MLR-87-1

EFFECT OF ANTI-STRIP AGENTS ON TEMPERATURE SUSCEPTIBILITY OF ASPHALT CEMENTS

By
Max I. Sheeler
Testing Engineer
Iowa Department of Transportation
Materials Office

March 1987

INTRODUCTION

Anti-strip agents can effect the temperature susceptibility of asphalt cement. This concern was expressed at the 33rd Annual Bituminous Conference in St. Paul, Minnesota by Mr. David Gendell, Director of Highway Operations. This study compares viscosity-temperature relationships of asphalt cement with and without anti-strip agent addition.

MATERIALS

The following materials were used in the study:

Asphalt Cement
- AC-10 grade, Koch Asphalt, Omaha, NE
- AC-10 grade, American Oil, Linwood, IA

Anti-Strip Agents
- Carstab BA-2000, Morton Thiokol
- Pave Bond AP Special, Morton Thiokol
- Redicote 82-S, Akzo Chemie America (Armak)

PROCEDURES

Kinematic viscosities were determined in accordance with Test Method No. Iowa 609C except temperatures were varied. Viscosities of original and treated asphalt were determined at 220, 250, and 275 degrees F.

Thin-film residues of original and treated asphalts were obtained in accordance with Test Method No. Iowa 605-B. Residue viscosities were determined at 250, 275, and 300 degrees F.

Viscosity results for each material combination were plotted on log-log graph paper to graphically show the viscosity-temperature relationships. It was assumed that all tested materials were Newtonian liquids and the straight line graph was plotted by linear regression.

TEST RESULTS

Detailed test results are given on the attached data sheet. Slopes of the log-log graphs are also tabulized on the same sheet.

DISCUSSION OF RESULTS

The coefficient of determination, r^2, was used to indicate how closely the straight line equation fits the experimental data. The value of r^2 lies between 0 and 1. The closer it is to 1, the better the fit.

All viscosity-temperature graphs of original and treated original asphalt had r^2 values of 1.00, indicating the Newtonian assumption was correct. The plotted points for thin-film residue viscosities look like a non-Newtonian curve might give the best fit; however, the worst straight line r^2 value for this data was 0.98. The Newtonian assumption is therefore considered valid for the temperature range being considered.

Slopes of the graphs indicate that the additives had little effect on the viscosity-temperature relationships of all material combinations. Koch asphalt was more effected by additive addition than Amoco asphalt. The most effect occurred with thin-film residues containing BA-2000. In this case the change in viscosity-temperature relationship was in the direction of improvement.

Although the results indicate little effect of anti-strip additives on viscosity-temperature relationships in the temperature range studied, the effect may be quite different and more significant at lower temperatures. Determining viscosities at lower temperatures requires special equipment that was not available.

RECOMMENDATION

It is recommended that the effect of anti-strip agents on cold temperature ductility of asphalt be determined to supplement information gained from this study.

