Oresins

STATUS REPORT

THE UTILITY OF PROCESS 11 VINYL CHLORIDE RESINS IN FLOORING APPLICATIONS

PHASE 1 - UNFILLED COMPOUNDS

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ABSTRACT

The performance of three ethylene modified vinyl chloride resins in an unfilled vinyl tile formulation are compared to conventional poly(vinyl chloride) resin. The resins exhibit greater flexibility, more resiliency, improved brittle temperature, greater extensibility, and easier processing characteristics than conventional Union Carbide Corporation suspension PVC counterparts. The level of ethylene contained in the sample of QXOM-7 did not exhibit the degree of influence on the tile properties or processing as that shown for QXOH-7 and QXOS-7.

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THE UTILITY OF PROCESS 11 VINYL CHLORIDE RESINS IN FLOORING APPLICATIONS

PHASE 1 - UNFILLED COMPOUNDS

INTRODUCTION

The first of a three phase program designed to compare the performance of Process 11 vinyl chloride resins in vinyl flooring applications with conventional poly(vinyl chloride) homopolymers has been completed.

SUMMARY AND CONCLUSIONS

The performances of QXOH-7, QXOM-7, and QXOS-7 as compared to QYSJ, QYTQ-7, and QYSL-7, respectively, in a typical unfilled vinyl tile formulation may be summarized, in general, as follows for the examined physical properties.

1) The influence of ethylene at three levels of external plasticization with FLEXOL® plasticizer DOP (20, 40, and 60 PHR) promotes softer, more flexible, less brittle, easier processing, and more extensible compounds. Larger differences are shown at the higher levels of plasticization.

2) The influence of ethylene is more pronounced on QXOH-7, and QXOS-7 than on QXOM-7; the respective levels are 1.05, 0.89, and 2.06 per cent.

3) The Process 11 resins require lesser amounts of external plasticization to achieve a desired physical property as indicated:

QXOH-7	11 per cent of total plasticizer in QYSJ
QXOM-7	7 per cent of total plasticizer in QYTQ-7
QXOS-7	21 per cent of total plasticizer in QYSL

4) Neither plasticizer incompatibility nor resin contribution to staining appear to be a problem.

5) QXOH-7 and QXOS-7 exhibit wider differences in processability than QXOM-7 when compared to their respective homopolymer controls. Higher torques are encountered during the fusion of the Process 11 resins when tested on the Torque-Rheometer.

6) QXOH-7 and QXOM-7 are suitable for conventional all vinyl tile; QXOS-7 may be used but higher processing temperatures are required.

DISCUSSION

This study is designed to show the effects of comonomer level, molecular weight, and plasticizer level on several important unfilled vinyl tile properties. The data are shown in Tables I thru III and in Figures 1 through 17. The observations reported herein are based more on trends rather than single points. Comments relative to the specific tests conducted in this investigation follow:

Shore A and D Hardness - Both tests, a measure of indentation of the approximate hardness of rubberlike materials, were run to insure comparative ratings on the soft to hard compounds. The Process 11 resins are indicated as exhibiting consistently lower readings (softer) than the controls as follows in a table (and others that follow) to indicate relative differences. Please refer to Table II for specific comparisons.

Resin		Average Test Units Lower Than Control Shore A		Shore D	
QXOH-7	1.05	2.0	(2%)	4.0	(9%)
QXOM-7	.89	2.0	(2.5%)	4.4	(7.2%)
QXOS-7	2.04	5.3	(6.0%)	8.7	(18.0%)

This indicates the effect of comonomer level and external plasticization on the subject resins; QXOS-7 is indicated as the most sensitive or most efficient in terms of internal plasticization.

McBurney Indentation, a measure of indentation resistance, indicates that the Process 11 resin is more susceptible to external plasticization than their homopolymer counterparts as shown below:

Resin		Average Test Units Lower Than Control McBurney 1 Minute, mils		10 Minute, mils	
QXOH-7	1.05	5.9	(12.5%)	3.9	(11.0%)
QXOM-7	.89	0		3.4	(11.1%)
QXOS-7	2.04	8.8	(14.0%)	10.0	(13.6%)

Again, QXOS-7 is indicated as the most efficient of the Process 11 resins tested.

Residual Indentation is a measure of indentation and of indention recovery. The differences between the Process 11 resins and the controls are very slight as indicated below:

Resin	Average Test Units Higher Than Control: Residual Indentation, mils		Per Cent Recovery	
QXOH-7	0.96	(24.5%)	-4	(5%)
QXOM-7	0.06	(1.9%)	-3	(3.7%)
QXOS-7	0.68	(25.0%)	+17	(21%)

All resins except QYSL exhibited a recovery of greater than 75 per cent, the minimum acceptable limit (Federal Specification L-T-751).

Tensile and Elongation are measures of extensibility. The Process 11 resins show a slight loss in tensile strength and a slight gain in elongation as expected. A comparison with the control resins follows:

Resin	Average Test Units Compared With Control: Tensile, psi Lower		Elongation, % Higher	
QXOH-7	162	(6.3%)	32	(13.8%)
QXOM-7	89	(3.0%)	18	(6.3%)
QXOS-7	286	(8.5%)	33	(11.1%)

The slight loss in tensile is not considered as serious for most flooring applications.

100 Per Cent Modulus is a measure of room temperature stiffness. The Process 11 resins exhibit a consistently lower value than the respective homopolymer control i.e. less stiff. A comparison with the controls follows:

Resin	Average Test Units Lower Than Control: Modulus, psi	
QXOH-7	222	(10.5%)
QXOM-7	165	(7.6%)
QXOS-7	433	(22.0%)

QXOS-7, again, is indicated as the most efficient of the resins tested.

Brittle Temperature (ASTM-D-746) is a measure of low temperature performance in impact. The Process 11 resins exhibit consistently better performance as shown by the following data:

Resin	Average Test Units Lower Than Control Brittleness, °C	
QXOH-7	4	(67%)
QXOM-7	3.3	(36%)
QXOS-7	6.7	(59%)

Apparent Melt Viscosity is a measure of processability. These compounds were tested at the standard conditions for plasticized compounds. The comparison with the controls follow:

Resin	Average Test Units Lower Than Control Apparent Melt Viscosity m-g/sec		Equilibrium Temperature °C	
QXOH-7	210	(15%)	2	(1%)
QXOM-7	13	(0.8%)	0	
QXOS-7	200	(5%) *	1	(0.7%) *

* 40 phr only

The melt characteristics of QXOH-7 and QXOS-7 are in general agreement with previous findings that indicate easier processing; the performance of QXOM-7 did not follow these previous results and is not consistent with the QXOH-7 and QXOS-7 performances.

Fusion Characteristics are a measure of the energy requirements in the initial processing operation. The Process 11 resins are more easily fused as indicated below:

Resin	Average Test Units Lower Than Control Fluxing Time min.		Fusion Temperature, °C	
QXOH-7	1.2	(20%)	7	(6%)
QXOM-7	4.2	(43%)	11	(10%)
QXOS-7	11.0	(81%) *	25	(22%) *

* - 60 phr

Higher maximum torques are obtained with the Process 11 resins which may be related to differences in particle geometrics. The faster fluxing of the Process 11 resins is thought to be related to the higher torques and thus higher frictional heat.

Stain Resistance - The Process 11 resins exhibit a stain level comparable to the controls. The stain levels of all resins were directly proportional to plasticizer concentration.

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/jb

Attachments:

3 Tables
17 Figures

TABLE I

PROCESS 11 - VINYL CHLORIDE RESINS

CHEMICAL AND PHYSICAL PROPERTIES

	QXOH-7 Blend 1	QXOM-7 Blend 3	QXOS-7 Blend 4
Ethylene, %	1.05	0.89	2.06
Inherent viscosity, ASTM A	0.775	0.98	1.31
Heating Loss, %	0.3	0.2	0.6
Contamination, slurry	2	1	2
Apparent density, lbs/ft^3	32.5	29	27
Particle size, median	160	181	215
Thru 200-mesh, %	7	2	2
Hard resin particles,			
17.5 mil, $ft.^{-2}$	40	0	0
10 mil, $ft.^{-2}$	1152	25	83
Clear fisheye test	8	2	2
Initial color mill test	102	113	114
Resin flow time, sec/400cc	3.4	-	-
Dry blend time, min.	4.8	3.3	2.0
°C	81	79	77

TABLE II

PROCESS 7 AND 11 POLY (VINYL CHLORIDE) RESIN

UNFILLED VINYL TILE PROPERTIES

Resin	Plasticizer Concentration, phr	Durometer "A"	Durometer "D"	McBurney Indentation, Mils 1 min	McBurney Indentation, Mils 10 min	Residual Indentation Mils	Residual Indentation Recovery %	Tensile Strength, psi	Ultimate Elongation, %	100% Modulus, psi	Brittleness, %	Stain - Relative(1) Asphalt	Stain - Relative(1) Sandura	Apparent Melt Viscosity m-g/sec	Apparent Melt Viscosity °C	Fusion Characteristics Time, min	Fusion Characteristics Temp. °C	Fusion Characteristics Max. Torque
QYSJ	20	97	73	4.8	6.4	0.16	84.5	3290	140	3280	+20	1	1	2000	154	4.0	111	4600
	40	84	38	30.9	37.4	2.3	93.8	2700	240	2050	-14	3	4	1270	146	6.8	109	1270
	60	71	22	36.5	51.0	6.4	73.8	1820	310	1070	-24	5	5	860	141	7.0	107	860
QXOH-7	20	96	68	7.3	9.8	0.99	78.3	3090	210	3040	+10	1	1	1720	151	3.3	110	4650
Blend 1	40	82	33	34.4	36.0	2.5	94.4	2590	260	1810	-16	3	4	1090	144	3.8	97	3350
	60	68	20	48.4	60.8	8.3	68.2	1640	330	880	-24	5	5	690	140	7.0	98	1800
QYTQ-7	20	98	74	4.6	6.4	0.16	79.2	3550	200	3420	+16	1	1	2400	158	4.7	114	4700
	40	85	40	33.2	40.0	2.8	93.2	3040	280	2080	-16	3	4	1540	149	11.4	120	2550
	60	70	23	45.0	49.6	6.1	83.3	2330	380	1050	-28	5	5	1050	144	13.2	114	1050
QXOM-7	20	96	70	6.3	9.6	0.45	79.3	3340	200	3230	+12	1	1	2440	157	2.5	101	2440
Blend 3	40	83	35	28.3	39.6	2.3	94.2	2960	300	1840	-18	3	4	1490	148	7.2	109	1490
	60	68	22	47.8	57.5	6.5	72.3	2350	400	990	-32	5	5	1020	144	7.2	106	1020
QYSL-7	20	97	76	4.0	5.0	0.0	16.7	3800	220	3650	+18	1	1	DNF			DNF	
	40	89	43	25.8	37.2	1.8	94.5	3590	300	2410	-20	3	4	2100	152		DNF	
	60	75	25	35.0	39.6	4.3	79.1	2700	370	1250	-32	5	5	1500	147	19.9	138	1350
QXOS-7	20	97	67	9.2	13.6	0.82	84.6	3700	260	3010	+10	1	1	3050	162		DNF	
Blend 4	40	81	31	36.2	43.2	2.2	94.1	3060	320	1740	-26	3	4	1900	151	7.7	117	3000
	60	67	20	45.9	55.2	5.1	71.2	2470	410	970	-38	5	5	1170	145	8.9	113	2150

