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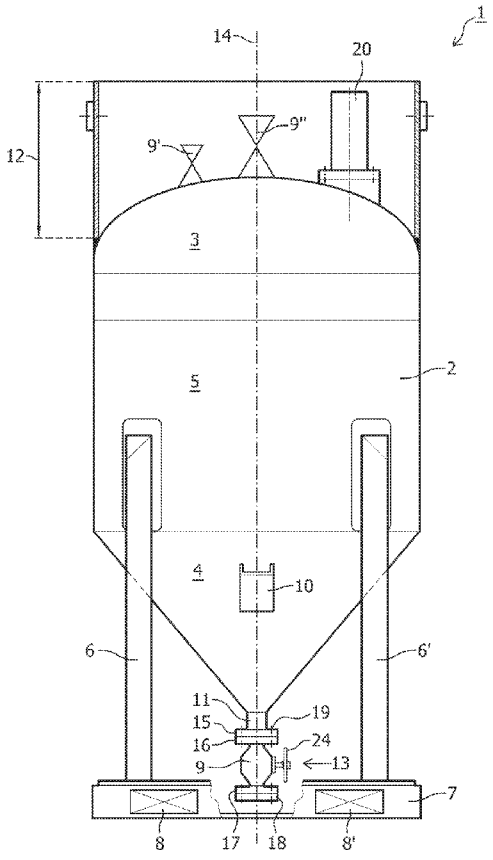


FIG. 1

(57) Abstract: The present invention relates to a method for handling a solid composition comprising a metallocene catalyst,comprising the step of: transporting said composition in a closed and oxygen-free transportation container provided with a bottom discharge opening. The container is advantageous for storing a metallocene catalyst, particularly in a dry form. Preferably, the bottom discharge opening of the method of the invention is provided with a ball valve. The container of the invention allows for safe transportation and handling of hazardous catalyst materials.

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METHOD FOR HANDLING METALLOCENE CATALYSTS

FIELD OF THE INVENTION

The present invention relates to an improved method for handling a solid composition comprising a pyrophoric and/or water reactive metallocene catalyst. The invention is of interest to the chemical industry, in particular in the production of polyolefins, such as polyethylene and polypropylene.

BACKGROUND OF THE INVENTION

Polyolefins, such as polyethylene (PE) and polypropylene (PP) are synthesized by polymerizing respectively ethylene (CH2=CH2) or propylene (CH2=CH2-CH3) monomers. Because it is cheap, safe, stable to most environments and easy to be processed, polyethylene and polypropylene polymers are useful in many applications. According to the properties polyethylene can be classified into several types, such as, but not limited to, LDPE (Low Density Polyethylene), LLDPE (Linear Low Density Polyethylene), and HDPE (High Density Polyethylene) as well as High Molecular Weight (HMW), Medium Molecular Weight (MMW) and Low Molecular Weight (LMW). Each type of polyethylene has different properties and characteristics.

Olefin polymerization such as ethylene and propylene polymerizations are frequently carried out in a loop reactor, generally under high pressure conditions, using ethylene or propylene monomer, liquid diluent and catalyst, optionally one or more co-monomer(s), and hydrogen. Suitable catalysts for the preparation of polyethylene and polypropylene comprise chromium-type catalysts, Ziegler-Natta catalysts and metallocene catalysts. Typically, the catalyst is used in particulate form. The polymerization is usually performed under slurry conditions, with the produced polymer usually in a form of solid particles which are suspended in the diluent. The slurry in the reactor is circulated continuously with a pump to maintain efficient suspension of the polymer solid particles in the liquid diluent. Polymer slurry is discharged from the loop reactor by means of settling legs, which operate on a batch principle to recover the slurry. Settling in the legs is used to increase the solids concentration of the slurry finally recovered as product slurry.

The product slurry may subsequently be fed to a second loop reactor serially connected to the first loop reactor wherein a second polymer fraction may be produced. Typically, when two reactors in series are employed in this manner, the resultant polymer product is a bimodal polymer product, which comprises a first polymer fraction produced in the first reactor and a second polymer fraction produced in the second reactor, and has a bimodal molecular weight distribution.

After the polymer product is collected from the reactor and the hydrocarbon residues are removed, the polymer product is dried, additives can be added and finally the polymer may be mixed and pelletized.

During the mixing step, polymer product and optional additives are mixed intimately in order to obtain a compound as homogeneous as possible. Preferably, mixing is done in an extruder wherein the ingredients are mixed together and the polymer product and optionally some of the additives are melted so that intimate mixing can occur. The melt is then extruded into a rod, cooled and granulated, e.g. to form pellets. In this form the resulting compound can then be used for the manufacturing of different objects.

Although metallocene catalysts have interesting properties for the production of ethylene or propylene, their handling is challenging and involves substantial safety risk. Metallocene catalysts are pyrophoric and water-reactive materials when substantially in a dry form, requiring protection from contact with water or humidity. As they may auto ignite when dry at temperature below 25 °C, their transport is severely restricted. As a consequence, catalysts and particularly metallocene catalysts are mixed with a liquid diluent to control their pyrophoric properties and stored in containers.

It is customary, and often even dictated, that hazardous materials be transported in containers with the discharge opening at the top, to avoid dangerous situations, such as leaks and spills, particularly with liquid compositions or even explosions. Once at the discharge site, the materials are generally discharged from the top of the container, a cumbersome process that may pose safety risks. Some containers incorporate complicated hinge systems that allow for moving of the discharge opening from an upward position during transportation, to a downwards position, when discharging at the production site. In view of their mechanical complexity, the risk of wear and the potentially abrupt movement of the hazardous materials inside the container, such container hinge systems introduce many complications that compromise safety of workers and environment.

