Adhesive Modifiers

MONSANTO COMPANY

Plastic Products & Resins Division

Bircham Bend Plant

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ADHESIVES F

MODIFIERS FOR PVAc EMULSIONS

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MODIFIERS FOR PVAc EMULSIONS

Introduction

The Plasticizer Products Group, Monsanto Central Research, are preparing data sheets for several of their new plasticizers for the adhesive industry. In order to obtain comparative data on these plasticizers versus competitive products, we were requested to evaluate the following on Gelva Emulsions S-55 and TS-65.

I. Viscosity Build
II. Quick Tack
III. Heat Seal Temperature
IV. Film Characteristics Including Clarity, Grits, Craters and Flexibility
V. Ultimate Tensile Strength, Modulus and Per Cent Elongation at the 15 Per Cent Plasticizer Level

The following ten plasticizers were to be tested at four levels: 2, 5, 10 and 15 per cent.

1. Diisobutyl Phthalate
2. Santicizer 218A
3. Santicizer 885
4. Santicizer 883
5. Eastman K135
6. Benzoflex 2-45
7. Benzoflex 50 (50/50 - 988/2-45)
8. Dibutyl Phthalate
9. Santicizer 160
10. Benzoflex 988

Details of Test Methods and Discussion of Results

Note: Due to the large amount of data produced by this project, each test will be covered on an individual basis, i.e. the test method will be described and a discussion of the relative performance of each plasticizer in each of the two Gelva Emulsions will be included.

I. Viscosity Build

A. Test Method

The viscosities were run on a Brookfield Viscometer, Model LVF at 25°C. Spindles, speeds and ranges are

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listed below:

#3 Spindle - 30 rpm 0 to 4,000 cps.
#3 Spindle - 12 rpm - 4,000 to 10,000 cps.

B. Test Results - S-55

The control was 1440 cps. The final viscosities at the 15 per cent plasticizer level ranged from a low of 2160 cps. for Santicizer 160 to a high of 3360 cps. for Eastman Kl35. There was little or no viscosity build at the 2 per cent plasticizer level, in some cases a slight decrease was observed. As the plasticizer level was increased (over the 2 per cent level), the viscosities increased proportionally but there was not enough difference between plasticizers to show clearly by graphical methods.

C. Test Results - TS-65

The control was 1860 cps. The final viscosities at the 15 per cent plasticizer level ranged from a low of 5200 cps. for Santicizer 160 to a high of 14,700 for Benzoflex 50. Several others were in the range of 8 - 9,000 cps., namely Santicizer 883, Santicizer 885 and Benzoflex 988. There was not enough difference in the remaining five to show clearly by graphical methods. See Fig. 1 for a comparison of the high viscosity and low viscosity materials and a representative of the 8,000 cps. category and one for the remaining five materials.

II. Quick Tack

A. Test Method

A 1.5 mil wet adhesive film was cast on bleached sulfite paper (Ditto paper). Another piece was placed over it immediately and a bond made with several passes of the palm of the hand. The time in seconds to produce 100 per cent paper failure is observed by slowly peeling the two sheets apart.

B. Test Results - S-55

There was some variation but most of the blends followed the pattern of DBP shown on curve #1 on Fig. 2. The others, varying from this pattern, Santicizer 160, Benzoflex 2-45 and Eastman Kl35 are also shown.

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C. Test Results - TS-65

There was only one variation in quick tack for this series. Once again as in the S-55 series Kl35 showed a much longer quick tack time at the 15% plasticizer level (28 seconds).

III. Heat Seal Temperature

A. Test Method

A 5 mil wet film is cast on Ditto paper. It is dried and then conditioned for 24 hours at 50% R.H. and 70°F. A front/back laminate is fused on a Pack-Rite Heat Sealer. The dwell time (5 sec.) and the jaw pressure (28.4 psi) are kept constant. The temperature is raised in 10°F. increments until a 100% paper tearing bond is obtained.

B. Test Results - S-55R

The heat seal temperatures dropped regularly as expected. The 2 per cent level of plasticizer caused little or no lowering of the heat seal temperature. They started at a higher temperature (140°F.) than TS-65 and at the 15% level were also slightly higher so as a result they were not as close to the pressure sensitive range where blocking would become a problem. No graphical presentation of this series is included as the curves would nearly be superimposed one on the other.

C. Test Results - TS-65

As expected, heat seal temperatures on all blends dropped off rapidly so at the 15 per cent plasticizer level the films were nearly pressure sensitive. All blends, however, increased in heat seal temperature about 10°F. at 2 per cent level. This is possibly due to migration of the low level of plasticizer to the interface without appreciably softening the polymer. At the higher plasticizer levels the softening of the polymer would offset the effect of the oily layer at the interface. At the 10 per cent level there is a considerable spread in heat seal temperatures from a low of 90°F. for Santicizer 883 to a high of 110°F. for DIBP and Eastman Kl35. See Fig. 3 and Fig. 4.

