AKRON RUBBER DEVELOPMENT LABORATORY, INC.
300 KENMORE BOULEVARD
AKRON, OHIO 44301
(216) 434-6664

A RUBBER INGREDIENT SURVEY

by

Bill Klingensmith

Bob Samples

Tom Maistros

Akron Rubber Development Laboratory, Inc.

Presented To

ACS Rubber Division Meeting

Fall 1985

AKRON RUBBER DEVELOPMENT LABORATORY, INC.
300 KENMORE BOULEVARD
AKRON, OHIO 44301
(216) 434-6664

TABLE OF CONTENTS

I. PURPOSE

The purpose of this paper is to describe in detail the information available in the Rubber Ingredient Survey for technical and purchasing personnel to compare raw materials.

The purpose of the Rubber Ingredient Survey is to compare the physical form, and for a compounded system,compare the processing characteristics, physical properties, viscosity and cure rate for materials that are of identical composition or considered substitutes for one another.

II. BACKGROUND

Akron Rubber Development Laboratory is an independently owned and operated testing laboratory located in Akron, Ohio. The laboratory has the capability to mix and test elastomers, fillers, oils, antidegradants, processing agents, curing systems, thermoplastic elastomers and all commonly used rubber materials.

The testing capabilities includes stress-strain, aging and weathering ability, extrusion, mold flow, processing, low temperature, ozone, set and all the tests commonly accepted and used by the rubber compounders.

The laboratory has been involved in the development testing of numerous products for use in rubber compounds. Many of these have become commercial and are used commonly by rubber companies.

Consequently the company is equipped and experienced in performing the useful tests for characterizing rubber raw materials.

III. SCOPE

There are many thousands of raw materials used in the rubber industry. These include thirty to forty different types of polymer, eight to ten major blacks, five to six non-black fillers, numerous oils, plasticizers, antidegradants, curing agents, processing agents and tacifiers. Most of these can be grouped based on their similarity in chemical composition.

For major ingredients like SBR, natural rubber, PBD, polychloroprene, nitrile, EPDM and N-220, 300, 500, 600 and 700 series blacks, there are numerous suppliers and manufacturers for equivalent products.

In recent years there has been a proliferation of sources for rubber in the United States. Many non-domestic producers have recognized that the U.S. is the worlds largest free market consumer and potential user for elastomers. As a result numerous non-domestic manufacturers are marketing in the U.S.

The purchaser and compounder of elastomers continually has to determine what is the best value (price x property) available. The compounder must constantly balance price and performance of different raw material sources. To achieve this the compounder now has an objective laboratory evaluation available to compare the properties of the major speciality elastomers made and/or marketed in the U.S. This is called "The Rubber Ingredient Survey" from Akron Rubber Development Laboratory, Inc.

The survey is available to subscribers who want to know the similarities and differences between competitive equivalent or substitute elastomers and ingredients.

The samples are obtained and then tested for basic raw material characterizations. The rubber or ingredient is then compounded into a receipe and tested for physical properties, processing characteristics and Monsanto processability testing. The test procedures used are summarized on the following page.

TEST PROCEDURES USED

The tests and procedures described here will be used for all Rubber-Ingredient Surveys. Other tests such as heat aging, extrudability or ozone resistance may be added when appropriate.

Thickness	Randall Stickney Micrometer
Mooney Viscosity	ASTM D 1646
Mooney Scorch Data	ASTM D 1646
Green Strength	Formed raw polymer in mold for approximately 30 sec. at 320°F - 340°F, cooled for 24 hrs. and pulled using Die C tensile dumb-bells.
Test Formulation	As defined in ASTM All ingredients mixed in B Banbury (Upside - Down Mix) for 1.8 minutes after ram is lowered.
Rheometer	ASTM D 2084
Stress - Strain Data	ASTM D 412
Hardness	ASTM D 2280
Tear	ASTM D 624
Bloom	Visual Observation
Specific Gravity - Long Cure Time	ASTM D 297
Dispersion - Long Cure Time	Rated 1 - 10 at 30X on cut sample
Monsanto Processability Tester	Standard Test Conditions (see appendix)
Garvey Die	ASTM D 2230
Compression Set	ASTM D 395 Method B

IV. TESTING AND SAMPLING METHODS

The laboratory staff has picked raw materials that are believed to be of interest to a large number of rubber manufacturers. These were selected after polling several large polymer manufacturers and rubber users as to which topics would be of most interest to them. The schedule for 1985 is:

EPDM	High Green Strength
Polychloroprene	W and GRT Types
Nitrile	Med ACN, High Mooney
SBR	1502 Type
Silica	Precipated Types
Oils	Aromatic Process Oils

Each manufacturer or supplier is contacted and a sample requested or purchased for each product to be evaluated. The lab staff works with the manufacturers of raw materials in defining what are considered equivalent or substitute grades.