SUMMARY OF THE INVENTION

Surprisingly, the present inventors have found an improved method for handling pyrophoric and/or water-reactive solid compounds, in particular metallocene catalysts. The present invention provides a method for transporting and handling pyrophoric and/or water-reactive metallocene catalyst in a convenient, economic, and above all, safe way. Accordingly, the present invention relates to a method for handling a solid composition comprising a metallocene catalyst in a dry form, comprising the step of transporting said

composition in a closed and oxygen-free transportation container provided with a bottom discharge opening wherein said bottom discharge opening is located at the bottom of the container during transport. For the purpose of the invention, the term “transporting” is defined as moving the longitudinal axis of said container in a horizontal direction (or plane).

The present inventors have found that solid compositions comprising metallocene catalyst in dry form can be more safely stored and handled when transported in a container with a bottom discharge opening that is located at the bottom of the container during transportation. The invention results in minimal shaking and maneuvering of pyrophoric and/or water-reactive solid dry metallocene catalyst material inside the container. The invention further provides for fast and tight connection between the container and the mud pot for discharging in a safe mode, and for ease of working. The inventors have found that solid pyrophoric and/or water-reactive metallocene catalyst compositions in dry form are more easily and more safely discharged through the bottom of the container versus the top of the container as is custom and often even mandated for hazardous materials, including liquids. Without wishing to be bound by any theory, use of the particular dry metallocene catalyst and/or inclusion of a catalyst support may contribute to more complete emptying of the container and, accordingly, the inventors have surprisingly found that the container of the invention can be substantially completely emptied of the dry metallocene catalyst, leading to lower safety risks such as spontaneous ignition of residue in the container.

The present invention will now be further described. In the following passages, different aspects of the invention are defined in more detail. Each aspect so defined may be combined with any other aspect or aspects unless clearly indicated to the contrary. In particular, any feature indicated as being preferred or advantageous may be combined with any other feature or features indicated as being preferred or advantageous. The description is only given by way of example and does not limit the invention. The reference numbers relate to the hereto-annexed figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 schematically illustrates a side view of a preferred transportation container suitable for use in a method according to an embodiment of the invention.

Figure 2 schematically illustrates a side view of a preferred transportation container with a bottom discharge opening with an L-shaped conduit.

Figure 3 schematically illustrates the details of a ball valve as preferably used in the invention, both in open (figure 3A) and in closed (figure 3B) position.

Figure 4 schematically illustrates a preferred compensator according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a method for handling a solid composition comprising a metallocene catalyst in a dry form for olefin polymerization. The method comprises the step of transporting said composition in a closed and oxygen-free transportation container, said container being provided with a bottom discharge opening, wherein said bottom discharge opening is located at the bottom of the container during transport. Preferably, the invention relates to a method for handling a solid composition comprising a metallocene catalyst in a dry form for olefin polymerization comprising the step of transporting said composition in a closed and oxygen-free transportation container provided with a bottom discharge opening wherein said bottom discharge opening is located at the bottom of the container during transport, wherein said transportation container comprises a recipient with a wall thickness of at least 9 mm.

Preferably, the bottom discharge opening of the method of the invention is provided with a ball valve. Preferably, the ball valve is connected to a blind flange. The ball valve provides for a robust though easily removable and safe closure of the container. It provides a leak-free container for hazardous solids. This is advantageous for allowing safe transport of a hazardous material such as the solid, substantially dry metallocene catalyst of the present invention and may be advantageously used for transferring by gravitational force said catalyst from said container to a mud pot for the preparation of a catalyst slurry. In an embodiment, the ball valve preferably comprises a spherical body, the part that controls the flow through the valve. The spherical body preferably has a hole or port through the middle, allowing flow from one end to the other end of the valve when open while blocking the flow when closed (the hole being perpendicular to the flow when closed). A handle, such as a lever or a wheel may be used for opening and closing. The ball valve is preferably connected to the recipient by means of flanges and bolts. Preferably, the ball valve is closed at the bottom with a blind that is attached to the bottom flange of the ball valve with bolts. To further improve closure, the ball valve is preferably combined with moisture shielding means, more preferably a blind flange with seals, as will be described below.

Preferably, the container of the invention contains a further ball valve at the top of the container for filling the container with the metallocene catalyst of the invention.

Preferably, the container of the invention contains yet a further ball valve op top of the container that can be used as a means for blanketing the catalyst of the invention with an inert medium as described below.

Preferably, the bottom discharge opening is facing downwards or sideways. If facing sideways, an L-shaped pipe may be used before or after the ball valve. It will be understood that, in the alternative, the L-shaped pipe may be part of the ball value and be located incorporated downstream from the top flange and/or upstream from the bottom flange.

The containers for use in the invention are particularly suitable for transferring said metallocene catalyst to a mud pot used for the preparation of a catalyst slurry. If an L–shaped pipe is used, it will be understood that preferably at least a second, but downwards-directed L-shaped pipe may be used in combination, in order to direct the flow of catalyst downwards to the mud pot.

Preferably, the catalyst is a metallocene catalyst. Preferably, the catalyst is in a dry form, which, according to the invention, is defined as containing less than 10% by weight of diluent, more preferably less than 5%, most preferably less than 1% by weight and particularly preferred substantially dry. Use of the metallocene catalyst in dry form may lead to savings on processing, transport volumes and transport costs. Use of a dry form – versus a slurry- allows for easier and more complete discharging through gravitational force. Further, preparation of a catalyst slurry may be postponed until the time it is required in a production installation, resulting in fresh mixtures of catalyst and diluent that can then be constituted in any desired concentration.

As used in this invention, the term “catalyst” refers to a substance that causes a change in the rate of a polymerization reaction without itself being consumed in the reaction. In the present invention it is especially applicable to catalysts suitable for the polymerization of olefin, for example ethylene to polyethylene or propylene to polypropylene, in particular it is applicable to metallocene catalysts. These catalysts will be referred to as polymerization catalysts.

