Biofuels: A Challenge To Elastomer Seals

Biofuels - bioethanol, biobutanol and biodiesel - are becoming a significant reality in the fuels landscape in the USA and North America, as well as Europe, South America and the Asia-Pacific regions.

Driving Biofuel Growth

Biofuel growth worldwide is being driven by the need to reduce dependency on foreign oil by expanding and diversifying the domestic fuel supply, coupled with growing concerns about the effects of greenhouse gases (CO_2) and the need to provide environmentally friendly oxygenates for gasoline to reduce ground level pollution. Prior to 2006, methyl tertiary butyl ether (MTBE) was used as an oxygenate in gasoline, but its use was discontinued, driven by US state bans due to water contamination concerns.

The need to reduce foreign oil dependency is also driven by global competition for natural resources and fluctuating prices for oil, gasoline and diesel. Biofuels, with their green, environmentally-friendly profile, offer compelling opportunities to fulfill such objectives.

Ethanol Fuel Facilities

US ethanol production from 139 biorefineries reached over 24 billion liters in 2007 (48% of the global production). A further 62 refineries are under construction (Source: Renewable Fuels Association[1]). Brazil is the second largest ethanol producing 21 billion liters. The EU is counting for only 3% in the worldwide production with 1.71 billion liters in 2007. Source: European Union of Ethanol Producers)

Globally, the International Energy Agency (IEA[2]) predicts that ethanol alone could potentially represent 10% of world gasoline by 2025.

Biodiesel Fuel Facilities

Current US biodiesel capacity across 171 production plants is 12.5 billion liters, although only 2.4 billion liters are expected to be produced in 2008 because of record feedstock prices (Source: National Biodiesel Board (NBB[3]) and BioFuels Business[4]).

The EU is the largest biodiesel-producing region in the world, accounting for 68% of methyl esters in 2007, with installed plant capacity increasing by 55% in 2007[4].

Effect Of Biofuels On Elastomers

This scenario points to significant growth in biofuel use. However, some biofuels can be aggressive to the elastomers used in the refining, delivery and dispensing of the biofuels, as well as, seals and hoses used in automotive.

Fluorohydrocarbon elastomers (FKM), notably DPE Viton® fluoroelastomer, have been successfully used in seals and hoses for over 45 years and is a preferred elastomer for today's fuel systems.

However, biofuels present their own set of material compatibility challenges. Relative to other fuel components, biodiesel has unstable chemistry subject to degradation and contamination in the distribution chain[5]. The aggressive, contaminated fuel attacks hydrocarbon rubbers such as nitrile rubber, widely used in fuel handling hose, gaskets and seals[6].

Ethanol-containing fuels pose the challenge of permeation, particularly to nitrile rubbers. Excessive permeation increases volatile emissions and loses valuable fuel.

Resistance Of Viton® To Biofuels

From its introduction in 1957, Viton® fluoroelastomer from DPE has a long-proven resistance to a wide range of solvents and fuels. Since the mid 1990s, manufacturers have specified Viton® for seals and gaskets for use in diesel fuel injectors because of its resistance to biodiesel fuels.

Different compounds of Viton® have been extensively tested in many current biofuels (see Figure1):

	Cure System						
	Bisphenol			Peroxide			
Type of Viton® Fluoroelastomer	A	B	F	GBL-S	GF-S	GLT-S	GFLT-S
Fluid							
Hydrocarbon automotive and aviation fuels—no oxygenate or biofuel content	1	1	1	1	1	1	1
Dry, unoxidized biodiesel (B100) and blends with petrodiesel	1	1	1	1	1	1	1
Wet biodiesel* and petrodiesel blends	NR	NR	NR	1**	1**	1**	1**
Aliphatic hydrocarbon process fluids, chemicals	1	1	1	1	1	1	1
Aromatic hydrocarbon process fluids, chemicals	2	2	1	1	1	2	1
Aqueous fluids: water, steam, mineral acids (H_2SO_4, HNO_3, HCl, etc.)	3	2	2	1	1	1	1
Methanol (methyl alcohol)	NR	2	1	2	1	NR	1
Ethanol (ethyl alcohol)	2	1	1	1	1	2	1
Temperature of retraction (TR-10)	–17°C	–13°C	–6°C	–17°C	–6°C	–30°C	–24°C
Static low temperature sealing (19% compression)	–32°C	–28°C	–23°C	–33°C	–19°C	–46°C	–40°C

