DuPont™ Krytox®
performance lubricants

Radiation Stability of Krytox® and Fluoroguard®

The results of some radiation exposure data obtained on our Krytox® 143AB fluorinated oil and Krytox® 240AB fluorinated grease that contains this oil are summarized in **Tables 1–4**. It is believed that these data are generally representative of the performance of all Krytox® oils and greases.

Samples of oil and grease, in tin-plated screw-cap metal cans, were exposed to a Cobalt-60 source. Rates and total dosages (gamma air equivalent) were varied as indicated, and each data point represents a separate sample.

Radiation of these fluoropolymers can result in depolymerization to volatile or, at least, lower molecular weight fragments. Some of these radiation products would be expected to be acidic. In fact, some evidence for corrosion of the metal containers was observed, but it was very minimal and random.

Following the prescribed total dosage exposure, the samples were removed from the radiation field and reweighed to determine weight losses. These are reported both as a function of total dosage (**Table 1**) and as a function of rate (**Table 2**).

Table 1
Radiation Stability of Krytox® 143AB Fluorinated Oil and Krytox® 240AB Fluorinated Grease
Cobalt-60 Source Weight Change versus Total Dose and Dose Rate

		Weight Change, %	
Total Dose, 106 rad*	Dose Rate, 106 rad/hr*	Krytox® 143AB Fluorinated Oil	Krytox® 240AB Fluorinated Grease
5	0.027	—	0.26
	0.048	0.02	0.31
	0.090	–0.16	0.24
10	0.027	–2.07	0.36
	0.048	–0.50	0.12
	0.090	–0.45	0.10
20	0.027	–2.59	0.27
	0.048	–2.52	–0.14
	0.090	–0.52	–0.08

*Gamma air equivalent

Table 2
Radiation Stability of Krytox® 143AB Fluorinated Oil and Krytox® 240AB Fluorinated Grease
Cobalt-60 Source Weight Change versus Dose Rate and Total Dose

Dose Rate, 106 rad/hr*	Total Dose, 106 rad*	Weight Change, %	
		Krytox® 143AB Fluorinated Oil	Krytox® 240AB Fluorinated Grease
0.027	5	—	0.26
	10	–2.07	0.36
	20	–2.59	0.27
0.048	5	0.02	0.31
	10	–0.50	0.12
	20	–2.52	–0.14
0.090	5	–0.16	0.24
	10	–0.45	0.10
	20	–0.52	–0.08

*Gamma air equivalent

In addition to weight change, the viscosity change of radiated Krytox® 143AB fluorinated oil was measured. These samples were vacuum stripped to remove any "light ends." The percent viscosity change is summarized in **Table 3** for a total dosage of 20 x 10^6 rad.

Table 3
Radiation Stability of Krytox®
Effect on Viscosity of Krytox® 143AB Fluorinated Oil
Cobalt-60 Source Total Dose 20 x 106 rad*

Dose Rate, 106 rad/hr*	Approximate Exposure Time, hr	99°C (210°F) Viscosity Change	
		Total, %	%/hr
0.027	741	–10.3	0.014
0.048	417	–1.6	0.004
0.090	222	–1.1	0.005

*Gamma air equivalent

Grease consistency, as determined by penetration measurements, was obtained on the radiated and original grease samples. While there was some minor softening of the grease, it was not considered to be significant and would not be expected to impede its performance. These data are summarized in **Table 4**.

Table 4
Radiation Stability of Krytox®
Effect on Consistency of Krytox® 240AB Fluorinated Grease Cobalt-60 Source

Total Dose, 106 rad*	Dose Rate, 106 rad/hr*	Consistency, Penetration, 0.1/mm	NLGI Grade**
5	0.027	287	#2
	0.048	290	#2
	0.090	290	#2
10	0.027	294	#2
	0.048	302	#1–2
	0.090	294	#2
20	0.027	294	#2
	0.048	313	#1
	0.090	309	#1–2
	—	—	—
Original Grease		279	#2

*Gamma air equivalent

**Lower NLGI numbers or higher penetrations indicate softer grease. NLGI #2 (265–295 penetration) is standard.

Radiation stability was evaluated in a nuclear reactor at 10^7 and 10^8 rad total dose. Only a minor change occurred at 10^7 rad, while a significant change in viscosity and acidity was observed at 10^8 rad.

The oil was subjected to a mixed dose of gamma as well as thermal and fast neutrons. The exposure in both tests was at the core face of the reactor. A dose of 10^7 or 10^8 rad of reactor radiation is probably considerably more severe than the same dose of pure gamma radiation.

All Krytox® PFPE fluorinated oils and Fluoroguard® polymer additives are chemically identical. They differ in average molecular weight and molecular weight distribution. The property changes shown for Krytox® 143AC, 143AB, and 240AB are believed representative of all Krytox® fluorinated oils and greases. This would include the 143 series oils, 240 series greases, GPL 10X series oils, the GPL 20X series greases, Fluoroguard® polymer additive oils—PCA, SG, and PRO, LVP grease, XHT series greases, Krytox® 1500 and 1600 series PFPE vacuum pump fluids, Krytox® FG H-1 rated food oils and greases, K fluids and other PFPE products.

Table 5
Krytox® 143AC Typical Properties

	After 107 Rad	After 108 Rad
Gaseous Product, Ratio of Vol. Gas/Vol. Liquid	1	6
Viscosity Loss, %	8	47
Neutralization No., mg KOH/g	2.9	11.6

The Krytox® 240AB grease consists of a 76 cSt PFPE oil with PTFE thickener. The 143AB oil is 76 cSt and the 143AC oil is 240 cSt at 40°C (104°F).

For this test, the reactor operating at full power gave a dose of 10^7 rad in 83 min (at the core face). The thermal neutron flux was 2×10^{12} neutrons/cm^2·sec, the fast neutron flux was 1×10^{12} neutrons/ cm^2·sec, and the gamma dose was 1.6×10^7 R/h.

For more information or technical assistance, call: **(800) 424-7502**

or visit us on the Web: **http://www.krytox.com**

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