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IV. Film Properties

A. Test Method

The film clarity, level of grits and crater formations were evaluated visually. The flexibility was evaluated quantitatively by hand. Water spot time was determined by placing a drop of water on a dry film and noting the time necessary for opacity to appear.

B. Test Results - S-55

In all cases, as expected, there was a gradual increase in flexibility with the increase in plasticizer level. Film clarity improved at the 5 per cent level in a few cases and in all cases at the 15 per cent level; the most improvement was noted in Benzoflex 245, 50 and 988 and in Santicizer 160. Grit level in the films varied considerably. (See attached data.) Only in DBP, Santicizer 160 and Benzoflex 988 were there fewer grits visible at the higher plasticizer levels. Also, cratering increased in most cases but decreased for DBP, Santicizer 160 and Benzoflex 988. The water spot time did not change in any case due to the addition of plasticizer.

C. Test Results - TS-65

In all cases there was a gradual increase in flexibility as the plasticizer level was increased. In all cases there was no noticeable change in film clarity at the 5 per cent level but there was a moderate amount of improvement at the 15 per cent level. In most cases there was no increase in the number of grits visible with the exception of Benzoflex 2-45. Santicizer 218A and Santicizer 885 showed a few grits at the 15 per cent level. No increase in craters were noted at any of the plasticizer levels. In general, adding plasticizer increased the water spot time particularly at the 15 per cent level.

V. Tensile Strength, Per Cent Elongation and Modulus (at 15% Level)

A. Test Method

One-half inch wide test specimens were run on an Instron Tester using the C cell and a cross-head speed of 0.5 inches per minute for the 2% level and 5.0 inches per

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minute for the 15% level. The thickness of the films was measured with a micrometer. The tensile strength, per cent elongation and modulus were obtained from the Instron data.

B. Tensile Strength

The tensile strengths of the S-55 series are shown on Fig. 5. DIBP started highest at the 2% level but decreased more rapidly than Santicizer 883, Benzoflex 245 and Benzoflex 50 at the higher plasticizer levels.

In the TS-65 series, Benzoflex 50 showed the highest values. Data are presented on Fig. 6.

C. Per Cent Elongation

These series were evaluated on the per cent increase in elasticity between the 2 per cent and 15 per cent plasticizer levels. In the S-55 series Santicizer 885 made the best showing with an increase of 173 per cent. DBP showed no increase in elasticity between the two plasticizer levels.

In the TS-65 series, Santicizer 885 again showed the greatest gain at 832 per cent. Eastman K135 showed the least increase with 325 per cent. It is interesting to note the much greater increase in the TS-65 series as compared to the S-55 series.

D. Modulus

In the S-55 series there were only minor differences in seven of the blends; they ranged from 210 psi to 227 psi. However, Eastman K135 at 170 psi, Benzoflex 988 at 155 psi and Santicizer 160 at 147 psi were lower than the closely grouped materials.

In the TS-65 series six of the blends were relatively equal in the range of 96.7 psi to 83.5 psi. Benzoflex 245 at 62.5 psi and Santicizer 218A at 65.0 psi were the low values in this series.

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TENSILE STRENGTH AND PER CENT ELONGATION

AT 2 PER CENT PLASTICIZER LEVEL

	PSI	Per Cent Elongation
TS-65 + 2%		
DIBP	1775	55
S 218A	1333	210
S 885	1082	110
S 883	1397	117
EK 135	1067	222
B 245	1050	70
B 50	2000	15
DBP	1065	255
S 160	1100	60
B 988	1900	155
S-55 + 2%		
DIBP	2000	142
S 218A	1365	65
S 885	1297	107
S 883	1297	190
EK 135	1330	220
B 245	1565	200
B 50	1165	200
DBP	850	180
S 160	1000	195
B 988	725	212

