Low Cost Intermesh Mixing

Tilt Intermesh mixing versus Conventional Intermesh batch mixing

Kneader Machinery USA has set out to demonstrate that by mixing with their patent pending MXI-rotor technology the same and better mixing results can be achieved, with less than half the cost of a comparable sized conventional intermeshing rotor mixers.

Photo 573 – #3 MB Dispersion
(Conventional type Intermeshing rotor)

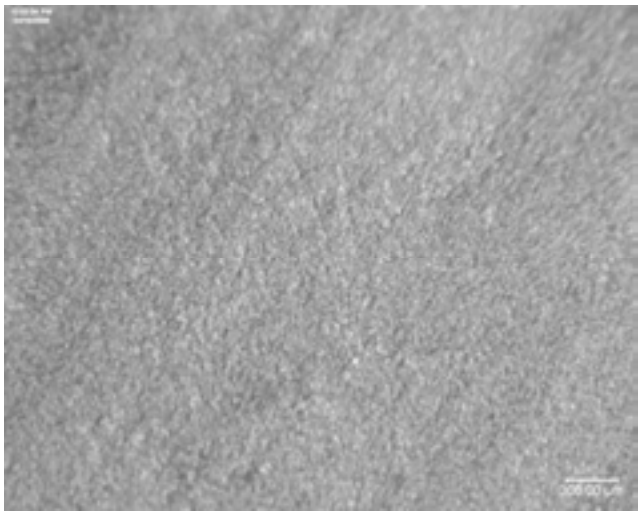


Photo 600 – #1 MB Dispersion
(KNEADER MXI-50 Intermeshing rotor)

There are generally two styles of mezzanine based internal mixers better known as “Tangential” rotor and “Intermeshing” rotor mixers. These mixers are well established in the market and utilized extensively in the rubber and plastics industries. OEM suppliers of these style mixers are Farrrel, Kobelco and HF Rubber Machinery .

Kneader’s MXI series mixers operate on floor level saving thousands of dollars in mezzanine costs and installation. The new MXI rotor design delivers optimal mixing performance while in ***most cases saving hundred’s of thousands of dollars in capital equipment costs.***

Based on test results it is clear that the MXI Intermesh rotors deliver equal if not superior compound dispersion and temperature control when compared to conventional intermesh mixers. Test results show physical properties are similar and Mooney scorch values are greatly improved with the MXI technology.

▪ TEST REPORT ▪

PN 77532

PO 2075

Compound Development

SUBJECT: Experimental comparison of mixing between a Conventional type batch mixer with Intermeshing rotors and a Kneader MXI-50 Intermeshing rotor tilt mixer.

The master batch compound selected for this comparison was specified as ASTM D3191. Compound selection, preparation, mixing and testing was performed or supervised by Akron Rubber Development Laboratories, Inc

The masterbatches from the Conventional type 50 liter mixer (Intermeshing rotors MB #3) and the MXI-50 Intermesh Tilt mixer (Intermeshing rotors compound #1) were mixed equally in time and temperature for the purpose of physical properties such as rheometer, Mooney scorch, tensile, modulus, elongation. Compound #2 was mixed using the MXI-50 Mixer, but the ingredient's were added all at one time and mixed two-minutes shorter to observe the difference in properties.

The cure was added to a small amount of each masterbatch material to yield the final properties. Photomicrographs were taken of the Masterbatch portion of the mix . Two mixes were produced using the MXI Tilt mixer and were labeled #1 and #2. One mix using the Conventional type intermeshing rotor mixer is labeled MB #3.

