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Technical Report

No. 13225

Effects of Guayule in Tank Track Pads

Contract: DAAE 07-85-M-R010
Firestone Project 44902
April 1987

Approved for Public Release By Steven W. Brunner

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In this report the effects of Guayule rubber in tank track pads are discussed. The triblend compound from Appendix A of Mil-t-11891 Rev. C was used as the control. The two Guayule compounds evaluated were versions of the triblend in which the natural rubber and the SBR were replaced with Guayule in separate formulations. The forumlations used and the physical data obtained from each are included in this report.

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SECURITY CLASSIFICATION OF THIS PAGE

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OBJECTIVE

The objective of this project was to determine the effects of replacing Natural rubber and Styrene Butadiene rubber with Guayule in a tank track pad compound.

SUMMARY

The control compound used in this project was the triblend formulation from Appendix A of MIL-T-11891 Rev. C. In this report, this will be referred to as TS934 which is Firestone's assigned compound number. In this formulation the SBR and Natural rubber were replaced by Guayule rubber individually and were assigned the numbers TM022 and TM023 respectively. The guayule rubber was furnished by the Government through the food protein R & D Center at Texas A & M University. Various grades of Guayule were sent to Firestone that were produced by a multitude of extraction methods. The only Guayule that was used was extracted by Toluene and Methanol, and Xylene and Methanol. These two lots were blended together in equal ratios to form the two experimental batches mentioned previously.

All mixing was performed by a number eleven Farrell Banbury. The mixing specification was taken from the MIL-T-11891 Rev. C. All batches were followed by the Firestone laboratory. No significant differences were noticed in the manner in which these batches mixed. All three compounds looked very good on the drop mill just before they were put into slab form.

After the mixing was completed, these batches were extruded by means of a cold feed Extruder that was fed by a mill. The extrusions were in the form of T-142 (M60) and T-157 (M2/M3) pads.

Seventy-five pads each were cured of T-142 and T-157 for each of the three compounds. The T-142 pads were cured 70 minutes at 300°F and the T-157 pads were all cured 45 minutes at 310°F. No significant problems were encountered in curing these parts.

After curing, parts were tested for adhesion to the metal inserts. This adhesion testing evidenced no adhesion failure. (In other words, this testing showed 100% stock tear.) Results can be found in the data section.

In addition to Adhesion, other facets of testing dictated by the MIL-T-11891 Rev. C. were also conducted. (1) Complete physicals were obtained from cured slabs, as well as, from the cured parts.

The cured pads were then indentified per the contract by means of metal stamping. The TS934 (triblend compound) which is the control, was stamped "FA" on the end of the bolts. TM022 in which the Guayule replaced the SBR was stamped "FB". TM023 in which the Guayule replaced the Natural rubber was identified with the letters "FC". Also, per the contract all pads were numbered sequentially on both the T-142 and T-157 pads, from 01 through 75 on the pad plates.

These pads were then packed in wooden crates with nuts attached and shipped to the assigned destination for field test evaluations.

(1) This testing included the infrared absorption. The charts for each of the three compounds are included in this report.

CONCLUSIONS

In replacing Natural rubber and SBR with Guayule in separate formulations very little differences were noted in mixing. The extrusions were also very similar. The cure rates were found to be similar with the TM022 (Formulation in which the SBR was replaced by Guayule) being somewhat faster curing due to the scorch safety was less than the other two. The TS934 and TM023 were nearly identical on the rheometer cure curves.

The two Guayule compounds (TM022 and TM023) were very comparable to the control with respect to physical properties. The control, however, did test higher in tensile and tear on the cured pads. This was not nearly as significant on the cured slabs for some unknown reason. On all three compounds, the cured slabs tested lower in tensile and higher in elongation. This normally indicates that the slabs may be somewhat undercured, however, since these were cured 30 minutes at 320°F, this is not believed to be the case.

The TM022 in which the SBR was replaced by Guayule tested quite low on aged elongation on the cured pad. This, however, was to be expected since the omission of the SBR should reduce the heat resistance of the compound. The Rheometer curve also demonstrated rapid reversion as compared to the other two compounds. One might expect pads fabricated from this compound to be very suspect to "blowing out" in service or in other words, undergo complete heat degradation.