The term "metallocene catalyst" is used herein to describe any transition metal complexes consisting of metal atoms bonded to one or more ligands. The metallocene catalysts are compounds of Group IV transition metals of the Periodic Table such as titanium, zirconium, hafnium, etc., and have a coordinated structure with a metal compound and

ligands composed of one or two groups of cyclopentadienyl, indenyl, fluorenyl or their derivatives. Use of metallocene catalysts in the polymerization of olefins has various advantages. Metallocene catalysts have high activities and are capable of preparing polymers with enhanced physical properties in comparison with the polymers prepared using Ziegler-Natta catalysts. The key to metallocenes is the structure of the complex. The structure and geometry of the metallocene can be varied to adapt to the specific need of the producer depending on the desired polymer. Metallocenes comprise a single metal site, which allows for more control of branching and molecular weight distribution of the polymer. Monomers are inserted between the metal and the growing chain of polymer.

In a preferred embodiment, the metallocene catalyst has a general formula (I) or (II):

$(Ar)_2MQ_2$ (I); or R"$(Ar)_2MQ_2$ (II)

wherein the metallocenes according to formula (I) are non-bridged metallocenes and the metallocenes according to formula (II) are bridged metallocenes;

wherein said metallocene according to formula (I) or (II) has two Ar bound to M which can be the same or different from each other;

wherein Ar is an aromatic ring, group or moiety and wherein each Ar is independently selected from the group consisting of cyclopentadienyl, indenyl (IND), tetrahydroindenyl (THI) or fluorenyl, wherein each of said groups may be optionally substituted with one or more substituents each independently selected from the group consisting of halogen, a hydrosilyl, a SiR_3 group wherein R is a hydrocarbyl having 1 to 20 carbon atoms, and a hydrocarbyl having 1 to 20 carbon atoms, and wherein said hydrocarbyl optionally contains one or more atoms selected from the group comprising B, Si, S, O, F, Cl and P;

wherein M is a transition metal selected from the group consisting of titanium, zirconium, hafnium and vanadium; and preferably is zirconium;

wherein each Q is independently selected from the group consisting of halogen; a hydrocarboxy having 1 to 20 carbon atoms; and a hydrocarbyl having 1 to 20 carbon atoms and wherein said hydrocarbyl optionally contains one or more atoms selected from the group comprising B, Si, S, O, F, Cl and P; and

wherein R" is a divalent group or moiety bridging the two Ar groups and selected from the group consisting of a C_1-C_{20} alkylene, a germanium, a silicon, a siloxane, an alkylphosphine and an amine, and wherein said R" is optionally substituted with one or more substituents each independently selected from the group consisting of halogen, a hydrosilyl, a SiR_3 group wherein R is a hydrocarbyl having 1 to 20 carbon atoms, and a

hydrocarbyl having 1 to 20 carbon atoms and wherein said hydrocarbyl optionally contains one or more atoms selected from the group comprising B, Si, S, O, F, Cl and P.

The term "hydrocarbyl having 1 to 20 carbon atoms" as used herein is intended to refer to a moiety selected from the group comprising a linear or branched C_1-C_{20} alkyl; C_3-C_{20} cycloalkyl; C_6-C_{20} aryl; C_7-C_{20} alkylaryl and C_7-C_{20} arylalkyl, or any combinations thereof. Exemplary hydrocarbyl groups are methyl, ethyl, propyl, butyl, amyl, isoamyl, hexyl, isobutyl, heptyl, octyl, nonyl, decyl, cetyl, 2-ethylhexyl, and phenyl. Exemplary halogen atoms include chlorine, bromine, fluorine and iodine and of these halogen atoms, fluorine and chlorine are preferred.

Illustrative examples of metallocene catalysts comprise but are not limited to bis(cyclopentadienyl) zirconium dichloride (Cp_2ZrCl_2), bis(cyclopentadienyl) titanium dichloride (Cp_2TiCl_2), bis(cyclopentadienyl) hafnium dichloride (Cp_2HfCl_2); bis(tetrahydroindenyl) zirconium dichloride, bis(indenyl) zirconium dichloride, and bis(n-butyl-cyclopentadienyl) zirconium dichloride; ethylenebis(4,5,6,7-tetrahydro-1-indenyl) zirconium dichloride, ethylenebis(1-indenyl) zirconium dichloride, dimethylsilylene bis(2-methyl-4-phenyl-inden-1-yl) zirconium dichloride, diphenylmethylene (cyclopentadienyl)(fluoren-9-yl) zirconium dichloride, and dimethylmethylene [1-(4-tert-butyl-2-methyl-cyclopentadienyl)](fluoren-9-yl) zirconium dichloride.

Preferably, the metallocene catalyst is provided on a solid support. The support should be an inert solid, which is chemically unreactive with any of the components of the conventional metallocene catalyst. The support is preferably a silica compound. In a preferred embodiment, the metallocene catalyst is provided on a solid support, preferably a silica support. The beneficial free flowing effect of the solid support allows for substantially complete emptying of the container of the invention.

In another embodiment, the invention provides a method further comprising the step of transferring said pyrophoric and/or water-reactive metallocene catalyst from a container to a mud pot for the preparation of a catalyst slurry suitable for olefin polymerization. Preferably, the catalyst is transferred by gravitational force.

The mud pot is preferably in the form of a vessel. As used herein the term "mud pot" refers to a catalyst storage vessel which contains solid-liquid slurry of metallocene catalyst and diluent. The step of transferring the catalyst can be performed by connecting the bottom discharge opening of the transportation container to the top of the mud put. Preferably, the mud pot is connected at its top (preferably to the compensator) by way of a flange and bolts, preferably the connection is sealed. The metallocene catalyst is

preferably transferred to a mud pot for the preparation of a catalyst slurry. Preferably, the mud pot is provided with a liquid diluent prior to the addition of the catalyst. More preferably, the catalyst is transferred into the liquid diluent provided into the mud pot by means of a conduit that opens in the liquid. In this way, the catalyst comes directly in contact with the liquid. Splashes can be avoided and also contact with traces of oxygen or moisture in the atmosphere above the liquid surface is avoided.