Figure1: Fluids Resistance and Low Temperature Properties for Types of Viton®

Tests[7,8] show that Viton® has:

1. Excellent compatibility with fresh and contaminated biodiesel, and with ethanol.

2. High resistance to permeation and chemical attack by alcohol, pure ethanol and blends of ethanol with hydrocarbon fuel (see Figures 2,3 and 4).

3. Long-term retention of critical properties in current and emerging biofuels.

4. Outstanding low temperature (-50°C to -65°C) static sealing performance in biofuels, (also at elevated temperatures).

Robust Biofuels Service

The results indicate that special formulations of Viton® are designed to deliver robust biofuels service and are the preferred alternatives for biofuel-handling hose, seals and gaskets.

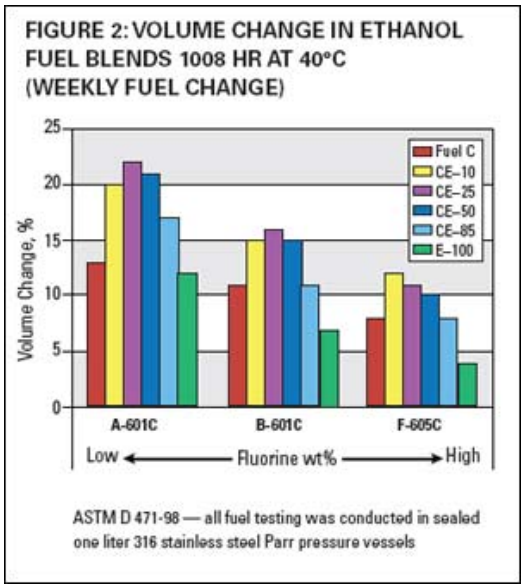
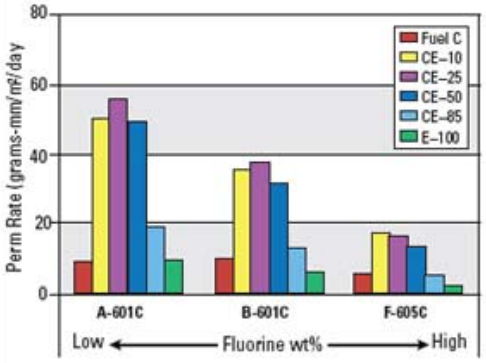
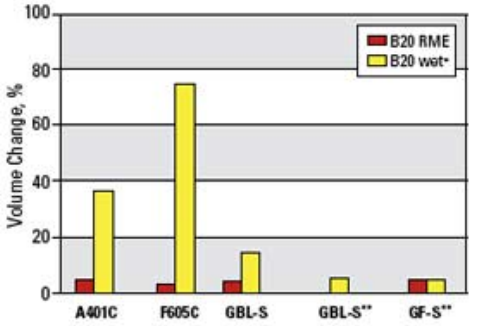


FIGURE 3: PERMEATION OF FUEL C/ ETHANOL FUEL BLENDS AT 40°C



SAE 2665 cup weight loss method

FIGURE 4: VOLUME CHANGE B20 RME AND B20 WET* RME AFTER 1008 HR AT 125°C



* Wet biodiesel containing water and acid simulating wet, oxidized biodiesel.

**Special formulation from DuPont Performance Elastomers

ASTM D 471-98 — fuel testing was conducted in sealed one liter 316 stainless steel Parr pressure vessels