The TS934 or triblend compound was the compound used for reference in the T-156 track qualification of 1985. The reference compound submitted by Firestone at that time performed extremely well. It will be interesting to see how well the Guayule compounds will fare against this previously tested compound

TABLE I

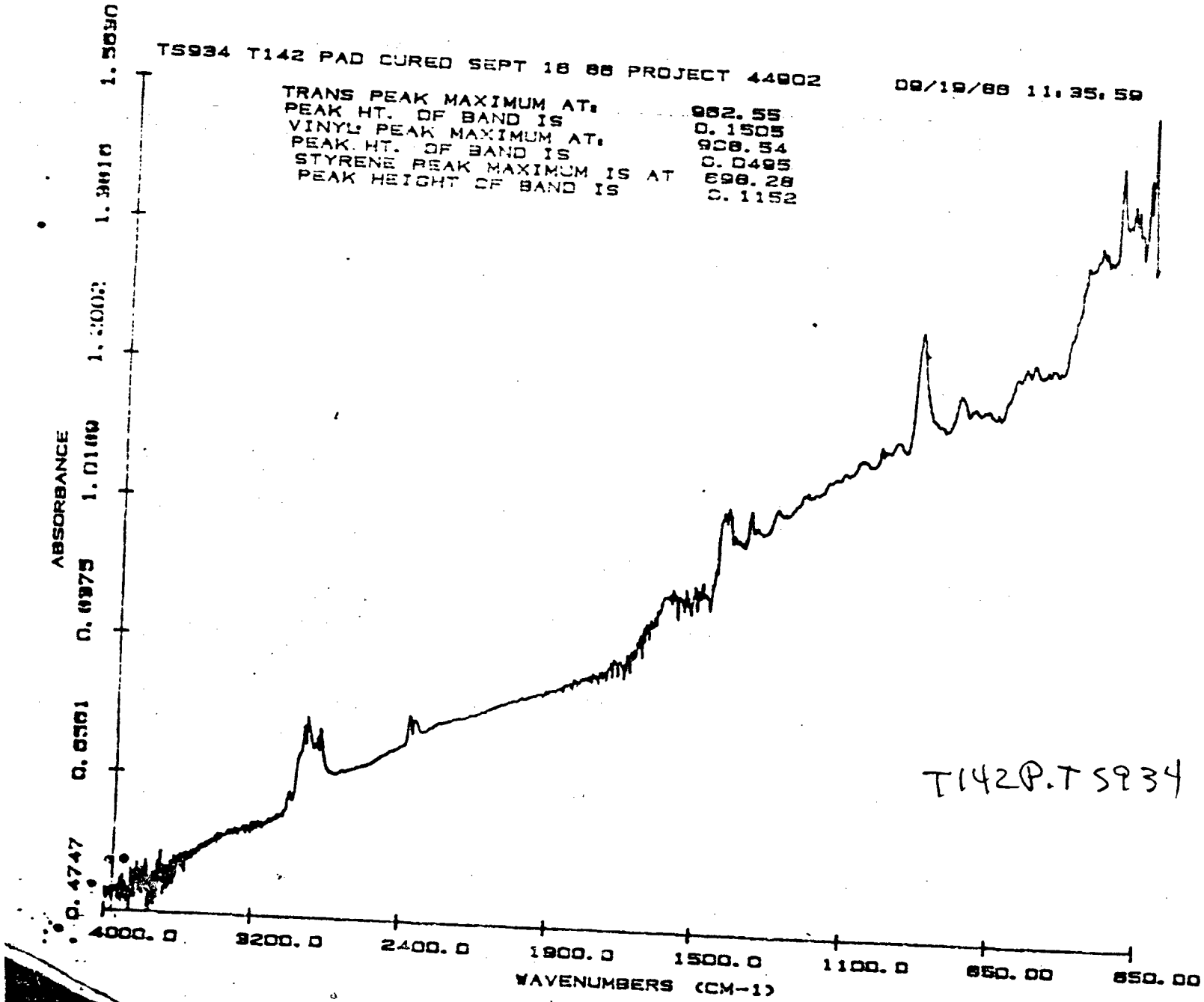
TABULATED DATA FROM CURED SLABS AND T-142 PADS

	TS934 (L)	TM022 (1)	TM023(1)	TS934 (2)	TM022 (2)	TM023 (2)
TENSILE (PSI)	2855	2754	2753	3479	2817	3091
MODULUS @ 300% (PSI)	1336	1239	1548	2286	2365	2097
