

MULTI-LAYER RECEPTACLE AND RESIDUE REMOVAL METHOD THEREFOR

BACKGROUND

The present invention broadly concerns receptacles for the storage and transportation of selected items or materials. More specifically, the present invention concerns containers suited for holding liquid substances such as agrochemicals, which can be rinsed with a suitable solvent to remove residue in the interior of the container. The present invention also concerns a method of removing residue from the interior of a receptacle.

Packaging is a fundamental need in modern society. At its very essence, packaging enables goods to be distributed over large geographical areas while both protecting and preserving the quality of the goods during their distribution and storage. Typically, packaging provides important information about the goods it contains, such as an explanation of the product, how the product is to be used, and legally pertinent information. Importantly, packaging can also provide a significant commercial advantage to companies who sell competing products. For example, the shape of a product's packaging and colors or illustrations appearing on the packaging can be a significant marketing tool, especially when consumers identify certain packaging characteristics with a particular source or brand of goods.

As markets continue to diversify and the economy grows, packaging solutions must continue to satisfy the economic, social and governmental requirements of existing and emerging products. Since the product and its packaging are so interdependent, meeting these demands requires more than just combining available materials to contain the goods. Rather, in today's commercial environment, a well-designed package requires the appropriate integration of structure, aesthetics, style, communication and legal elements specific to each product. Moreover, successful packaging solutions should be cost efficient and environmentally responsible.

Packaging solutions that are environmentally responsible will continue to be an important driver in the discovery of new packaging materials and designs. Of particular importance is the advancement of environmentally responsible packaging for hazardous materials, such as agrochemicals, heavy metals, and organic chemicals, which is strictly regulated by governments and agencies in various countries, including the United States of America. Indeed, environmental, safety, and commercial pressures have triggered stringent regulatory requirements

designed to reduce soil and groundwater contamination resulting from the disposal of partially filled containers or residue left in improperly rinsed containers. As a result, many hazardous materials manufacturers that are subject to these disposal schemes or have customers that are subject thereto, now consider the product packaging and its disposal to be of equal importance to the product itself.

The agrochemical industry, for example, has developed strategies and programs in effort to reduce the impact of their products on the environment. For example, agrochemical companies have made substantial advancements to place their products in reusable packaging as well as to create recycling programs to systematically and efficiently refill the containers as incentives to use these programs. While these programs do lessen the amount of containers that need to be disposed, these containers cannot be used indefinitely. For example, the integrity of the packaging can deteriorate after sufficient use, rendering it unusable. Additionally, and perhaps even more common, the names of agrochemical manufacturers change over time for a variety of reasons such as mergers or acquisitions. Also, product names change and even the packaging dimensions or configurations are typically modified over time. As a result, potentially vast quantities of containers with the incorrect names, sizes, or configurations are no longer useable and are eventually disposed.

Despite the increasing use of reusable containers, many agrochemical products must be packaged one-way or non-reusable containers. In fact, a significant quantity of agrochemical products are packaged non-reusable containers because a large percentage of farms are too small to make practical use of reusable containers. These containers must also be properly cleaned prior to disposal in designated areas.

As may be appreciated from the foregoing examples pertaining to the agrochemical industry, vast quantities of retired and one-way containers are subject to disposal regulations. In the US, for example, the Environmental Protection Agency (EPA) has imposed and enforces regulations requiring that agrochemical containers be rinsed by prescribed rinsing methods, such as the "pressure rinsing" and "triple rinsing", prior to their disposal. Pressure rinsing generally involves use of a special nozzle attached to the end of a hose while, triple rinsing simply refers to rinsing the pesticide container three times. Both of these rinsing methods have been

shown to remove more than 99% of pesticide residue remaining in the container after it has been emptied.

Despite the advancements made thus far in packaging solutions and efforts to employ reusable containers, there is still a need for improved packaging design features and materials that alleviate the environmental impact of agrochemical products and other hazardous materials. In particular, there is a need for containers that can be more efficiently and effectively rinsed to better protect soil and water contamination and help users better comply with applicable disposal regulations. There is also a need to develop containers that use less disposal space in designated sites. The present invention is directed to meeting these needs.

SUMMARY OF THE INVENTION

According to the present invention, then, there is provided a receptacle having an interior that is sized and adapted to receive and hold a selected substance. The receptacle comprises a container body surrounding the interior and having a mouth in communication therewith. The container body includes an inner layer formed of a first material that is soluble in the presence of a selected solvent and having a first thickness. The container also includes an outer layer supported by said inner layer and formed of a second material that is insoluble in the selected solvent of a selected second thickness. The first thickness of said inner layer may be greater than the second thickness of said outer layer.