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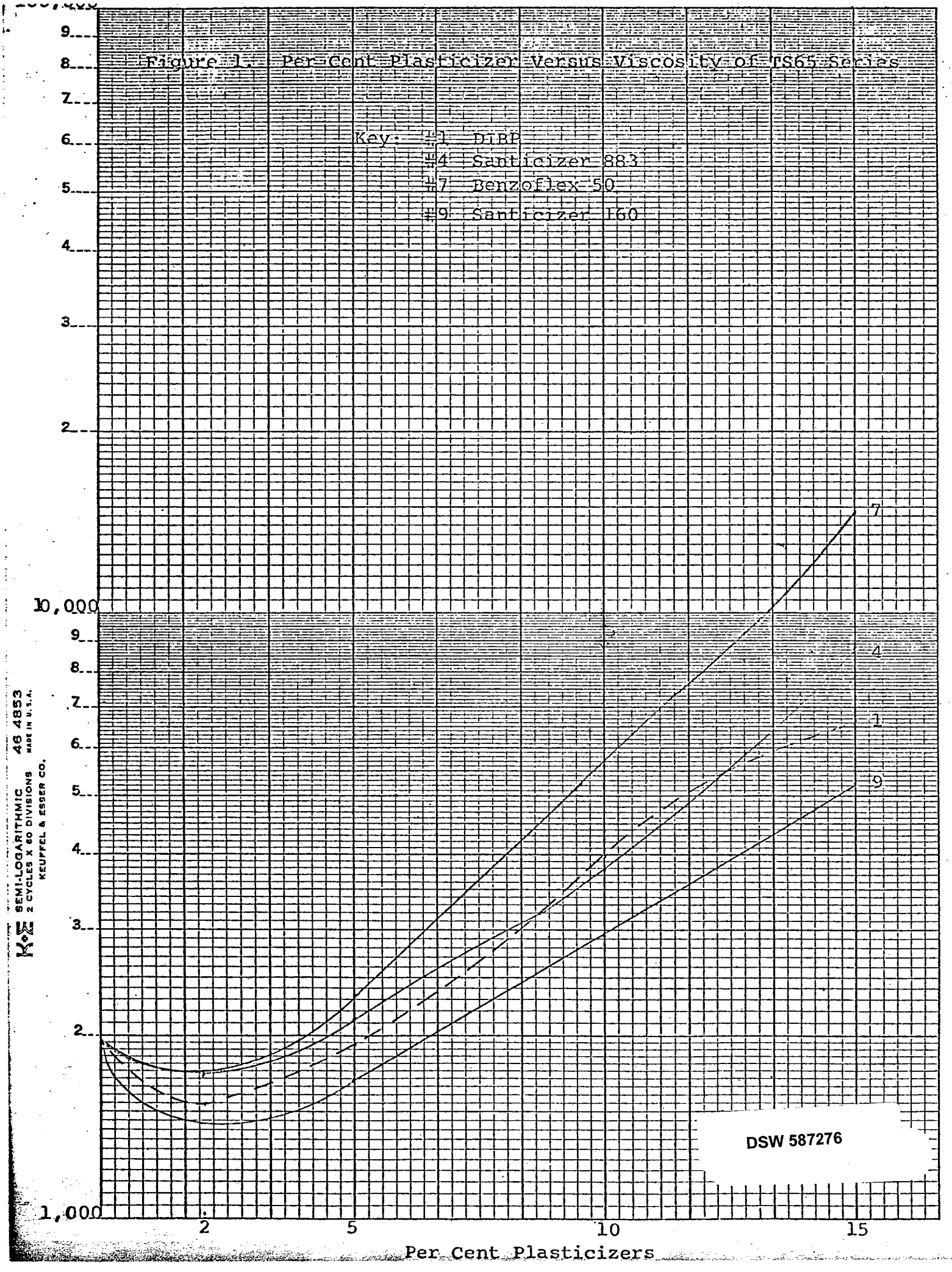
TENSILE STRENGTH

PER CENT ELONGATION AND MODULUS AT 15 PER CENT PLASTICIZER LEVEL

TS-65 + 15%	PSI	Per Cent Elongation	Modulus At 100% Elongation
DIBP	213	825	83.5
S 218A	167	862	65.0
S 885	273	942	93.5
S 883	167	900	70.0
EK 135	247	547	86.6
B 245	130	550	62.5
B 50	283	732	97.0
DBP	126	752	63.3
S 160	229	865	93.5
B 988	226	532	96.7
S-55 + 15%			
DIBP	339	237	217
S 218A	293	205	217
S 885	310	280	220
S 883	399	312	214
EK 135	257	230	170
B 245	410	337	210
B 50	417	297	227
DBP	280	170	236
S 160	263	271	147
B 988	287	283	155