ELONGATION (%)	551	584	488	435	350	411
DUROMETER (SHORE A)	70	72	70	72	73	72
AGED 166 HRS.@ 158°F						
TENSILE (PSI)	2828	2825	2643	3324	2617	2824
ELONGATION (%)	445	492	363	362	262	318
C-TEAR (PPI)	280	530	262	507	290	281
HOT C-TEAR (PPI)	267	265	205	226	183	179
LOAD COMPRESSION, % (3)	49.51	48.82	46.23	NOT TESTED	NOT TESTED	NOT TESTED
ADHESION (LBS.MIN.)	N/A	N/A	N/A	92	95	120

(1) Data taken from .075 in. slabs cured 30 minutes @ 320°F.

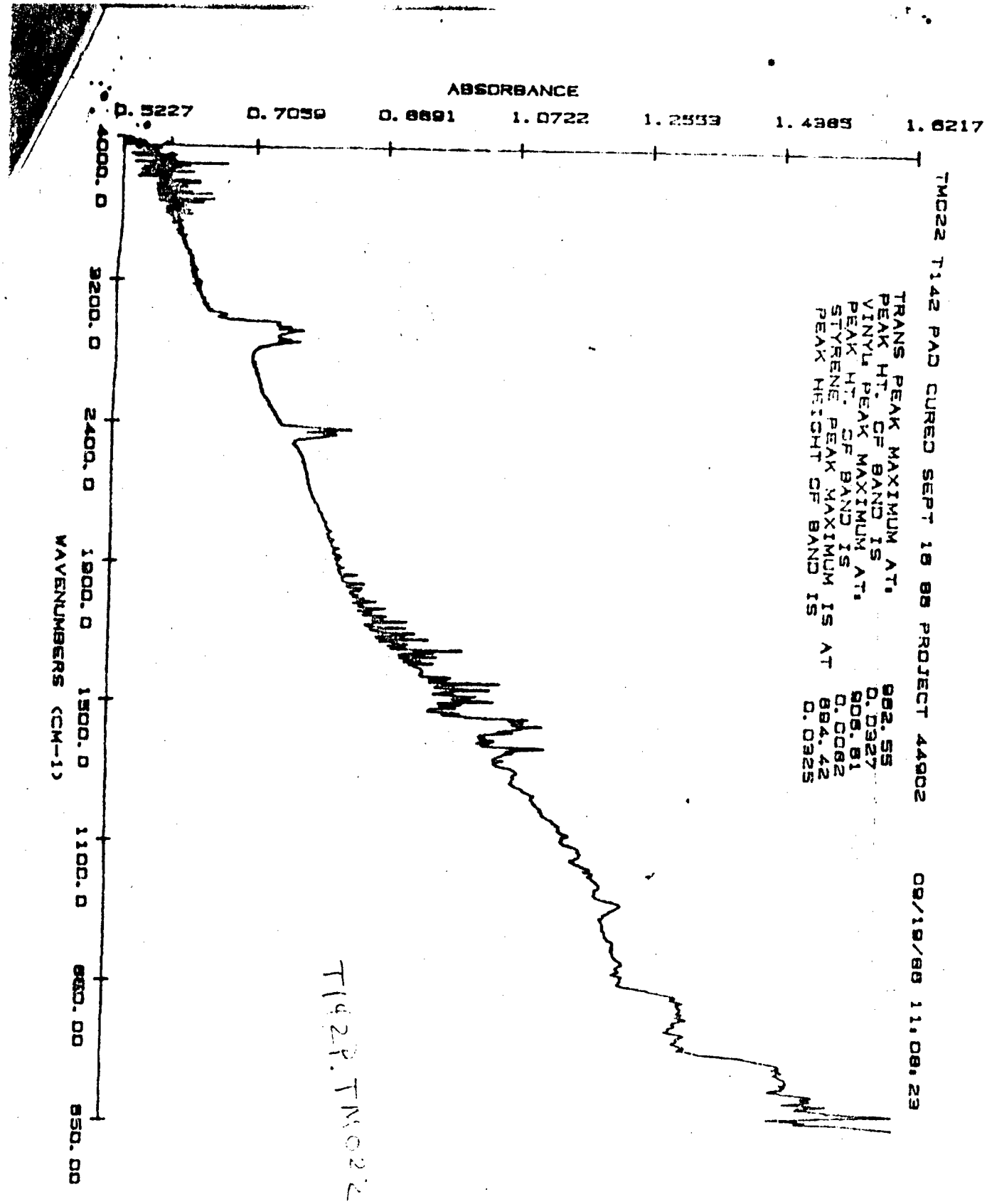
(2) Data taken from T-142 pads cured 70 minutes @ 300°F.