MATERIAL DEPARTMENT
DATA SHEET

MLR-87-1

VISCOSITY-TEMPERATURE DATA

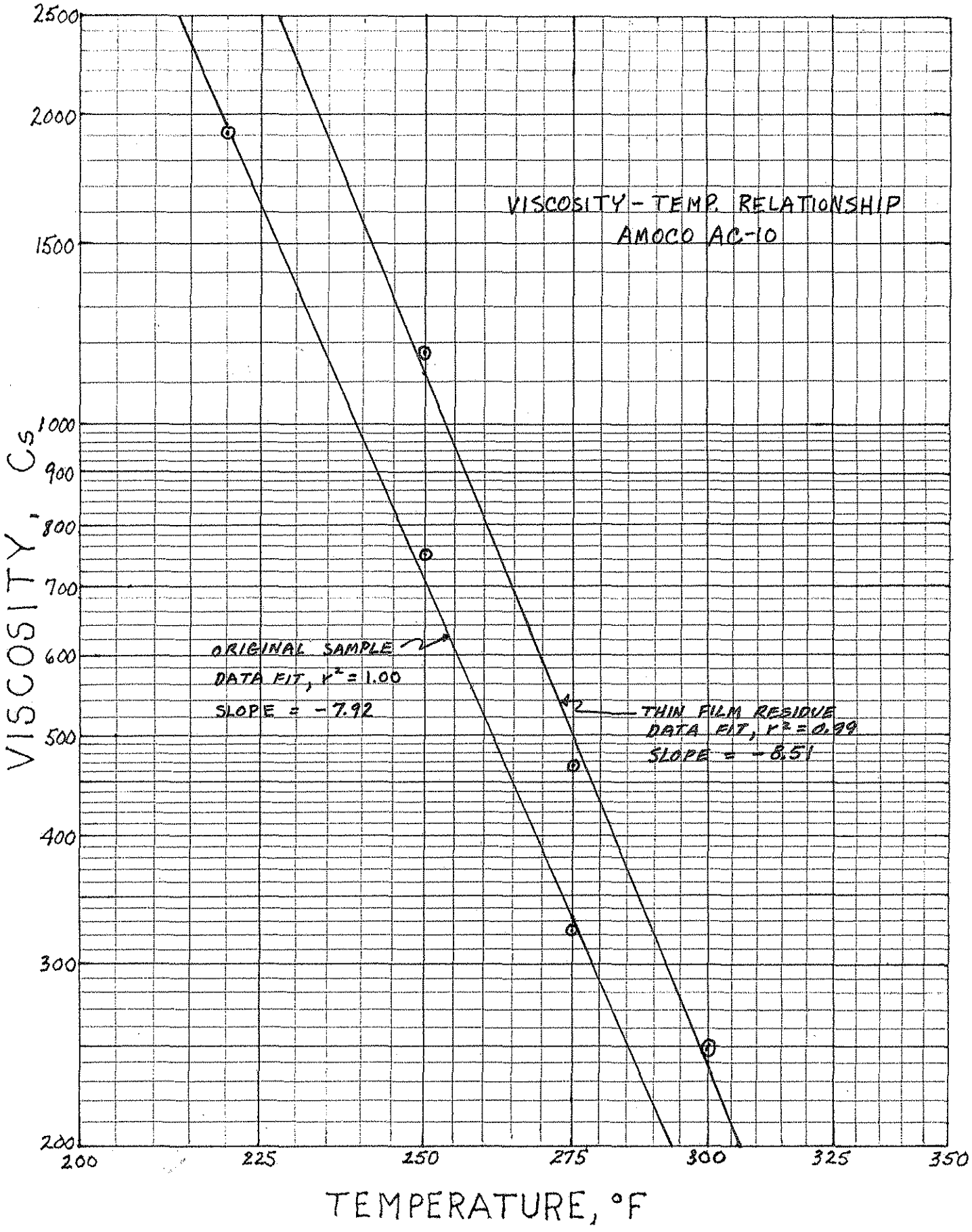
(Viscosities in Centistokes)