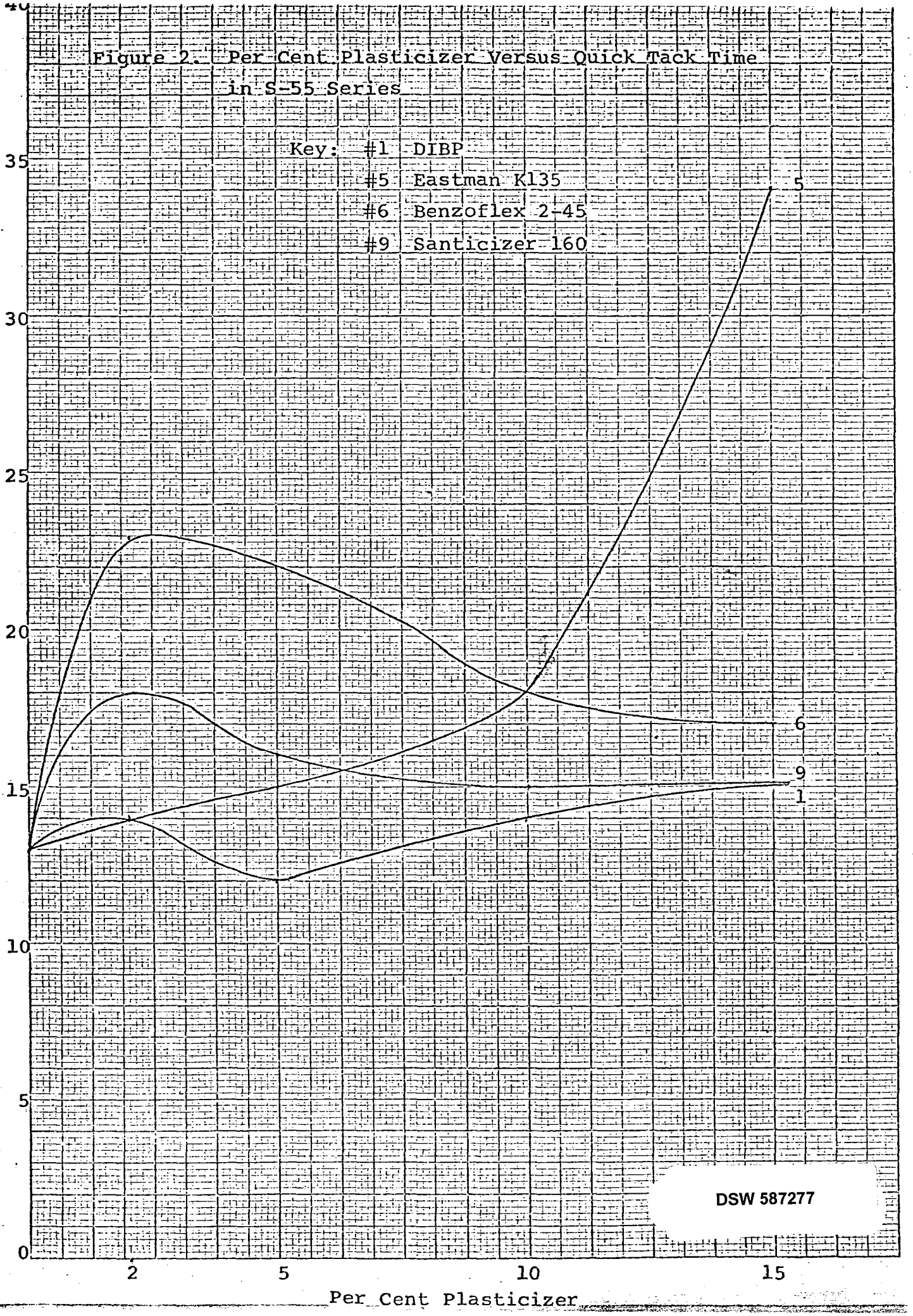
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Figure 1. Per Cent Plasticizer Versus Viscosity of TS65 Series



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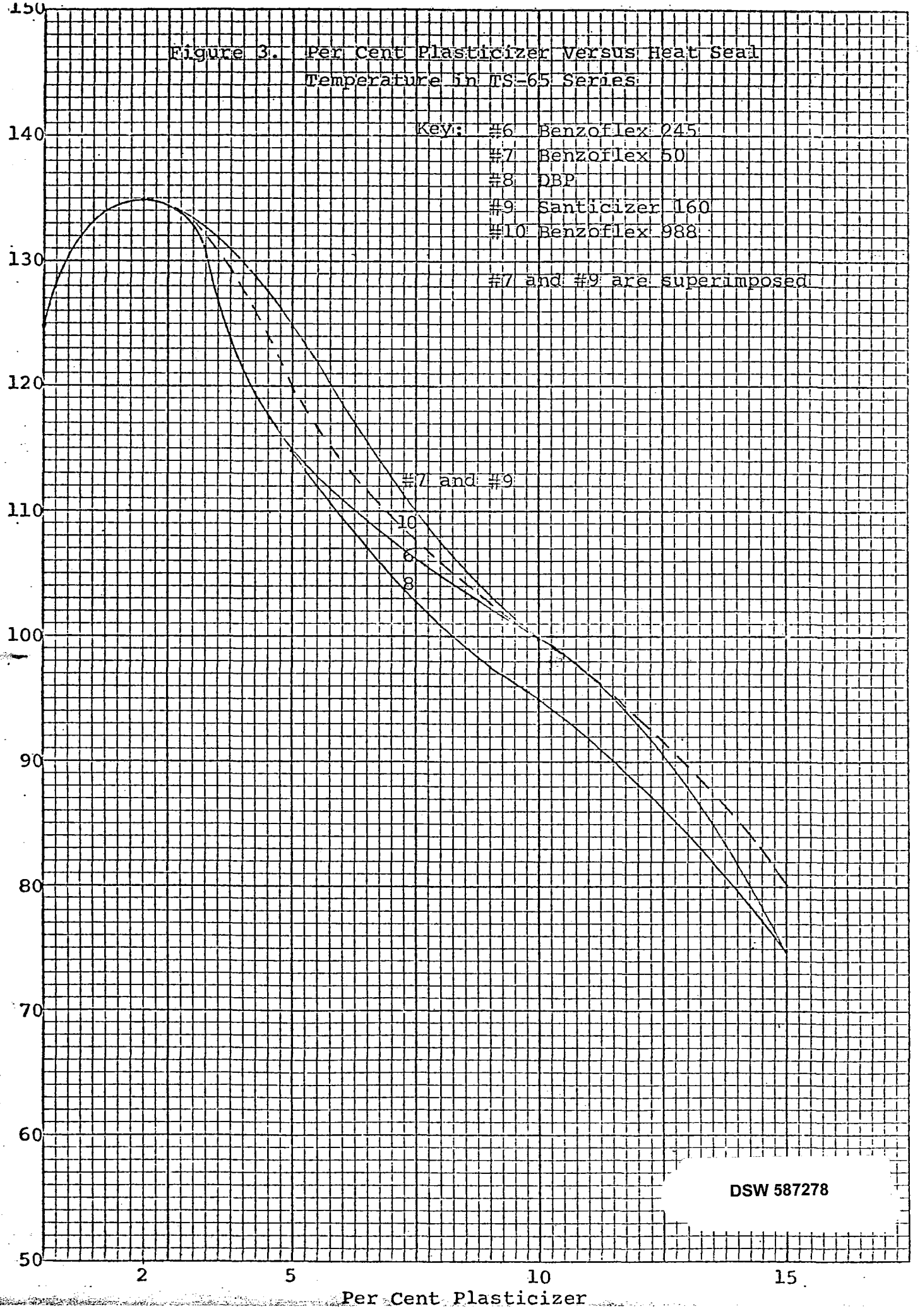
Figure 2. Per Cent Plasticizer Versus Quick Tack Time in S-55 Series



