



Akulon®

Akulon® Fuel Lock

The simplest and most cost-effective way to meet the EPA and CARB evaporative emission regulations for small engine fuel tanks

Akulon® Fuel Lock is a family of cost-competitive materials that reduce evaporative emissions from small engine fuel tanks by more than 99%. This far exceeds the regulations set out by both the Environmental Protection Agency (EPA) and the California Air Resources Board (CARB). The use of Fuel Lock in small engine tanks can help prevent the release of 250 million tons of hydrocarbons into the earth's atmosphere to bring cleaner air to residents of smog-prone urban centers.

In 2008, the EPA published its final regulations for the remediation of the evaporative emissions of fuel tanks for small engines used in handheld power equipment, riding mowers, walk-behind mowers, generators, non-fixed marine tanks, ATVs, utility vehicles and personal watercraft. Without this new mandate, small engines would account for 33% (1.3 million tons) of volatile organic hydrocarbon compounds, 31% (15.6 million tons) of carbon monoxide emissions, 6% (311,300 tons) of nitrogen emissions, and 12% (44,000 tons) of particulate matter emissions from mobile sources by 2030. The EPA expects that lowering small engine emissions will help to alleviate

the formation of ground-level ozone and smog to create cleaner air and reduce air pollution-related health problems for some 140 million Americans living in and around our major population centers.

According to EPA regulation 40 CFR 1060, the quantity of hydrocarbon permeation allowed to pass through the wall of a small engine fuel tank is limited to 1.5 grams per square meter of internal tank area per day at 28 °C, or 2.5 grams per square meter per day at 40 °C. Any equipment produced after January 1, 2012, must adhere to the new regulations. New tanks must comply with the permeation requirements for five years - a durability requirement that has more than doubled from the previous standard - meaning the barrier performance of the tanks cannot degrade over time.

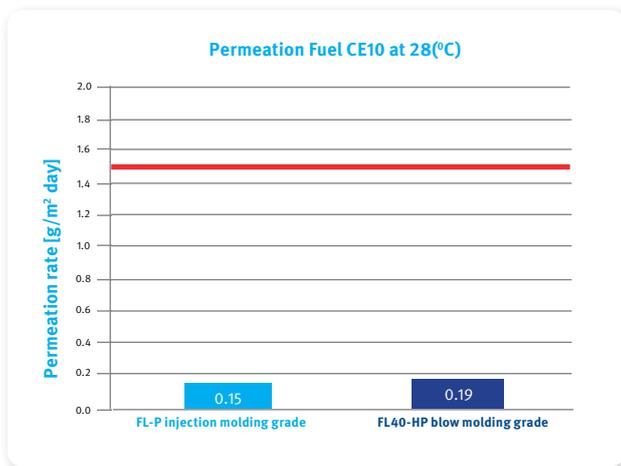
High-density polyethylene (HDPE), the material most commonly used for fuel tanks and containers, emits 25 to 30 grams of hydrocarbons per square meter per day, more than 15 times the allowable limit. This material can no longer be used in its current form. Fluorinated HDPE has been proven to lose its barrier performance during normal use of the equipment, and therefore is a risky choice for replacing normal HDPE due to the reliability and durability of compliance. As a global specialist in materials sciences, DSM developed Akulon Fuel Lock to respond to a real market need for innovative materials that surpass the new EPA regulations.



Akulon Fuel Lock: EPA-compliant polyamide 6

Akulon Fuel Lock is a family of polyamide 6 materials with a permeation rate that's less than 20% of the EPA's permissible limit. The material's enhanced barrier performance is inherent in the material, ensuring that there will be no change in emission rate over the usable life of the tank. Our cost-effective mono-material combines low permeation with excellent processing characteristics for injection and blow molding, and it easily works with the tooling and equipment you currently use with HDPE. DSM manufactures the material in North-America, Europe and Asia, providing you with added peace of mind through guaranteed stock reliability. Akulon Fuel Lock is available in two primary grades:

- **Akulon® Fuel Lock FL-LP** is a low permeation polyamide 6 designed for injection molding and welded tank applications. Available in natural or black.
- **Akulon® Fuel Lock FL40-HP** is a low permeation polyamide 6 designed for blow molding tank applications. Available in natural and black.