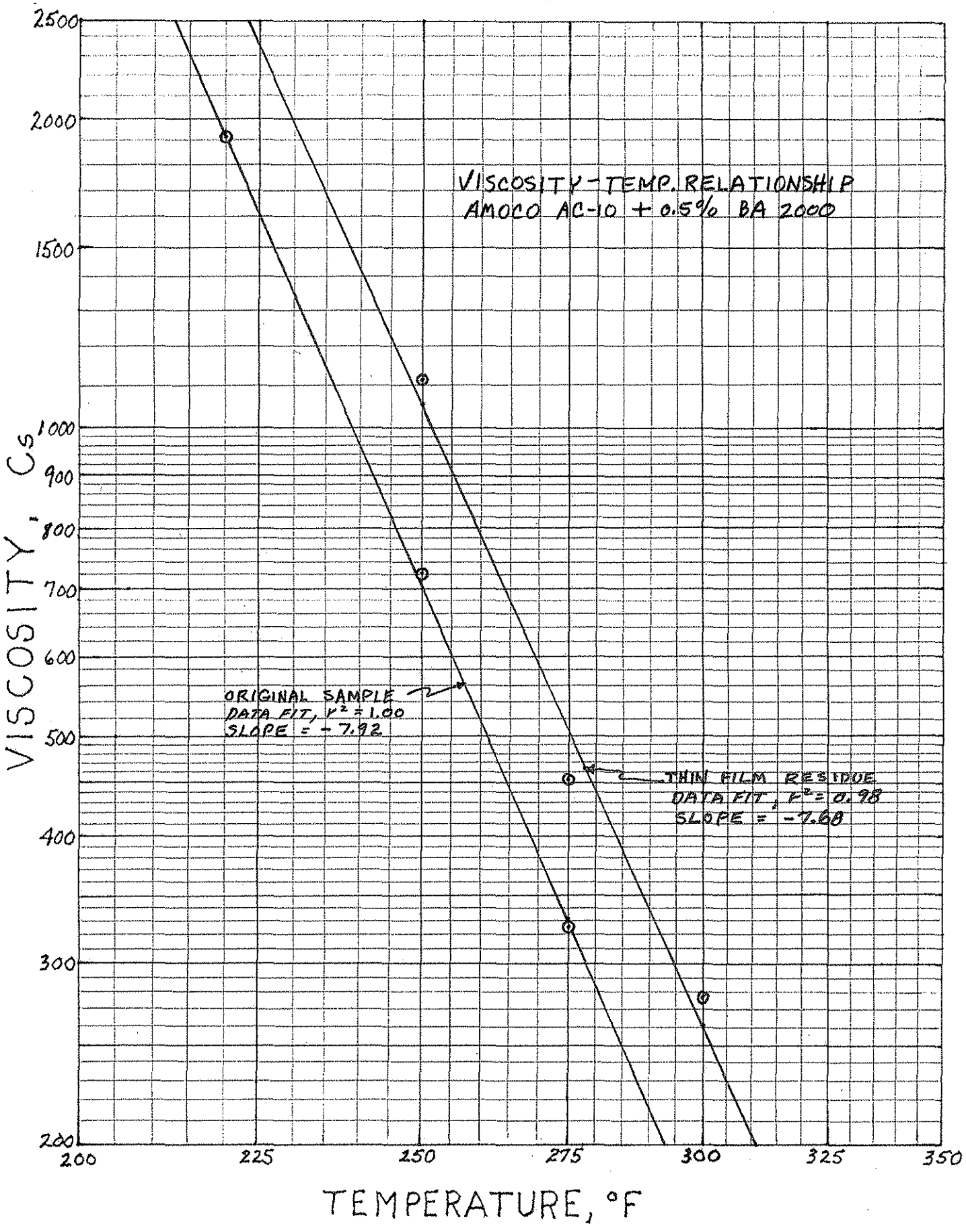
ASPHALT IDENT.	ANTI-STRIP ADDITIVE		ORIGINAL ASPHALT			THIN-FILM RESIDUE			
	NAME	%	220°F	250°F	275°F	% LOSS	250°F	275°F	300°F
AMOCO AC-10 AB6-250	NONE	—	1905	747	323	0.34	1176	467	250
	BA 2000	0.5	1910	724	325	0.48	1122	454	278
	PAVEBOND AP SPEC.	0.5	1912	714	319	0.50	1137	460	243
	REDICOTE 82-S	0.5	1875	688	312	0.40	1106	446	234
KOCH AC-10 AB6-297	NONE	—	2030	691	315	0.44	1142	481	251
	BA2000	0.5	1762	672	304	0.60	1041	448	275
	PAVEBOND AP SPEC.	0.5	1851	677	305	0.61	1089	459	243
	REDICOTE 82-S	0.5	1846	666	325	0.47	1017	426	233