The invention also provides a preferred method comprising the step of connecting said bottom discharge opening to said mud pot with a compensator. By the term "compensator" it is meant, an expandable pipe. A preferred compensator comprises an expandable corrugated layer that is adaptable in length and preferably can withstand pressure. The compensator for use in the invention preferably absorbs dilatation movements and vibration and preferably provides a tight fit irrespective of dilatation of the fixed structures. Preferably, the compensator for use in the invention contains an internal pipe. Preferably, the compensator has a flange at the top for connection to the container (preferably to the ball valve of said container), preferably connected with bolts. Preferably, the compensator has a flange at the bottom for connection to the mud pot for use in the invention, preferably connected with bolts. The compensator is preferably compatible with the metallocene catalyst in dry form that is to be transferred through it and is preferably manufactured from metal (most commonly stainless steel), plastic, polytetrafluoroethylene (PTFE, known by the DuPont brand name Teflon), or an elastomer such as rubber. The compensator may also be designed for other criteria, such as noise absorption or anti-vibration.

Preferably, the container is emptied using a container emptying means. Accordingly, the invention preferably relates to a method comprising the step of removing said pyrophoric and/or water-reactive metallocene catalyst from said transportation container to said mud pot using a vibrator pad. The advantage of providing a transportation container with a vibratory mechanism is that a container can safely be emptied more completely and most importantly more safely thereby leaving less product behind in the container after the emptying operation than with a method not using a vibratory mechanism such as a vibrator pad. Alternatively, a vibrating structure, such as a vibrating table, can be connected to the container to provide vibrations for removal of the catalyst from the transportation container. Use of a combination of the vibrator pad and the silica support for the catalyst is particularly useful to substantially completely empty the container of the hazardous catalyst, while ensure a safe transfer.

The bottom discharge opening of said transportation container can also be provided with an eductor. By the term "eductor" it is meant, an aspirator, also called an eductor-jet, which is a device that produces vacuum by means of the Venturi effect. The eductor assists the transfer of the catalyst from the transportation container to the mud pot. In one embodiment, the eductor is fitted to the bottom discharge opening on the inlet side of the ball valve. In another embodiment, the eductor is fitted on the outlet side of the ball valve.

Preferably, the bottom discharge opening of the transportation container for use in the invention is provided with moisture shielding means. In a more preferred embodiment of the invention, said moisture shielding means is selected from a blind flange, a threaded plug and a camlock cap. The moisture shielding means help in preventing that moisture come in contact with the solid pyrophoric and/or water-reactive metallocene catalyst. Preferably, the bottom discharge opening of the transportation container is shielded with a cap or the valve is surrounded by panels such that the opening is shielded from direct contact with a liquid, such as, for instance, rain. Preferably, seals are used to ensure a tight connection between the flanges as used in the present invention and to prevent exposure to moisture.

Preferably, the method of the invention comprises the step of mounting the container in a stackable frame. This may provide for further protection and safety. The frame serves to support the recipient, facilitates dismountable stackability, the open frame allowing convenient and full access to all sides. Use of transportation container in the form of a stackable frame allows easy mounting on transportation means such as a ship, truck or train.

To further facilitate stacking one or more of the frame apices or edges may be disposed with a locating means configured to couple with corresponding locating means on another frame. The locating means allows a frame to be stacked within a given tolerance, vertically on top of another frame, preventing misalignment and sideways displacement. The locating means can be any in the art, for instance an upper and lower surface co-operating rim, or a protrusion-groove arrangement, whereby a protrusion provided at the base of one frame is configured to couple with a groove provided in the top of another frame (or *vice versa*). Because the locating means prevents misalignment, the possibility becomes available to stack 2, 3, 4, 5, 6, 8, 9 or 10 frames vertically. It also has the advantage that the container can be easily positioned in a production installation.

Preferably the metallocene catalyst is blanketed with an inert medium comprising nitrogen or argon, preferably nitrogen, more preferably dry nitrogen. By the term "dry nitrogen" it is meant that the nitrogen is essentially free of moisture. Nitrogen is particularly suitable as

buffer gas due to its inert properties, its availability and relatively low cost. Preferably the nitrogen is substantially free of oxygen, preferably 99.5%; more preferably 99.9%; most preferably 99.99% free of oxygen to control oxidation of product stored in the container.

Preferably, the method of the invention comprises the step of blanketing said pyrophoric and/or water-reactive metallocene catalyst with dry nitrogen, preferably at a pressure of between 1.5 x 10^5 Pa and 2.0 x 10^5 Pa (which is equivalent to 0.5 and 1.0 barg which is equivalent to 1.5 bar and 2.0 bar), more preferably of around 1.7 x 10^5 Pa (equivalent to 0.7 barg), wherein “blanketing” is the process of applying a gas to the empty space in a container. The terms "inerting" or "padding" are other terms used to describe displacement of air and nitrogen blanketing. Blanketing comprises using a buffer gas to protect products inside the container. Blanketing is a method of controlling pressure in a container. It serves to prevent air and moisture from entering the container. Advantageous effects of blanketing are a longer life of the product in the container, reduced hazards, longer equipment life cycles.

Preferably, the container comprises a means of allowing the blanketing gas into the system and a means to vent the gas should the pressure get too high, such as pressure release valve. Pressure release valves are commercially available on the market and known to a person skilled in the art. When the pressure inside the container drops below a set point, a valve opens and allows the blanketing gas to enter. Once the pressure reaches the set point, the valve closes. As a safety feature, many systems include a pressure vent that opens when the pressure inside exceeds a maximum pressure set point. This helps to prevent the container from rupturing due to high pressure. Since most blanketing gas sources will provide gas at a much higher than desired pressure, a blanketing system will also use a pressure reducing valve to decrease the inlet pressure to the tank.