MB # 3
CONVENTIONAL TYPE 50 LITER INTERMESHING ROTOR MIXER

MIXING SPECIFICATION & DATA
STAGE I
Starting temperature 32°C (95°F), Rotor Speed 50 rpm, Ram Pressure 48 psi

TIME, minutes	INGREDIENT or PROCEDURE
0	Polymer
1	Black, Sulfur, ZnO, Stearic acid
2.5	Sweep Slow to 24 rpm
4	Sweep 250°F, Slow to 15 rpm
5	Sweep 267°F, Slow to 13 rpm
5'40"	dump 315°F

Mixed compounds placed on mill with roll temperatures @ 50° C (122° F). Cut three times each side, three end passes with the nip at 3/8 inch, 1 ½ minutes conveyer to second mill, 1 ½ sheet to dip tank and cool for 30 minutes.

MB #1
KNEADER MXI 50 LITER INTERMESHING ROTOR MIXER

MIXING SPECIFICATION & DATA
STAGE I

Starting temperature 32° C (95° F), Rotor Speed 50 rpm, Ram Pressure 35 psi

TIME, minutes	INGREDIENT or PROCEDURE
0	Polymer
1	Black, ZnO, Sulfur, Stearic Acid
1 ½ or 200°F	Sweep lower to 40 RPM
4 or 280°F	Sweep slow to 30 RPM
5	sweep 30 RPM
5' 40"	dump 320°F

Due to efficient cooling the rotor RPM did not have to be limited to 13 RPM to control the batch temperature rise.

Mixed compound was placed through a vertical, roller die to squeeze and cool the compound to a final sheet.

The following cure parameters were obtained and used to produce the tensile plaques from all of the masterbatches.

RHEOMETER DATA; ASTM D 2084-06
Tech Pro rheoTECH ODR
160°C (320° F) 3° arc 100 inch lbs. 30 minute Chart Speed 100 cpm

	MB#1	MB#2	MB#3
Maximum Torque, M_H, lbf·inch	96.61	99.77	90.70
Minimum Torque, M_L, lbf·inch	18.26	19.30	18.72
Scorch Time, $t_S 2$, minutes	4.08	3.89	3.22
Cure Time, t_{50}, minutes	10.81	10.53	7.79
Cure Time, t_{90}, minutes	17.18	16.60	12.82

MOONEY SCORCH, ASTM D 1646-06
Monsanto MV 2000 Viscometer
121°C (250° F) Large Rotor 150 Range

	MB#1	MB#2	MB#3
Initial Viscosity, IV	99.70	112.20	111.70
Minimum Viscosity, MV	68.90	73.00	69.90
t_5, minutes/seconds	54.62	53.56	37.98

CURING & MOLDING DATA, ASTM D 3182-05

Test Plaque Size, inches	6 x 6 x 0.075
Cure Temperature,	145°C (293° F)
Cure Time, minutes	50

ORIGINAL PHYSICAL PROPERTIES, ASTM D 412-06a & DUROMETER HARDNESS D 2240

ASTM die C dumbbells tested @ 20 inch/minute crosshead speed
Dumbbells rested 24 hours @ 23°C (72° F) after curing and before testing
Durometer taken at instantaneous readings.

	MB#1	MB#2	MB#3
Ultimate Elongation, %	368	356	313
100% Modulus, psi	614	660	671
200% Modulus, psi	1861	1969	2079
300% Modulus, psi	3117	3220	3491
Tensile Strength, psi	3683	3729	3690
Durometer, Shore A	71	75	73

PHILLIPS DISPERSION RATING; ARDL PROCEDURE WI 3809

The samples were cut with a razor blade and pictures were taken at 30x magnification with an Olympus SZ60 Zoom Stereo Microscope interfaced with a PaxCam ARC digital camera and a Hewlett Packard 4600 Laser Jet color printer. The pictures of the samples were the compared to a Phillips standard dispersion-rating chart having standards ranging from 1 (bad) to 10 (excellent). See Pictures for optical photomicrographs of the samples with embedded rating charts. A Phillips Dispersion Rating chart is also included for comparison.

