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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification [7] :
B65D 90/06, F16L 59/02, F17C 3/04

A1

(11) International Publication Number: WO 00/02800

(43) International Publication Date: 20 January 2000 (20.01.00)

(21) International Application Number: PCT/US99/15186

(22) International Filing Date: 6 July 1999 (06.07.99)

(30) Priority Data:
98112975.2 13 July 1998 (13.07.98) EP

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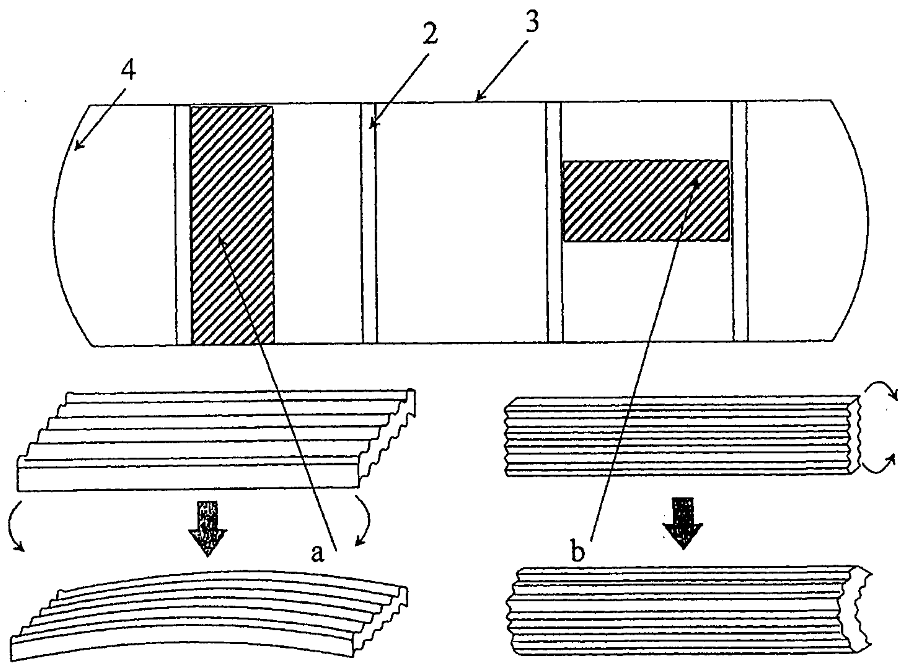
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PROPYLENE POLYMER FOAM FOR THERMAL INSULATION OF CONTAINERS



(57) Abstract

The invention relates to the use of a flexible polypropylene foam, comprising greater than 50 percent by weight of propylene monomeric units, for thermally insulating containers, especially temperature–controlled bulk tank transportation containers like for example IMO containers. Preferably the propylene polymer foam is a strand foam made of a resin comprising at least 20 percent of a high melt strength polypropylene and up to 20 percent of a homopolymer or copolymer of ethylene, each based on the total weight of the resin.

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PROPYLENE POLYMER FOAM FOR THERMAL INSULATION OF CONTAINERS

The present invention relates to the use of propylene polymer foam for thermal insulation of containers, especially bulk tank transportation containers. Bulk tank transportation containers are large vessels and usually classified as tank containers, swap tanks, road tanks, trailer tanks, and rail tank cars.

Safe and efficient transportation of bulk liquids over long distances is a main concern of any kind of industry. Traditionally, bulk liquids are transported in drums holding several hundred liters. However, for movements crossing seas, large marine tank containers often with capacities of up to 26,000 liters or more have become an attractive alternative to the traditional transportation in drums. These tank containers are designed to prevent accidental damage and tampering compared to other methods of carrying bulk liquids, such as drums. As a result the risk of cargo loss or contamination is significantly reduced. Moreover, tank containers deliver time and labor savings. Since they are handled by using standard equipment, transfer at ports and terminals is simple and switching between road, rail and sea straightforward. The use of tank containers offers a safe and cost-effective method of moving bulk liquids, while using a recyclable resource. Tank containers carry a far greater payload for the equivalent space and shipping cost compared with a rectangular standard box container filled with palletized drums. Swap tanks, road tanks, tank trailers and rail tank cars have similar benefits for land movements across and between countries, offering more cost effective and safe movements.

A tank container is basically a pressure vessel mounted in a frame. The pressure vessel has a cylindrical shape with its ends rounded. Its shell, generally denoted as "tank shell", is usually made of stainless steel. The function of the frame is to support and protect the tank as well as to facilitate the stowage, securement and handling by standard ISO (International Standards Organization) container equipment. The overall dimensions and corner castings conform to ISO container recommendations. When properly handled the frame is designed to cope with the stresses of a fully loaded tank.