Test Formulation

Resin	100 parts
FLEXOL® DOP	as shown
Mark KCB	3
Stearic Acid	0.25

Specimen Preparation

Two roll 8" x 16" mill
Roll speed - 70 fpm
Roll Temperature - 170°C
Mill time - 4 minutes after fluxing
Hydraulic press - platen temperature - 170°C

1) Relative rating System 1 = Good 5 = Poor

TABLE III

PROCESS 7 AND 11 POLY (VINYL CHLORIDE) RESIN

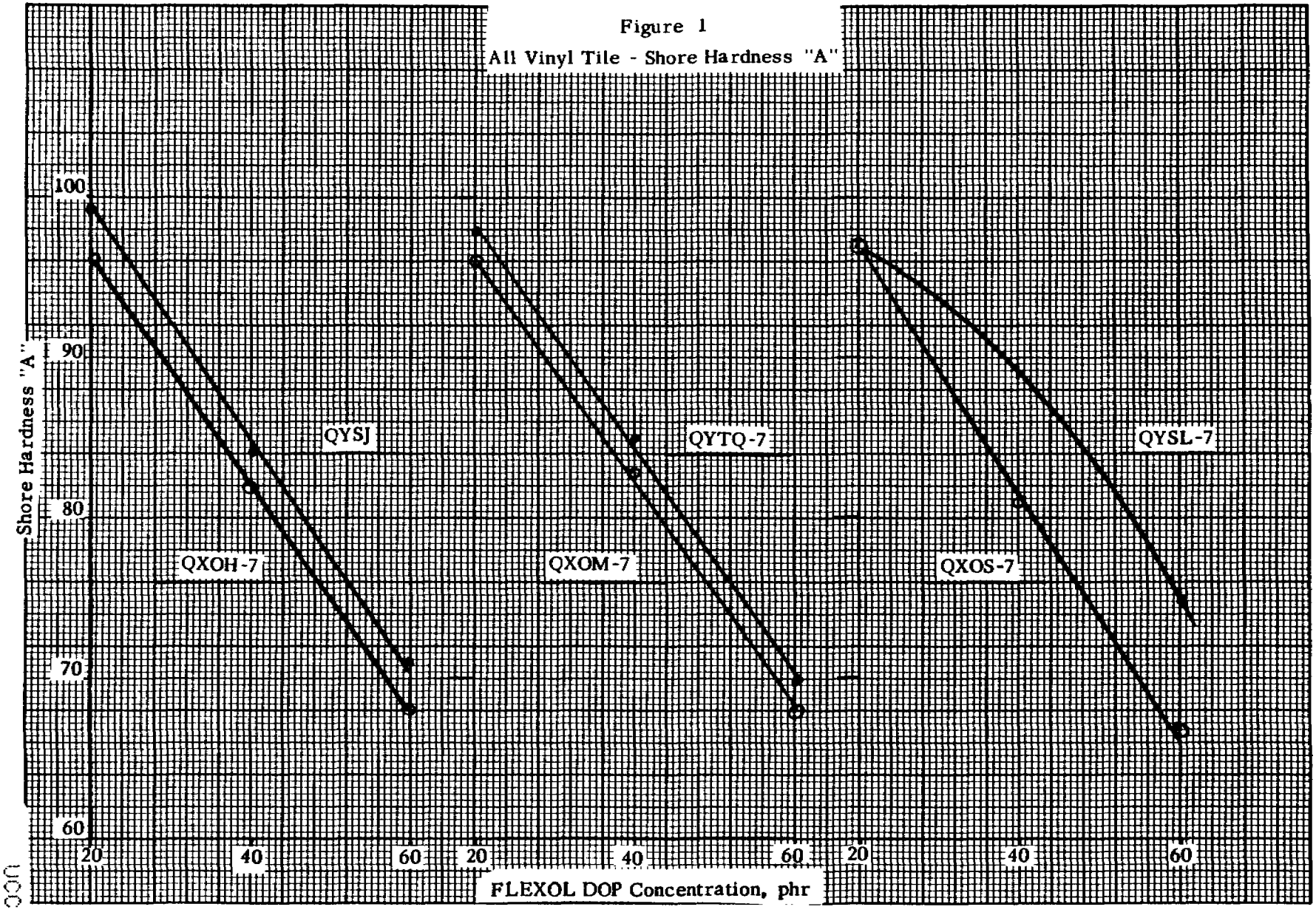
UNFILLED VINYL TILE PROPERTIES

PERFORMANCE SUMMARY

Test	Efficiency Parameter	Per Cent Less Plasticizer Required By Process 11 Resins Than Control		
		QXOH-7	QXOM-7	QXOS-7
Shore A	80	8.6	6.4	24.1
Shore D	50	10.3	14.3	27.3
McBurney One-Minute, mils	22	5.1	10.6	24.4
Residual Indentation, mils	4.0	3.2	0	6.9
Tensile Strength, psi	3000	22.0	7.7	25.7
Ultimate Elongation, %	300	8.5	9.1	22.7
100% Modulus, psi	2000	9.8	9.6	24.1
Brittleness, °C	0	6.9	4.3	12.4
Apparent Melt Viscosity, m-g/sec	1500	21.5	0	20.7

Figure 1

All Vinyl Tile - Shore Hardness "A"



