

WHITE PAPER

POLYETHYLENE FOR DIESEL FUEL STORAGE

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Understand the
guidelines and
considerations when
using polyethylene for
diesel fuel storage
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THE SUITABILITY OF POLYETHYLENE FOR DIESEL FUEL STORAGE HAS BECOME MORE WIDESPREAD IN RECENT YEARS. WHAT ARE THE GUIDELINES AND CONSIDERATIONS WHEN USING POLYETHYLENE FOR DIESEL FUEL STORAGE.

Choosing the appropriate grade of polyethylene is the first step. But there are a number of design factors specific to the storage of diesel that need to be incorporated to ensure compliance with Australian Standards.

Polyethylene has been successfully used for the manufacture of water storage tanks since the mid 1990's. It has overtaken traditional materials such as concrete and steel due to the many benefits it offers. It's light, strong, long-lasting and cost effective. These are many of the same attributes ideal for the storage of diesel. Qenos' flagship rotomoulding grade LL711UV is suitable for the storage of diesel. This paper describes the guidelines and considerations when using polyethylene for diesel fuel storage.

WHAT TESTING NEEDS TO BE CONDUCTED?

Hydrocarbon fuels such as diesel are known to permeate into and pass through polyethylene over time. As diesel fuel permeates into polyethylene the material becomes softer and more flexible. The changes in properties and permeation rate need to be taken into account when considering the use of polyethylene for diesel fuel storage vessels.

To gain an understanding of how Alkatuff LL711UV reacts to contact with diesel fuel several tests were conducted at the Qenos Technical Centre located in Melbourne. The testing consisted of chemical compatibility, conducted according to ASTM D543, resistance to environmental stress cracking (ESCR) according to ASTM D1693A and storage testing.

Chemical compatibility was tested by immersing samples of Alkatuff LL711UV in diesel fuel for a period of 4 weeks. The samples were then assessed for changes in tensile properties, weight and dimensions.



Samples exposed and tested in accordance with ASTM D543 at 23°C



STORAGE TESTING WAS CONDUCTED BY SEALING 120G OF DIESEL FUEL IN 4MM THICK ROTATIONALLY MOULDED PIPE SAMPLES FOR A PERIOD OF 8 MONTHS AT 23°C.

The results of the testing were as follows.

Property	Change (%)
Yield Tensile Strength	-9
Ultimate Tensile Strength	-1
Elongation	+1
Weight of disc	+3
Diameter of disc	+1
Thickness of disc	+1

The increase in weight and dimensions indicate that the material has absorbed some diesel fuel. This absorption has resulted in a softening of the material as indicated by the decrease in yield tensile strength.

Resistance to environmental stress cracking was assessed by immersing samples of Alkatuff LL711UV in diesel fuel at 23°C and placing them under stress in a calibrated test unit. There were no failures after 1300 hours of exposure, indicating the material has good resistance to cracking in a diesel environment at ambient temperature.

Storage testing was conducted by sealing 120g of diesel fuel in 4mm thick rotationally moulded pipe samples for a period of 8 months at 23°C. Over that time period there was a weight loss of 0.002%. This indicated that Alkatuff LL711UV provided a good barrier to migration of diesel fuel at 23°C.

Having performed well in the internal assessment the next step was to have Alkatuff LL711UV assessed by an independent authority for the suitability of storage of diesel fuel. Genos chose to have the material put through the rigor of assessment to the European Union regulation for Automotive fuel tanks by the TÜV Rheinland Group in Berlin.

Fifteen litre tanks were moulded and supplied to the TÜV Rheinland Group to be tested for mechanical properties and chemical resistance to diesel fuel in accordance with the requirements of international UN regulation No.34,Annex 5 (ECE-R34).

The testing conducted in Berlin consisted of the following.

- Cold temperature Impact Testing -40°C
- Tensile testing of material after exposure to diesel fuel
- Permeation testing at 40°C
- Pressure testing at 53°C

Results from the rigorous testing program were outstanding such that TÜV Rheinland Kraftfahrt GmbH has certified Alkatuff LL711UV for use in the production of rotationally moulded fuel tanks. The certification applies to petroleum based diesel fuel containing up to 5% biodiesel.



Rotational moulded pipe containing diesel fuel for storage testing



Alkatuff LL711UV undergoing low temperature impact testing

WHAT ARE THE GUIDELINES FOR DIESEL STORAGE TANKS?

