the like. The containers described herein may be employed for confining either stationary or flowing fluids over a wide range of temperatures, the temperature being limited only by the ability of the polymeric wall or walls to withstand operating conditions. Heating or cooling of the container may be effected by means of an external source which concurrently heats or cools the container and the purge gas. The heating or cooling means, likewise, may be incorporated within the space between the walls of the container. Finally, the temperature of the container may be controlled by means of independently heated or cooled purge gas. The free space between the inner and outer members may provide an additional feature in the present invention by serving as a thermal barrier between the corrosive material being contained and the external environment.

A particularly preferred embodiment of the present invention is depicted in FIGURES 1 to 7.

FIG. 1 is an elevation view of a kettle or container with a portion of the exterior wall broken away to expose the interior member.

FIGURE 2 is a transverse sectional view along line 2—2 of FIGURE 1 showing the exterior and interior members.

FIGURE 3 is an enlarged fragmental transverse sectional view along line 3—3 of FIGURE 1 showing constructional details of the head and base portions of the container.

FIGURE 4 is an enlarged fragmental sectional view of the ribbed sheeting forming the interior member of the container.

FIGURE 5 is an enlarged fragmental perspective view showing the ribbed sheeting forming the side and bottom of the interior member of the base portion of the container.

FIGURE 6 is an enlarged fragmental perspective view showing the ribbed sheeting forming the side and top of the interior member of the base and head portions of the container and, also, showing the overlap at the flanges of the base and head portions of the ribbed sheeting forming the interior member of the container.

FIGURE 7 is a vertical enlarged fragmental view showing the ribbed sheeting forming the head liner portion of the interior member of the container.

More specifically, FIGURES 1 and 3 show a kettle or container having a cylindrical metal exterior member which is split at the top so as to provide a removable head 1 which may be affixed to the base 2 of the container by a plurality of bolts 3, inserted through holes suitably positioned along the flanges of the head and the base, to effect sealing. A ribbed-type interior member is utilized, with the interior member being fabricated from ribbed sheeting, FIGURE 4, which is formed from a tetrafluoroethylene-hexafluoropropylene copolymer. The sheeting is vacuum formed to the desired shape to fit the base and head of the container. If preferred, the liner 4 for the base 2 of the container may be formed by joining together, using conventional melt bonding techniques, sections of sheeting corresponding to the side, bottom and flange of the liner. The liner 5 for the head 1 may be similarly formed. A section is cut from each of the parallel ribs in both liners 4, 5 to form a cross-channel or manifold 6 so as to permit uniform urging of the system by providing equidistant paths of gas flow between the inlet and outlet purge gas ports 7. FIGURE 2 depicts the interior and exterior members with the parallel longitudinal channels 8 through which passes the purge gas, while FIGURE 5 shows a portion of the side and bottom of the base liner 4. FIGURE 6 depicts the overlap of the flanges of the base liner 4 and the head

liner 5 with appropriate spacing washers 9, and FIGURE 7, the head liner 5 with parallel channels 8, the cross-channel or manifold 6 and the spacing washer 9.

A dual-walled container of the aforesaid description is filled with 10 weight percent hydrochloric acid, then heated to and maintained at 200° F. for 10 days. During this time a dry air purge gas is passed between the interior and exterior members of the vessel at a rate of 75 cc. per minute (corrected to standard temperature and pressure). After 10 days the vessel is cooled and the acid is removed. The metal exterior member beneath the liner is free from any evidence of chemical attack and the acid is still water white. Furthermore, the outside of the polymeric liner is free of blisters. A control experiment run at the same conditions without the liner results in serious corrosion and pitting of the metal exterior member as well as discoloration and contamination of the acid. A second control experiment run with the polymeric liner but without the purge gas results in less corrosion to the metal shell than without the liner, but the outer wall of the liner is blistered.

We claim:

1. A container for retaining fluid materials, said container comprising a supporting, rigid exterior member, an interior member fabricated from an organic polymer and having a passage leading therefrom which provides a means of conducting said fluid materials through said exterior member, a plurality of support means for maintaining said interior member in spaced relation to and separated from said supporting exterior member, said support means occupying 3 to 50% of the spaced volume between said interior and exterior members, a means for introducing a purge gas between said interior and exterior members, a deflection means for diverting said purge gas uniformly between said interior and exterior members and means for removing said purge gas.

2. The container of claim 1 wherein said organic polymeric interior member is fabricated from a ribbed film having a nominal thickness of 0.01 to 0.10 inch, a wall distance between ribs of 0.05 to 0.50 inch and a rib height of 0.01 to 0.30 inch, said organic polymer being selected from the group consisting of hydrocarbon polymers,

halogenated hydrocarbon polymers, polycarbonates, polyamides, polyoxymethylenes and chlorinated polyethers.

3. The container of claim 1 wherein said organic polymeric interior member is fabricated from a fluorinated hydrocarbon polymer.

4. The container of claim 1 wherein said plurality of support means are predominantly parallel-spaced ribs 0.01 to 0.30 inch in height and extending peripherally about said interior member with an interior wall distance between ribs of 0.05 to 0.50 inch.

5. A method for containing corrosive chemical fluids, said method comprising introducing said corrosive fluid into an enclosing, organic polymeric, interior member through a passage leading therefrom through a rigid, exterior, supporting member, said exterior member having a purge gas entrance port and a purge gas exit port, said interior member being separated from and held in spaced relation to said exterior member by a plurality of support means, said support means occupying 3 to 50% of the space volume between said interior and exterior members, passing an inert purge gas through said gas entrance port and removing said purge gas through said gas exit port.

6. The method of claim 5 wherein said organic polymeric interior member is fabricated from a polymer selected from the group consisting of hydrocarbon polymers, halogenated hydrocarbon polymers, polycarbonates, polyamides, polyoxymethylenes, and chlorinated polyethers.

7. The method of claim 5 wherein said organic polymeric interior member is fabricated from a fluorinated hydrocarbon polymer.

8. The method of claim 5 wherein said plurality of support means are predominantly parallel-spaced ribs 0.01 to 0.30 inch in height and extending peripherally about said interior member with an interior wall distance between ribs of 0.05 to 0.50 inch.

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