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U39545

Figure 2

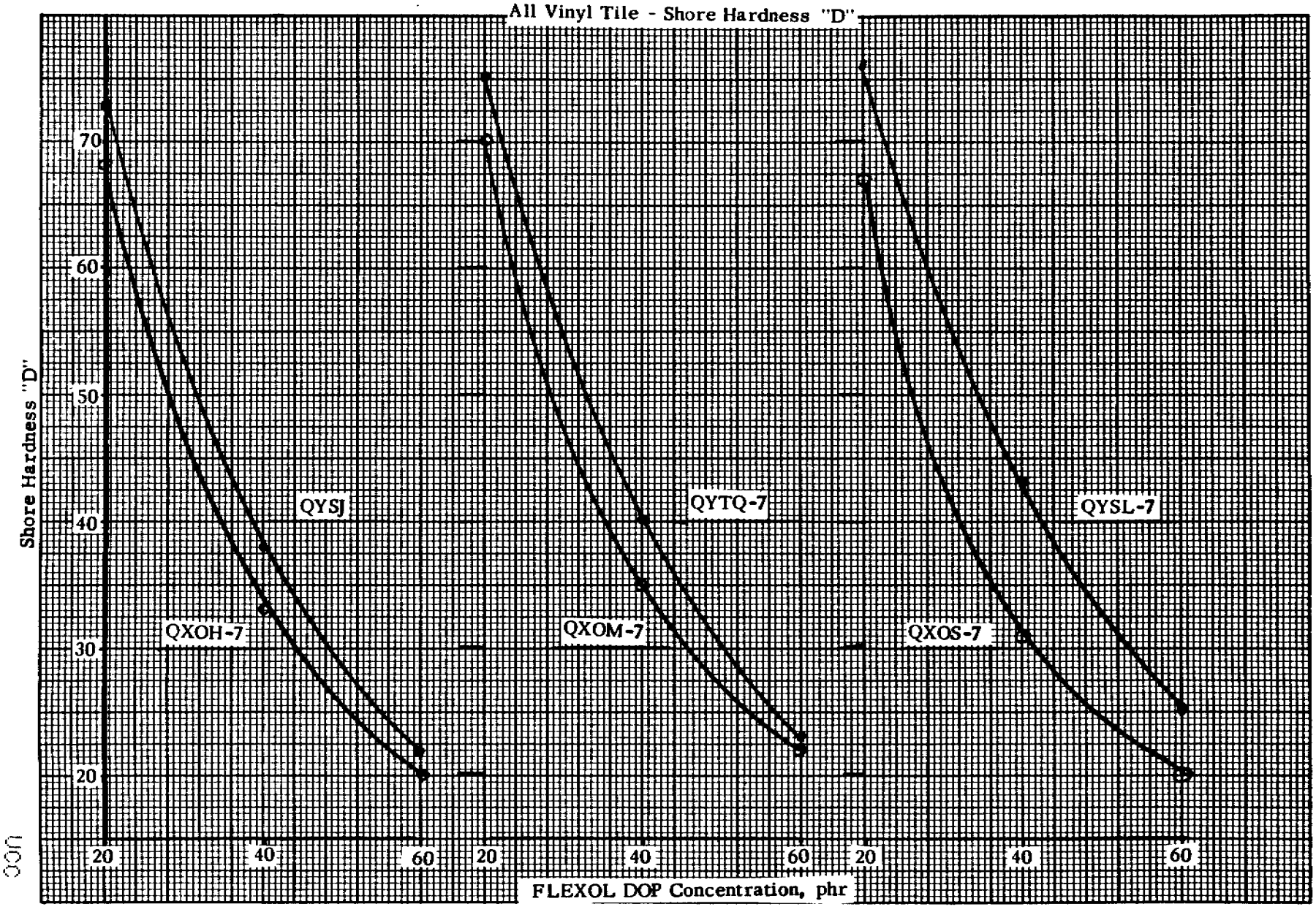


Figure 3

All Vinyl Tile - One Minute McBurney

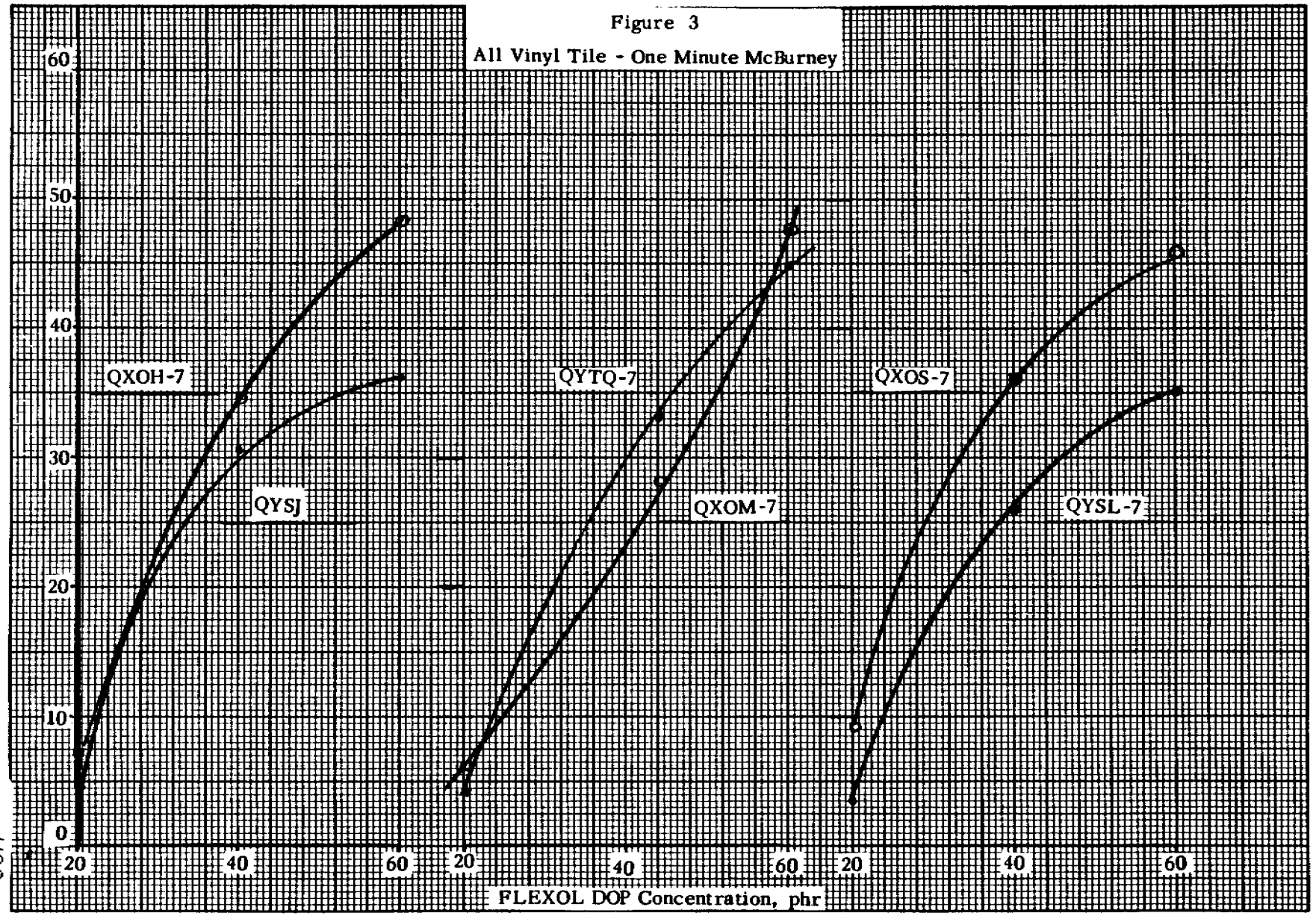
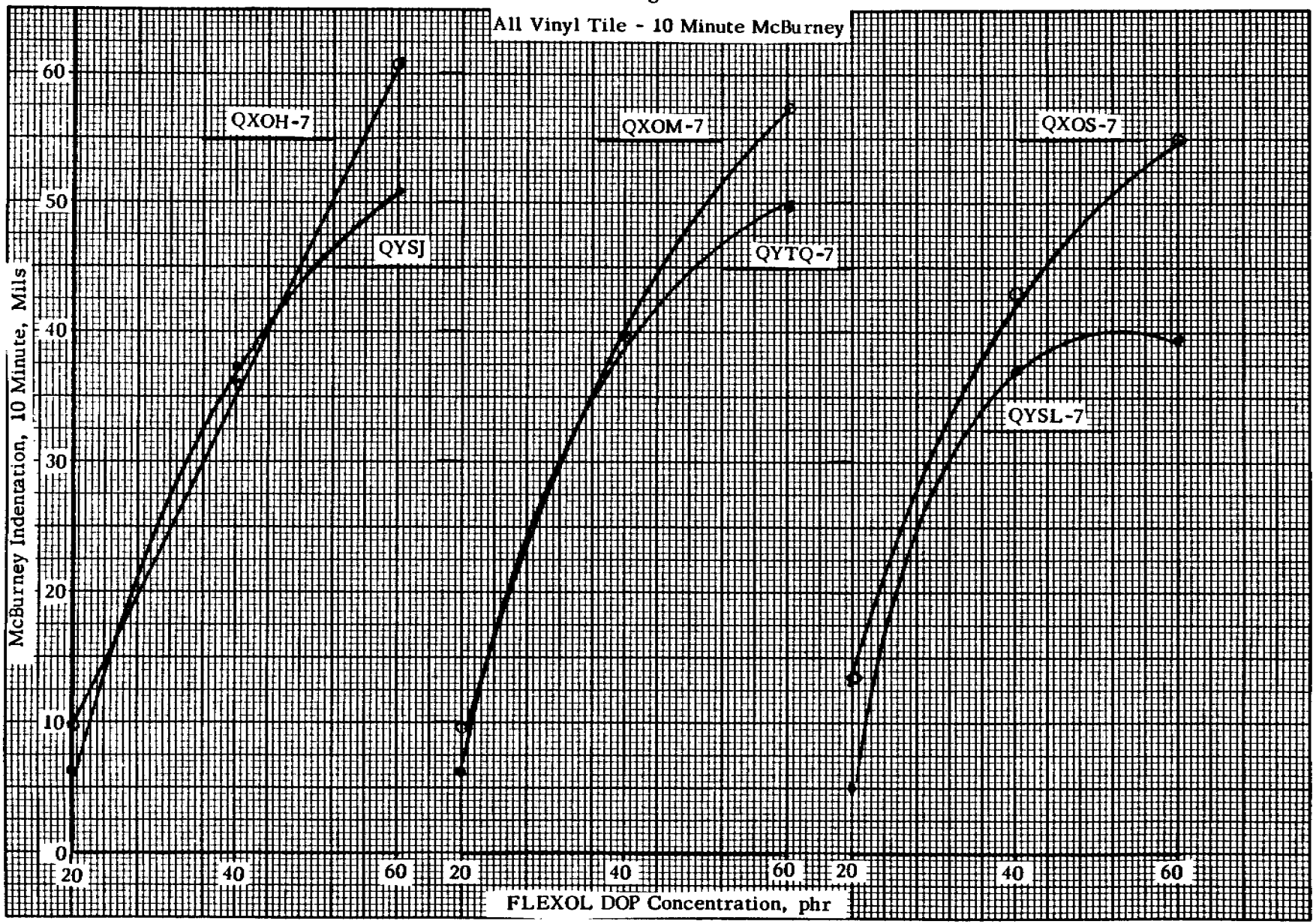