The inner layer is preferably substantially continuous and surrounds a majority of the container interior and may be formed of a material that is either hot water soluble or cold water soluble and that is also impervious to hazardous substances. For example, the inner layer maybe formed of polyvinyl alcohol. The outer layer, on the other hand, may be formed of polypropylene, polyvinylchloride, high density polyethylene, low density polyethylene, or polyethylene terephthalate.

The container may further be provided with a middle layer or tie layer interposed between the inner layer and the outer layer. The middle layer may be formed of a material selected from the group consisting of polyvinyl acetate, ethylene polyvinyl acetate, polyamide, and ethylene vinyl alcohol.

Also contemplated herein is a method of removing chemical residue from the interior of a container wherein the container interior is surrounded by an inner

sidewall layer formed of a water soluble material, said method comprising contacting the container interior with a sufficient quantity of water to dissolve said inner sidewall layer.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a representative receptacle having a sidewall according to the present invention;

Fig. 2 is a perspective view, partially broken away, of the receptacle in Fig. 1, showing the inner and outer sidewall layers;

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Fig 3 is a cross-section of the receptacle shown in Fig. 2 taken about lines 3-3 of Fig. 2;

Fig. 4 is a perspective view, partially broken away, of an alternate embodiment of the according to the present invention; and

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Fig. 5 is a cross-section of the receptacle shown in Fig. 4, taken about lines 5-5 of Fig. 4.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

The present invention generally relates to a receptacle or container adapted for the storage and transportation of selected materials or items, including liquid, gel, or solid substances. These selected items or materials can be either hazardous or non-hazardous substances. As will be appreciated from the description below, the container has particular utility for the storage and transportation of liquid hazardous substances such as agrochemicals. As used herein, a hazardous substance (or dangerous goods) generally refers to a substance that is potentially toxic or detrimental to human health or the environment. Such hazardous materials can be in the form of solids, liquids, or gels and include agrochemicals, poisons, radioactive materials, explosives, flammable or nonflammable gases, to name a few. Also as used herein, the term "agrochemicals" generally refers to pesticides, such as herbicides, insecticides, fungicides and other types of agricultural chemicals that are often potentially harmful materials and are commonly made in concentrated form as a solid, a liquid, a dispersion or a gel, for example.

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One aspect of the container is the multilayer construction of the container body, which is adapted to both safely contain hazardous substances and facilitate the removal of residue from the container interior prior to its disposal. The multilayer

construction is versatile and may be incorporated into a variety of containers of selected configurations including both reusable and one-way containers.

For the sake of simplicity, the container disclosed herein and shown in the accompanying figures is in the configuration of a conventional jug and described in the context of liquid agrochemical products. However, it should be appreciated that the utility of the container is not limited to this configuration nor is it limited to the transportation and storage of the liquid agrochemical products. Other container configurations are also contemplated, such as trays, blister packages, tubes, bulk or mini-bulk tanks, or any suitable container for transportation and storage for the product selected.

With reference first to Figs. 1 and 2, a first representative receptacle is shown in the form of container 10 having the configuration of a conventional 2.5 gallon jug typically used as a one-way container to transport and store a variety of liquid agrochemical products. Container 10 includes container body 20 surrounding container interior 18, which is sized and adapted to receive and hold a selected substance, such as a liquid agrochemical product. Container 10 also includes a bottle finish or mouth (not shown), which communicates with interior 18 that is sealable in a conventional manner with removable cap 14, as is known in the art. Container 10 may further be provided with handle 12 that is adapted to be grasped by a user's hand.

With continued reference to Fig. 2 and reference now to Fig. 3, container body 20 has a multilayer construction including an inner sidewall or inner layer 22 and an outer sidewall or outer layer 24. As shown, inner layer 22 may be a continuous layer that is coextensive with outer layer 24, but the container body is not limited to this construction. For example, the inner layer need not be fully coextensive with the outer layer. However, since the inner layer is in direct contact with the agrochemical product once it is received in the container, it is preferably at least substantially continuous and surrounds at least a majority of the container interior.

