



Producers of Specialty Chemicals

Struktol Company of America

201 E. Steels Corners Road • P. O. Box 1649 • Stow, Ohio 44224-0649
www.struktol.com

High Surface Area Silica
in
High Performance Tread
with
Next Generation Struktol Process Additives
(STRUKTOL[®] CY 48 and STRUKTOL[®] KK 49)
and
STRUKTOL[®] SCA 98
(Tetrasulfide)

Struktol Rubber Lab Project 09006 Part 3

Paul Danilowicz
Benny Bezilla

STP0268

Phone: (330) 928-5188
Fax: (330) 928-8726



Technical Services: 1-800-327-8649
E-mail: customerservice@struktol.com

Next Generation Struktol Process Additives

STRUKTOL® KK 49

Blend of fatty acid derivatives

DP 105C

Zn 10%

STRUKTOL® CY 48

Blend of fatty acid derivatives

DP 97C

Zn ~8%

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High Surface Area Silica in High Performance Tread with Next Generation Struktol Process Additives SCA98 (Tetrasulfide)

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Outline

- Formulations
- Mix Spec
- Mix Data
- Physical Property Data
- Conclusions

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Formulations

First Pass	1	2	3	4	5
<u>INGREDIENT</u>	<u>MASS</u>	<u>MASS</u>	<u>MASS</u>	<u>MASS</u>	<u>MASS</u>
DURADENE 751B	103.5	103.5	103.5	103.5	103.5
TAKTENE 220	25	25	25	25	25
N220	10	10	10	10	10
SCA 98 Tetrasulfide	5	5	5	5	5
ZNO	2.5	2.5	2.5	2.5	2.5
ST ACID	2	2	2	2	2
6PPD	2	2	2	2	2
SUNDEX 790	5	5	5	5	5
ZS P200MP	75	75	75	75	75
KK 49	0	4	6	0	0
CY 48	0	0	0	4	6
TOTAL	230	234	236	234	236

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Formulations

Second Pass	1	2	3	4	5
MB 1	230				
MB 2		234			
MB 3			236		
MB 4				234	
MB 5					236
TOTAL	230	234	236	234	236

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Formulations

Final Pass	1	2	3	4	5
MB 1	230				
MB 2		234			
MB 3			236		
MB 4				234	
MB 5					236
DPG	2.2	2.2	2.2	2.2	2.2
CBS	2.2	2.2	2.2	2.2	2.2
SULFUR	1.7	1.7	1.7	1.7	1.7
TOTAL	236.1	240.1	242.1	240.1	242.1

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Mix Spec

First Pass mix spec (65 rpm, fill factor 70%)

0 SECONDS ADD RUBBER
 30 SECONDS ADD 1/3 SILICA
 60 SECONDS ADD 1/3 SILICA
 90 SECONDS ADD SILANE, OIL, CARBON BLACK, ADDITIVES AND REST OF SILICA
 180 SECONDS OR 266F RAM LIFT
 300 SECONDS OR 302F BRUSH AND SWEEP
 420 SECONDS OR 320F DISCHARGE
 ROTOR SPEED 65 RPM AT DISCHARGE 30 PSI

2nd pass mix spec for batch rotor speed started at 110 rpm, at 320F changed rotor speed to 60 rpm fill factor 70%)

0 SECONDS ADD all MB
 320F AUTO RAM LIFT, CHANGE ROTOR SPEED TO 60 RPM
 DISCHARGE 7 MINUTES AFTER ROTOR SPEED

Mix spec final pass for batch (65 % fill factor)

0 SECONDS ADD ALL RUBBER
 15 SECONDS ADD CURES
 60 SECONDS BRUSH AND SWEEP
 150 SECONDS OR 226F DISCHARGE
 ROTOR SPEED 77 RAM PRESSURE 30 PSI

