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Report

St. Louis Research Report No. 2252

FINAL REPORT
ON

AROCLOR 1248 - EFFECT OF ADDITIVES ON
THE VISCOSITY AND FLASH POINT

JOB NO. 2-02-750.01-3371

March 11, 1959

Reported by: A.M. Ellenburg



ST. LOUIS, MO.

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MONSANTO CHEMICAL COMPANY
Organic Chemicals Division
St. Louis Research Department

St. Louis Research Report No. 2252

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INTRODUCTION

The use of Aroclor 1248 in liquid heating systems continues to grow each year. Even though Aroclor 1248 is the lowest chlorinated biphenyl mixture that does not burn, there is a drawback in the viscosity at low temperatures. A compromise has been made in the low temperature viscosity in order to keep the fire resistance feature of the Aroclor 1248.

A program was planned to study the addition of some common liquids to Aroclor 1248 in regard to their effect on the specific gravity, viscosity, flash point and fire point. If any outstanding shift in properties could be found, a new heat transfer medium might be made available.

SUMMARY

A group of six additives were employed to make the study on changing the characteristics of Aroclor 1248. Monoisopropylbiphenyl, diisopropylbiphenyl, biphenyl, diphenyl oxide, dodecylbenzene and Aroclor 1232. The individual compounds were added in portions of 5, 10, and 20 percent by weight to Aroclor 1248. The change in properties were measured.

Aroclor 1242 and mixtures of Aroclor 1242 and Aroclor 1248 were also included in the study.

CONCLUSIONS

Aroclor 1242 offers an improvement in the low temperature viscosity over Aroclor 1248 which would allow the Aroclor 1242 to be used as low as 20°F. instead of the present non-pumpability of Aroclor 1248 at 50°F.

The addition to Aroclor 1248 of 5 to 20% of low viscosity high boiling compounds do not improve the viscosity sufficiently. Furthermore, the fire resistance of the Aroclor is impaired.

Alkylation of Aroclors also failed to impart the desired properties needed to improve fluidity of Aroclor 1248.

RECOMMENDATIONS

Give consideration to the use of Aroclor 1242 for a heat transfer medium where low temperature cooling is desirable. Improved viscosity, lower density and high heat capacity are found when compared with Aroclor 1248. Fire resistance is the property that needs critical study.

Chlorinate mixtures of biphenyl and diphenyl oxide to obtain an improvement in low temperature viscosity and to study the fire resistance of the chlorinated mixture.

Make mixtures of Aroclor 1248 and terphenyls to study the effect on viscosity and fire resistance.

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PATENT STATUS

No patents exist on the use of Aroclor per se as a heat transfer medium. This work does not warrant any patent consideration.

REFERENCES

1. U.S. Patent 2,741,598 - April 10, 1956, R.J. Good to Monsanto Chemical Co. A heat transfer medium consisting of 65% by weight Aroclor 1244, 25% ortho-terphenyl and 13% biphenyl.
2. Final Report No. 1306, 2-02-750.01-2957, "Aroclor as a Heat Transfer Medium in a Lamont Forced Circulation Heater", by Ellenburg, August 26, 1955.
3. Final Report No. 1184, 2-02-750.01-2682, "Alkylation of Aroclors for Evaluation as Extender Plasticizers", by W.W. Marshall, January 17, 1955.
4. Monsanto Technical Bulletin, "Engineering Heat Transfer Data for Use with Aroclor 1248".

EXPERIMENTAL WORK

The physical properties of the compounds used are listed in the following table:

TABLE I

Compound	Flash Point	Fire Point	Viscosity, cs.		Sp. Gr. at 25°C.
			210°F	100°F	
Aroclor 1248	380°F	None ⁽¹⁾	3.20	45.4	1.450
Aroclor 1242	350	None ⁽¹⁾	2.35	17.7	1.390
Diisopropylbiphenyl	345	380	2.4	12.4	0.952
Monoisopropylbiphenyl	282	306	1.402	4.655	0.980
Biphenyl	255	270	0.93	---	0.992 (73°/4°C.)
Diphenyl oxide	239	275	0.9	2.46	1.073
Dodecylbenzene	270	295	1.76	4.94	0.871 (15.5/15.5°C.)
Aroclor 1232	305	460	2.0	7.0	1.266
Aroclor 1242 (25%): Aroclor 1248 (75%)	375	None ⁽¹⁾	2.95	34.2	1.435
Aroclor 1242 (33%): Aroclor 1248 (66%)	370	None ⁽¹⁾	2.90	30.5	1.430

Note (1) - No fire point up to boiling temperature.