V. TESTING EXAMPLES

As mentioned previously, the following materials have been or will be tested in 1985.

High Green Strength	-	EPDM
Polychloroprene Rubber	-	4 W Types and 3 GRT Types
Nitrile	-	Med ACN, High Mooney plus medium mooney and good processing medium ACN
Silica	-	7 Percipitated silica
SBR	-	1502 Type
Process Oil	-	Aromatic type

The following are the specific ingredients that were tested for the EPDM, Polychloroprene, nitrile and silica reports.

The following tables summarize the range of values found for some of the products tested. In addition samples of three sample EPDM test reports and a summary sheet are enclosed to show the format of the information available.

EPDM SCORCH
AND
CURE RATES

Mooney Scorch	Rheometer @ 320 °F		
T_{35} @ 257°F	TS_1	T_{90}	Max. Torque
21.1 min.	2.5	11.9	37.8
24.9	2.3	11.0	35.8
22.5	2.5	11.9	37.1
24.9	2.5	13.3	33.1
39.4	3.7	16.1	34.2
19.1	2.3	11.3	35.9

PHYSICAL PROPERTIES
RANGES FOR
HIGH GREEN STRENGTH EPDM

	Minimum	Maximum
Tensile, psi	2100	2490
300% Modulus, psi	760	1115
Elongation, %	495	630
Extrusion Rating	12	15
Comparison Set, % 22 hr/212°F	27.6	42.2

COMPARISON OF PROPERTIES
NITRILE RUBBERS
ASTM RECEIPE

	Minimum	Maximum
Acetone Extract, %	2.5	5.6
Volume Increase ASTM No. 3 Oil 70 hrs./212°F	+ 9.0%	+ 17.0%

No. S- 5628

PURCHASE DATE: Sept. 84

NAME A

TEST DATE Oct. 84

RAW MATERIAL DESCRIPTION

Bale Characteristics

Length	28"	Weight	50 lbs.	Lot No.
Width	14"	Color	White Opaque	
Thickness	7"	Form	Solid, Friable Pellets	
Description and Condition	Good, Clean	Sp. Gr.	.87	

Bale Packaging

How received Boxed____ Paper Bag____ Plastic Bag X

Plastic Film Properties

Thickness	4 mil		
Melt point °C	-	weight/ft²	9 grams

Banner Nonmenclature

Length	37"	Thickness	2 mil
Width	2"	Melt point	-

RAW POLYMER PROPERTIES

Mooney Viscosity D 1646, 100°C (212°F)			125°C (257°F)
ML1 +	0'	96.0	-
	4'	81.8	60.4
	8'	78.5	56.6

Green strength @ 75°F, psi 750

UNVULCANIZED COMPOUND DATA

Mooney Viscosity D 1646, 100°C (212°F)			125°C (257°F)
ML1 +	0'	142.9	82.4
	4'	42.8	32.2
	8'	41.1	31.5

Scorch Data D 1646	125°C (257°F)
LR, minutes to:	
3 point rise	15.3
5 point rise	17.0
10 point rise	20.3
18 point rise	23.1
35 point rise	27.2

Bloom

Nil

S-5628

DATE TESTED: Oct 84

TEST FORMULATION

1.	EPDM	100.0 PHR	6.	Sulfur	1.50
2.	N-762	100.0	7.	MBT	0.50
3.	Sunpar 2280	75.0	8.	TMTD	1.50
4.	Zinc Oxide	5.0			
5.	Stearic Acid	2.0			

Cure System

MIX PROCEDURE:

0' Load Powders, oil rubber
160°F Sweep ram
200°F Discharge Batch

MONSANTO RHEOMETER, D 2084, 1° Arc, 100 cpm, 320°F

ts 1	3.1 min.	ML	5.7 in. lb.
t 90	15.5 min.	MHF	31.0 in. lb.