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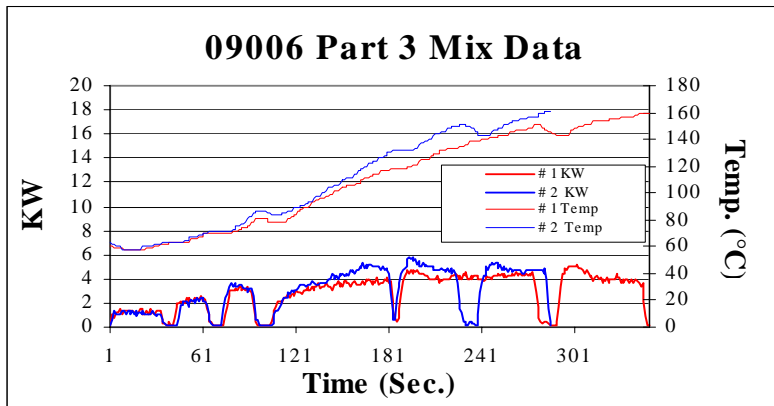
Mixing Observations

Compound	Temp (°C)	Probe Temp(°C)	Energy (WH)	First pass comments
BATCH 1 (Control)	160	170.9	277	Ok
BATCH 2 (KK 49) 4 phr	160	174.1	233	Ok
BATCH 3 (KK 49) 6 phr	160	172.6	232	Ok
BATCH 4 (CY 48) 4 phr	160	174.1	220	Ok
BATCH 5 (CY 48) 6 phr	160	175.4	206	Ok

Significant Reduction in mix energy with Struktol Additives

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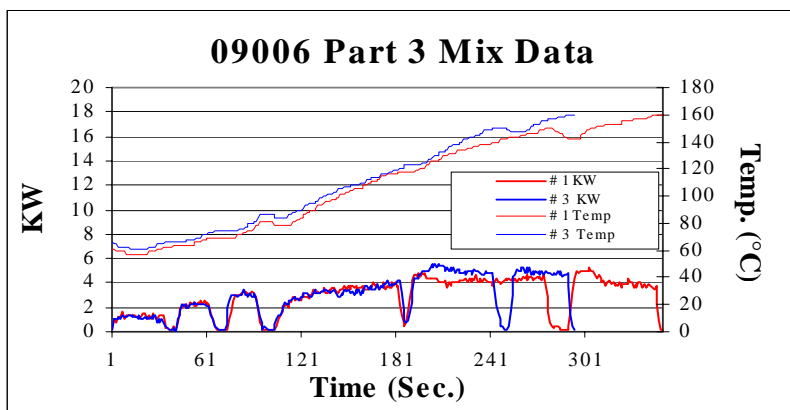
Mixing Observations



Mixing Time Reduced with Struktol Additives
Mixing Peaks Shifted with Struktol Additives

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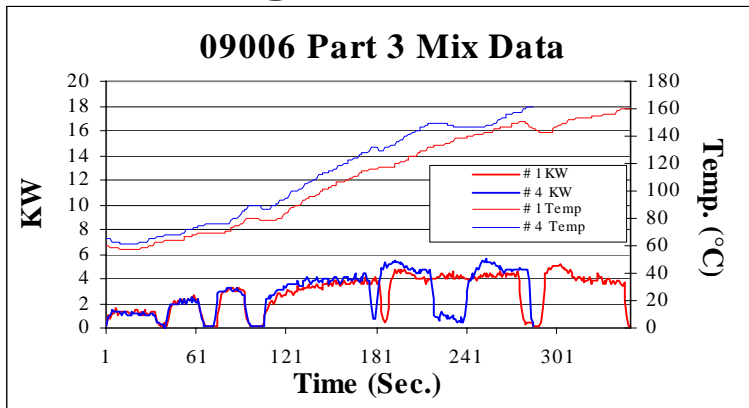
Mixing Observations



Mixing Time Reduced with Struktol Additives
Mixing Peaks Shifted with Struktol Additives