10 X 10 TO ½ INCH 46 1320
7 X 10 INCHES MADE IN U.S.A.
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Figure 3. Per Cent Plasticizer Versus Heat Seal Temperature in TS-65 Series

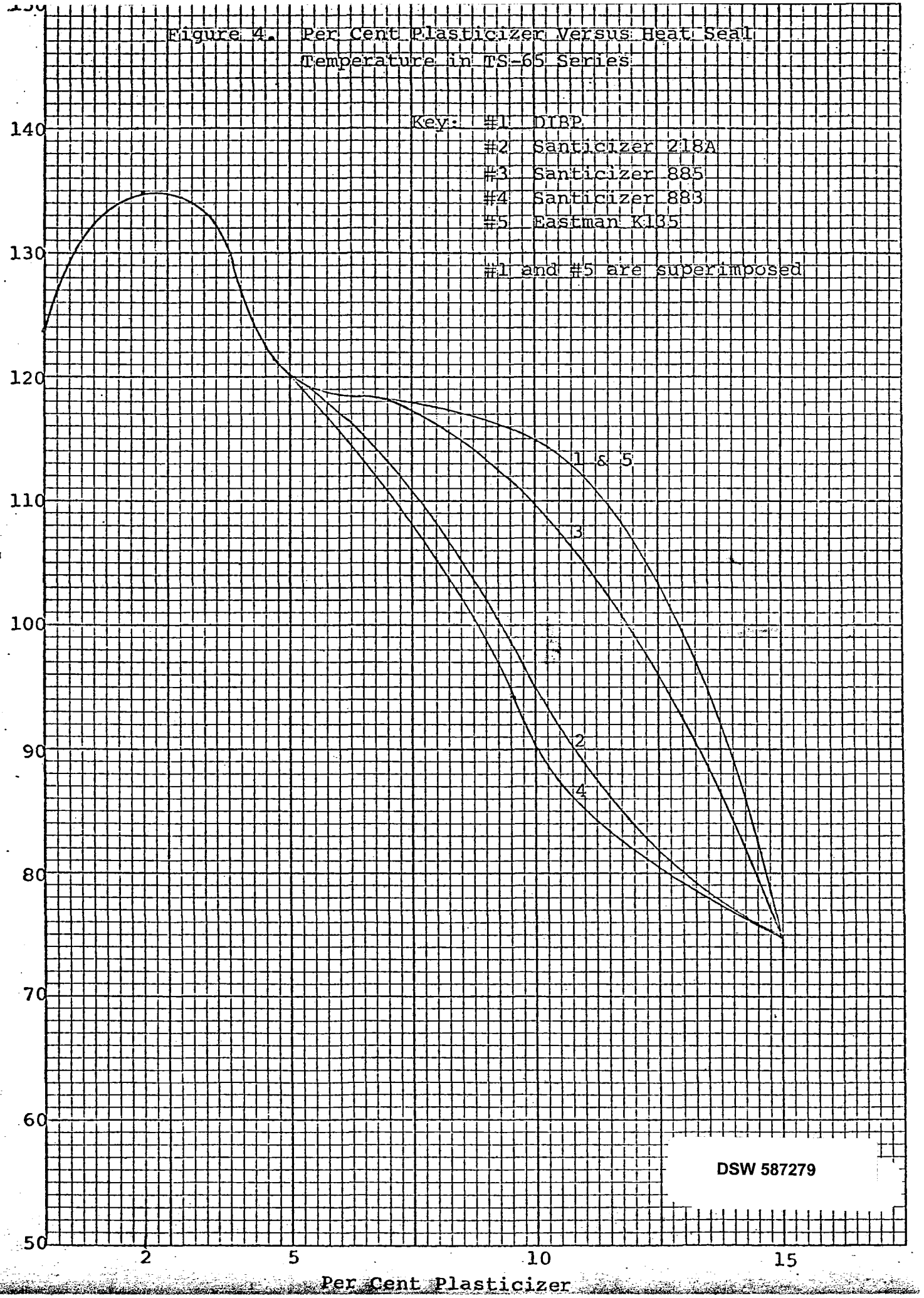


10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

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Figure 4. Per Cent Plasticizer Versus Heat Seal Temperature in TS-65 Series