Inner layer 22 may be formed of a material that dissolves or deteriorates when in contact with a suitable solvent such as water, or when in contact with a cleaning solution comprising surfactants, soap, or combinations thereof. Preferably, the solvent used to dissolve or deteriorate inner layer 22 is either hot water or cold water. An inner layer material that is hot water soluble material generally dissolves or otherwise disintegrates in water having a temperature above about 50°C. On the

other hand, a selected inner layer material that is cold water soluble dissolves or otherwise disintegrates in water having a temperature below about 50°C and preferably at a temperature between about 5°C and 35°C.

Representative materials which may be used to form the inner layer include
5 polyvinyl alcohol; polyethylene oxide; polyoxyethylene; cellulose derivatives; sodium polyacrylate; polylactic acid; lactic acid esters and ethers of polyvinyl alcohol; lactic esters and ethers of cellulose; carrageenan; pectin; combinations of the above; and combinations of the above with starches. The cellulose derivative group could consist of: methyl cellulose; methylhydroxyethyl cellulose; methylhydroxypropyl
10 cellulose; hydroxypropyl cellulose; cellulose; cellulose monoacetate and hydrophobically modified cellulose derivatives. The outer layer, on the other hand, is formed of a material that does not dissolve or disintegrate when in contact with the solvent selected to dissolve the inner layer and is preferably not water soluble. Representative materials which may be used to form the outer layer include
15 polypropylene, polyvinylchloride, high density polyethylene, low density polyethylene, and polyethylene terephthalate.

Inner layer 22 and outer layer 24 each should have a thickness suitable to provide the container with the necessary structural integrity to hold the container's selected configuration during normal rigors of the transportation. Further, outer layer
20 24 should be of suitable thickness to shield the inner layer from exposure to the environment as well as water or other solvents that would cause it to deteriorate. Inner layer 22 may have a thickness between about .01 mm and 4.0 mm, while outer layer 24 may have a thickness between about 1.0 mm and 4.0 mm.

The ratio of thickness of the inner layer to the outer layer may vary as desired.
25 For example, as shown in Figs. 3 and 4, inner layer 22 is thicker than outer layer 24. More particularly, inner layer 22 has a selected first thickness "d₁" sufficient to be freestanding and hold the container's selected configuration during normal rigors of the transportation and storage of the product it contains. Outer layer 24 is bonded to and supported by inner layer 22 and has a selected second thickness "d₂" that is
30 less than that of "d₁". Outer layer 24 provides additional rigidity to the overall container, while protecting inner layer 22 during shipment and storage of the agrochemical product. In this configuration, outer layer 24 is frangible or otherwise lacks sufficient structural integrity to retain the selected configuration of the container and deforms under pressure without the support of the inner layer. Generally, then,

outer layer forms a continuous protective shell about inner layer 22. Additionally, outer layer 24 provides a substrate on which product labels may be adhered or otherwise provided to identify the product and any required legal information.

Now that the construction of container 10 has been described in some detail, it may now be appreciated how the multilayer construction facilitates the removal of residue that collects or otherwise builds up during the course of contact with the product. Once it is determined that container 10 is to be disposed and the product is used or otherwise removed from the container interior, the container must be properly rinsed prior to disposal, particularly if the container is used for a hazardous substance. Since the inner layer is water soluble, it will begin to deteriorate or dissolve when in contact with water. Accordingly, if one chooses to employ, for example, the EPA triple rinsing procedure described in the Background, at least some of the inner layer will dissolve while performing triple rinsing steps. As the inner layer continues to dissolve or disintegrate, the layer, along with the residue adhered thereto will be flushed through the mouth or finish of the container. It is anticipated that the removal of the inner layer will achieve the effective removal of the residue thereon, and preferably at least 99.9999% of the chemical residue in the container interior.

After a sufficient amount or the entire inner layer has been removed, the outer layer or shell of the container will remain and ultimately be disposed of in the landfill. Since the outer layer is frangible and no longer supported by the inner layer, it will easily deform or collapse under an insignificant amount of pressure, thereby reducing its size so as to take up less space in the disposal site than its original configuration prior to removal of the inner layer.

By way of example, container 10 described above may be used for the storage and transportation of a herbicide containing mesotrione, which is the active ingredient for example, in a product marketed under the trademark Callisto® registered to Syngenta Crop Protection, Inc. located in Greensboro, North Carolina. A container having an inner layer formed of suitable material that is cold water soluble would preferably be used. This is because mesotrione would not impair or damage in the inner layer while stored therein. Alternatively, an inner layer formed of a hot water soluble material would be useful for storing a seed treatment product having thiamethoxam as an active ingredient such as the seed treatment product

marketed under the trademark Cruiser® also registered to Syngenta Crop Protection, Inc.