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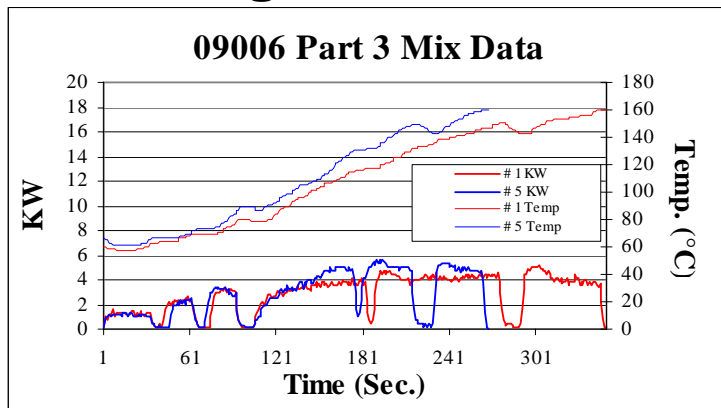
Mixing Observations



Mixing Time Reduced with Struktol Additives
Mixing Peaks Shifted with Struktol Additives

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Mixing Observations



Mixing Time Reduced with Struktol Additives
Mixing Peaks Shifted with Struktol Additives

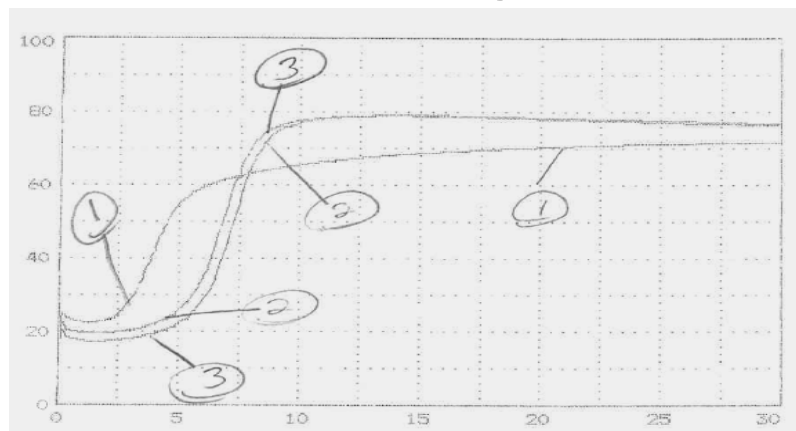
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Mixing Observations

Compound	Temp (°C)	Probe Temp(°C)	Energy (WH)	Second pass comments	Final pass comments
BATCH 1 (Control)	171	180.1	171	Ok	Ok
BATCH 2 (KK 49) 4 phr	175	182.5	175	Ok	Ok
BATCH 3 (KK 49) 6 phr	169	176.7	169	Ok	Ok
BATCH 4 (CY 48) 4 phr	178	184.8	178	Ok	Ok
BATCH 5 (CY 48) 6 phr	171	178.5	171	Ok	Ok

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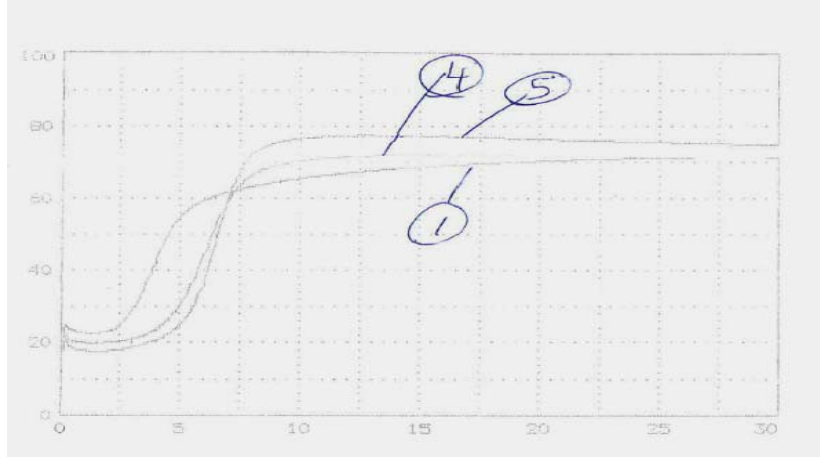
Rheometer Curves