(3) Test performed on 0.500 inch buttons cured 45 minutes @320°F.



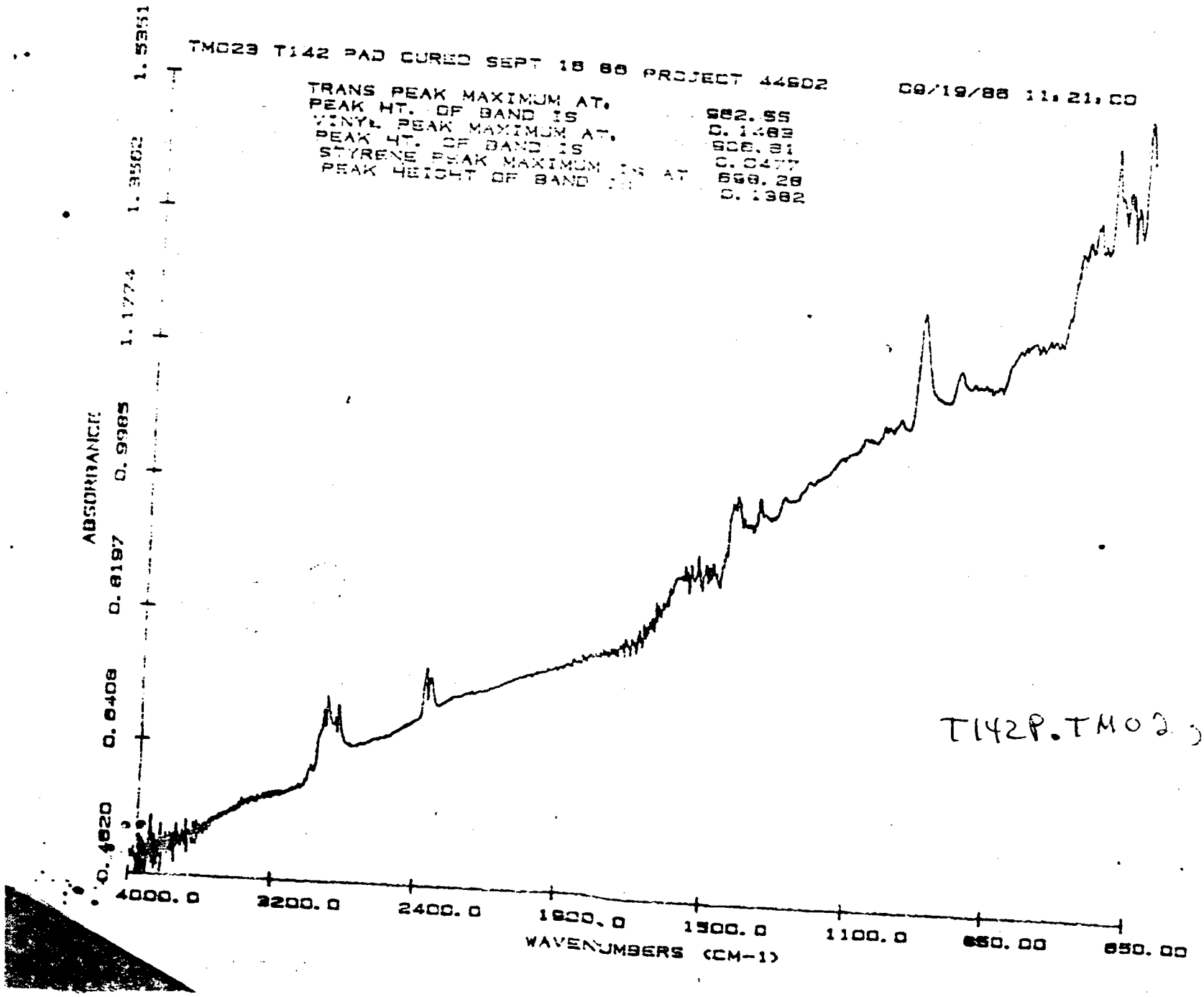
(8)

