

Rethink Technologies Inc.

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Fluoroelastomer-Based TPE Technologies:

- Blended TPEs based on T-530/T-550/ETFE
- FKM/ETFE-based TPVs (ongoing R&D work)

Blended TPEs based on T-530 + ETFE + Fillers

- Initially developed to enhance injection moldability in project for Liquid Metronics
- Lower cost than T-530
- Excellent chemical resistance
- Not transparent
- Radiation crosslinkable
- More expensive than TPVs based on FKM + ETFE...limited market potential
- Millable!

FKM/ETFE Dynamic Vulcanizates (TPVs)

- Modest raw materials cost (~\$12-15/lb)
- Good chemical resistance
- Feasible to customize properties for specific applications at lower cost compared to T-530/T-550 technology
- Preliminary work in internal batch mixers
- Scale-up can be to twin-screw or Rethink proprietary method
- 30-35% ETFE, 65-70% FKM
- Compatibilizers are critical (T-550 works)
- Millable!

Key Issues for TPV Development

- Cure system: need to control cure rate at ~250C (can use Cri-Tech methods)
- Compatibilization critical (block polymers, fillers, process aides)
- Processing equipment options (batch mixers versus twin screw compounding)
- Particle size determined by interfacial tension, shear stress during phase inversion, primarily

US Patent 6,737,479: “Dynamically Cured Fluoroelastomer Blends”

- Cri-Tech patent, by Roger Faulkner
- FKX: atmospheric pressure cure FKM (HAV, microwave, salt bath, IR tunnel)
- First application: O-ring cord
- Methods are applicable to FKM/ETFE TPVs

FKX Technology Base

- Relies on low sensitivity of peroxide-cure FKMs to bisphenol/amine cure systems
- Bisphenol or amine cure is used to dynamically vulcanize FKM in a matrix of peroxide-cure FKM
- Final formulation is peroxide cured
- Adheres well to other peroxide-cured elastomers

FKX Products

- US Patent granted; no foreign patents
- 100% FKM-based
- Atmospheric pressure cure
- Excellent tear strength, fatigue
- Good compression set resistance
- Good fuel & fluids resistance
- Relatively high Mooney viscosity
- Special purpose grades feasible

FKX Products

- Useful properties without post-cure
- Excellent adhesion to VMQ & FVMQ
- Economical compared to peroxide-cured FKM
- High green strength
- Can be formulated for high fatigue resistance or low compression set

FKX-7xx Series Typical Properties (10' @ 177C + 16 hr @ 232 C)

<u>Property</u>	<u>FKX-755</u>	<u>FKX-765</u>	<u>FKX-775</u>
Shore A	55	65	75
Tensile (psi)	1800	2300	2150
Elongation	310%	250%	160%
100% modulus	260	650	1200
Compression set (22 hr @ 200 C)	9%	14%	12%