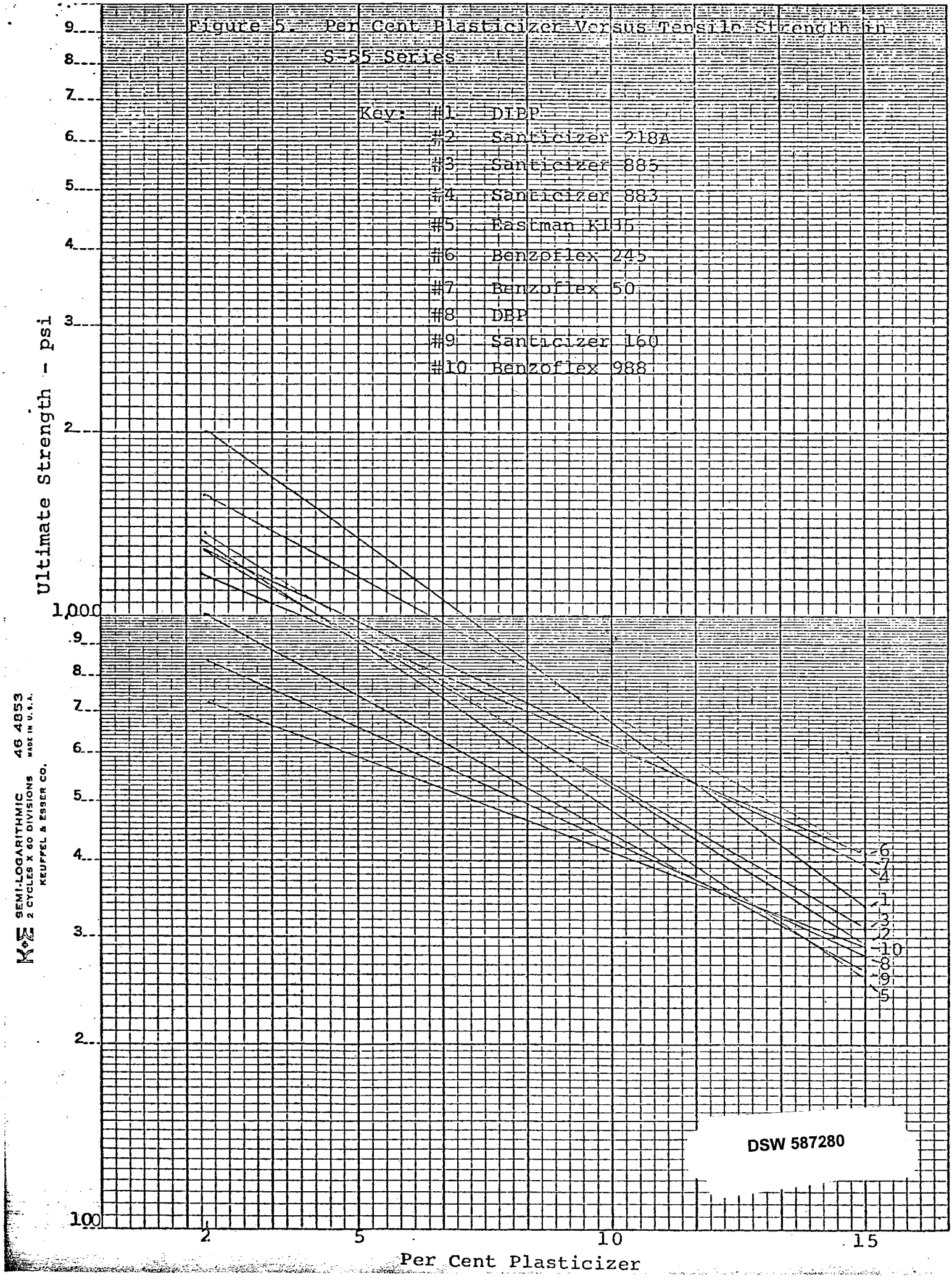


KE 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

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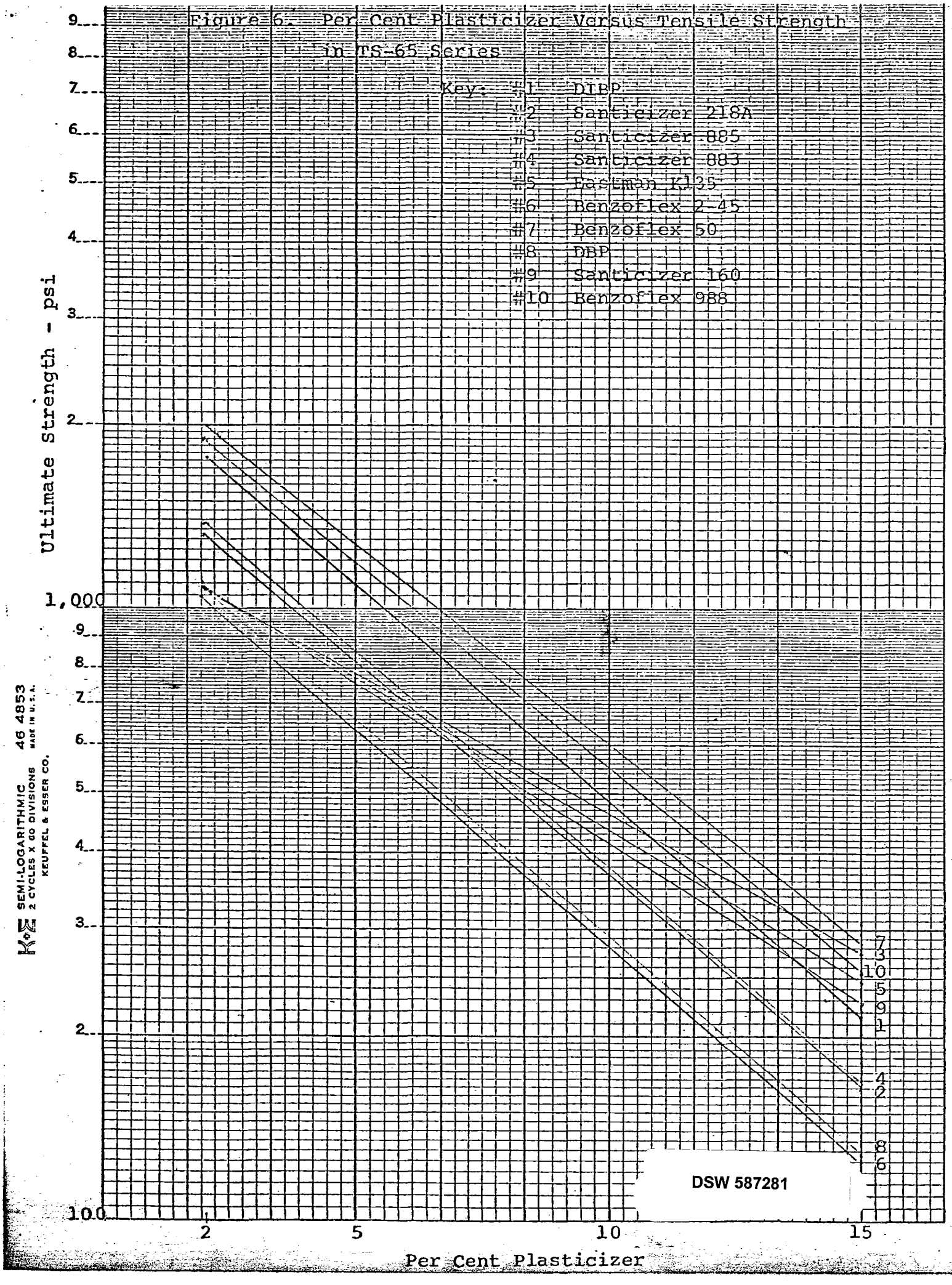
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Figure 5. Per Cent Plasticizer Versus Tensile Strength in S-55 Series



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Figure 6. Per Cent Plasticizer Versus Tensile Strength in TS-65 Series



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PERFORMANCE PROPERTIES OF TS65 SERIES

	Viscosity 25°C CPS	Quick Tack Ditto Sec.	Heat Seal Face/Back Deg.F	Film Clarity	Film Grits	Film Craters	Film Flexibility	Water Spot
Diisobutyl Phthalate								
0 Percent	1860	8	125					
2 "	1520	13	135					
5 "	1920	10	120	0	0	0	+ +	+
10 "	4000	12	110					
15 "	6600	16	75	+	0	0	+ +	+
Santicizer-218A								
0 Percent		8	125					
2 "	1860	10	135					
5 "	2220	10	120	0	0	0	+ +	0
10 "	3000	12	95					
15 "	6500	13	75	+	+	0	+ +	+
Santicizer 885								
0 Percent		8	125					
2 "	1880	9	135					
5 "	2220	10	120	0	0	0	+ +	+
10 "	5450	10	115					
15 "	9100	13	75	+	+	0	+ +	+
Santicizer 893								
0 Percent		8	125					
2 "	1740	11	135					
5 "	2060	9	120	0	0	0	+ +	+
10 "	3620	10	90					
15 "	8550	14	75	+	0	0	+ +	+
Eastman X 135								
0 Percent		9	125					
2 "	1740	10	135					
5 "	2280	11	120	0	0	0	+ +	+
10 "	5500	15	110					
15 "	6600	28	75	+	0	0	+ +	+
Benzoflex 2-45								
0 Percent		8	125					
2 "	1860	10	135					
5 "	2260	10	115	0	+	0	+ +	0
10 "	5550	11	100					
15 "	6900	13	75	+	+	0	+ +	+