T142P.TS934



T1421. TMC22

(9)


TM023 T142 PAD CURED SEPT 18 88 PROJECT 44602
09/19/88 11:21:00
TRANS PEAK MAXIMUM AT, 982.55
PEAK HT. OF BAND IS 0.1483
VINYL PEAK MAXIMUM AT, 906.81
PEAK HT. OF BAND IS 0.0477
STYRENE PEAK MAXIMUM IS AT 698.28
PEAK HEIGHT OF BAND IS 0.1382
ABSORBANCE
1.5351
1.3502
1.1774
0.9985
0.8197
0.6408
0.4620
4000.0
3200.0
2400.0
1800.0
1500.0
1100.0
650.00
650.00
WAVENUMBERS (CM-1)
T142P.TM02

(10)

Firestone

WOOSTER, INDIANA 44691

COMPOUND SPECIFICATION

corrected

COMPOUND NO. TS-934

USE: MIL-T-11891 REV C Tri Blend (ground side)

DATE TEMPERATURE F

COLOR: BLACK

MIXING TIME: 5', 4', 3' BATCH WEIGHT @ 400, 460, 470

DATE: 3/12/84

CYCLE TIME: BATCH WEIGHT @

COMPUTER NO.

REPLACES: 14A

COMPOUNDED S P HAAS

CODE	MATERIAL	100 RMC FORMULA WEIGHT	100 RMC FORMULA VOLUME	BANBURY # WEIGHT	BANBURY # WEIGHT	%
5539 MB						
	SBR POLYMER	35.00		90.00		18.
	DIENE POLYMER	30.00		77.00		16.
	NATURAL POLYMER	35.00		90.00		18.
	N220 CARBON BLACK	45.00		116.00		24.
	ZINC OXIDE	3.00		7.72		1.
	STEARIC ACID	1.50		3.86		.
	FLECTOL FLAKES	2.00		5.14		1.
	SUNDEX 790	4.00		10.28		2.
		155.50		400.00		
2540 MB 5539 MB						
	1st master batch	155.50		397.50		
	N220 carbon black	20.00		51.00		10.
	Santoflex 13	3.00		7.67		1.
	Sunolite 100 wax	1.50		3.83		.
		180.00		460.00		
TS934 5540 MB						
	2nd master batch	180.00		458.04		
	sulfur	1.30		3.31		.
	Santocure IPS	3.20		8.14		1.
	PVI	0.20		.51		.
TOTALS		184.70		470.00		100.

REMARKS: (REASON FOR CHANGE, SPECIAL INSTRUCTIONS, ETC.)

CONTROL COMPOUND FOR T156 TANK TRACK (GROUND SIDE) AS SPECIFIED IN U.S. GOV'T. SPEC MIL-T-11891 Rev C(compound 14A)

B. F. 2.57 2.55 2.54

CONTROL TEST REQUIREMENTS			STANDARD PHYSICALS	
TEST	STANDARD	FREQ.		
RHEOGRAPH @	SEE CHART		100% MOD.	
COMPRESSION			300% MOD.	
COLOR	SEE SPECIMEN		TENSILE	2000
HARDNESS (DUROA)	±		ELONGATION	2900
TENSILE (PSI)	MIN.		HARDNESS	400
ELONG (%)	MIN.		SP. GRAVITY	72
MODULUS (PSI)				1.14
SPECIFIC GRAVITY	±			
LOW TEMPERATURE				
VISCOSITY				
U. C. BUTTON CURE:	MIN. @			

(11)

Firestone

NOBLESVILLE, INDIANA 46060

COMPOUND SPECIFICATION

COMPOUND NO. TM022

USE: T-142 - T-157 Pads

BASE _____ TEMPORARY X

COLOR:

DATE: 12-5-84

MIXING TIME: 5' - 4' - 3'

BATCH WEIGHT #

COMPUTER NO.

