WHITE PAPER

POLYETHYLENE CONTAINERS FOR DANGEROUS GOODS

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Find out what properties are important in the selection of a polyethylene resin for the manufacture of containers for dangerous goods
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A DANGEROUS GOOD IS A MATERIAL, SUBSTANCE OR OTHER ITEM THAT EXHIBITS HAZARDOUS CHARACTERISTICS, WITH THE POTENTIAL TO CAUSE DAMAGE IF NOT CONTROLLED AND MANAGED PROPERLY. SUCH GOODS CAN IMPACT HUMAN HEALTH AND SAFETY, PROPERTY AND THE NATURAL AND BUILT ENVIRONMENT.

In Australia, the management of dangerous goods is governed by edition 7.3 of the Australian Dangerous Goods Code (ADG7.3). The code's main focus is on logistics and defining "consistent technical requirements for the land transport of dangerous goods across Australia".

Manufacturers of plastic containers for chemical storage understand that the objective is to produce a container that will not crack, spilt or deform and lose its contents while containing a potentially aggressive chemical agent. While container design plays a major role in container performance, this paper focuses on the choice of material for the container and how this affects the manufacturing process itself.

Dangerous goods containers are physically much more robust than their non-dangerous goods counterparts as the objective is to produce a container that will not crack, split or deform and lose its contents while containing a potentially aggressive chemical agent. The polyethylene selected for dangerous goods applications must possess good rigidity and creep resistance to perform well under pressure testing and in stack testing, have a sufficiently high molecular weight to provide melt strength and support for good parison formation and provide a sufficiently broad processing window to ensure repeatable high quality pinch-off performance.

WHAT DIFFERENTIATES A DANGEROUS GOODS CONTAINER?

All dangerous goods containers are required to feature a certification that outlines the fitness for a particular purpose. Containers must address different performance requirements according to the nature of the substance they are intended to hold. The certification provides assurance that the container has met these specific requirements.

Dangerous goods containers are physically much more robust than their non-dangerous goods counterparts, ensuring an increased level of security and protection from the stored substance. For non-dangerous applications such as water, the same container can simply be made to a lighter weight (reduced wall thickness).

TESTING DANGEROUS GOODS CONTAINERS

Dangerous goods containers undergo rigorous testing in order to ensure they meet the stringent requirements for certification to contain dangerous goods.

The category or class that the substance falls into determines the testing regime that is applied. Different substances demand different resistance properties, and the contents must be chemically compatible with the grade of polyethylene in which they are stored.

> **THE OBJECTIVE IS TO PRODUCE A CONTAINER THAT WILL NOT CRACK, SPLIT OR DEFORM AND LOSE ITS CONTENTS**

There are three main tests that dangerous goods containers go through in order to assess whether they're fit for purpose:

- **Drop test:** Also known as the impact test, this is conducted at -18 degrees Celsius and from different heights according to the category of the chemical intended to be stored. While very cold, -18 degrees Celsius is well above the glass transition temperature of polyethylene, so polyethylene grades that are specifically designed for toughness can deliver good physical performance in this test. Resin manufacturers achieve good low temperature impact performance by developing resins with a combination of high molecular weight components which enable good impact resistance and low molecular weight components to deliver ease of processing.
- **Pressure test:** This test is performed to assess the container's ability to withstand the prolonged application of pressure.
- **Stack test:** This test involves stacking the filled containers and then storing at 40°C. The stack must maintain its integrity over a four week period.

THE IMPORTANCE OF PINCH-OFF

Most polyethylene containers for the storage of dangerous goods are manufactured by blow moulding, a process that begins by extruding a molten tube of the resin known as a parison.

The design of a polyethylene grade for dangerous goods applications happens at the molecular level. The presence of high molecular weight components ensures sufficient melt strength to allow the parison to form and hang with the required characteristics during manufacture.

Once formed, the parison is surrounded by the mould, pinched to form a seal at the bottom and then blown into shape. The line where the sides of the molten tube are pinched together forms a welded seam which appears across the base of the container. The quality of this weld is crucial to container integrity. A common cause of failure is a relative thinning of the material at the pinch-off line in comparison to the wall of the container. This thinning can compromise the integrity of the container, causing the container to split when dropped or under impact.

A polyethylene resin specifically designed for dangerous goods applications will also provide a wide processing window, enabling repeatable and high integrity pinch-off formation under a range of machine operating conditions.

It is also worth stating that a mould design that promotes uniformity in wall thickness distribution will greatly assist in eliminating potential weak points in the container.

CRACK RESISTANCE

The material chosen for the manufacture of the container must be highly resistant to cracking. In the case of polyethylene, certain chemicals can accelerate the formation of cracks by physical means, a process known as environmental stress cracking. A chemical that causes an acceleration of the cracking through direct physical attack is called an environmental stress cracking agent.

For a polyethylene to perform well in the storage of chemicals, it must have inherently good Environmental Stress Crack Resistance (ESCR). This property is governed by the number and size of molecules making up the polyethylene. There must be a sufficient number of large molecules present to tie the structure of the polyethylene together in order to provide resistance to cracking under an applied stress.

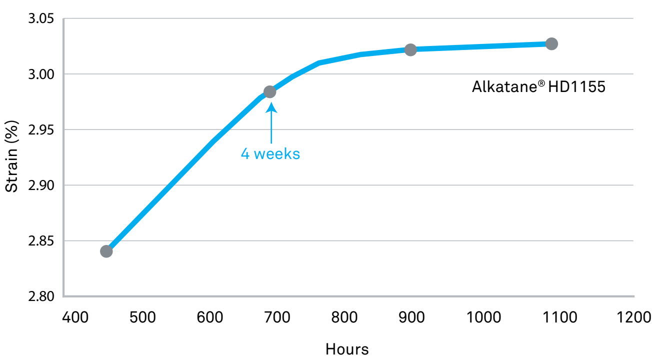
CREEP RESISTANCE

In order to perform well in pressure testing and stack testing a polyethylene must possess good rigidity and creep resistance, properties which are built in to the polyethylene resin during the molecular design process. Creep resistance is the material's resistance to stretching or flexing over time.

When containers are filled and stacked they will initially flex and then continue to flex slowly (creep) over time. The initial flex of a given design will be determined by the rigidity of the material. For polyethylene, this is governed by the density of the material. The materials used for free standing blow moulded containers typically have a relatively high density in order to reduce this initial flexing. Resistance to continued flexing is achieved by the combination of high density and inclusion of molecules of sufficiently high molecular weight. High performance in creep resistance tests is particularly important with large mouldings.

In order to determine the behaviour of a polyethylene grade in a pressure or stacking situation (both apply stress to the material) Qenos generates data by pressurizing pipe produced from the same material and measuring the strain (how much it expands) over time.

Strain vs. Time at 6MPa, 40°C



The graph above illustrates how Qenos Alkatane HD1155 behaves at 40 degrees Celsius under a high stress loading of 6 MPa. Of significance is the reduction in the rate of creep (increase in strain) beyond the 4 week period prescribed in the stack test. This data offers further confidence of the fitness for purpose of this material in applications such as the long term storage of stacked product at elevated temperatures.

HOW THE RESIN SUPPLIER CAN HELP

Qenos is committed to helping its customers mould high quality containers for dangerous goods applications and offers advice on best practices and on-site support. Qenos has amassed years of experience in producing polyethylene for dangerous goods applications and brings a strong advisory presence to the industry.

Qenos supplies a range of polyethylene resins specifically designed for dangerous goods applications, from small jerry cans (1 - 5 litres) to drums with integrated handles (10 - 25 litres) and IBCs (1,000 litres).

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