Reduced viscosity and increased cure state with KK 49

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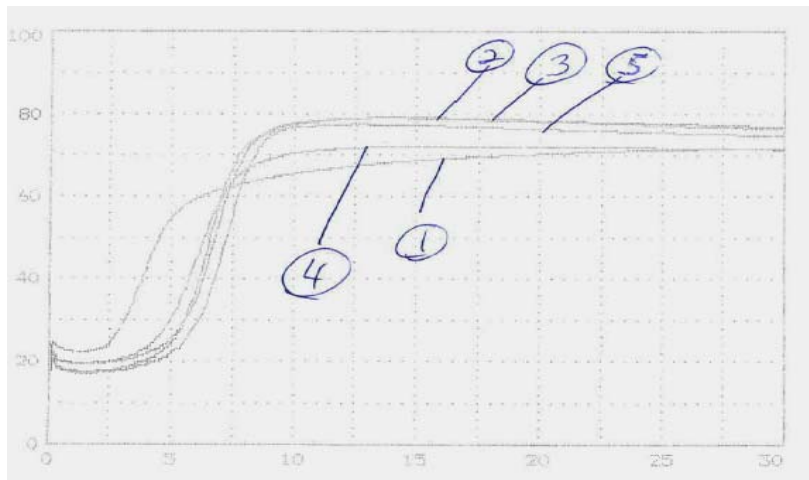
Rheometer Curves



Reduced viscosity and increased cure state with CY 48

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Rheometer Curves



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Rheometer Data

160°C; 3° arc; 100 range; 30 minutes – Tech Pro

Compound	Min Torque	Max Torque	T _{s2}	T ₅₀	T ₉₀	T-2 Reversion
BATCH 1 (Control)	22.43	71.65	2.58	4.38	11.75	-
BATCH 2 (KK 49) 4 phr	19.47	79.03	3.92	6.83	8.46	26.25
BATCH 3 (KK 49) 6 phr	17.32	79.09	4.13	7.25	8.88	28.25
BATCH 4 (CY 48) 4 phr	19.70	72.17	3.63	6.17	8.29	-
BATCH 5 (CY 48) 6 phr	17.66	77.40	3.83	6.58	8.00	25.67

Increased cure state and reduced minimum torque with KK 49 and CY 48

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Mooney Viscosity

ML (1+4) @ 100°C Aged Mooney

Compound	Initial Viscosity	ML (1+4)	Initial Viscosity 3 day	ML (1+4)	Initial Viscosity 14 day	ML (1+4)	Initial Viscosity 28 day	ML (1+4)
BATCH 1 (Control)	139.6	92.9	159.2	102.4	195.3	107.8	-	-
						MS	125	67.2
BATCH 2 (KK 49) 4 phr	125.0	88.2	142.7	94.4	155.5	94.5	171.7	98.9
BATCH 3 (KK 49) 6 phr	116.4	82.9	130.0	89.4	140.2	88.4	152.9	91.7
BATCH 4 (CY 48) 4 phr	124.7	88.1	145.9	98.1	156.6	98.9	175.3	102.5
BATCH 5 (CY 48) 6 phr	115.7	83.6	132.4	91.5	144.7	93.5	160.7	95.1

**Decreased viscosity for better processability for KK 49 and CY 48
Better viscosity control with time providing more stable stock storage**

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Mooney Scorch

ML @ 125°C

Compound	Min Torque	T ₅	T ₃₅	Cure Index
BATCH 1 (Control)	86.8	12.60	19.34	6.74
BATCH 2 (KK 49) 4 phr	81.7	26.21	36.65	10.44
BATCH 3 (KK 49) 6 phr	78.2	27.95	37.52	9.57
BATCH 4 (CY 48) 4 phr	86.1	23.91	32.98	9.07
BATCH 5 (CY 48) 6 phr	81.2	24.40	34.78	10.38