Results

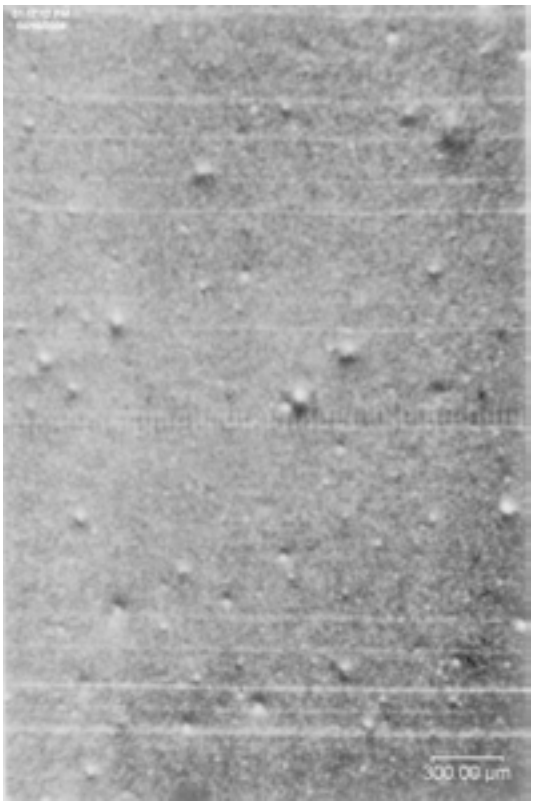
Sample	Phillips Dispersion Rating
#3 MB Uncured (see Photo 573)	7 (with Size 3 Agglomerate)
#1 MB Uncured (see Photo 600)	10
#2 MB Uncured (see Photo 602)	8

Prepared By: _____ Approved By: _____

Robert May Jon F. Kopsky

573

Phillips Dispersion
Rating 7 with Size 3



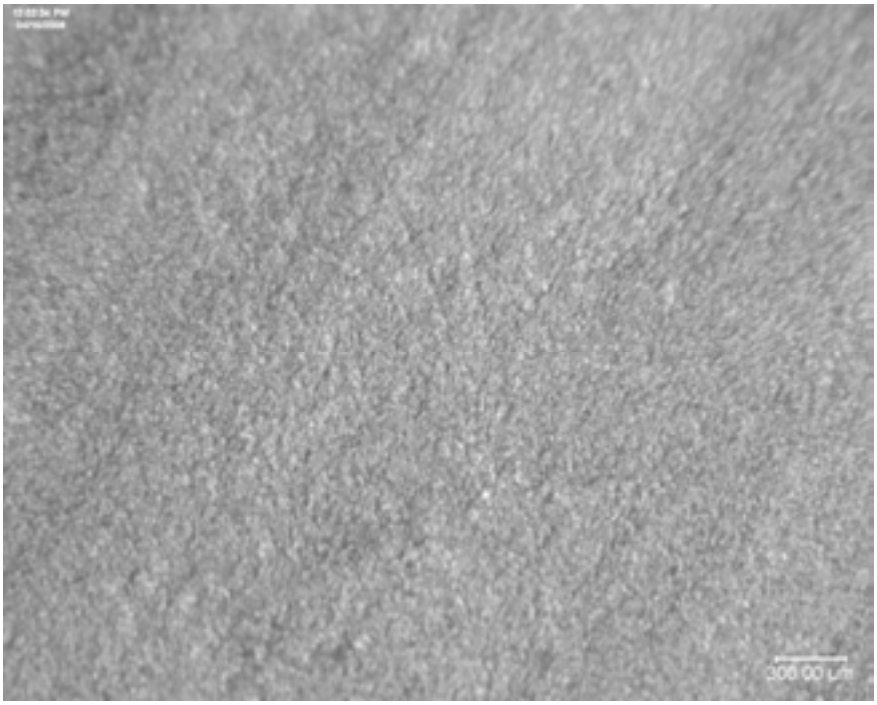
Phillips Dispersion
Rating 7

FIGURE A: Photo 573 – Kneader Machine P/N 77532 Sample #3 MB Dispersion
(Conventional type Intermeshing rotor)