Finding a material that is suitable for storing diesel is just the first step. Passing the ECE-R34 testing is the most rigorous indicator we have to confirm the chemical compatibility of LL711UV with diesel. But it doesn't mean that diesel storage tanks made from LL711UV are "certified". For that there are two key Australian Standards that apply:

"AS1940:2017 The Storage and Handling of Flammable and Combustible Liquids"

and

"AS/NZS 4766:2006 Polyethylene storage tanks for water and chemicals" (currently under review).

Australian Standards are not mandated by regulation but they support good industry practice by providing reputable technical guidance. In the case of a combustible liquid such as diesel the Standards play a key role in ensuring safety risks are managed.

For many consumers and businesses, ensuring adherence to Australian Standards for their diesel storage is a key factor in their purchasing decision.

AS1940:2017 THE STORAGE AND HANDLING OF FLAMMABLE AND COMBUSTIBLE LIQUIDS

One of the key changes in the 2017 review of AS1940 was that the use of plastic polyethylene or other composite polymeric tanks for the minor storage of combustible liquids is now permitted.

There are certain conditions that apply:

- Volume must be less than 10,000 litres
- Static discharge and venting provisions are required
- Storage must be outside with 15m distance clearance
- Bund must be of non-combustible material (the definition for the non-combustible bund material rules out self-bunded polyethylene tanks).

AS1940 covers all facets of design, manufacture and installation so it isn't possible to manufacture a tank and claim certification. However it is possible for a tank manufacturer to claim **compliance** with AS1940 and this will be a necessary prerequisite if the tank in service is to achieve certification.

AS1940, in particular the 2017 review, is important because it "opens the door" for polyethylene to be used for diesel storage.

Within AS1940 the section on design and material refers to AS/NZS 4766 and this is where the material requirements are specified in detail.

AS/NZS 4766:2006 POLYETHYLENE STORAGE TANKS FOR WATER AND CHEMICALS

AS/NZS 4766 specifies the requirements for the design and manufacture of non-buried polyethylene storage tanks that are rotationally moulded in one-piece seamless construction.

Several of the requirements in AS/NZS 4766 are common across water and chemical storage eg.

- Material properties such as stress cracking resistance and UV resistance
- Design elements such as the requirement to have the tank design analysed and verified by a qualified professional engineer using finite element analysis (FEA)

- Evaluation of the rotational moulding process via Impact Testing

In AS/NZS 4766 there is one clause specific to the storage of chemicals and hence diesel (clause 5.10 "chemical resistance") which states:

The suitability of a polyethylene base resin used in compounds that are intended for use in chemical storage tanks shall be based on relevant chemical resistance data from base resin manufacturers. The suitability of the data shall be agreed between the base resin supplier and other parties, as required. Such agreement shall be based on relevant documented field experience, published chemical reference texts or laboratory analysis.

Meeting the requirements of this clause is not straight-forward.

However, AS/NZS 4766 is currently undergoing review and one of the key focus areas of the review is to ensure polyethylene is a material of choice for diesel storage.

DIESEL STORAGE CONSIDERATIONS IN THE 2018 REVIEW OF AS/NZS 4766

Storage of diesel (or any other chemical) in a polyethylene tank is different to storage of water. As mentioned previously, the polyethylene walls of the tank are softened by contact with the diesel. This needs to be accounted for by choice of polyethylene grade, design and wall thickness.

Engineering experts and the Association of Rotomoulding Australasia (ARMA) are working on a simple method to take into account the effect that diesel has upon PE. The approach is to use a safety factor based upon a standard test that measures the change in tensile yield strength after 1000 hours immersion in diesel fuel. One such test that can be performed locally is conducted according to the British Standard EN858-1:2002 "Separator Systems for Light Liquids". It is proposed that this test be introduced into the revised AS/NZS 4766.

HOW CAN THE RESIN SUPPLIER HELP?

The resin supplier can assist with the provision of material data, in particular creep modulus data to enable Finite Element Analysis which is key for the design of any rotationally moulded tank.

Then, specifically for diesel storage, tensile yield stress results after 1000 hours immersion in diesel fuel as per EN858 will enable the design engineer to take into account the softening effect that diesel fuel has on polyethylene in determining the required wall thickness.

Genos has data supporting both of the above available for LL711UV.

REFERENCES

1. "Testing Creep for Polyethylene Water Tanks" – white paper – Genos website
2. "Finite Element Analysis" – information brochure – Genos website
3. "Genos Roto Grades Creep Data" – information brochure – Genos website
4. "Alkatuff LL711UV Creep Data at 40°C" – information brochure – Genos website

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