Figure 4



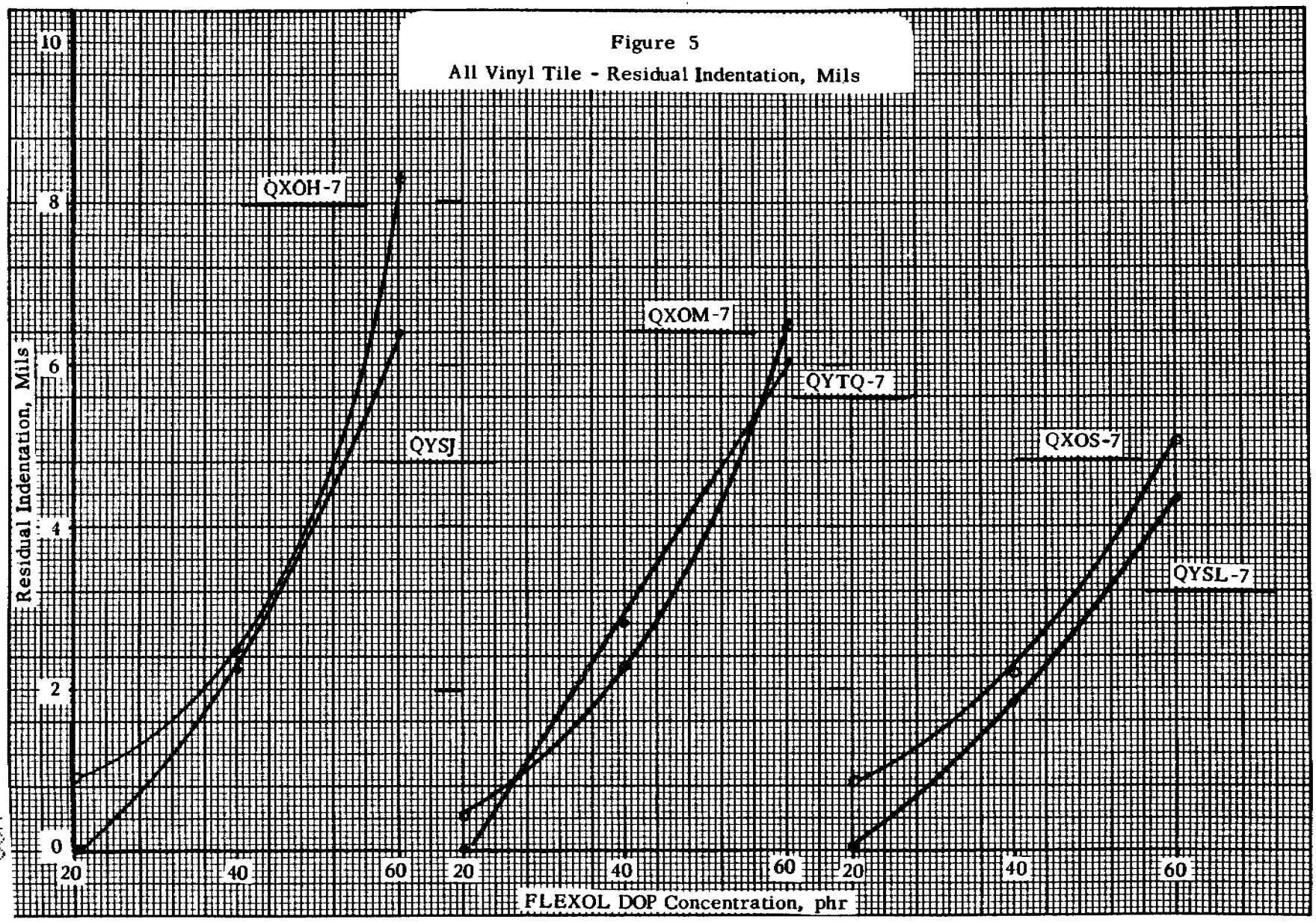


Figure 5
All Vinyl Tile - Residual Indentation, Mils
Residual Indentation, Mils
10
8
6
4
2
0
QXOH-7
QYSJ
QXOM-7
QYTQ-7
QXOS-7
QYSL-7
20
40
60
20
40
60
20
40
60
FLEXOL DOP Concentration, phr

Figure 6

All Vinyl Tile - Residual Indentation, Recovery

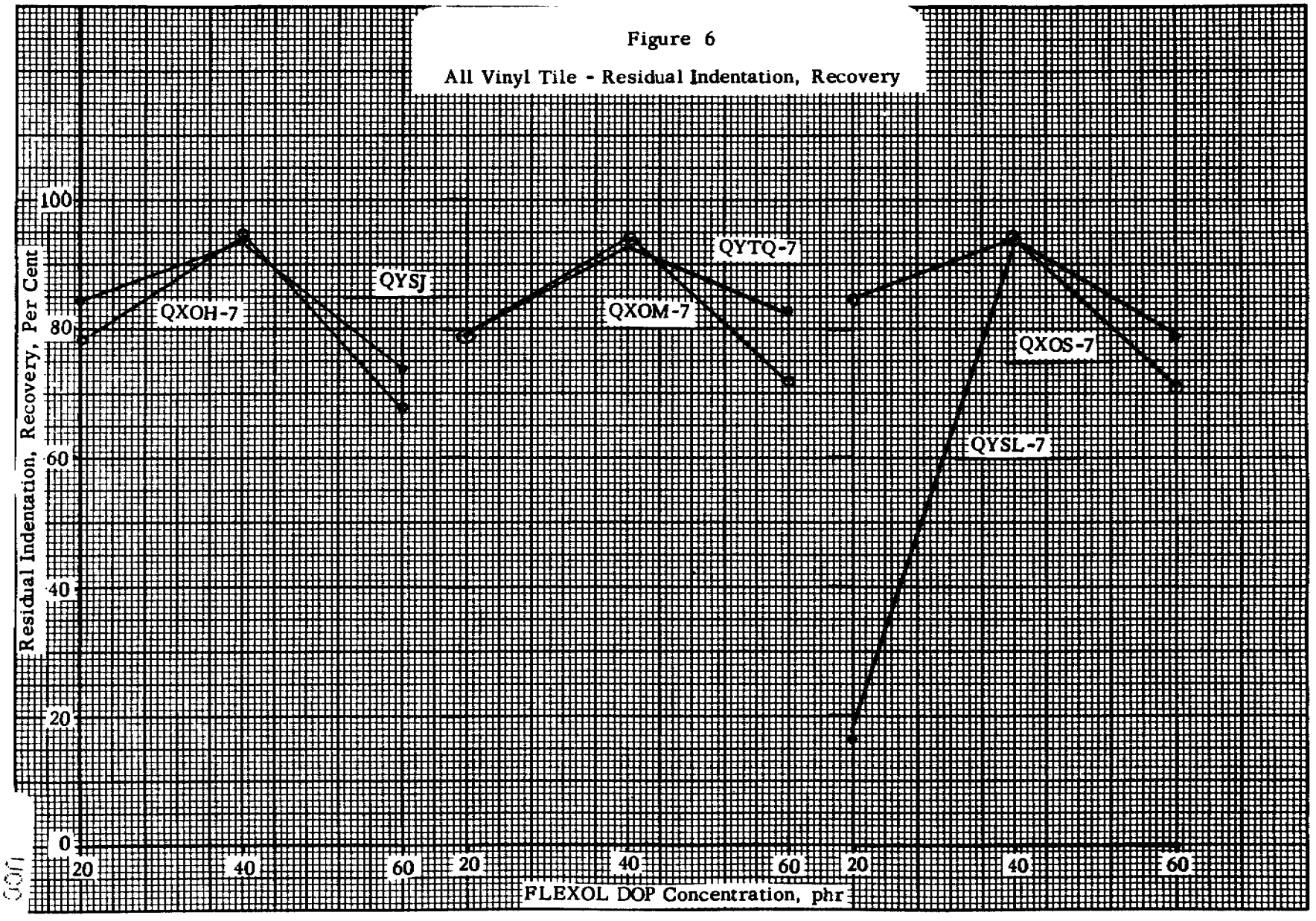
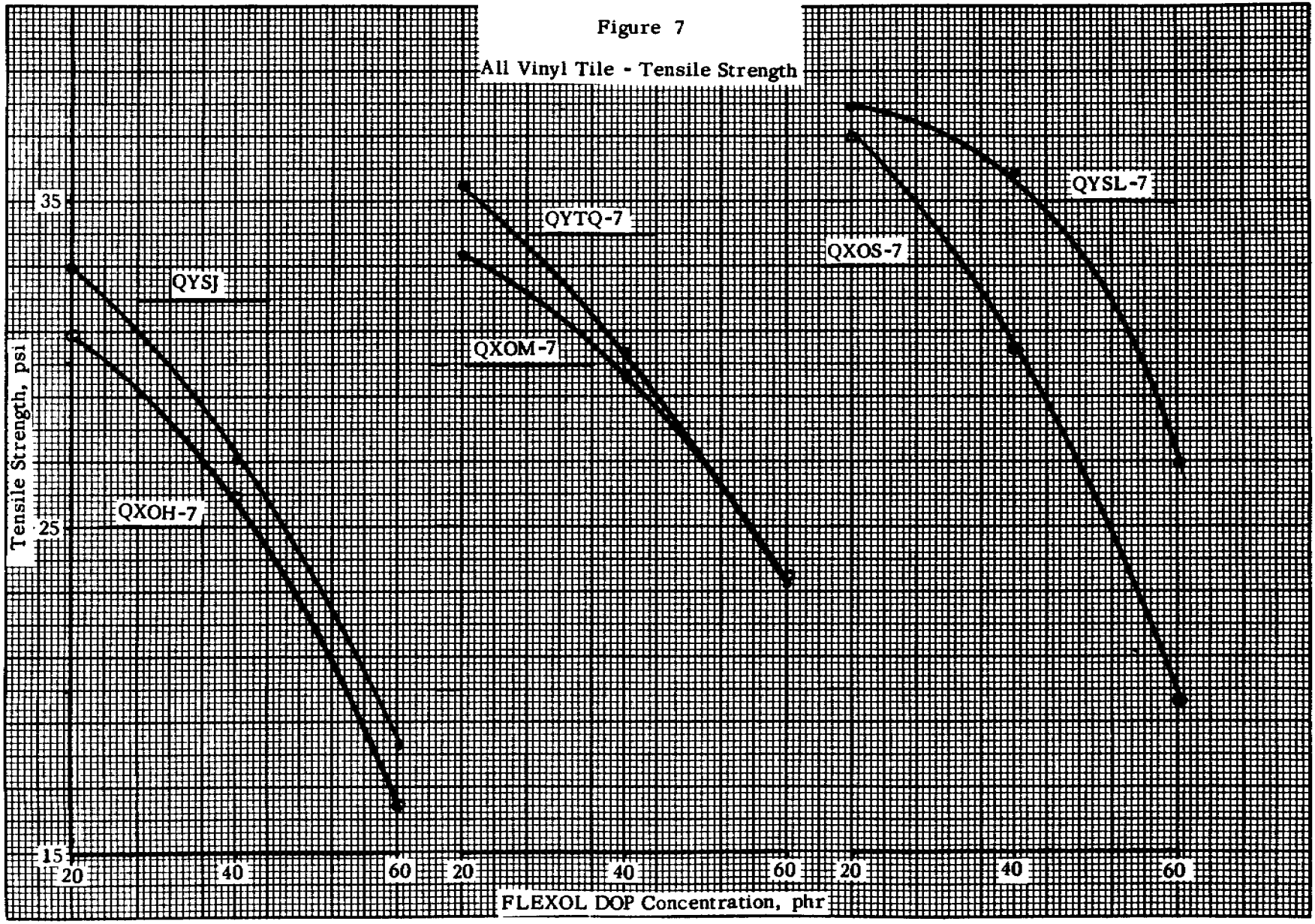