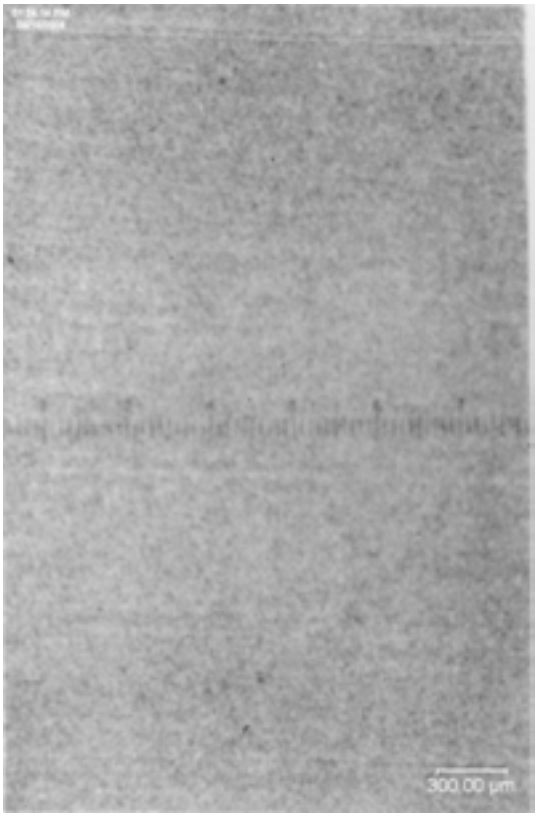
Don Kierstead
Akron Rubber Development Laboratories, Inc.
6/18/2008 4:04:03 PM

Report created with
PAX-it for Windows

600



Phillips Dispersion
Rating 10



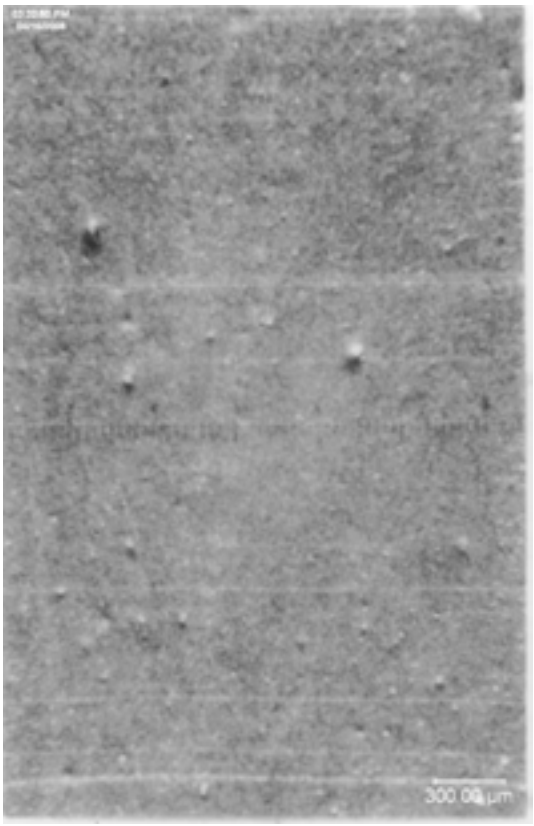
Phillips Dispersion
Rating 10

FIGURE E: Photo 600 – Kneader Machine P/N 77532
Sample #1 MB Dispersion
(KNEADER MXI-50 Intermeshing rotor)