STRESS STRAIN DATA

	Cure Time @ 320°F 5'	10'	15'
300% Modulus, psi	620	820	930
Tensile, psi	2160	2300	2380
Elongation, psi	670	610	590
Tension Set @ Brk, %	46	33	28
HARDNESS, shore A	60	60	60
TEAR, Die C, pli	199	193	189
BLOOM	slight	nil	nil
SPECIFIC GRAVITY	-	-	1.10
DISPERSION, 30x (1-10)	-	-	7.0

PROCESSING DATA

MIXING DATA

Banbury , speed, RPM 78
mix time, min. 2.9
Final temp. 255°F (probe)

Mill
Roll temp 150°F
Banding Nip (in)
.250 Bagged
.200 Bagged
.150 Bagged
.100 Back Rolled

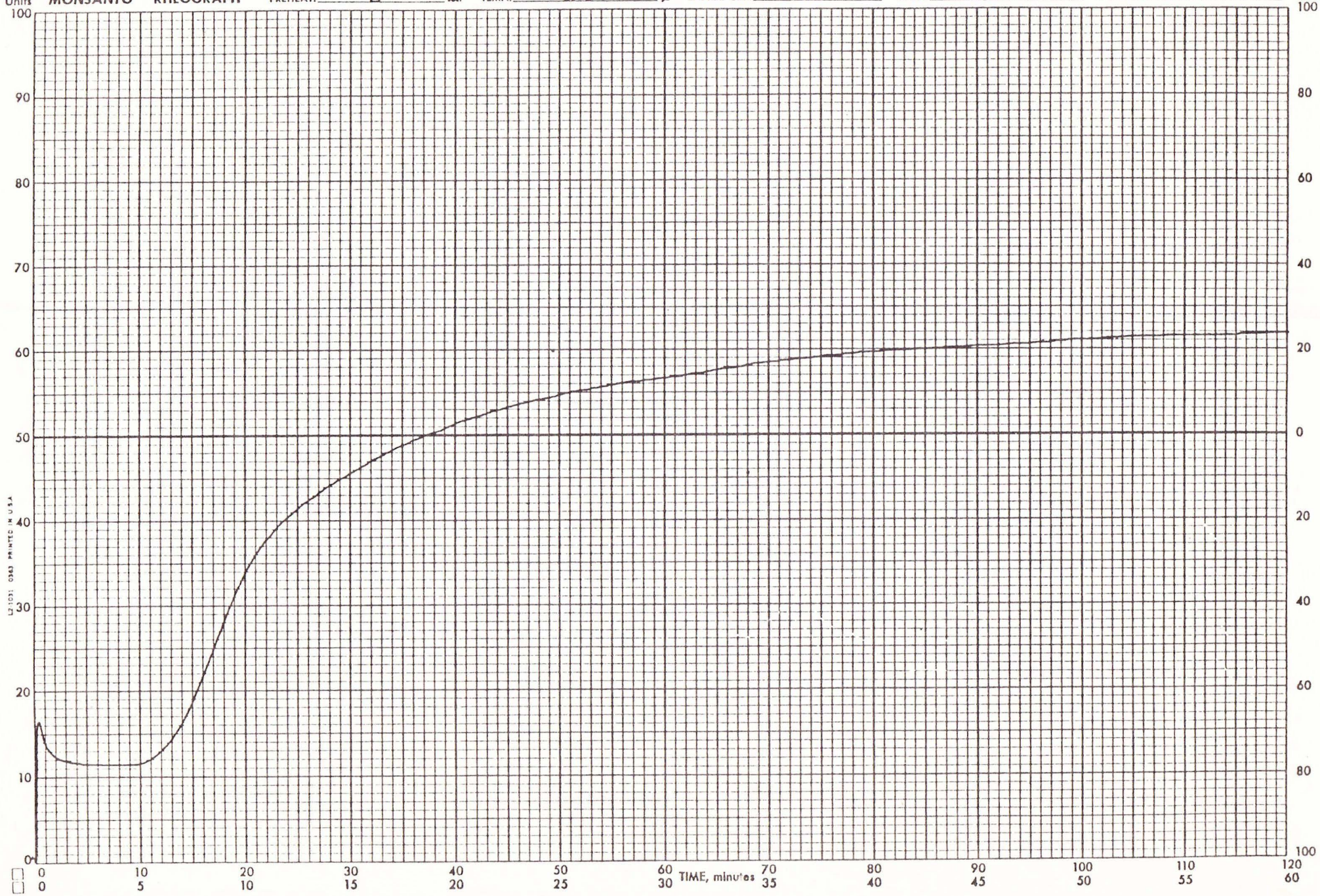
MONSANTO PROCESSABILITY TESTER

Test Temp

Shear-stress	Shear-rate	Stress-relaxation
Die swell,	Running	
	Relaxed	

MONSANTO RHEOGRAPH

STOCK: S-5628 PREHEAT: 8 sec. TEMP.: 320 °F °C CHART MOTOR: 30 min. RANGE SEL.: 30 DATE: 10-18-84 OPER.: [illegible] PROJ. NO.: 7741



No. S- **5629** PURCHASE DATE: **Sept 84**

NAME **B** TEST DATE: **Oct 84**

RAW MATERIAL DESCRIPTION

Bale Characteristics

Length	**22"**	Weight	**65 lbs.**	Lot No.
Width	**14"**	Color	**White, Translucent**	
Thickness	**6.5"**	Form	**Solid**	
Description and Condition	**Good, Clean**	Sp. Gr.	**.87**	

Bale Packaging

How received Boxed_____ Paper Bag_____ Plastic Bag_**X**___

Plastic Film Properties

Thickness	**2 mil**		
Melt point °C	**-**	weight/ft^2	**5 grams**

Banner Nonmenclature

Length	**30"**	Thickness	**2 mil**
Width	**1.8"**	Melt point	**-**

RAW POLYMER PROPERTIES