Figure 7

All Vinyl Tile - Tensile Strength



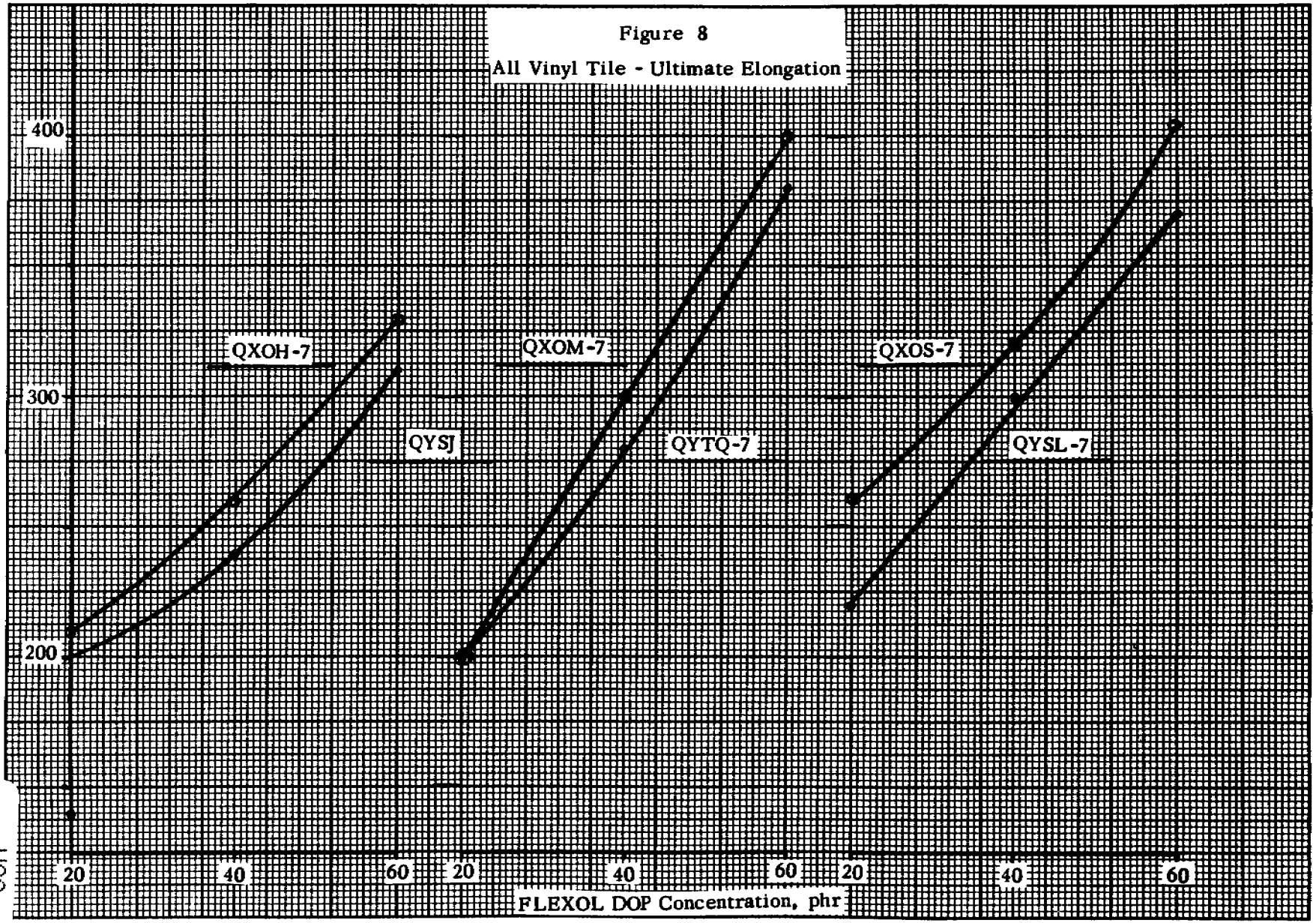


Figure 8
All Vinyl Tile - Ultimate Elongation
Ultimate Elongation, Per Cent
400
300
200
QXOH-7
QYSJ
QXOM-7
QYTQ-7
QXOS-7
QYSL-7
20
40
60
20
40
60
20
40
60
FLEXOL DOP Concentration, phr
UCC 039552

Figure 9

All Vinyl Tile - Modulus (100 Per Cent)

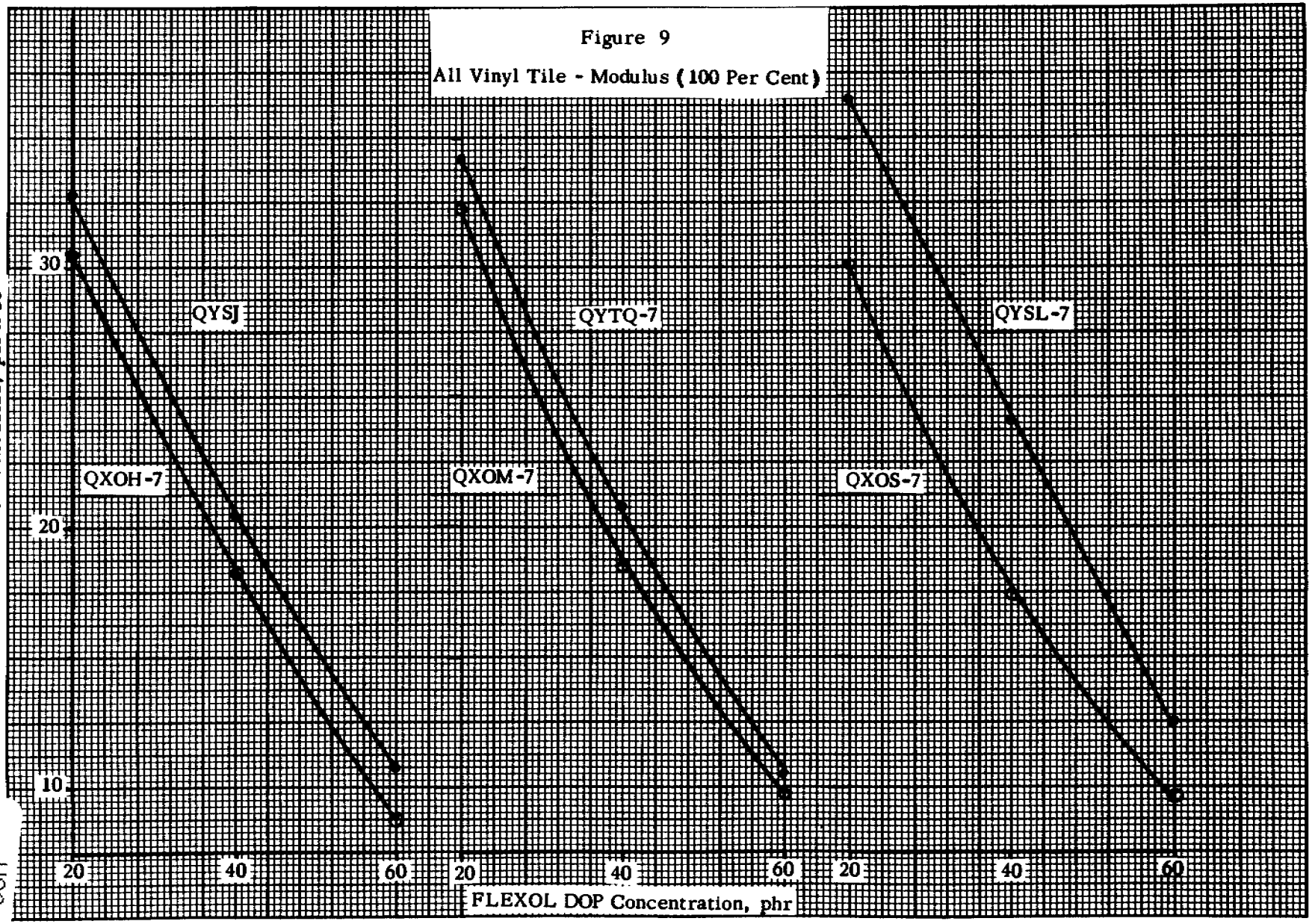
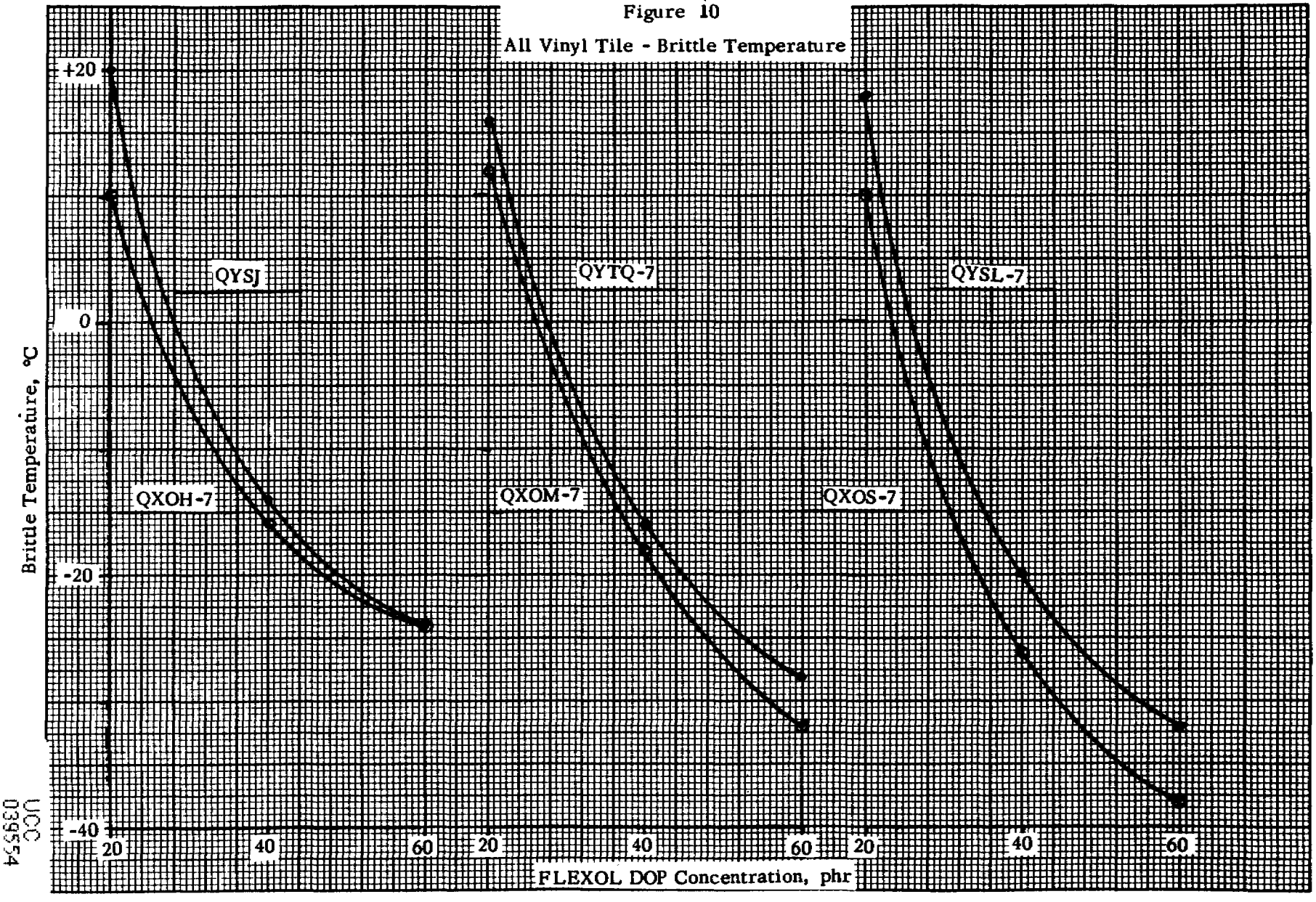