Don Kierstead
Akron Rubber Development Laboratories, Inc.
6/18/2008 4:04:03 PM

602

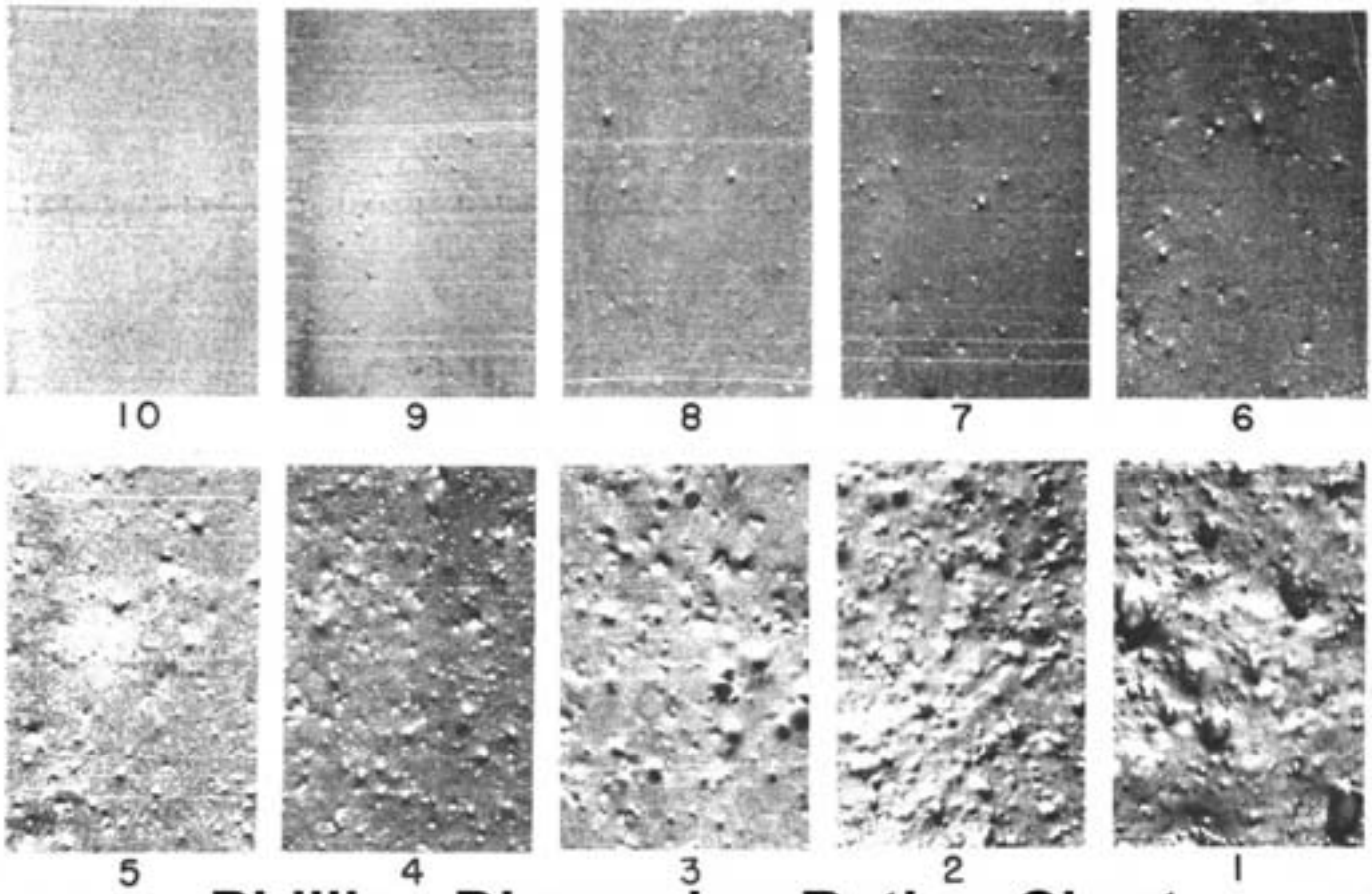
Phillips Dispersion
Rating 8



Phillips Dispersion
Rating 8

FIGURE G: Photo 602 – Kneader Machine P/N 77532
Sample #2 MB Dispersion
(KNEADER MXI-50 Intermeshing rotor)