Blanketing may be used with positive and negative tank pressure. Preferably, the container is blanketed with pressure of 0.5 to 1.0 barg (equivalent to 1.5 x 10^5 to 2.0 x 10^5 Pa); more preferably of around 1.7 x 10^5 Pa (equivalent to 0.7 barg).

Preferably, the recipient is pressurized to a transportation pressure between 2.5 x 10^5 and 9.5 x 10^5 Pa (equivalent to 1.5 and 8.5 barg), preferably between 3 x 10^5 and 9 x 10^5 Pa (equivalent to 2 and 8 barg), more preferably between 4 x 10^5 and 7 x 10^5 Pa (equivalent to 3 and 6 barg), most preferably around 4.45 x 10^5 Pa (equivalent to 3.45 barg). The transportation pressure in a pressurized vessel may be calculated by ASME (American Society of Mechanical Engineers) or API (American Petroleum Institute) codes.

The discharge pressure of the transportation container, meaning the pressure applied in the container for discharging its content from the recipient, is preferably larger than the pressure of the mud pot the content will be discharged to. Preferably, a pressure of 6 x 10^5 Pa (equivalent to 5 barg) is provided for emptying the transportation container.

Preferably, a method is provided, wherein said transportation container comprises a recipient for encompassing said pyrophoric and/or water-reactive metallocene catalyst, with a wall thickness of at least 9 mm, preferably at least 9.5 mm, preferably at least 10 mm. Preferably, said recipient is selected from carbon steel, stainless steel, or other steel alloys.

Preferably, a method is provided, wherein said transportation container comprises a steel recipient for encompassing said pyrophoric and/or water-reactive metallocene catalyst, preferably a stainless steel recipient with a wall thickness of at least 10 mm, preferably at least 15 mm, preferably at least 20 mm.

Stainless steel is also known as inox steel or inox and is defined as a steel alloy with a minimum of 10.5 or 11% chromium content by mass. Stainless steel does not stain, corrode, or rust as easily as ordinary steel. It is also called corrosion-resistant steel. Different grades and surface finishes may be used to provide a container for comprising pyrophoric and/or water-reactive metallocene catalyst.

Preferably, said recipient is pressurized up to 9.5 x 10^5 Pa (equivalent to 8.5 barg). Preferably, said recipient is provided with a spring loaded pressure relief valve (or safety valve), preferably a spring loaded pressure relief valve capable of relieving pressure upon reaching a pressure between 9.5 x 10^5 to 9.7 x 10^5 Pa (equivalent to 8.5 and 8.7 barg).

Preferably, the recipient has an effective volume of 0.1 to 12 m^3, preferably 0.5 to 5 m^3. It is preferably designed so that its dimensions make it possible to load it in maritime containers. In an example, the recipient has the following features: a wall thickness of minimum 9.5 mm; an allowable transportation pressure of maximum 9.62 x 10^5 Pa (equivalent to 8.62 barg); a capacity of maximum 900 liters, a transportation pressure of maximum 4.5 x 10^5 Pa (equivalent to 3.5 barg), a spring loaded pressure relief valve set at 9.62 x 10^5 Pa (equivalent to 8.62 barg).

The container for use in the invention provides for simple and straight-forward discharging procedures. The transportation container is preferably discharged by gravitation. Preferably, the container is placed above a mud pot. The mud pot and the bottom discharge opening are connected, either by a straight conduit extending vertically downwards or by an L-shaped conduit. Opening of the bottom discharge opening, for

instance by opening of the ball valve that closed off the opening, will release the content of the container. Preferably, the bottom discharge opening is connected to a conduit extending vertically downwards. This allows transfer of the catalyst without the need for means to support catalyst transfer. In case an L-shaped conduit is used, the transfer of the catalyst from the transportation container to another vessel such as a mud pot may be enhanced using pneumatic conveyor.

The above aspects and embodiments are further supported by reference to figures 1, 2, 3 and 4 which illustrate preferred transportation containers according to embodiments of the invention. Figure 1 schematically depicts a transportation container 1, preferably a stainless steel portable tank, containing a recipient 2 with longitudinal axis 14, supporting legs 6, 6', a base plate 7 with forklift openings 8, 8', and a skirt 12. Recipient 2 comprises a cylindrical body 5, a conical top portion 3, a cone-shaped funnel bottom portion 4, and a vibrator pad 10 and safety valve 20. In the centre of the cone-shaped bottom portion 4, recipient 2 is provided with a pipe 11 that faces downwards and is provided with a bottom discharge opening 13 facing downwards and containing a ball valve 9 with wheel 24. Bottom discharge opening 13 may be fitted with an eductor (not displayed) fitted to the inlet side of the valve. Top flange 16 of ball valve 9 is connected with bolts 19 to bottom flange 15 of recipient 2 and bottom flange 17 to blind 18. Ball valve 9'' at the top of the container may be used to fill the container with catalyst, while ball valve 9' at the top may be used as means to blanket the catalyst in the container with an inert medium.

Figure 2 schematically represents a transportation container 1, as in figure 1, with an L-shaped pipe 11 and a bottom discharger 13 facing side ways. It will be understood that the L-shape may also be incorporated downstream from –or after the- ball valve 9 or as part of the ball valve, downstream from flange 16 and/or upstream from flange 17.

Figure 3 illustrates a preferred ball valve 9 for use as a bottom discharger in the present invention wherein the ball valve housing 23 contains a spherical body 21 with a hole 25, and seals 22. The ball valve housing is connected to top flange 16 and bottom flange 17. Figure 3A illustrates an ball valve 9 with a spherical ball 21 wherein the hole 25 is positioned such as to open the ball valve, while figure 3B illustrates a closed ball valve further having blind 18 that is attached with bolts 19, 19'.

Figure 4 illustrates a compensator 30 that may be advantageously used in the present invention with top flange 26, bottom flange 27, pipe 28, and corrugated layer 29. Compensator 30 is connected with bolts 19 to the top flange 31 of mud pot 32.