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PERFORMANCE PROPERTIES OF TS65 SERIES (continued)

	Viscosity 25°C CPS	Quick Tank Ditto Sec.	Heat Seal Face/Back Deg.F	Film Clarity	Film Grits	Film Craters	Film Flexibility	Water Spot
Benzoflex 50								
0 Percent	1960	8	125					
2 "	1740	9	135					
5 "	2340	8	125	0	0	0	++	0
10 "	5850	9	100					
15 "	14,700	13	75	+	0	0	++	+
Dibutyl Phthalate								
0 Percent	1860	8	125					
2 "	1480	11	135					
5 "	1880	11	115	0	0	0	++	+
10 "	5100	11	95					
15 "	6000	17	75	+	0	0	++	+
Santicizer 160								
0 Percent	1860	8	125					
2 "	1440	12	135					
5 "	1660	9	125	0	0	0	++	+
10 "	2960	11	100					
15 "	5200	13	75	+	0	0		+
Benzoflex 988								
0 Percent		8	125					
2 "	1760	9	135					
5 "	2300	10	120	0	0	0	++	0
10 "	5300	10	110					
15 "	8750	13	80	+	0	0	++	+

Key:
0 - essentially no change
\+ - slight improvement or increase
++ - considerable improvement or increase
\- - slight detraction or decrease
= - considerable detraction or decrease

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PERFORMANCE PROPERTIES OF S55 SERIES — S55R #7011

	Viscosity 25°C CPS	Quick Tack Ditto Sec.	Heat Seal Face/Back Deg.F	Film Clarity	Film Gels	Film Craters	Film Flexibility	Water Spot
Diisobutyl Phthalate								
0 Percent	1440	13	140					
2 "	1420	14	140					
5 "	1640	12	110	0		0	+ +	0
10 "	2160	14	110					
15 "	3280	15	100	+		0	+ +	0
Santicizer - 218 A								
0 Percent		13	140					
2 "	1420	14	140					
5 "	1620	13	110	0		+	+ +	0
10 "	2120	13	110					
15 "	2960	15	100	+		0	+ +	0
Santicizer 885								
0 Percent		13	140					
2 "	1460	13	140					
5 "	1640	13	120	0		+	+ +	0
10 "	2180	14	110					
15 "	2960	16	90	+		+	+ +	0
Santicizer 883								
0 Percent		13	140					
2 "	1440	12	140					
5 "	1600	13	125	0		0	+ +	0
10 "	2120	14	110					
15 "	2840	15	90	+		0	+ +	0
Eastman K 135								
0 Percent		13	140					
2 "	1480	14	130					
5 "	1660	15	110	0		+	+ +	0
10 "	2280	18	110					
15 "	3360	34	110	+		+	+ +	0
Benzoflex 2-45								
0 Percent		13	140					
2 "	1460	23	130					
5 "	1540	22	120	0		+	+ +	0
10 "	2120	18	110					
15 "	2620	17	99	+ +		+	+ +	0

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PERFORMANCE PROPERTIES OF S55 SERIES (continued)

	Viscosity 25°C CPS	Quick Tack Ditto Sec.	Heat Seal Face/Back Deg.F	Film Clarity	Film rity	Film Craters	Film Flexibility	Water Spot
Benzoflex 50								
0 Percent		13	140					
2 "	1460	16	120					
5 "	1730	15	110	0	+	+	+ +	0
10 "	2230	17	110					
15 "	3040	17	90	+ +	+	+	+ +	0
Dibutyl Phthalate								
0 Percent	1440	13	140					
2 "	1200	18	145					
5 "	1560	16	130	+	0	(-)	+ +	0
10 "	2080	15	120					
15 "	2560	15	100	+	(-)	(-)	+ +	0
Santicizer 160								
0 Percent	1440	13	140					
2 "	1280	18	135					
5 "	1520	17	125	+	0	(-)	+ +	0
10 "	1920	15	120					
15 "	2160	17	115	+ +	(-)	(-)	+ +	0
Benzoflex 988								
0 Percent	1440	13	140					
2 "	1440	17	140					
5 "	1640	15	125	+	0	(-)	+ +	0
10 "	2240	15	120					
15 "	2640	15	110	+ +	(-)	0	+ +	0

Key: 0 - essentially no change
+ - slight improvement or increase
++ - considerable improvement or increase
- - slight detraction or decrease
= - considerable detraction or decrease

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