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TABLE II

Physical data of mixtures of Aroclor 1248 and the compounds employed to determine the possible use as a heat transfer medium.

Compound Added	% Added by weight	Flash Point °F.	Fire Point °F.	Viscosity at 210°F., cs.	Viscosity at 100°F., cs.	Sp. Gr. at 25°C.
Polyisopropylbiphenyl	5%	430	none*	3.15	38.22	1.417
"	10%	385	none	3.15	34.17	1.384
"	20%	365	590	2.94	27.61	1.316
Biphenyl	5%	365	none	2.80	27.41	1.422
"	10%	345	540	2.52	19.61	1.396
"	20%	320	355	2.00	11.32	1.342
Diphenyl Oxide	5%	375	none	2.81	28.06	1.426
"	10%	335	445	2.45	18.83	1.405
"	20%	310	345	1.96	10.38	1.354
Dodecylbenzene	5%	380	none	3.02	33.49	1.404
"	10%	335	425	2.84	27.19	1.361
"	20%	330	390	2.59	19.15	1.286
Monoisopropylbiphenyl	5%	385	none	2.98	33.12	1.423
"	10%	360	none	2.74	25.55	1.385
"	20%	335	470	2.40	17.55	1.329
Aroclor 1232	5%	405	none	3.13	40.19	1.450
"	10%	380	none	2.83	28.73	1.434
"	20%	360	none	2.64	23.83	1.414

* - no fire points up to boiling point of mixture

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The combination of these additives and the subsequent effect on the various critical properties of Aroclor 1248 are shown in Table II. (See following page)

Some further testing was done on various modified chlorinated biphenyls and other chloro compounds to see the effect on the viscosity and other properties that certain substituents would have. These results are tabulated below:

TABLE III

Compound	Flash Point °F.	Fire Point °F.	Viscosity, ck.		Boiling Temp.
			210°F	100°F	
Chlorinated Diphenyl Ether (54% Cl ₂)	525	>760	6.3	474	210-235 at 4 mm
Polybutylated Aroclor 1221 (9.3% Cl ₂)	405	465	10.1	496	---
Isopropyl Aroclor 1242 (33.8% Cl ₂)	435	540	8.1	529	170-185 at 2 mm
n-Butyl Aroclor 1232 (25.7% Cl ₂)	400	465	4.2	51.5	185-227 at 2 mm
Chlorinated Dodecylbenzene (24% Cl ₂)	350	370	3.1	20.9	102-190 at 3 mm

DISCUSSION

It is apparent from the data in Table II that all of the additives have an adverse effect on the fire resistance as shown by the flash point. Fire points are not affected in the 5% range by the non-chlorinated compounds, but the effect on viscosity and density is also negligible at this level. Whereas the low temperature viscosity is greatly reduced at the 20% level, the fire point is low enough to make the material flammable in all cases.

The Aroclor 1242 alone appears to offer the best chance in alleviating the viscosity deficiencies in the Aroclor 1248 at low temperatures. At 100°F., Aroclor 1242 has a viscosity of 17.7 centistokes as compared to 43 centistokes for Aroclor 1248. On extrapolation, the curves in Figure 2 show that the pumpable temperature of Aroclor 1242 is 20°F. (-7°C.) instead of 50°F. (10°C.) for Aroclor 1248 by comparable viscosities. This is more improvement than is obtained by 20% of any of the additives in Table II except biphenyl or diphenyl oxide. These two compounds are too low boiling to fit into the temperature range where Aroclor 1248 is used.

In Figure 1, the viscosity effect of the most viscous additive, polyisopropylbiphenyl, and biphenyl are shown graphically. By extending the plots to lower temperatures, it is shown again that Aroclor 1242 is the most logical compound or mixture studied that will give the type improvement desired for a better heat transfer medium.

From Table III, it is difficult to say that alkylation offers any beneficial effect on low temperature viscosity. Thus, no improvement in ease of pumping or better heat transfer at low temperature would result from alkylating Aroclor. It is also apparent that the alkylation of the Aroclors improves the flash points by increasing the boiling point, but the fire point is at a lower temperature than the corresponding Aroclor.

MATERIAL SPECIFICATIONS AND ANALYTICAL PROCEDURES

The Aroclor 1242 and Aroclor 1248 are standard commercial items and their properties are well documented.

