Oil Seal Compatibility Surveillance Panel
Meeting Minutes
ASTM Meeting #144

2/14/07

D. Bell

Meeting Attendance:

B. Koehler (SWRI)
D. Bell (Afton)
D. Bartlett (Lz)
J. Gropp (Lz)
D. Smith (Parc)
S. Eliot (ExMo)
D. Misich-Korpi (Lz, phone)
Chris Prengaman (Lz)
T. Marougy (Eaton)
C. Koglin (Afton)
B. Grinfield (SWRI, phone)
D. Lind (TMC)
C. Schenkenberger (Lz)
Salvatore Rea (Infineum, phone)
J. D'Harte (American Axle)

Approval of Prior Meeting Minutes

The OSCT Surveillance Panel teleconference minutes of 6/21/06, 7/7/06, 7/17/06, and 9/26/06 were unanimously approved with 7 in favor and 0 abstentions.

Review of New Elastomer Batch Data

The data generated at both labs (Lz & SWRI) by the new protocol was presented by TMC (D. Lind) and reviewed by the OSCT Surveillance Panel on the following new batches of elastomers:

- Polyacrylate PA337 600 slabs ref oils: 160-1 & 161-1
- Fluoroelastomer FL370 152 slabs ref oils: 160-1 & 161-1
- Nitrile NI332 600 slabs ref oils: 161-1 & 168-1

PA337:

Percent elongation using ref oil 160-1 and 161-1 were high outside the Shewhart limit on lab C and was also high, but inside the limits for lab B. The percent volume using ref oil 160-1 was low outside of the Shewhart limit for percent volume for lab B but well within the limit for lab C. All other results in both ref oils were well within the acceptance bands.

Motion by J. Gropp and 2nd by T. Marougy: Both test labs conduct further testing on PA337 on 2 more sets of 12 samples using ref oils 160-1 and 161-1 for all parameters (%volume increase, %elongation, and shore hardness). The two tests should be staggered

to start at each lab within several days but less than one week to expedite the testing. Motion passed unanimously: 7 approved/0 opposed/0 absentions

Once data is complete, TMC will notify OSCT chairman (D. Bell) who will conduct an OSCT Surveillance Panel teleconference to review the data and determine if PA337 can be approved.

OSCT chairman to notify TEI (C. Knight) and have him send more PA337 to both labs for completing the testing above. Also make TEI aware that we may need more polyacrylate slabs made relatively quickly if PA337 is not approved.

FL370:

Motion: Based on the acceptable initial %volume, %elongation and shore hardness, approve FL370 batch. Motion approved unanimously 8 approved/0 opposed/0 abstentions, so FL370 fully approved for testing seal candidates via ASTM D5662.

NI332:

Motion: Based on the acceptable initial %volume, %elongation and shore hardness, approve NI332 batch. Motion approved unanimously 8 approved/0 opposed/0 abstentions, so NI332 fully approved for testing seal candidates via ASTM D5662.

Information and data was presented to show that sulfur-cured Nitrile seals are far more severe than peroxide-cured seals and Federal Mogul commented that 95% of the US and UK OEMs use peroxide-cured Nitrile seals with the remaining being low tier customers that order by catalog. Freudenberg currently supplies sulfur-cured Nitrile seals that are used for ASTM D5662 and 1000 hour immersion seal testing.

Don Bell will issue a memo to relevant OEMs, seal manufacturers, and LRI committee members to determine if the current polyacrylate, Nitrile, and fluoroelastomers that are currently being used for ASTM D5662 and 1000 hr immersion testing are still relevant. If not, work will progress to identify seals that are best for testing.

OSCT (D5662) SP Meeting Agenda Feb. 14, 2007

- Call to Order / Review and Update Membership
- Approval of OSCT SP meeting minutes
- Review of Data to Approve new Elastomer Batches
- New Items
- Adjournment

Approval of Minutes

- Approval of OSCT SP minutes on the TMC website from the following teleconference meetings:
  - 6/21/06
  - 7/7 and 7/18/06
  - 9/26/06

Review of Data Generated On New Elastomer Batches

- The "new" protocol was followed to approve fresh batches of elastomers:

			TMC Ref Oils
Fluoroelastomer	FL370	152 slabs	160 & 161
Nitrile	NI332	600 slabs	161 & 168
Polyacrylate	PA337	600 slabs	160 & 161

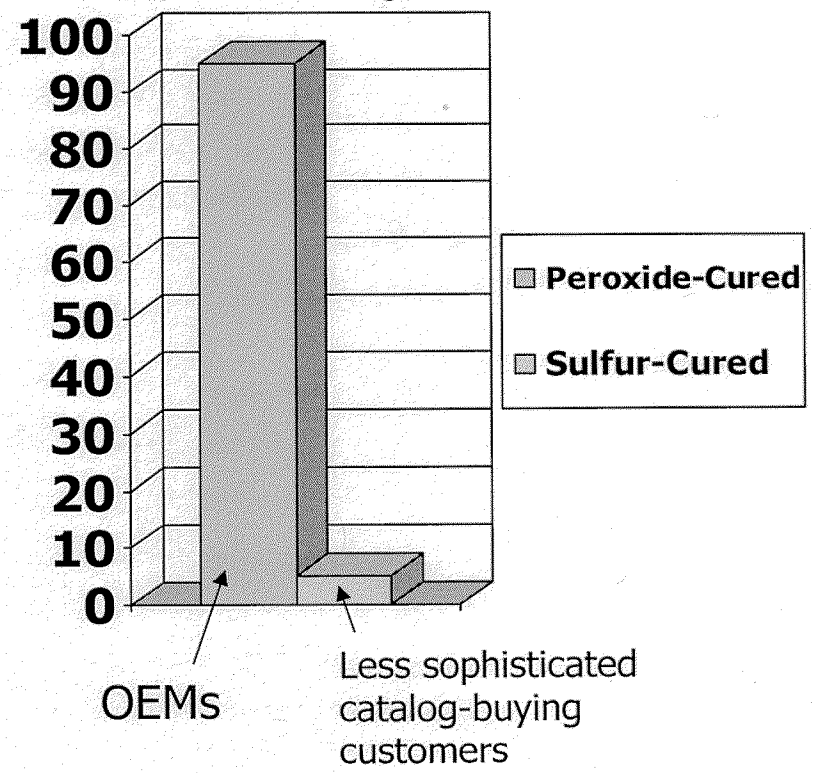
- Vote to approve new elastomer batches or decide how to proceed if not approved