Figure 10

All Vinyl Tile - Brittle Temperature



UOC 039554

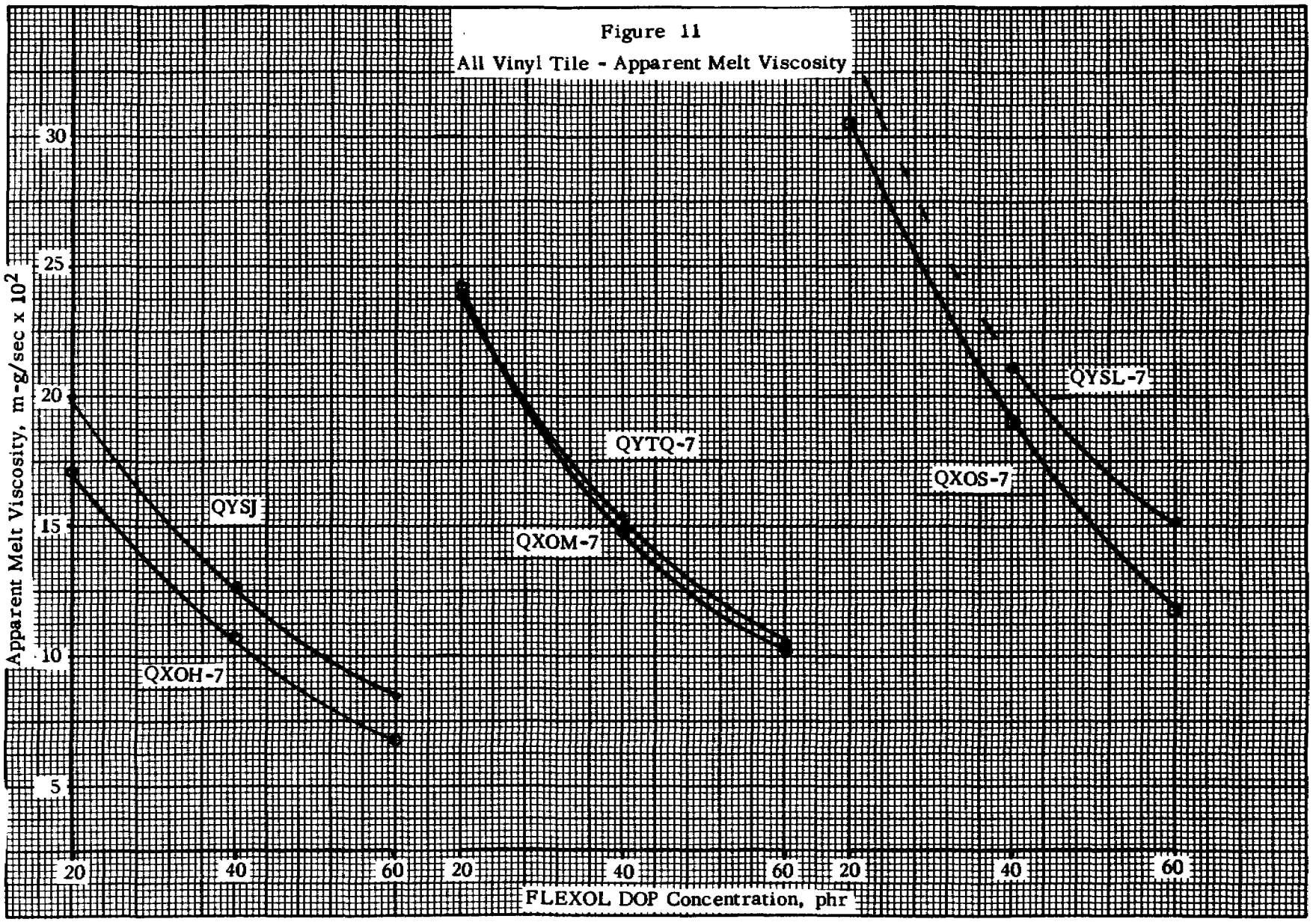


Figure 11
All Vinyl Tile - Apparent Melt Viscosity
Apparent Melt Viscosity, m-g/sec x 10^2
30
25
20
15
10
5
QYSJ
QXOH-7
QXOM-7
QYTQ-7
QXOS-7
QYSL-7
20
40
60
20
40
60
20
40
60
FLEXOL DOP Concentration, phr

UCC 039555

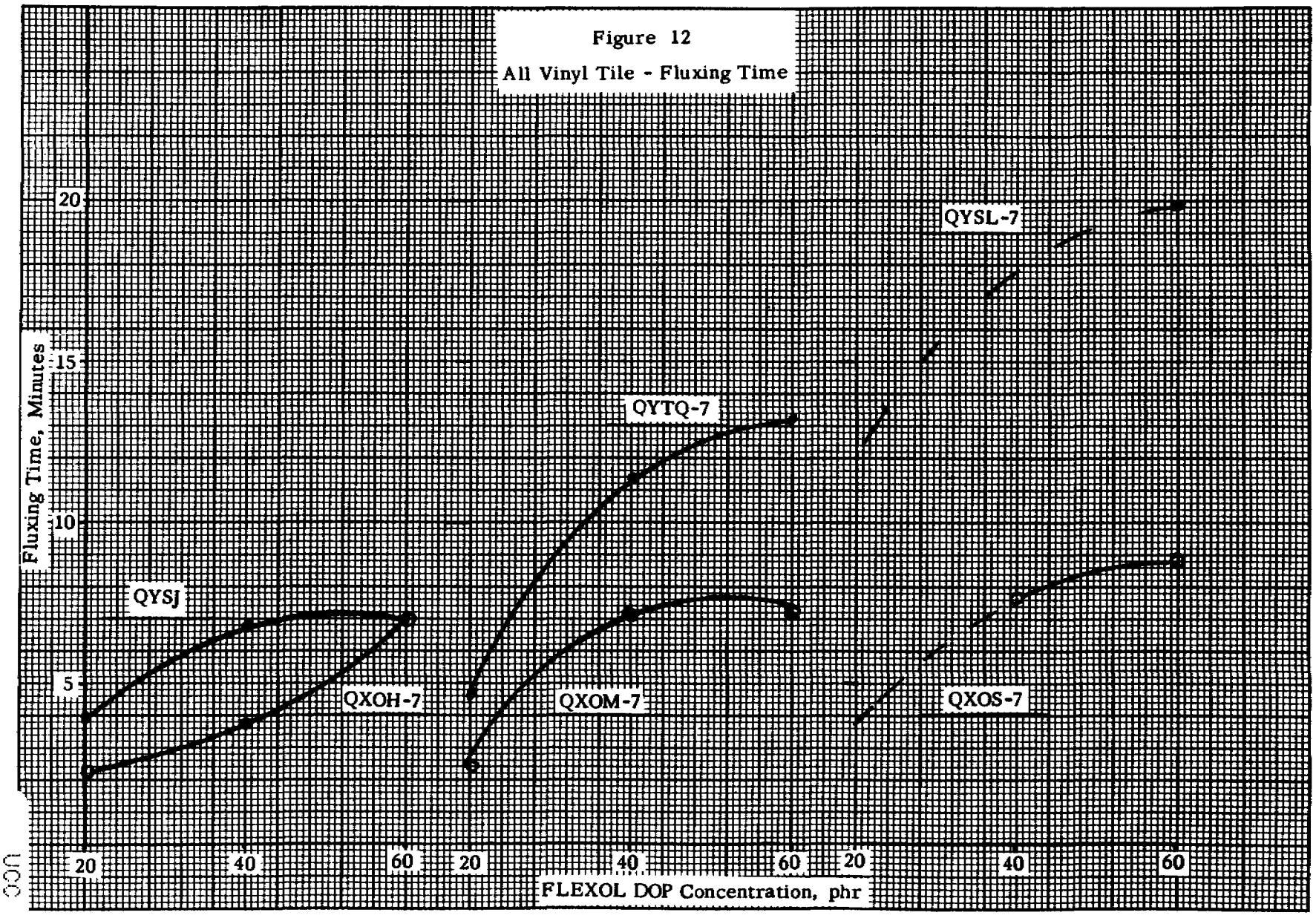


Figure 12
All Vinyl Tile - Fluxing Time
Fluxing Time, Minutes
20
15
10
5
QYSL-7
QYTQ-7
QYSJ
QXOH-7
QXOM-7
QXOS-7
20
40
60
20
40
60
20
40
60
FLEXOL DOP Concentration, phr