Scorch Safety Doubled with KK 49 CY 48

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Tensile Data

Unaged

Compound	Cure Time @ 160°C	Shore A Duro	Tensile (MPa)	Elongation (%)	100% Mod. (MPa)	200% Mod. (MPa)	300% Mod. (MPa)
BATCH 1 (Control)	13	64	17.6	385	2.4	6.2	11.9
BATCH 2 (KK 49) 4 phr	13	67	20.1	399	2.8	7.1	13.6
BATCH 3 (KK 49) 6 phr	13	67	19.2	416	2.7	6.6	12.2
BATCH 4 (CY 48) 4 phr	13	64	20.6	379	2.8	7.7	14.8
BATCH 5 (CY 48) 6 phr	13	65	20.5	436	2.7	6.6	12.3

Increased Tensile, Elong. and Modulus with KK 49 and CY 48

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Oven Aged Tensile

70 Hrs @ 100°C

Sample	Shore A	Pts. Change	Tensile (Mpa)	Pct. Change	Elong. %	Pct. Change	100% Mod. (Mpa)	Pct. Change	200% Mod. Mpa	Pct. change
BATCH 1 (Control)	75	11	14.9	-15.3	154	-60.0	8.0	233.3	-	
BATCH 2 (KK 49) 4 phr	77	10	14.1	-29.9	180	-54.9	6.6	135.7	-	
BATCH 3 (KK 49) 6 phr	77	10	16.5	-14.1	221	-46.9	6.5	140.7	-	
BATCH 4 (CY 48) 4 phr	76	12	15.6	-24.3	196	-48.3	6.6	135.7	-	
BATCH 5 (CY 48) 6 phr	75	10	14.2	-30.7	175	-59.9	7.4	174.1	-	

Better retention of aged properties with KK 49 and CY 48

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Tear Strength

ASTM D – 624 Die C N/MM

Compound	23°C	100°C
BATCH 1 (Control)	39.6	38.1
BATCH 2 (KK 49) 4 phr	52.1	48.4
BATCH 3 (KK 49) 6 phr	47.3	50.7
BATCH 4 (CY 48) 4 phr	47.8	42.8
BATCH 5 (CY 48) 6 phr	50.3	45.4

Tear Strength better with KK 49 CY 48

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Heat Build Up

250 lb. Weight; 0.325" Throw; 45 minute test

Compound	Cure time 160C	Duro	Temp
BATCH 1 (Control)	52	66	134.3
BATCH 2 (KK 49) 4 phr	52	67	135.5
BATCH 3 (KK 49) 6 phr	52	67	139.5
BATCH 4 (CY 48) 4 phr	52	66	138.0
BATCH 5 (CY 48) 6 phr	52	67	130.8

Heat Build Up is equivalent

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MER

Tension/Compression/Cylindrical / 1 HZ

COMPOUND	Tan delta/ average of 3 / 23c	Tan delta/ average of 3 / 100c
BATCH 1 (Control)	.150	.094
BATCH 2 (KK 49) 4 phr	.152	.100
BATCH 3 (KK 49) 6 phr	.154	.100
BATCH 4 (CY 48) 4 phr	.145	.098
BATCH 5 (CY 48) 6 phr	.149	.103

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Spiral Mold Flow

Cured at 160°C

Compound	Cure	Weight 1	Weight 2	Weight 3	Average Weight
BATCH 1 (Control)	13	1.464	1.448	1.412	1.441
BATCH 2 (KK 49) 4 phr	13	1.690	1.644	1.655	1.663
BATCH 3 (KK 49) 6 phr	13	1.729	1.762	1.698	1.730
BATCH 4 (CY 48) 4 phr	13	1.576	1.572	1.613	1.587
BATCH 5 (CY 48) 6 phr	13	1.713	1.727	1.704	1.715

Significantly increased flow for better processability with KK 49 and CY 48

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Conclusions

Struktol Additives KK 49 and CY 48

- Reduced mix energy and mix time.
- Increased cure state.
- Better scorch resistance.
- Higher tensile and modulus.
- Better tear.
- Reduced viscosity for better processability/ extrudability (less scrap/workaway).

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