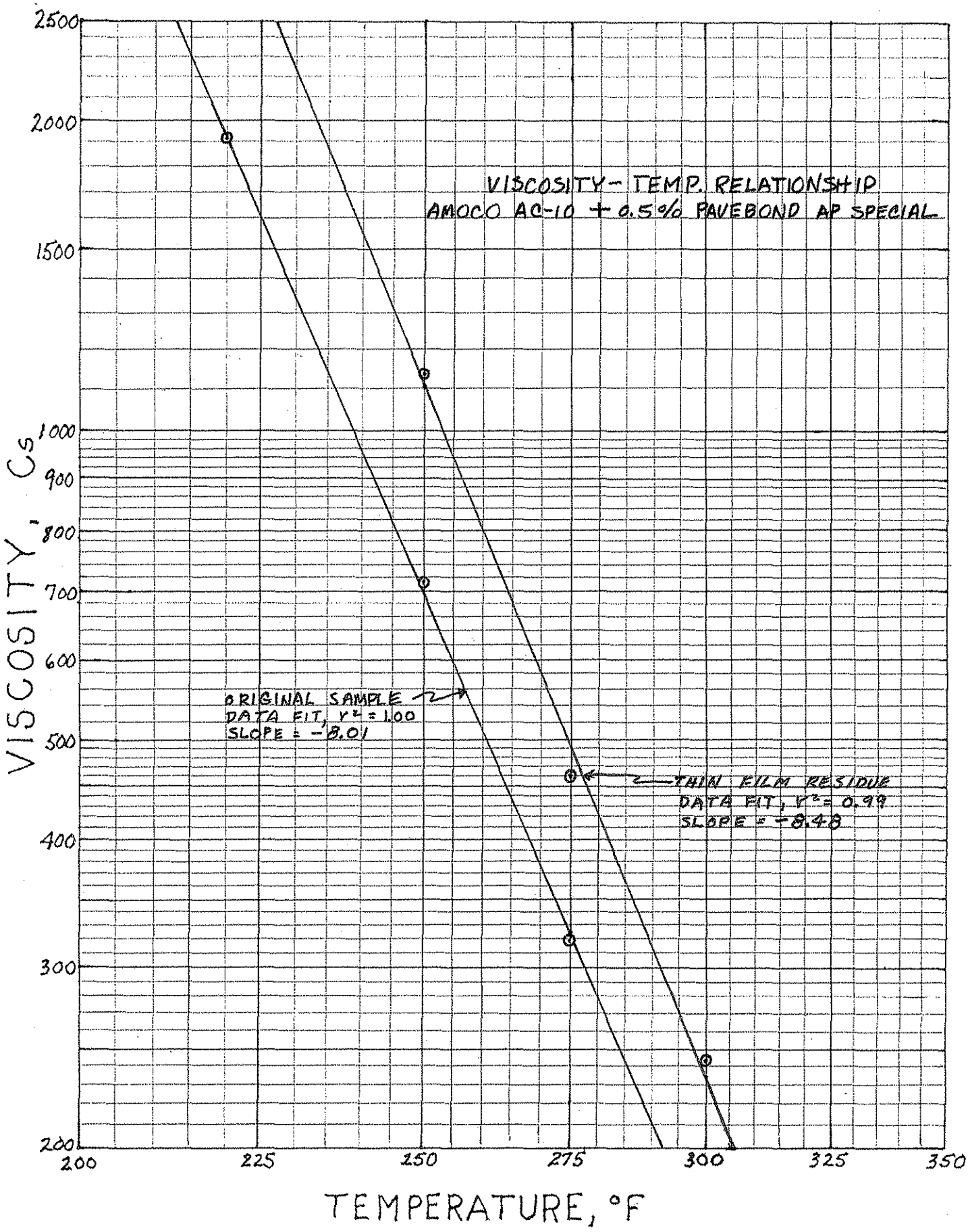
VISCOSITY/TEMPERATURE
SLOPES OF LOG-LOG GRAPHS*

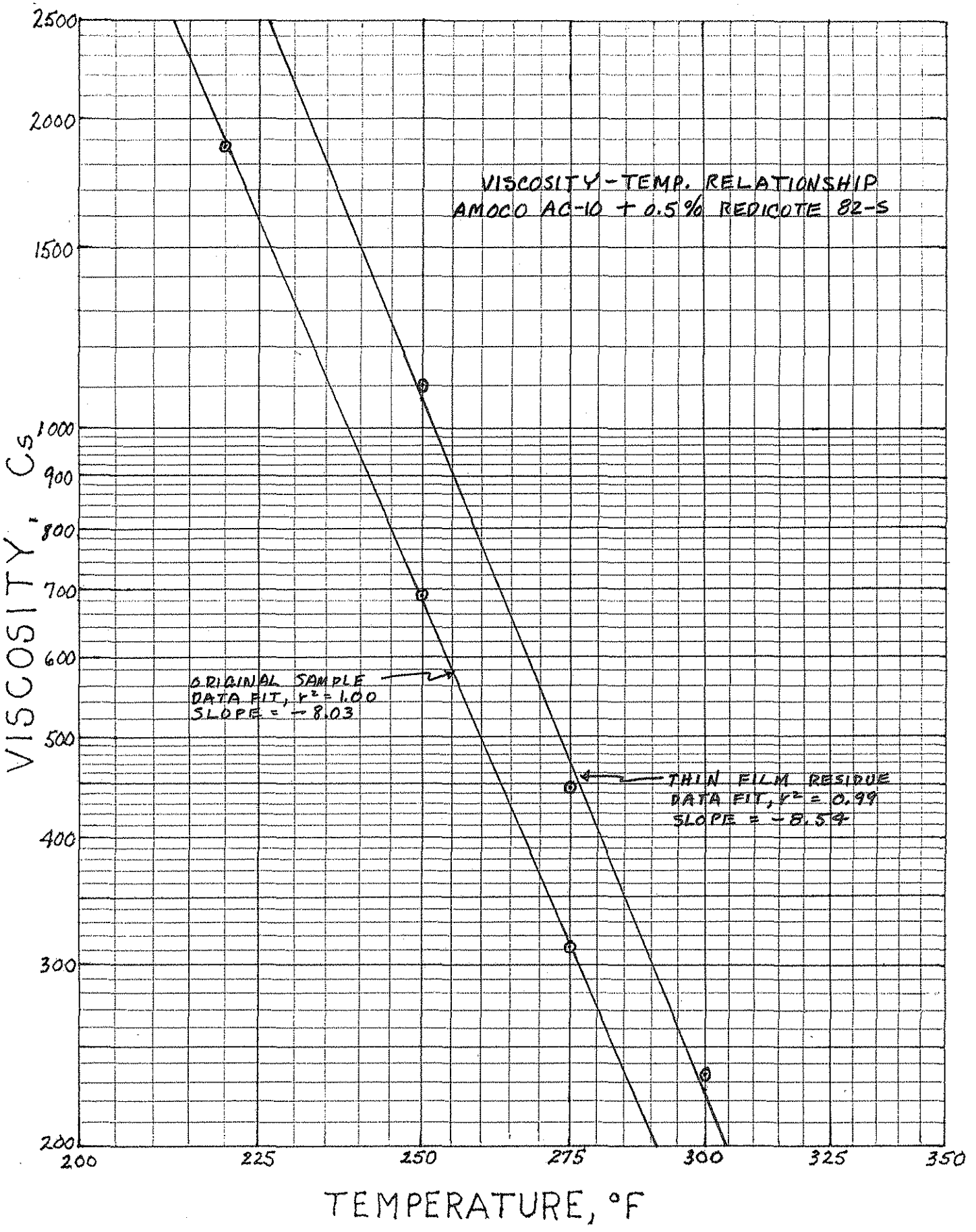
ADDITIVE	AMOCO		KOCH	
	ORIG.	THIN-F.	ORIG.	THIN F.
NONE	-7.9	-8.5	-8.4	-8.3
BA 2000	-7.9	-7.7	-7.9	-7.3
PAVEBOND AP SP.	-8.0	-8.5	-8.1	-8.2
REDICOTE 82-S	-8.0	-8.5	-7.8	-8.1