Don Kierstead
Akron Rubber Development Laboratories, Inc.
6/18/2008 4:04:03 PM



Phillips Dispersion Rating Chart
Photos @ 30X

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PHILLIPS DISPERSION RATING; ARDL PROCEDURE WI 3809

The samples were cut with a razor blade and pictures taken at 30x magnification with an Olympus SZ60 Zoom Stereo Microscope interfaced with a PaxCam ARC digital camera and a Hewlett Packard 4600 LaserJet color printer. The pictures of the samples were then compared to a Phillips standard dispersion-rating chart having standards ranging from 1 (bad) to 10 (excellent). See Photo's for optical photomicrographs of the samples with embedded rating charts. A Phillips Dispersion Rating is also included chart for comparison.

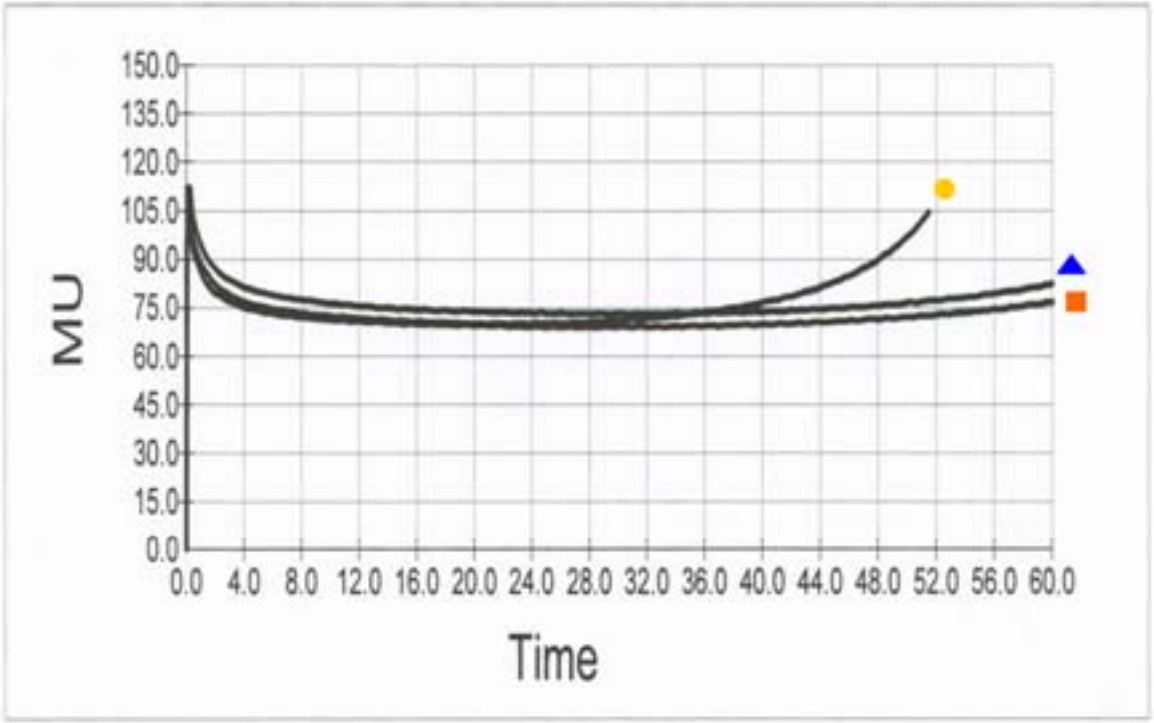
Results;