Nitrile Elastomer

- Comments regarding nitrile seals from Federal Mogul and BRUSS:
  - Nitrile seals have limited use in automotive applications where the recommended 100°C maximum limit is easily exceeded
    - Used primarily as wheel end seals
  - Sulfur-cured Nitriles that we test from Freudenberg are out-dated

Approximate Sale of Nitrile Seals In US and Europe

Source: Fed Mogul



Nitrile Elastomer Processing Leads To Sensitivity To Gear Oil

(Source: Federal Mogul)

- Nitrile seals are cured with sulfur donors or peroxides
- Sulfur donors are used for the D5662 nitrile seal (Freudenberg sourced) test and for the 1000 hr immersion test
  - can be fast curing (cheap), easy to process (high ultimate elongation) and can provide good flex life due to flexible polysulfidic crosslinks (-S-S-S-S-)
  - Sulfur-cured nitriles should not be used with sulfur containing lubes due to the remaining -C=C- sites in the polymer and the presence of accelerators in the rubber compound
    - Afton conducted regression analysis of numerous dynamic and immersion seal results of our sulfur-phosphorus gear chemistry and found that sulfur and amines were statistically significant factors for having negative impact on % elongation of sulfur-cured nitrile seals
  - Sulfur-cured elastomers have relatively poor heat resistance and compression set resistance versus peroxide-cured elastomers

Nitrile: Peroxide Cured

(Source: Federal Mogul)

- Versus sulfur-cured nitrile, peroxide-cured provides for:
  - Improved performance in sulfur containing lubes
    - crosslinking by sulfur is slow due to absence of accelerators
  - Improved heat resistance
    - -C-C- bonds instead of -C-S- and -S-S- bonds
  - Improved compression set resistance
    - -C-C- crosslinks do not break and reform like -S-S-
- Peroxide-cured nitriles are predominately used in OEM automotive applications
  - Sulfur-cured nitriles are used only in the least demanding applications

Sulfur vs Peroxide Cured Nitrile Seal Comparison

1000 hr/100°C Immersion Test

Same S/P Additive in Same Base Stock

Nitrile NI329 (Sulfur-Cured)

Hours	% Vol Change	Points Hardness Change	% Tensile Strength Change	% Elongation Change	Reversion	Bend Test	Sediment
100	6.88	-1	-43.6	-55.3	None	Pass	None
200	7.88	-2	-35.5	-61.5	None	Pass	None
300	8.2	2	-24.1	-69.4	None	Pass	None
400	8.23	6	-11.4	-75.5	None	Pass	None
500	8.17	8	-0.5	-80	None	Pass	None
600	8.31	10	7.4	-83.6	None	Pass	None
700	8.4	13	16.5	-86.9	None	Pass	None
800	8.38	13	10.7	-90.4	None	Pass	None
900	8.37	16	11.9	-94.9	None	Pass	None
1000	8.41	17	21.6	-97.2	None	Pass	None
LRI Guidelines	+/-15	+/-10	-25 max	-55 max	Must pass	Must pass	No limit

Gear oil has >500,000 miles with no seal issues using peroxide-cured seals on wheel ends

Nitrile MO737 (Peroxide-Cured)

Hours	% Vol Change	Points Hardness Change	% Tensile Strength Change	% Elongation Change	Reversion	Bend Test	Sediment
100	6.38	-2	-24.9	-28.7	None	Pass	None
200	7.02	1	-25.1	-29.7	None	Pass	None
300	7.4	2	-30	-35.6	None	Pass	None
400	7.84	2	-29.4	-44.7	None	Pass	None
500	7.9	1	-21.8	-38.3	None	Pass	None
600	7.72	2	-23.1	-38.3	None	Pass	None
700	7.88	4	-24.7	-48.2	None	Pass	None
800	8.05	4	-25.4	-57.5	None	Pass	None
900	8.13	5	-25.5	-58	None	Pass	None
1000	8.62	5	-18.7	-38.9	None	Pass	None
LRI Guidelines	+/-15	+/-10	-25 max	-55 max	Must pass	Must pass	No limit

Nitrile Seal Summary

- Sulfur-cured Nitrile seals are not well-suited to typical gear oils due to the sulfur content of the additive, and is seldom chosen as an axle seal material for critical areas
  - Primarily used for wheel end seals – low temperature application
  - OEMs favor peroxide-cured nitriles

Recommendation

- Consider transitioning D5662 and thus 1000 hr Immersion Seal Test from the more severe and outdated sulfur-cured nitrile seals to the less severe and more up-to-date and OEM represented peroxide-cured nitrile seals