EXAMPLE

An example of a preferred method according to the invention will now be described with reference to Figure 1. The recipient of a transportation container is loaded with a powder comprising a metallocene catalyst. The recipient is a stainless steel recipient with a wall thickness of about 12mm. The powder is essentially dry, meaning free of moisture, because the powder is pyrophoric. The container is closed. Dry nitrogen is introduced into the container to a pressure of 1.7×10^5 Pa (equivalent to 0.7 barg) and an oxygen-free container is obtained.

The container with the metallocene catalyst powder is hoisted onto a truck and transported to a polymerization plant requiring metallocene catalyst. During transport the bottom discharge opening is facing downwards.

On arrival to the polymerization plant the container is off loaded from the truck by means of a fork-lift. The fork-lift transports the container to a platform. The frame of the container is mounted on top of a mud pot for the preparation of catalyst slurry.

The blind is removed from the ball valve. The valve itself is not removed. A compensator is connected to the outlet of the valve. A flow of nitrogen is applied to remove traces of oxygen. Pressure provided to the transportation container is higher than the pressure of the mud pot. The valve is opened providing access to the recipient of the transportation container. The catalyst is discharged into the mud pot. The conduit connecting the bottom discharge opening to the mud pot may further be provided with an eductor.

The pyrophoric and/or water-reactive metallocene catalyst is transferred from said transportation container to said mud pot by gravitational force. In Europe use of a gravity conveyor for transferring the metallocene catalyst to the mud pot is preferred while use of a pneumatic conveyor is preferred in America.

Preferably, transfer of metallocene catalyst from the transportation container to the mud pot is supported using a vibrator pad. Vibrations are applied to the container. They enhance the removal of pyrophoric and/or water-reactive metallocene catalyst from the transportation container. A substantially complete transfer from catalyst from the transportation container to the mud pot is obtained.

When the transportation container is substantially freed from its catalyst content, the ball valve is closed and the transportation container is disconnected from the mud pot. The blind is reconnected to the outlet of the ball valve.

The recipient with a wall thickness of at least 9 mm resists to punctures during transport which avoids oxygen entrance as such and avoids pyrophoric reactions with excessive heat generation.

CLAIMS

1. Method for handling a solid composition comprising a metallocene catalyst in a dry form, comprising the step of transporting said composition in a closed and oxygen-free transportation container provided with a bottom discharge opening wherein said bottom discharge opening is located at the bottom of the container during transport, wherein said transportation container comprises a recipient with a wall thickness of at least 9 mm.

2. Method according to claim 1, wherein the bottom discharge opening is provided with a ball valve, preferably connected to a blind flange.

3. Method according to any of claims 1 to 2, wherein said catalyst is provided on a support, preferably a silica support.

4. Method according to any of claims 1 to 3, further comprising the step of transferring by gravitational force said catalyst from said container to a mud pot for the preparation of a catalyst slurry.

5. Method according to claim 4, further comprising the step of connecting said bottom discharge opening to said mud pot with a compensator.

6. Method according to any of claims 4 to 5, further comprising the step of removing said catalyst from said transportation container to said mud pot using a vibrator pad.

7. Method according to any of claims 1 to 6, wherein said bottom discharge opening is provided with an eductor.

8. Method according to any of claims 1 to 7, wherein said bottom discharge opening is provided with moisture shielding means, preferably selected from a blind flange, a threaded plug, a camlock cap and mixture thereof.

9. Method according to any of claims 1 to 8, further comprising the step of mounting said transportation container in a stackable frame.

10. Method according to any of claims 1 to 9, further comprising the step of blanketing said catalyst with dry nitrogen, preferably at a pressure of between 1.5×10^5 to 2.0×10^5 Pa).

11. Method according to any of claims 1 to 10, wherein said transportation container comprises a steel recipient, preferably a stainless steel recipient with a wall thickness of at least 10 mm.

12. Method according to claim 11, wherein said recipient is pressurized up to 9.5×10^5 Pa.

13. Method according to any of claims 11 to 12, wherein said recipient is provided with a spring loaded pressure relief valve, preferably a spring loaded pressure relief valve capable of relieving pressure upon reaching a pressure between 9.5×10^5 to 9.7×10^5 Pa.