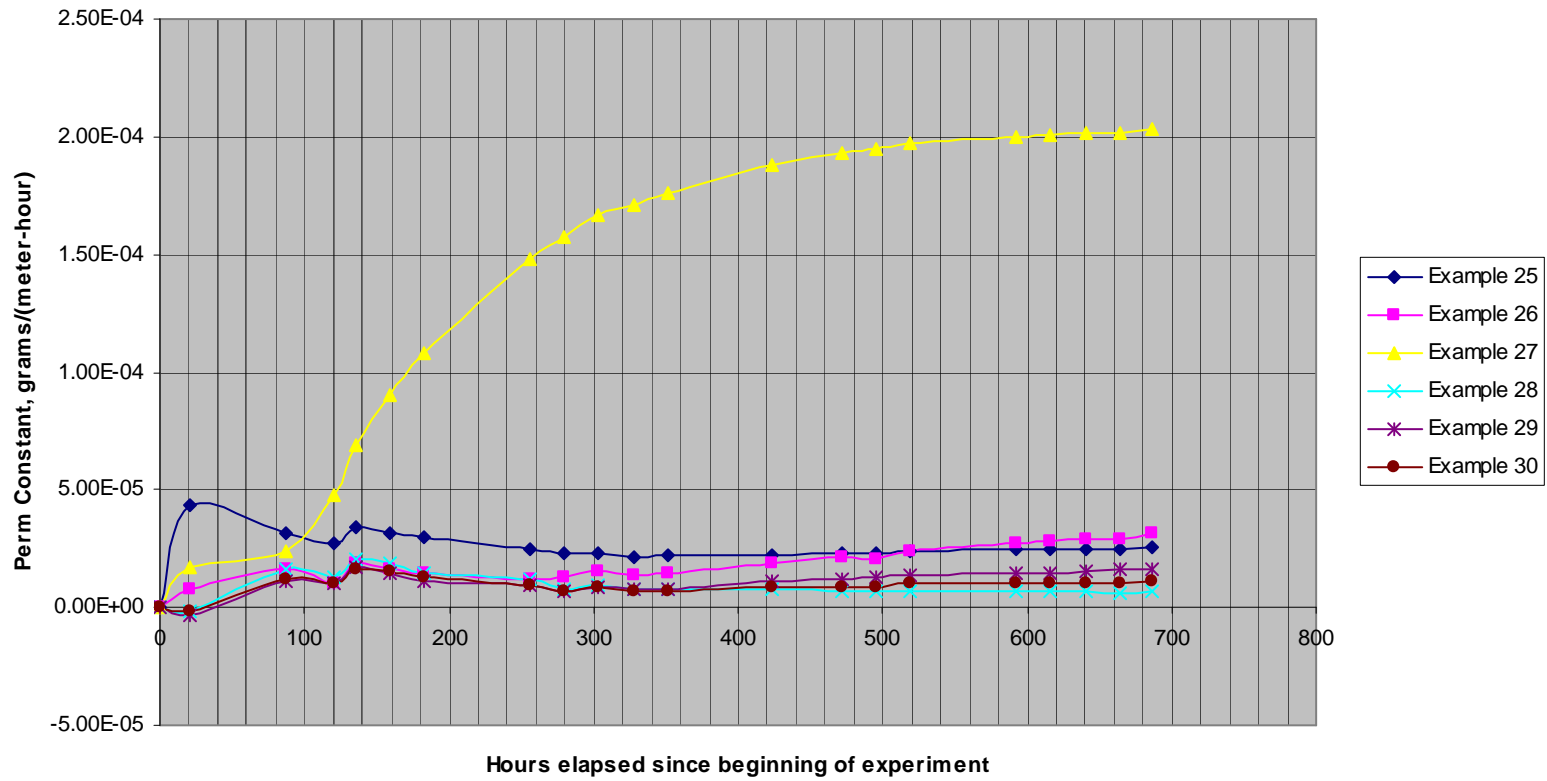
FKP Products

- US Patent 6,538,069: “Polymer blends of PVDF thermoplastics blended with FKM fluoroelastomers;”
- Compatibilized FKM/PVDF blends
- Extremely low permeability
- Dynamically vulcanizable
- Relatively stiff (~90 Shore A)
- Excellent injection molding flow
- Initial offering: FKP-990