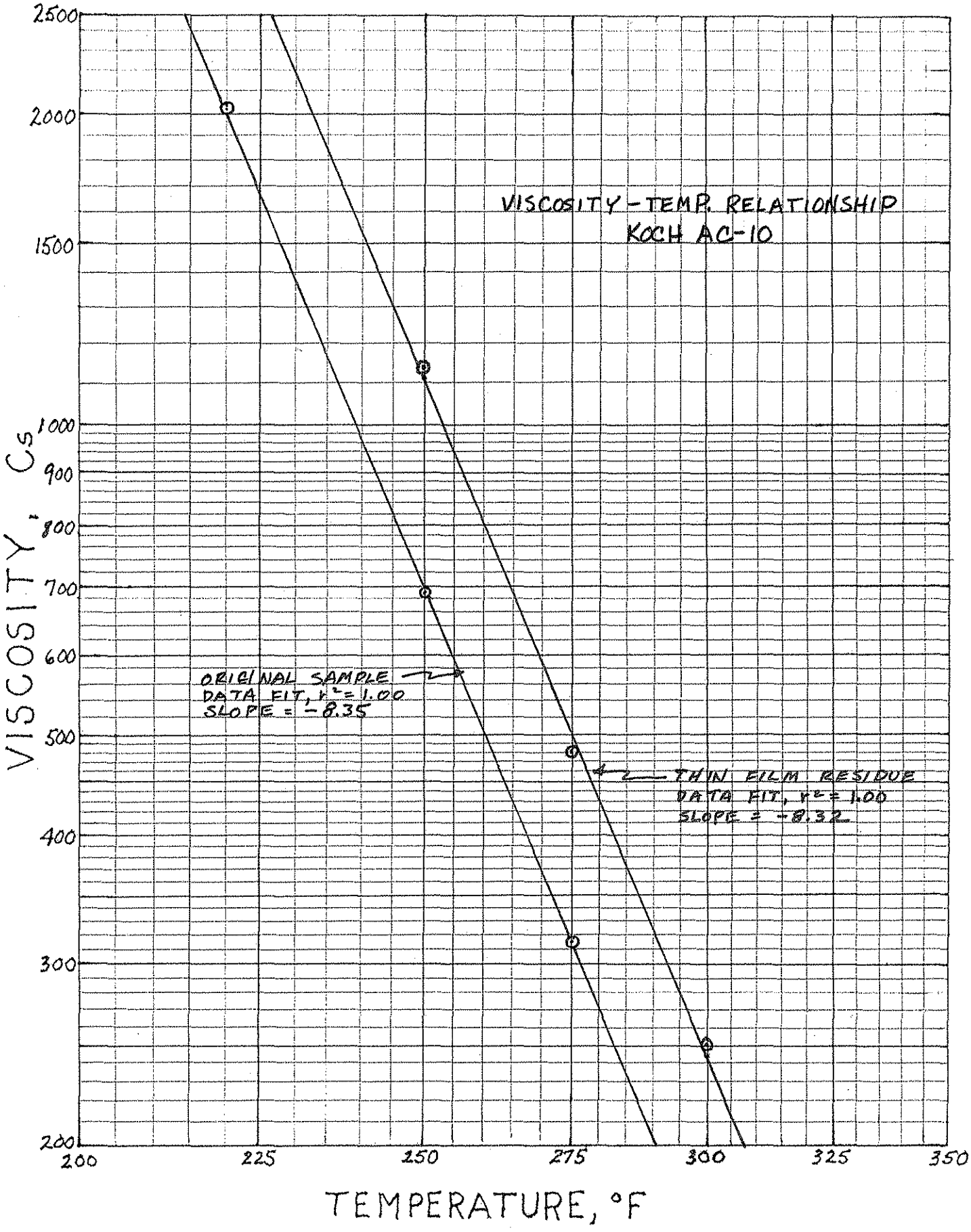
*Larger negative slope indicates more change in viscosity with change in temperature.