CYCLE TIME:

BATCH WEIGHT #

REPLACES: New

COMPOUNDER C. W. Murphy

CODE	MATERIAL	100 RHC FORMULA WEIGHT	100 RHC FORMULA VOLUME	BANBURY # WEIGHT	BANBURY # WEIGHT	%
5639						
	Guayle Rubber	35.		90 00		16.95
	Diene Rubber	30.		77 00		16.25
	Natural Rubber	35.		90 00		18.95
	N-220	45.		116 00		24.38
	Zinc Oxide	3.		7 72		1.62
	Stearic Acid	1.5		3 86		.81
	Flectol Flakes	2.		5 14		1.08
	Sundex 790	4.		10 28		2.16
		155.5		400 00		
5640						
5639		155.5		397 5		
	N-220	20.		51 00		10.83
	Santoflex 13	3.		7 67		1.62
	Sunolite 100	1.5		3 83		.81
		180.		460 00		
TM022						
5640		180.		458 04		
	Sulfur	1.3		3 31		.70
	Santocure IPS	3.2		8 14		1.73
	Santogard PV1	.2		51		.11
TOTALS		184.7		470 00		100

REMARKS: (REASON FOR CHANGE, SPECIAL INSTRUCTIONS, ETC.)

S. F. /

Reference solicitation DAAE07-85-Q-X803

2.57
2.55
2.54

Reference paragraph C.1.2

CONTROL TEST REQUIREMENTS				STANDARD PHYSICALS	
	TEST	STANDARD	FREQ.		
	RHEOGRAPH @	SEE CHART		100% MOD.	
	DISPERSION			300% MOD.	
	COLOR	SEE SPECIMEN		TENSILE	
	HARDNESS (DUROA)	±		ELONGATION	
	TENSILE (PSI)	MIN.		HARDNESS 72	
	ELONG (%)	MIN.		SP. GRAVITY 1.14	
	MODULUS (PSI)				
	SPECIFIC GRAVITY	±			
	LOW TEMPERATURE				
	VISCOSITY				
Q. C. BUTTON CURE:		MIN. @			
Q. C. SLAB CURE:		MIN. @			

COMPOUND NO.

Firestone

NOBLESVILLE, INDIANA 46060

COMPOUND SPECIFICATION

USE: T-142 - T-157 Pads

COLOR:

MIXING TIME: 5'-4'-3' BATCH WEIGHT #

CYCLE TIME: BATCH WEIGHT #

COMPOUND NO. TM023

BASE TEMPORARY X

DATE: 12-5-84

COMPUTER NO.

REPLACES: New

COMPOUNDER C. W. Murphy

CODE	MATERIAL	100 RHC FORMULA WEIGHT	100 RHC FORMULA VOLUME	BANBURY # WEIGHT	BANBURY # WEIGHT	%
5641						
	SBR Polymer	35.		90 00		18.95
	Diene Polymer	30.		77 00		16.25
	Guayle Rubber	35.		90 00		18.95
	N220	45.		116 00		24.38
	Zinc Oxide	3.		7 72		1.62
	Stearic Acid	1.5		3 86		.81
	Flectol Flakes	2.0		5 14		1.08
	Sundex 790	4.0		10 28		2.16
		155.5		400 00		
5642						
5641		155.5		397 5		
	N-220	20.		51 00		10.83
	Santoflex 13	3.		2 67		1.62
	Sunolite 100	1.5		3 83		.81
		180.0		400 00		
TM023						
5642		180.		458 04		
	Sulfur	1.3		3 31		.70
	Santocure IPS	3.2		8 14		1.73
	Santogard PVI	.2		51		.11
TOTALS		184.7		470 00		100.

REMARKS: (REASON FOR CHANGE, SPECIAL INSTRUCTIONS, ETC.)

B. F. /

Reference Solicitation DAAE07-85-Q-X803
Reference paragraph C.1.3

2.57
2.55
2.54

CONTROL TEST REQUIREMENTS

TEST	STANDARD	FREQ.
RHEOGRAPH @	SEE CHART	
DISPERSION		
COLOR	SEE SPECIMEN	
HARDNESS (DUROA)	±	
TENSILE (PSI)	MIN.	
ELONG (%)	MIN.	
MODULUS (PSI)		
SPECIFIC GRAVITY	±	
LOW TEMPERATURE		
VISCOSITY		
Q. C. BUTTON CURE:	MIN. @ °F	
Q. C. SLAB CURE:	MIN. @ °F	

STANDARD PHYSICALS

100% MOD.	
300% MOD.	
TENSILE	
ELONGATION	
HARDNESS	72
SP. GRAVITY	1.14

COMPOUND NO.