Mooney Viscosity D 1646, 100°C (212°F) 125°C (257°F)

ML1 +	0'	-	-
	4'	**84.4**	**62.2**
	8'	**78.8**	**57.6**

Green strength **@ 75°F, psi** **550**

UNVULCANIZED COMPOUND DATA

Mooney Viscosity D 1646, 100°C (212°F) 125°C (257°F)

ML1 +	0'	**125.1**	**102.5**
	4'	**40.5**	**31.4**
	8'	**38.6**	**30.2**

Scorch Data D 1646 125°C (257°F)

LR, minutes to:	
3 point rise	**16.8**
5 point rise	**18.8**
10 point rise	**22.3**
18 point rise	**25.8**
35 point rise	**32.1**

Bloom

Nil

S- 5629 DATE TESTED: Oct 84

TEST FORMULATION

1.	EPDM	100.0 PHR	6.	Sulfur	1.50
2.	N-762	100.0	7.	MBT	0.50
3.	Sunpar 2280	75.0	8.	TMTD	1.50
4.	Zinc Oxide	5.0			
5.	Stearic Acid	2.0			

Cure System

MIX PROCEDURE:

0' Load Powders, oil, rubber
160°F Sweep ram
200°F Discharge Batch

MONSANTO RHEOMETER, D 2084, 1° Arc, 100 cpm, 320°F

ts 1	3.2 min.	ML	5.5 in. lb.
t 90	13.5 min.	MHF	28.5 in. lb.

STRESS STRAIN DATA

	Cure Time @ 320°F 5'	10'	15'
300% Modulus, psi	710	970	1020
Tensile, psi	2170	1980	1940
Elongation, psi	650	540	500
Tension Set @ Brk, %	33	20	16
HARDNESS, shore A	55	56	56
TEAR, Die C, pli	189	183	173
BLOOM	nil	nil	nil
SPECIFIC GRAVITY	-	-	1.10
DISPERSION, 30x (1-10)	-	-	7

PROCESSING DATA

MIXING DATA

Banbury, Speed RPM 78
mix time, min. 2.8
Final temp. 236°F (probe)

Mill

Roll Temp 150°F
Banding Nip (in)
.250 Bagged
.200 Banded
.150 Banded
.100 Banded
No back rolling