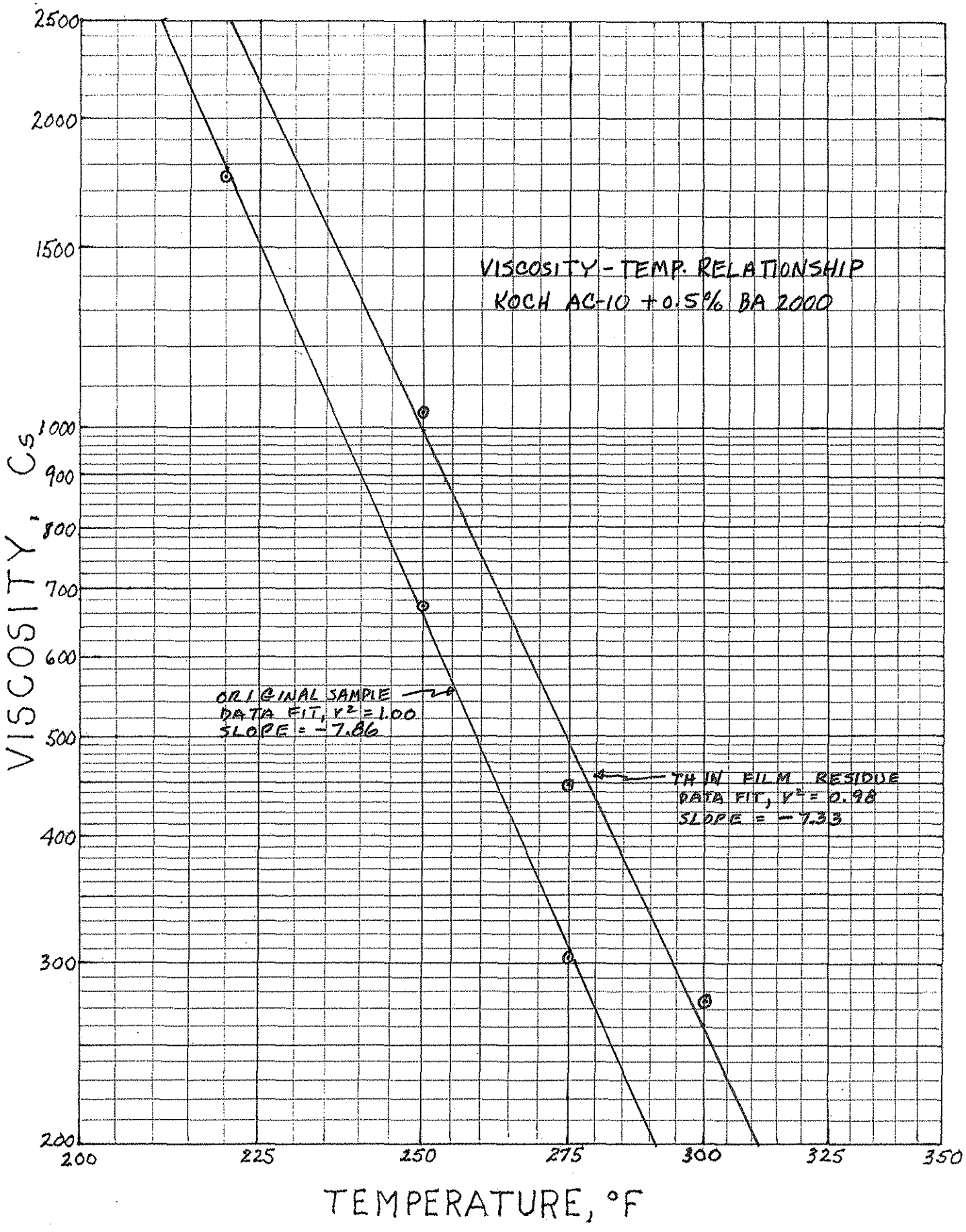

VISCOSITY - TEMP. RELATIONSHIP
AMOCO AC-10
ORIGINAL SAMPLE
DATA FIT, r² = 1.00
SLOPE = -7.92
THIN FILM RESIDUE
DATA FIT, r² = 0.99
SLOPE = -8.51
VISCOSITY, Cs
TEMPERATURE, °F
2500
2000
1500
1000
900
800
700
600
500
400
300
200
200
225
250
275
300
325
350