Sample	Phillips Dispersion Rating
#3 MB (see Photo 573)	7 (with Size 3 Agglomerate)
#1 MB (see Photo 600)	10
#2 MB (see Photo 602)	8

compuGRAPH V6.5.26

Akron Rubber Development Laboratory
ASTM D 1646

Report Date : Friday, April 11, 2008 10:54:25 AM
PROJECT NUMBER : PN77532
TEST DATE : Friday, April 11, 2008
CUSTOMER : Kneader Machine
COMPOUND I.D. :
Upper Die Temperature Setpoint : 121.0 C
Lower Die Temperature Setpoint : 121.0 C

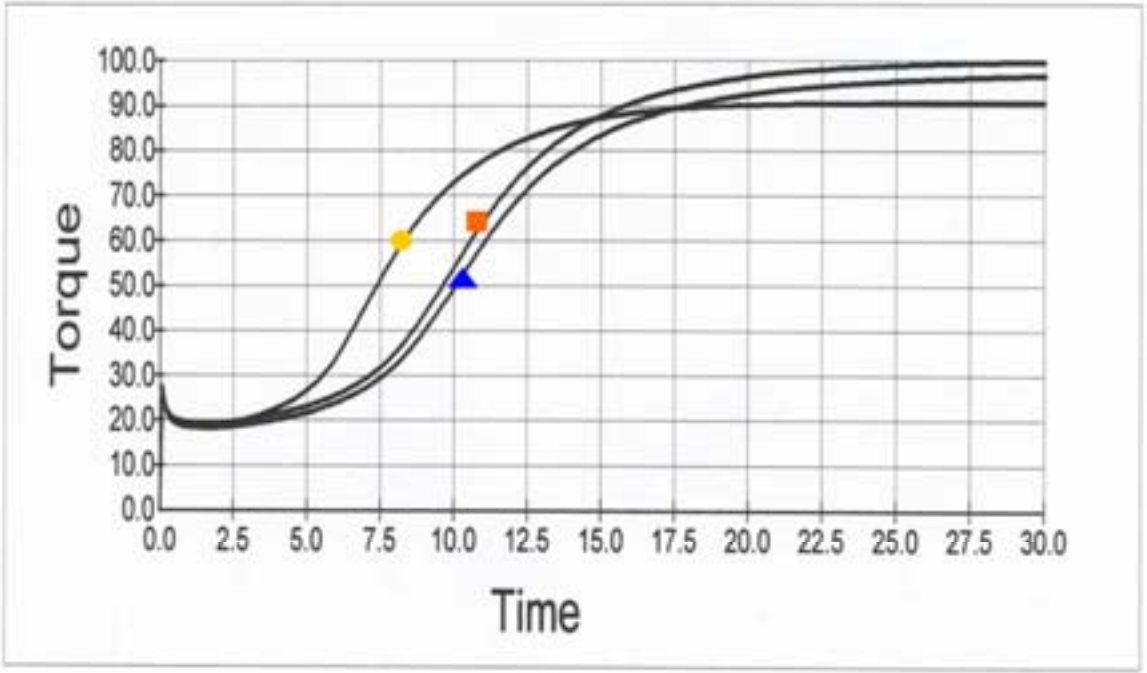


Test ID.	MI	ML	Ts5
#1MB ▲	99.70	68.90	54.62
#2MB ■	112.20	73.00	53.56
#3MB ●	111.70	69.90	37.98

compuGRAPH V6.5.26

Akron Rubber Development Laboratory
ASTM D 2084

Report Date : Friday, April 11, 2008 10:08:32 AM
Compound ID : PN77532
Mix Date : Friday, April 11, 2008
Test Type : ASTM D 2084 - ODR
Customer : Kneader Machine
Degree Arc : 3
Upper Die Temperature Setpoint : 160.0 C
Lower Die Temperature Setpoint : 160.0 C



Test ID.	MH	ML	Tc50	Tc90	Ts2
#1MB ▲	96.61	18.26	10.81	17.18	4.08
#2MB ■	99.77	19.30	10.53	16.60	3.89
#3MB ●	90.70	18.72	7.79	12.82	3.22

Test Notes