MONSANTO PROCESSABILITY TESTER

Test Temp

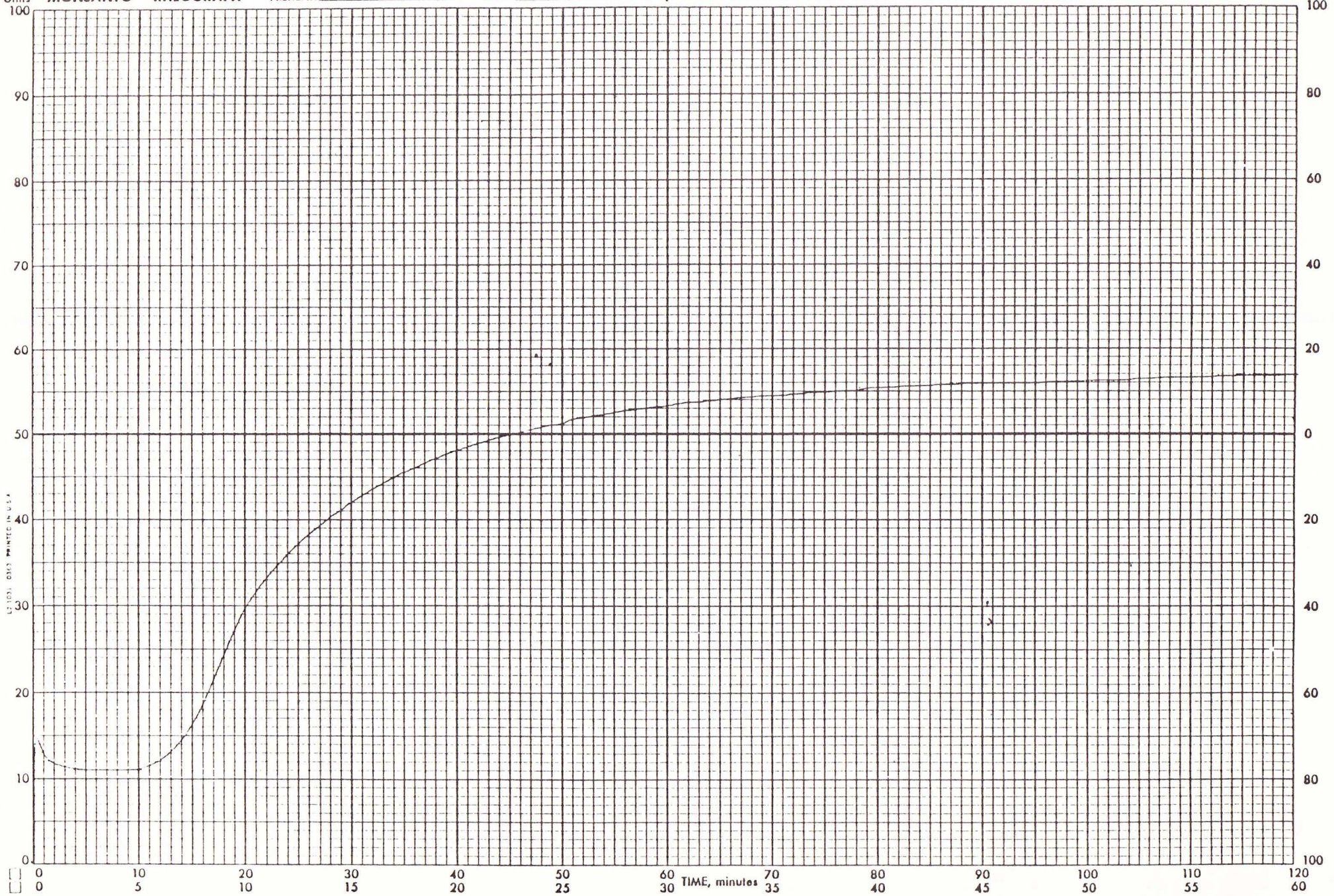
Shear-stress Shear-rate Stress-relaxation

Die swell, Running

Relaxed

Scale Units **MONSANTO RHEOGRAPH**

STOCK: S-5629 PREHEAT: 8 sec. TEMP.: 320 °F °C CHART MOTOR: 30 min. RANGE SEL.: 30 DATE: 10-12-84 OPER.: LS PROJ. NO.: 7741



No. S- 5630

PURCHASE DATE: Sept 84

NAME C

TEST DATE: Oct 84

RAW MATERIAL DESCRIPTION

Bale Characteristics

Length	28"	Weight	60 lbs.	Lot No.
Width	14"	Color	White, Opaque	
Thickness	8"	Form	Solid	
Description and Condition	Good, Clean	Sp. Gr.	.87	