With reference now to Figs. 4 and 5, a second exemplary embodiment of a container according to the present invention is shown. Similar to container 10 shown above, container 110 has a multilayer container body 120 that surrounds container interior 118. However, as shown here, container body 120 is formed of three layers: inner layer 122, outer layer 124, and tie layer or middle layer 126 located therebetween. Middle layer 126 may be formed of a material suitable to assist in keeping the inner layer and the outer layer together. For example, middle layer 126 may be formed of polyvinyl acetate, ethylene polyvinyl acetate, polyamide, and ethylene vinyl alcohol.

As should be appreciated, the multilayer container body can be formed of a plurality layers, and is not limited to the exemplary embodiments described above with reference to the figures. For example, the container body could be provided with multiple inner or outer layers and tie layers as needed to form a suitable receptacle or container for the selected material. Preferably though, the inner layer or layers are formed of a material that will dissolve or disintegrate in the presence of a suitable solvent to effectively remove residue in the interior of the container. The container contemplated herein may be formed by ordinary processes known in the art such as co-extrusion, blow molding, injection molding, or any suitable process.

From the foregoing, it may also be appreciated that the present invention contemplates a method of removing residue located in the interior of a container that may be accomplished by the steps inherent in the described structure. Generally, the method includes contacting the interior of a container with a selected solvent adapted to dissolve or otherwise disintegrate at least a portion of the inner layer or sidewall that surrounds the container interior. The method includes repeated rinsing of the container interior sufficient to flush a portion of the inner layer of the container body and cause removal of the residue. This method can also cause accomplish the step of removing the interior support of the overall container configuration such that the remaining outer layer of the container body is collapsible under an insignificant amount of pressure.

Accordingly, the present invention has been described with some degree of particularity directed to the exemplary embodiments of the present invention. It should be appreciated, though, that the present invention is defined by the following

claims construed in light of the prior art so that modifications or changes may be made to the exemplary embodiments of the present invention without departing from the inventive concepts contained herein.

What is claimed is:

1. A receptacle having an interior that is sized and adapted to receive and hold a selected substance, comprising a container body surrounding the interior and having a mouth in communication therewith, said container body including:
 - (A) an inner layer formed of a first material that is soluble in the presence of a selected solvent, said inner layer having a first thickness; and
 - (B) an outer layer supported by said inner layer and formed of a second material that is insoluble in said selected solvent and having a second thickness.
2. A receptacle according to claim 1 wherein the first thickness of said inner layer is greater than the second thickness of said outer layer.
3. A receptacle according to claim 1 wherein said inner layer is substantially continuous and surrounds a majority of the container interior.
4. A receptacle according to claim 1 wherein said inner layer is either hot water soluble or cold water soluble.
5. A receptacle according to claim 1 wherein said inner layer is formed of polyvinyl alcohol.
6. A receptacle according to claim 1 wherein said inner layer is impervious to hazardous substances.
7. A receptacle according to claim 1 wherein said outer layer is formed of polypropylene, polyvinylchloride, high density polyethylene, low density polyethylene, or polyethylene terephthalate.
8. A receptacle according to claim 1 wherein said selected substance is a liquid, hazardous material.
9. A receptacle according to claim 1 wherein said container body includes a middle layer interposed between said inner layer and said outer layer.
10. A receptacle according to claim 9 wherein said middle layer is formed of a material selected from the group consisting of polyvinyl acetate, ethylene polyvinyl acetate, polyamide, and ethylene vinyl alcohol.
11. A container for the transportation and storage of a selected hazardous substance and having a container interior adapted to receive the hazardous substance, said container comprising:

(A) an inner sidewall surrounding at least a majority of the container interior and formed of a water soluble material; and

(B) a frangible outer shell layer bonded to said inner sidewall and formed of a water insoluble material.

5 12. A container according to claim 11 wherein said selected hazardous substance is an agrochemical selected from the group consisting of fungicides, insecticides, herbicides, and bactericides.

13. A container according to claim 11 including a middle layer interposed between said inner sidewall and said outer shell.

10 14. A method of removing chemical residue from the interior of a container wherein the container interior is surrounded by an inner sidewall layer formed of a water soluble material, said method comprising contacting the container interior with a sufficient quantity of water to dissolve said inner sidewall layer.