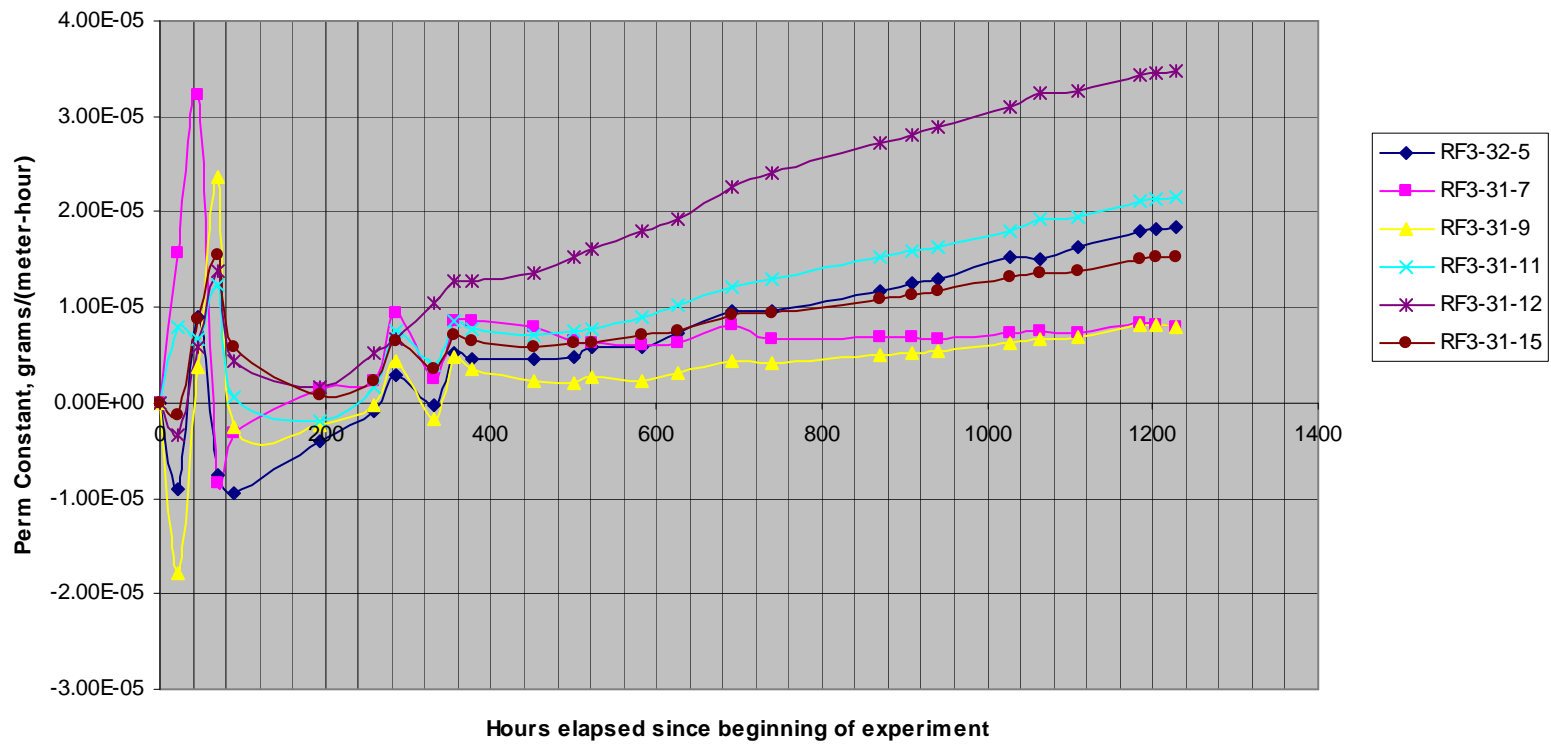
FKP-990 Key Properties

- Excellent permeation resistance
- Electrically conductive (10^6 ohm-cm)
- Tensile strength ~1450 psi
- Tensile elongation ~200%
- Fast cure
- Poor compression set resistance
- Excellent injection moldability

Figure 1: Aggregate Permeation Constant versus Time



Average Permeation Rate, CM15



PVDF/FKM TPVs

- FKP-990 can be dynamically vulcanized
- Resultant TPV has similar conductivity & permeation resistance
- Relatively stiff for an elastomer, but still flexible (not appropriate for peristaltic)
- Recyclable on a rubber mill!
- Extrudable at modest temperature (no special metallurgy required).

New Fluoroplastic/FKM TPVs

- ETFE-based TPVs under development for Daikin America
- Starting with dipolymer FKM
- Higher service temperature than PVDF-based TPVs
- Initially for rotary seals
- Millable at moderate temperature: unexpected recyclability
- Excellent potential for hoses