Other types of bulk tank transportation containers also comprise a mainly cylindrical vessel, optionally surrounded by an outer cladding.

Tank containers, as well as other bulk tank transportation containers, conform to the advisory and mandatory requirements of internationally recognized codes; in particular, tank containers must adhere to the codes of the International Maritime Organization (IMO). For that reason, the above-described tank containers are generally denoted as "IMO tanks" or "IMO tank containers".

In order to protect the carried liquids from undesirable fluctuations in temperature most bulk tank transportation containers are insulated. As some of the transported products must be heated during loading, unloading and during transportation (for example, molten chocolate) bulk tank transportation containers also comprise a heating system such as electrical or steam heating. From an economical standpoint it is reasonable to design many bulk tank transportation containers with a heating system. This gives the tank the flexibility to carry both cargoes that require heating during loading, discharge and/or transportation, and cargoes which do not require heat input. The more costly alternative would be to own or lease both treatable and nonheatable bulk tank transportation containers. This alternative would also reduce the vessel utilization rate. For IMO tank containers, the most efficient and widespread heating system is steam heating usually consisting of a series of steam channels on the outside of the lower half of the tank.

In case of IMO tank containers the insulation is arranged around the pressure vessel and covered by an outer cladding usually made of glass-reinforced plastic resin or marine grade aluminum. The insulation of steam heatable IMO tank containers must, as a matter of fact, at least withstand the operating temperatures of the pressurized steam. Generally, temperature resistance of up to 130°C is required. It is pointed to the fact that even for the insulation of non-heated tanks, for example, tanks carrying refrigerated liquids, a temperature resistant insulation material is desirable as steam cleaning might then be employed with these tanks. Insulation materials fulfilling the temperature resistance requirement and which are used in the art include expanded polyurethane, expanded polyisocyanurate, mineral wool and glass wool, as well as combinations of said expanded polymers with mineral wool and/or glass wool. For other types of bulk tank transportation containers, expanded polystyrene is also used as insulation material, but should be used only for moderately heated (up to 70°C) tanks due to the lower temperature resistance of EPS foam.

Expanded polyurethane and expanded polyisocyanurate are both rigid foams which cannot be bent around the cylindrical shell of the pressure vessel. In order to be adapted to the cylindrical share, these rigid foams must be cut in single blocks which are then arranged on the shell of the pressure vessel and held in place by for example, tightening straps or adhesive. Alternatively, rigid foams are fabricated to enable the fitting to the curved surfaces. In many cases this involves fabricating a curved section from a larger block, which is highly wasteful and expensive. These curved segments are fragile leading to an additional waste and cost. Another technique it to cut grooves into flat rigid foam boards to bend the boards. Again this is costly, the boards are fragile and breakage occurs leading to further wastage. Furthermore, the fabrication of the rigid foams and later handling and installation generates significant levels of irritant dust. Injected polyurethane technology used to insulate tanks has other problems. The foam sticks to the inner tank and outer cladding, making maintenance of the tank more difficult. Problems can arise too due to the differential expansion of the tank shell and outside cladding, particularly when the tank is being heated and/or cleaned.

Polyurethane foam does not have sufficient heat resistance alone and hence, a costly double layer comprising a heat resistant lagging of mineral wool or glass wool and a second lagging of high compressive strength polyurethane foam blocks is often used. In case the insulation material is expanded polyisocyanurate it is often used as 1-piece being grooved or it is fabricated into curved segments fitting the cylindrical shell of the pressure vessel exactly. Both rigid foam alternatives are very expensive implying the afore-mentioned drawbacks. Moreover, the friable nature of the expanded foams can lead to extensive wear from vibrations caused during transportation.

Compression resistance of the insulation material is another important feature in order to avoid damage of the outer cladding when for instance personnel walk thereon during maintenance. An insulation made solely of mineral wool or glass wool is disadvantageous since mineral wool and glass wool both lack the required compression resistance and impact resistance and do not maintain the outer circular shape of the container in the course of time. In view of the insufficient compression resistance of mineral wool or glass wool, it is necessary to employ strips of high compression strength foam plastic material to support the cladding.

Although the expected lifetime of bulk tank transportation containers is about 20 years they are re-clad after about 10 years including removal and renewal of the insulation. The replacement of the insulation material is necessary since all types of insulation materials currently used in bulk tank transportation containers can absorb significant amounts of water resulting in a undesirable increase in weight and reduction of thermal insulation properties. The entry of water and other liquids into the insulation will

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