Standard analytical procedures were used for the analysis in Table II. ASTM D-92 for flash and fire points, ASTM D-445 for viscosities and ASTM D-287 for density were used for obtaining these data.

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APPENDIX

The data for the preparation of the samples considered are found on Notebook Pages:

81151-81200	- Anniston
84851-84859	- Anniston
88720	- Anniston
A-78326	- St. Louis
SL-12325	- St. Louis
A-102326	- St. Louis
A-102330	- St. Louis

Figure 1 - Aroclor 1248 plus additives

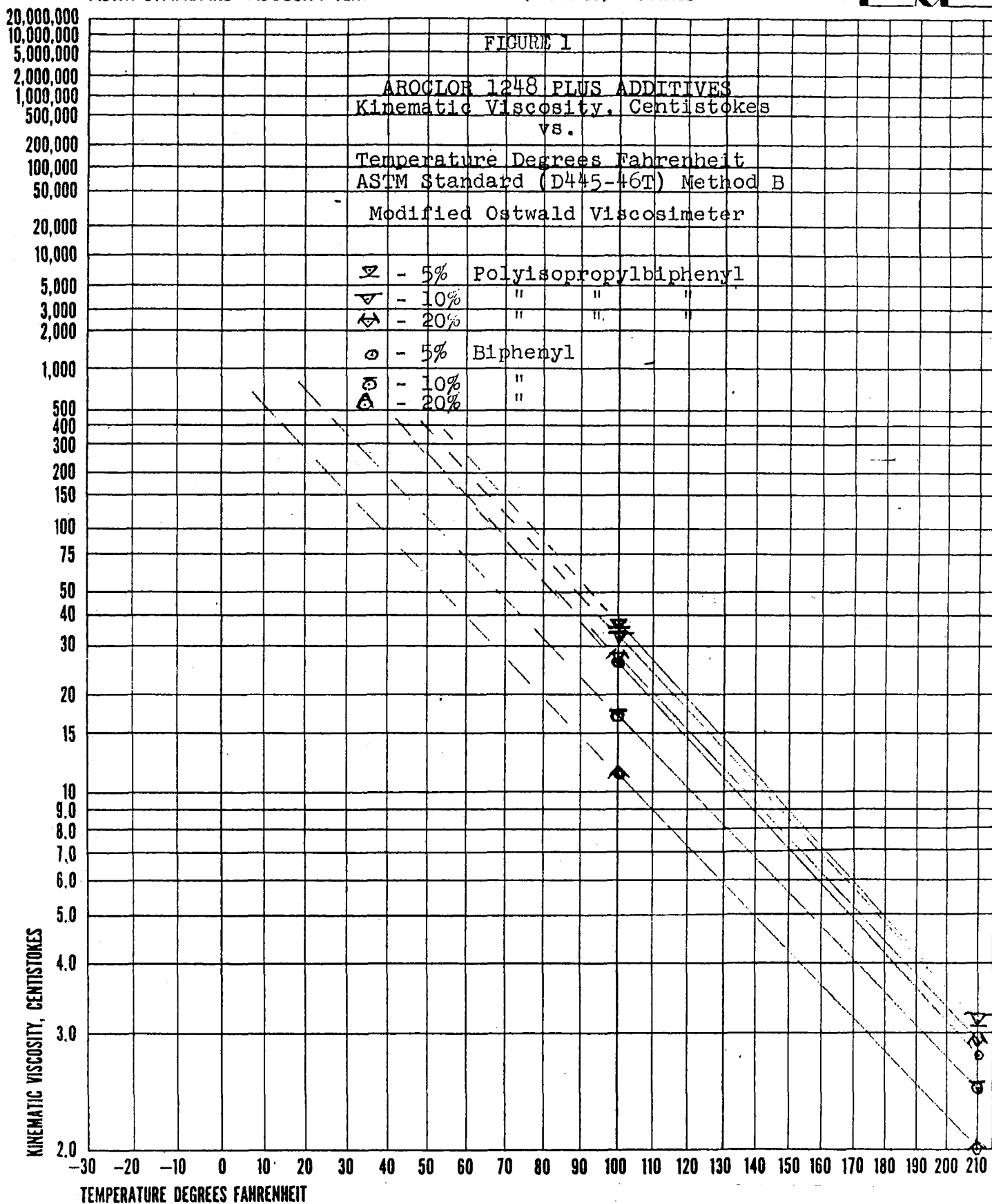
Figure 2 - Kinematic Viscosity of Aroclor 1242 and Aroclor 1248