Figure 13

All Vinyl Tile - Fluxing Temperature

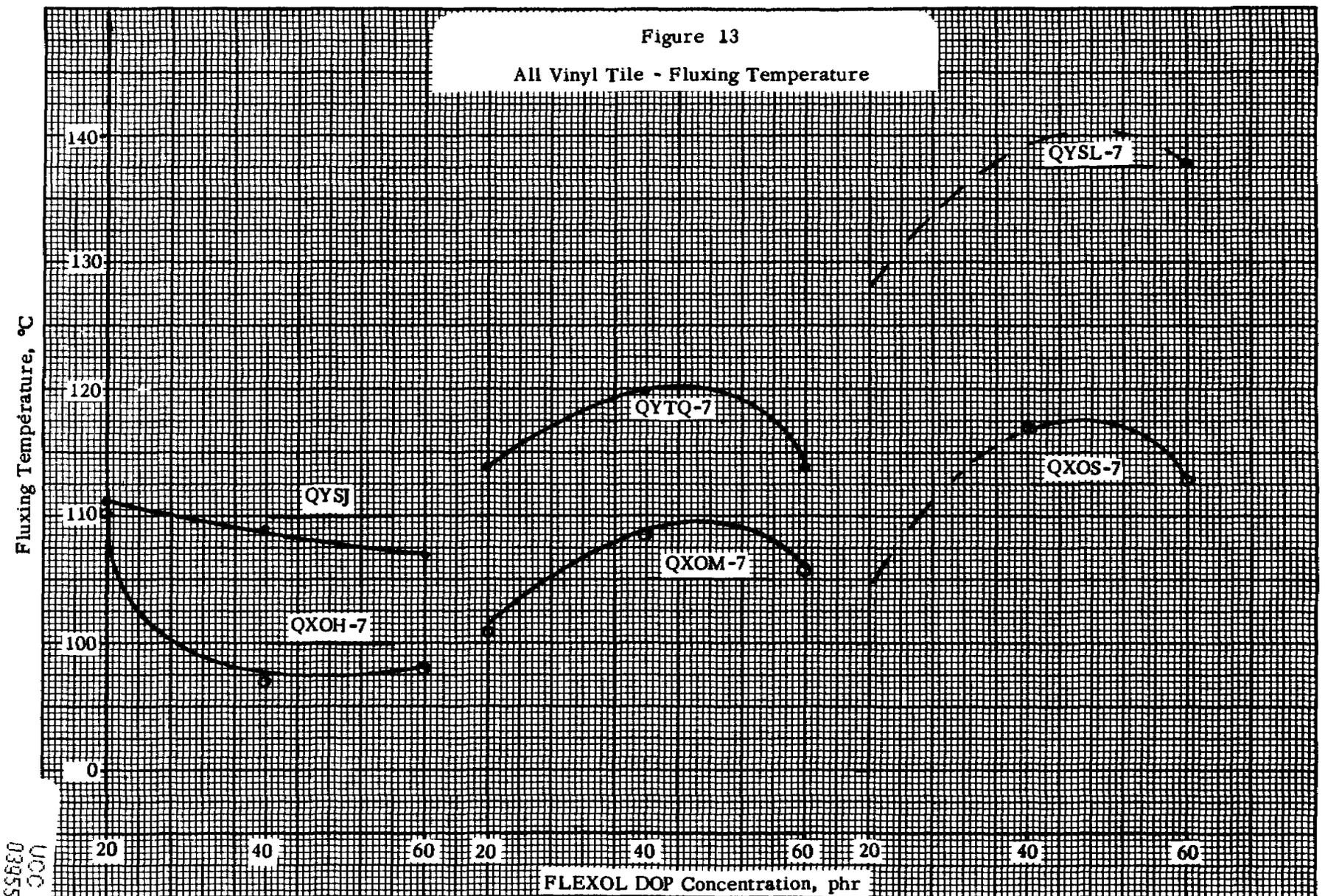
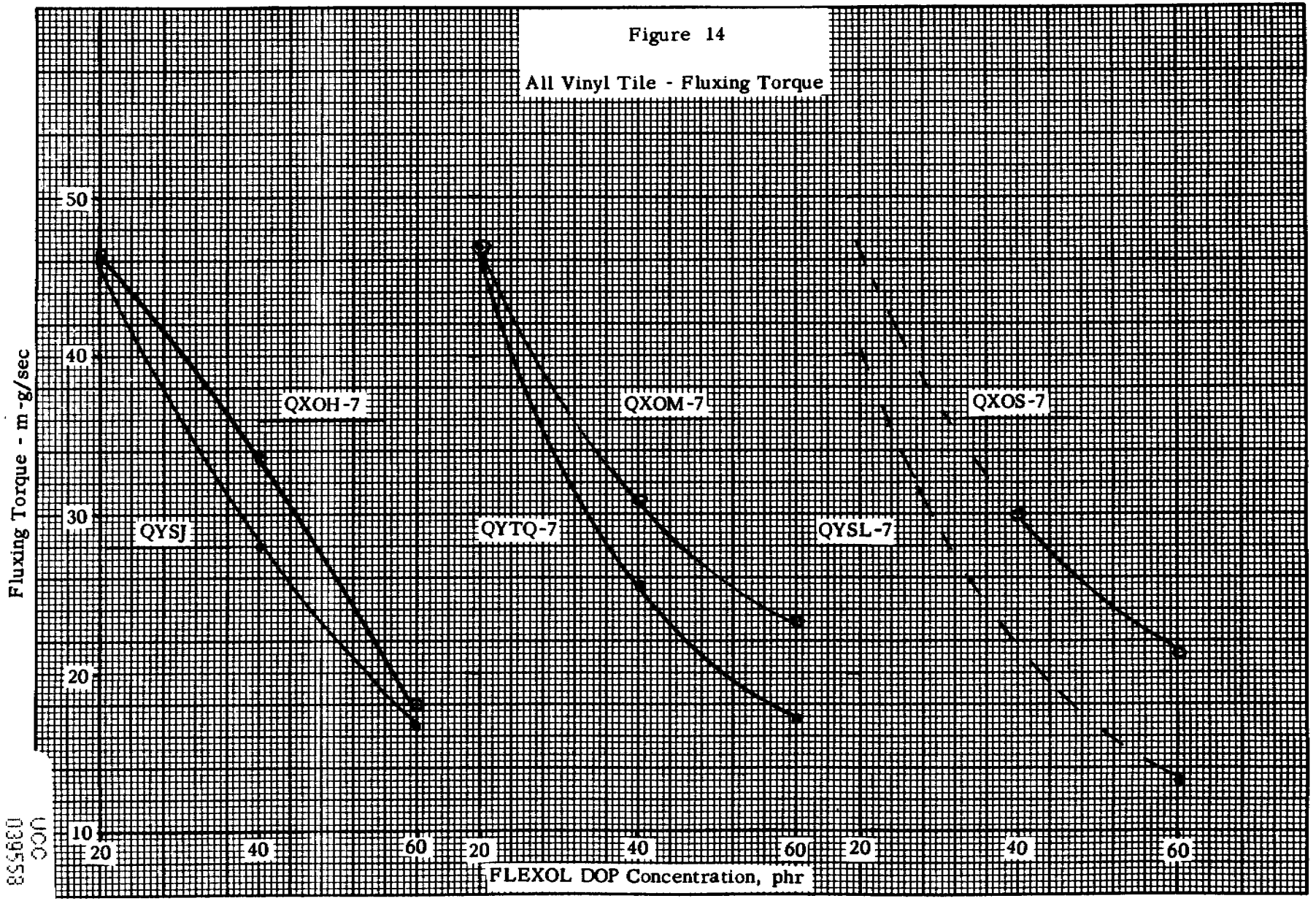