Bale Packaging

How received Boxed_____ Paper Bag_____ Plastic Bag X

Plastic Film Properties

Thickness	2 mil		
Melt point °C	-	weight/ft²	5 grams

Banner Nonmenclature

Length	38"	Thickness	2 mil
Width	2"	Melt point	-

RAW POLYMER PROPERTIES

Mooney Viscosity D 1646, 100°C (212°F) 125°C (257°F)

ML1 +	0'	-	-
	4'	78.4	58.5
	8'	72.6	54.0

Green strength @ 75°F, psi 425

UNVULCANIZED COMPOUND DATA

Mooney Viscosity D 1646, 100°C (212°F) 125°C (257°F)

ML1 +	0'	144.0	134.0
	4'	41.1	31.5
	8'	38.7	30.0

Scorch Data D 1646 125°C (257°F)

LR, minutes to:	
3 point rise	16.3
5 point rise	18.5
10 point rise	22.0
18 point rise	25.1
35 point rise	30.2

Bloom

Nil

S- 5630

DATE TESTED: Oct 84

TEST FORMULATION

1.	EPDM	100.0 PHR	6. Sulfur	1.5	
2.	N-762	100.0	7. MBT	0.50	
3.	Sunpar 2280	75.0	8. TMTD	1.50	
4.	Zinc Oxide	5.0			
5.	Stearic Acid	2.0			

Cure System

MIX PROCEDURE:

0' Load powders, oil rubber
160°F Sweep Ram
200°F Discharge Batch

MONSANTO RHEOMETER, D 2084, 1° Arc, 100 cpm, 320°F

ts 1	3.2 min.	ML	5.5 in. lb.
t 90	14.7 min.	MHF	29.3 in. lb.

STRESS STRAIN DATA

	Cure Time @ 320°F 5'	10'	15'
300% Modulus, psi	610	830	890
Tensile, psi	2320	2320	2400
Elongation, psi	710	610	600
Tension Set @ Brk, %	37	26	22
HARDNESS, shore A	53	54	55
TEAR, Die C, pli	197	176	178
BLOOM	nil	nil	nil
SPECIFIC GRAVITY	-	-	1.10
DISPERSION, 30x (1-10)	-	-	8.

PROCESSING DATA

MIXING DATA

Banbury , speed, RPM 78
mix time, min. 2.6
Final temp. 236°F (probe)

Mill

Roll Temp 150°F
Banding Nip (in)
.250 Bagged
.200 Banded
.150 Banded
.100 Loose Band