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VISCOSITY CURVES

ASTM STANDARD VISCOSITY-TEMPERATURE CHART (D 341-39) MODIFIED



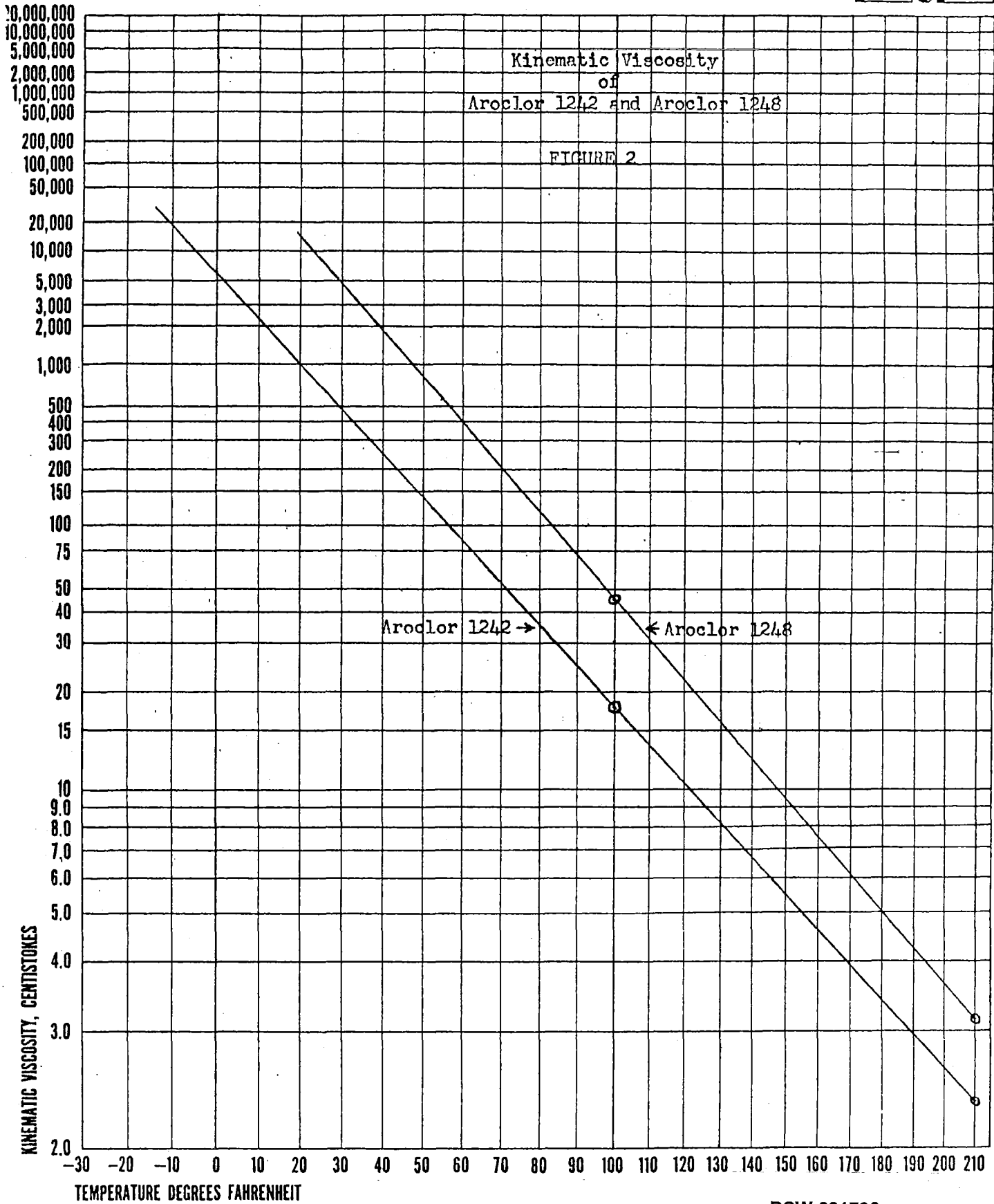
DSW 621791

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VISCOSITY CURVES

ASTM STANDARD VISCOSITY-TEMPERATURE CHART (D 341-39) MODIFIED



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