Figure 14

All Vinyl Tile - Fluxing Torque



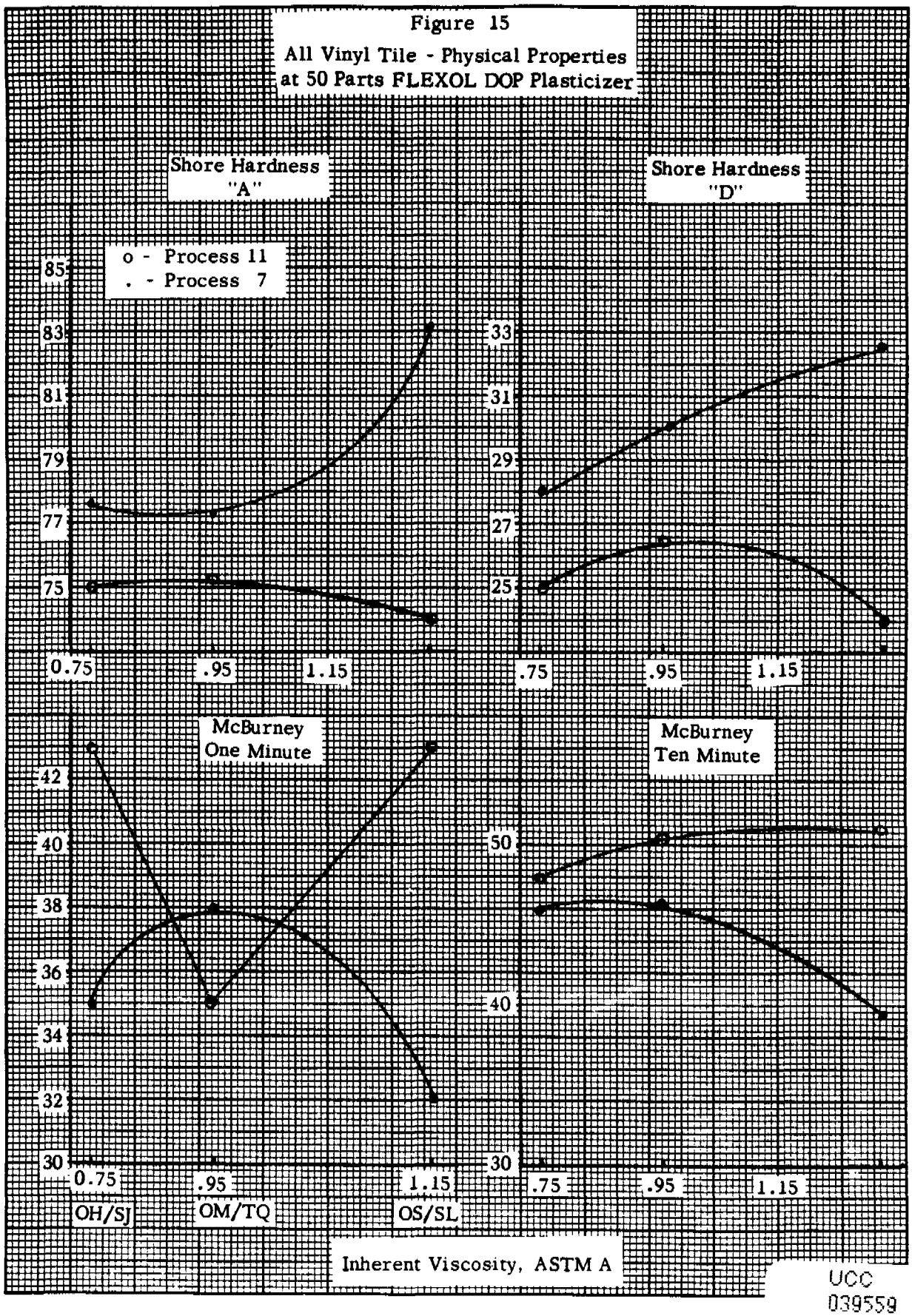
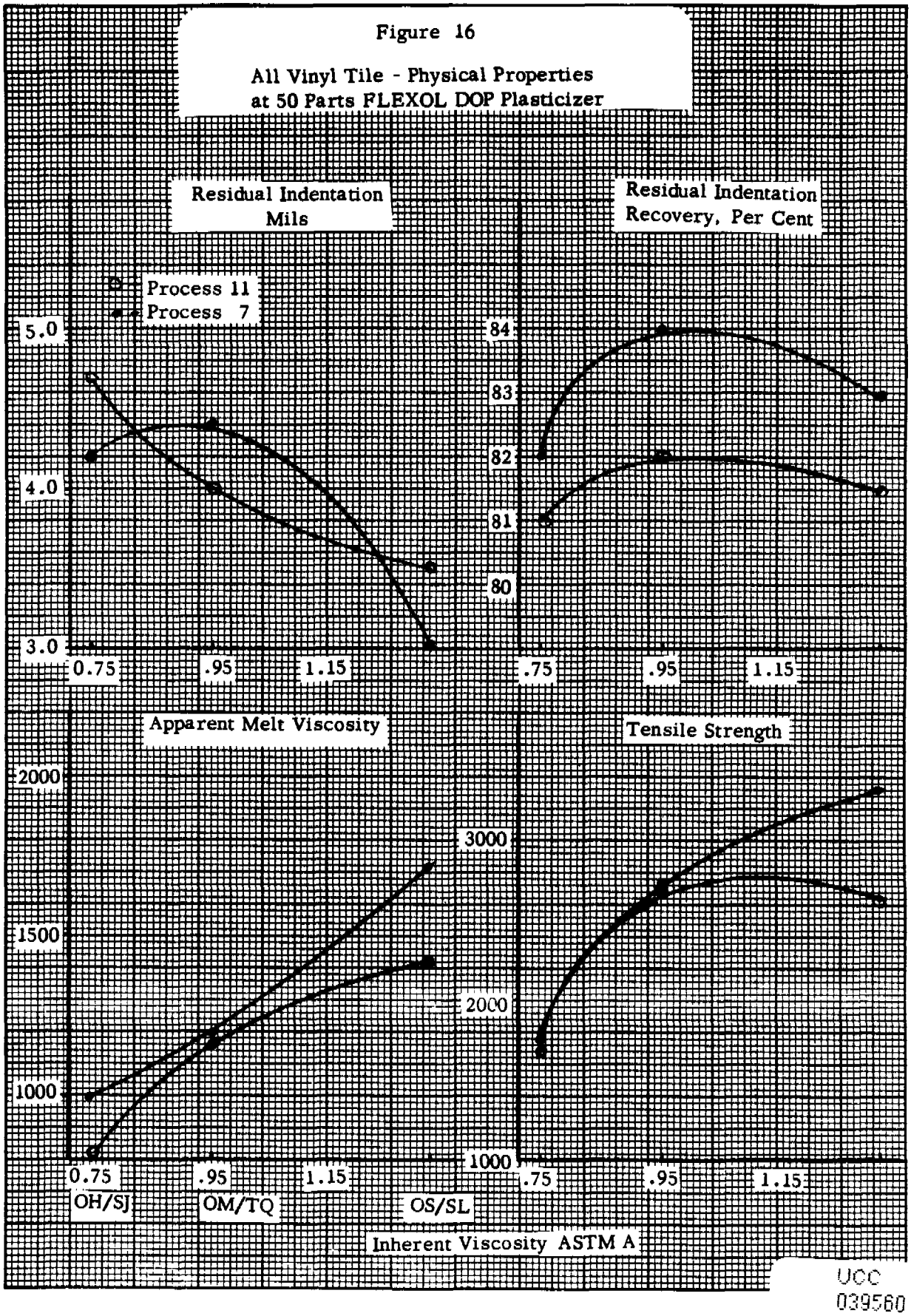


Figure 15
All Vinyl Tile - Physical Properties
at 50 Parts FLEXOL DOP Plasticizer
Shore Hardness "A"
Shore Hardness "D"
o - Process 11
. - Process 7
85
83
81
79
77
75
33
31
29
27
25
0.75
.95
1.15
.75
.95
1.15
McBurney One Minute
McBurney Ten Minute
42
40
38
36
34
32
30
50
40
30
0.75
.95
1.15
.75
.95
1.15
OH/SJ
OM/TQ
OS/SL
Inherent Viscosity, ASTM A
UCC
039559

Figure 16

All Vinyl Tile - Physical Properties
at 50 Parts FLEXOL DOP Plasticizer



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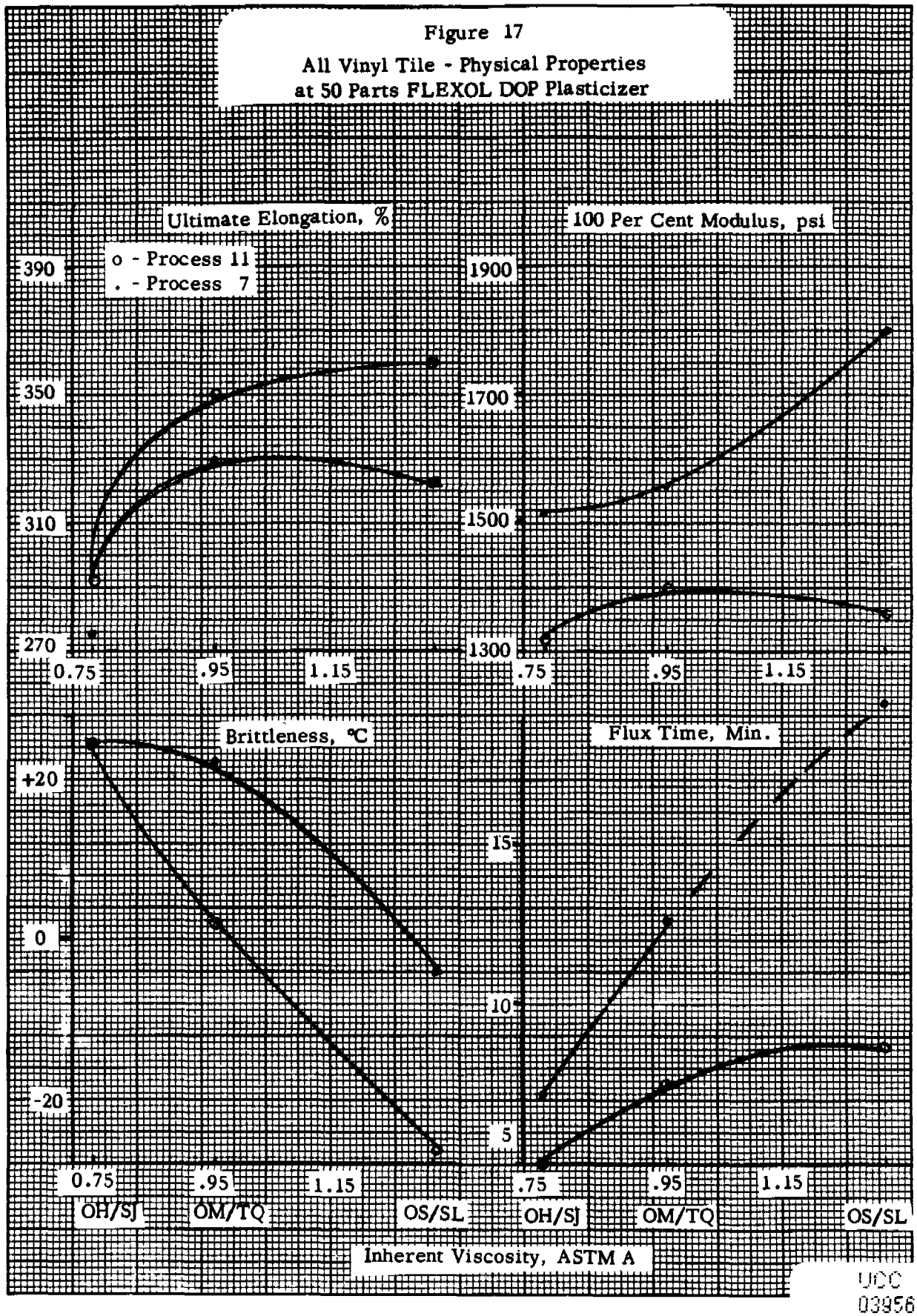
039560

Figure 17

All Vinyl Tile - Physical Properties
at 50 Parts FLEXOL DOP Plasticizer



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039561

Notebook Reference: 443 - pages 23 - 34

Period Covered: March 21 to April 15, 1966

Account Number: 224A90

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