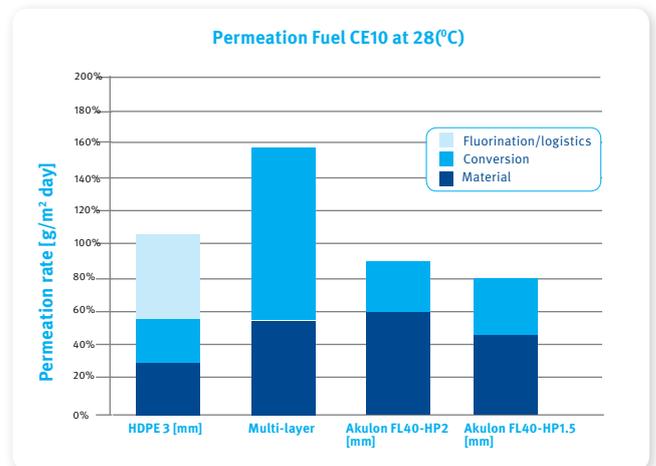


A cost-effective, drop-in solution

Akulon Fuel Lock is equivalent in cost to most other permeation control technologies, and less expensive than post-processing treatments and multi-layer co-extrusion. The material is easily adaptable into your existing HDPE processing set-up. With mold shrink values that overlap those of HDPE, Akulon Fuel Lock compounds have been successfully molded using injection molds, blow molding equipment, and hot plate and vibration welding equipment that were originally used for HDPE, eliminating the time and cost associated with re-tooling your operation. In contrast to fluorination, a process applied to HDPE after molding to improve its barrier capabilities, Fuel Lock requires no press-side additives or additional post-processing. It's ready to use out of the box, creating compliant fuel tanks in one process without the cost and logistical planning needed to ship tanks to a separate location for additional treatments. As a batch process, fluorination suffers from a lack of reliability and from the need for ongoing quality testing. The permeation control of fluorination has also been demonstrated to deteriorate over time as the coating wears off due to the sloshing of fuel in the tank or through the continuous rubbing of the tank during normal use. This progressive loss of evaporative remediation raises questions about the long term durability required by the EPA.

Save on material and process costs

The process of making fuel tanks from the Akulon Fuel Lock mono-material can be certified once, ensuring the quality and low permeation rates across all tanks produced from the material since the barrier performance is inherent rather than batch dependent. With a permeation rate that is less than 20% of the EPA limit, Akulon Fuel Lock has been intelligently designed to eliminate concerns about non-compliance, EPA fines and the risk of costly equipment recalls. It provides the potential to revise your fuel tank designs with significantly thinner walls to use less material and reduce weight, while significant cycle time reductions can be achieved due to the inherently faster recrystallization rate from the melt, compared to HDPE. The use of regrind Fuel Lock, from blow molding "lay-flat" and other scrap, may be used at very high levels without affecting processability, permeation characteristics or mechanical properties.

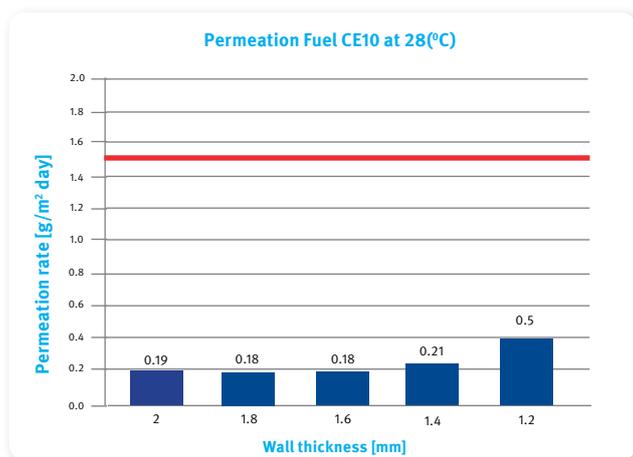


The most reliable and robust EPA-compliant solution

Akulon Fuel Lock is an extremely robust solution that works reliably under the often extreme conditions of use for outdoor power equipment. It possesses excellent purpose-fit mechanical properties, including high strength, stiffness and impact resistance. Fuel Lock has been specially formulated to provide excellent low temperature toughness at temperatures down to -40%. Fuel Lock has a higher melt point than HDPE, enabling its use in closer proximity to engine heat. Add to that a 200 percent increase in tensile strength and a flexural modulus that is 60% higher than HDPE, and it proves to be a robust solution that's ready to drop into your existing fuel tank manufacturing process.

Fuel Lock and Biofuels

Fuel Lock has been formulated to be exceptionally resistant to chemical attack and extraction by all currently used fuels and biofuels. Extensive laboratory validation by DSM shows that the use of ethanol as a bio-extender in gasoline at levels up to 20 wt. % does not affect permeation rates, impact strength or the extraction of oligomers (low molecular weight nylon fractions that have been known to interfere with small engine operation).



Simple, seamless and surpasses EPA limits

A number of solutions are currently available on the market: fluorinated HDPE, HDPE with nano-clay additives, multi-layer, co-extrusion, and mono-layer polyamide 6 or polyamide 66. While fluorinated HDPE creates an effective barrier against volatile hydrocarbons, durability is a cause for concern since testing has shown that the coating can wear off both the internal and external wall of the fuel tank during normal use. HDPE with nano-layers can also be an effective barrier, however its efficacy is extremely dependent on the process parameters and non-compliant permeation behavior can be a result of improper processing. Multi-layer co-extrusion has proven itself extremely effective in the automotive industry, however its over-design makes it cost intensive for the production volumes in this market due to the high cost of capital equipment needed for production.

DSM Engineering Plastics

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DSM has created a bold new material to meet the small engine market's changing needs. Akulon Fuel Lock is the most advanced, robust and cost-effective mono-material solution for small engine fuel tanks. It is EPA and CARB compliant, surpassing the new regulation by more than 80 percent, and seamlessly drops into your existing HDPE manufacturing process while avoiding the hazardous environmental effects of fluorination.

Partnering for a brighter future

At DSM, we understand that switching materials in your production plant has the potential to a risk-laden process. That's why we try to mitigate the risks as much as possible. We back all of our material sales with extensive research and development, as well as a collaborative partnership where we work with you to solve any technical issues along the way. With manufacturing facilities on three continents and vertical integration in the monomer precursor to polyamides, we offer a security of stock that buys our customers peace of mind, comfortable in the knowledge that supply will never be an issue with DSM.