MONSANTO PROCESSABILITY TESTER

Test Temp

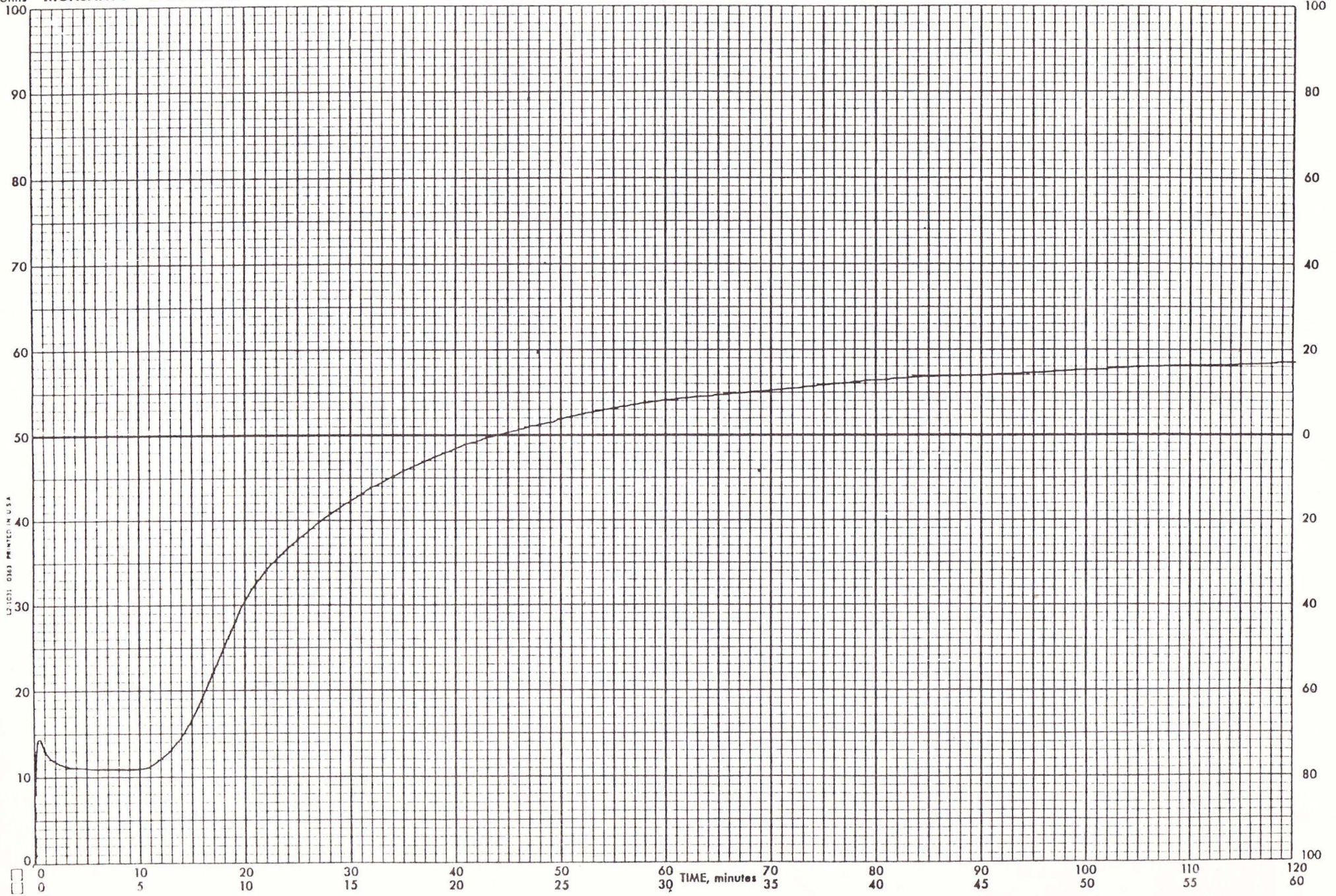
Shear-stress Shear-rate Stress-relaxation

Die swell, Running

Relaxed

Scale Units **MONSANTO RHEOGRAPH**

STOCK: S-5630 PREHEAT: 0 sec. TEMP.: 320 °F °C CHART MOTOR: 30 min. RANGE SEL.: 50 DATE: 10-12-84 OPER.: LJ PROJ. NO.: 7741



	POLYMER		
Product Name	A	B	C
Manufacturer			
Form	Bale	Bale	Bale
Weight (lbs)	50 lbs.	65 lbs.	60 lb.s
Specific Gravity	.87	.87	.87
Polymer ML 1 + 4 @ 212°F	81.8	84.8	78.4
ML 1 + 4 @ 257°F	60.4	62.2	58.5
Green Strength (psi)	750	550	425
Compound ML 1 + 4 @ 212°F	42.8	40.5	41.1
ML 1 + 4 @ 257°F	32.2	31.4	31.5
T_5	17.0	18.8	18.5
T_{35}	27.2	32.1	30.2
Gravey Die Rating			
Maximum Possible 16	12	13	14
Rheometer @ 320°F			
t_s (minutes)	3.1	3.2	3.2
T_{90} (minutes)	15.5	13.5	14.7
MHF (in.lb)	31.0	28.5	29.3
Stress Strain			
Tensile Strength, psi	2300	1980	2320
300% Modulus, psi	820	970	830
Elongaiton, %	610	540	830
Hardness, Shore A, pts.	60	56	54
Tear, C, ppi	193	183	176
Compression Set, Method B (%)			
22 hrs. @ 212°F			
Cured 20'/320°F	35.0	36.0	30.0
Cured 50'/320°F	17.0	18.0	17.5

VI. USES

The following are some of the uses for the Rubber Ingredient Survey.

Purchasing
Comparing packaging and form
Verification of departure from stated values
Processing differences
Value comparisons
Factory handling
Technical
Value judgements
Starting point for raw material evaluations
Processing differences
Difference in scorch and cure characteristics
Banbury and mill handling properties
Compare processability testor data to conventional test data