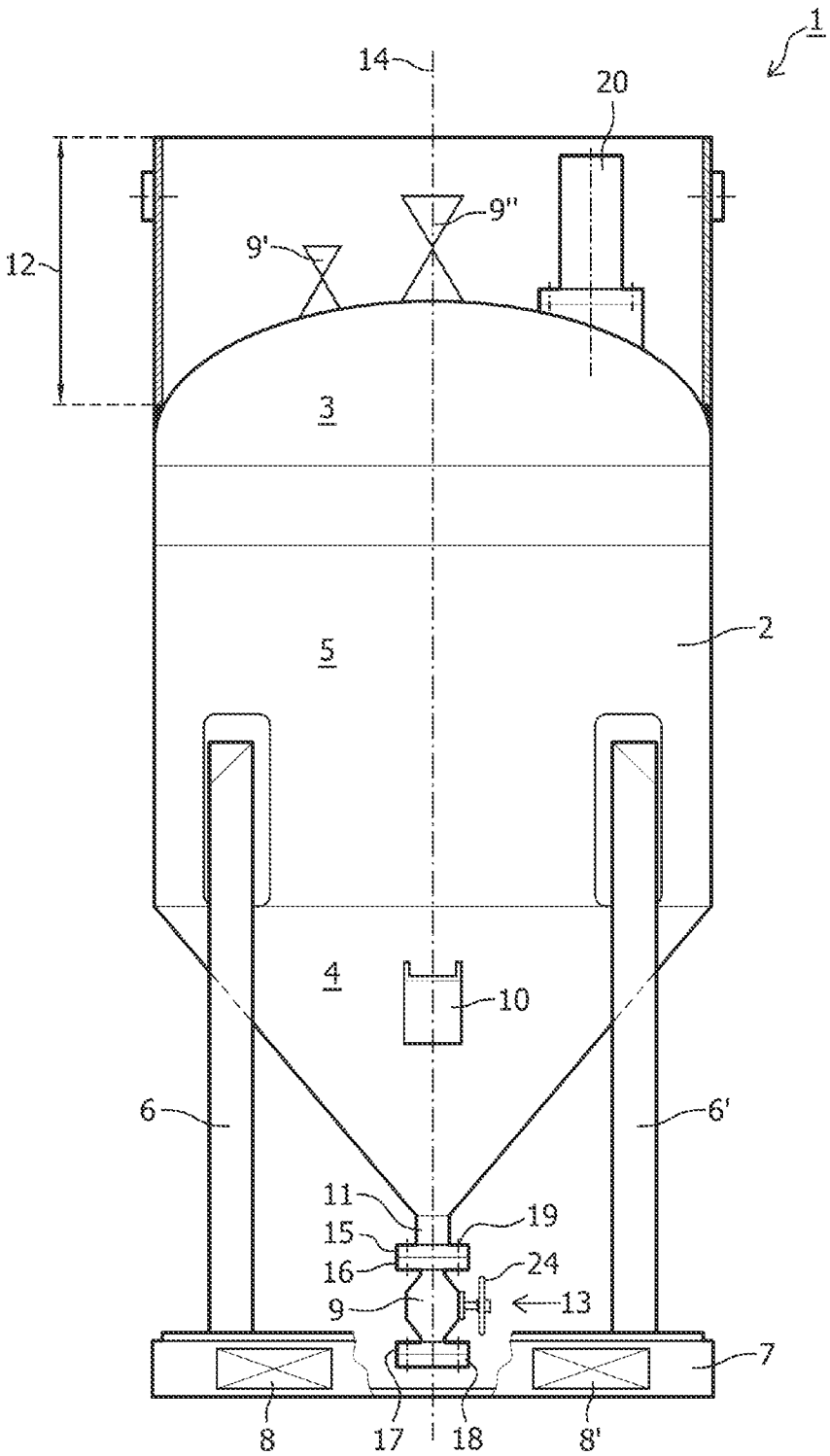


FIG. 1

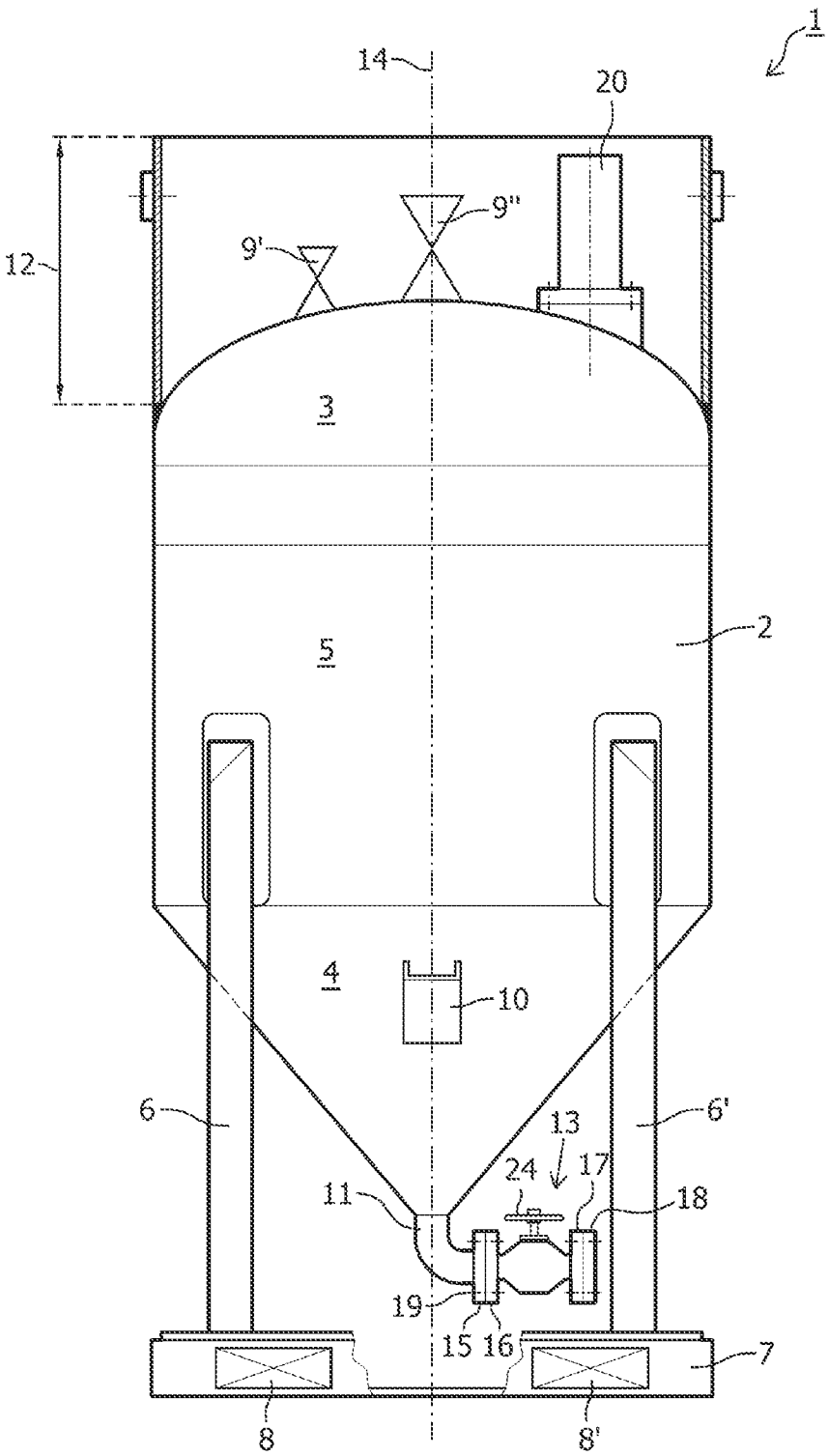


FIG. 2

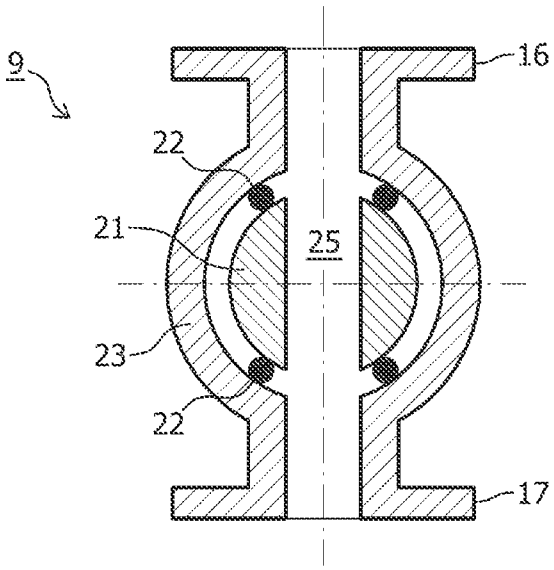


FIG. 3A

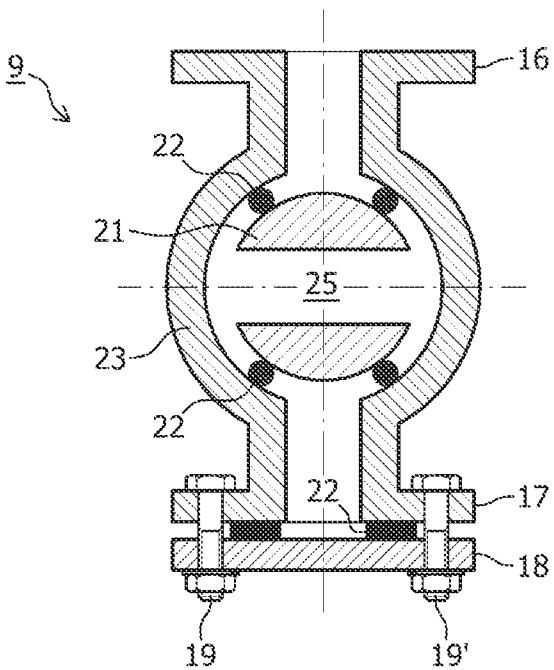


FIG. 3B

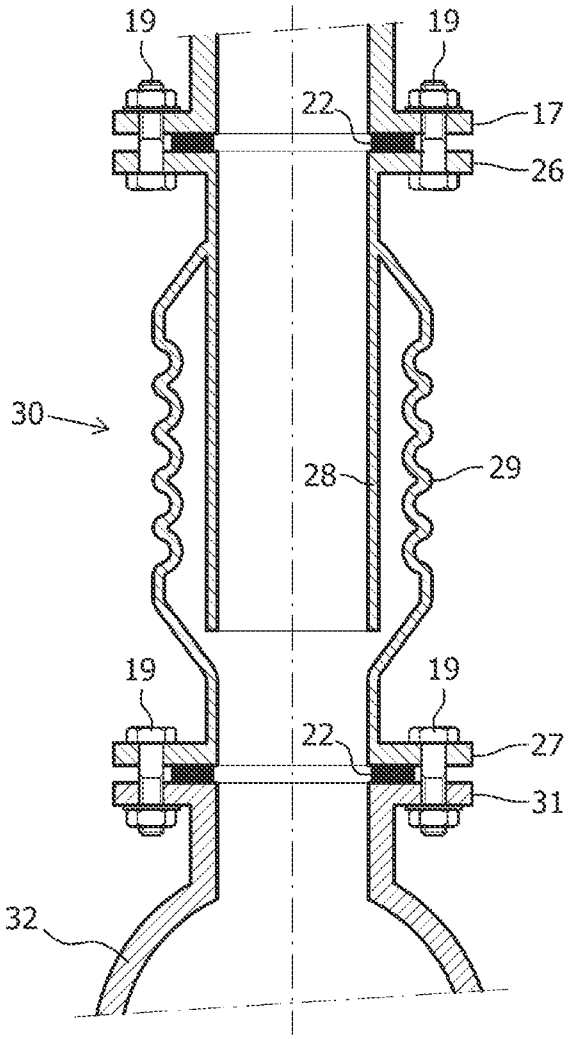


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/063145

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65D88/12 B65D88/54 C08F2/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65D C08F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 946 068 A (ERICKSON MICHAEL E [US] ET AL) 7 August 1990 (1990-08-07) column 1, lines 5-8 column 2, lines 18-42 column 3, line 37 - column 4, line 18 column 6, lines 41-62; figures 1, 4-6	1-13
Y	CN 2 841 572 Y (CATALYST AND CHEMICAL CONTAINE [SG]) 29 November 2006 (2006-11-29) abstract	1-13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
2 September 2011	14/09/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Buesing, Guenter

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	"Albemarle Catalysts Concept for a Total Catalyst Management", Albemarle Catalysts Company BV, Amersfort (NL) , 31 December 2007 (2007-12-31), XP002614461, Retrieved from the Internet: URL:http://www.albemarle.com/Products_and_services/Catalysts/HPC/Services/Total_catalysts_management/_Technical_papers/Concept_Total_Catalyst_Management.pdf [retrieved on 2010-12-15] sections 1, 8; pages 3, 7 -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/063145

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4946068 A	07-08-1990	CA 1275266 C	16-10-1990
CN 2841572 Y	29-11-2006	NONE	