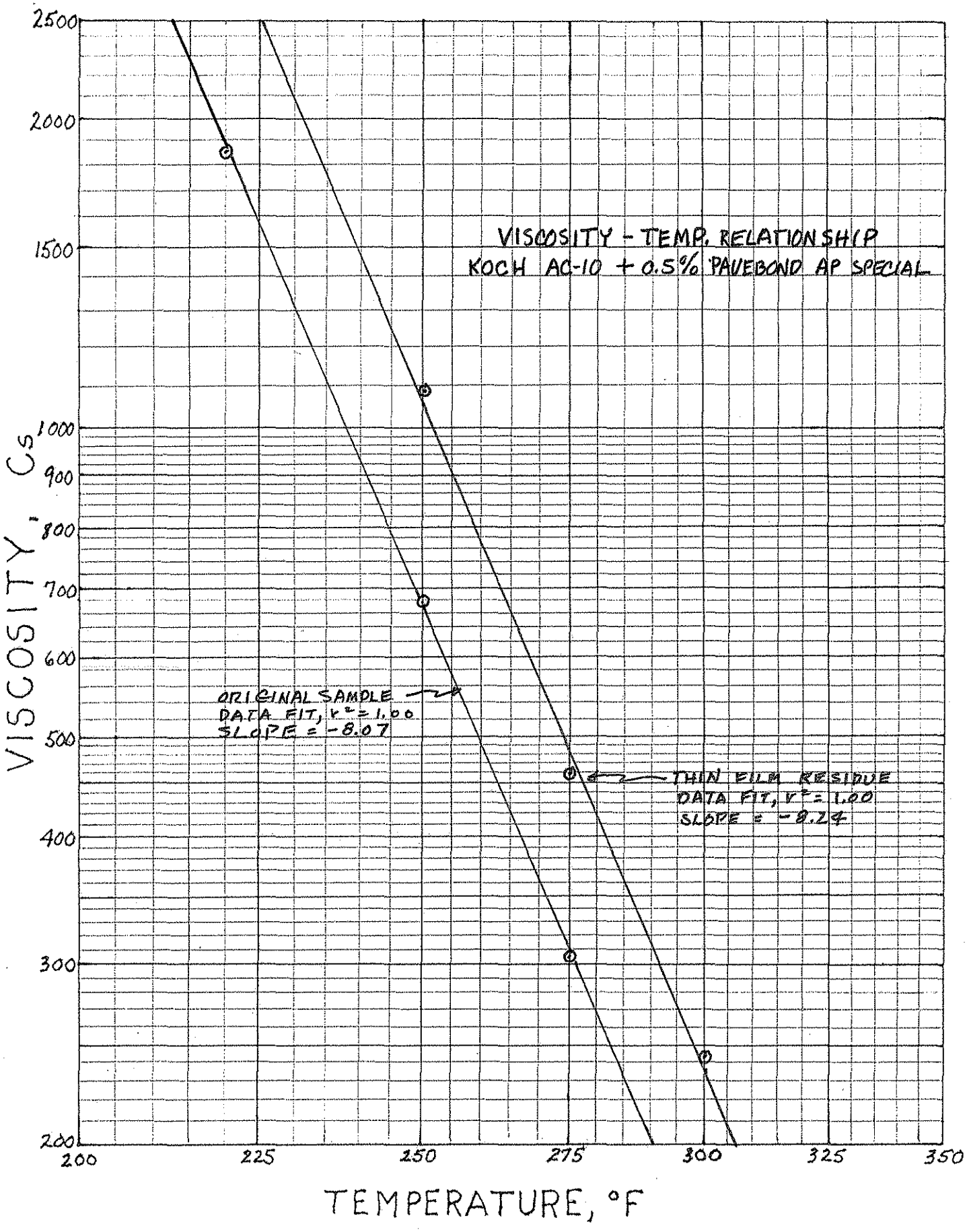

VISCOSITY-TEMP. RELATIONSHIP
AMOCO AC-10 + 0.5% BA 2000
ORIGINAL SAMPLE
DATA FIT, r² = 1.00
SLOPE = -7.92
THIN FILM RESIDUE
DATA FIT, r² = 0.98
SLOPE = -7.68
VISCOSITY, Cs
2500
2000
1500
1000
900
800
700
600
500
400
300
200
200
225
250
275
300
325
350
TEMPERATURE, °F

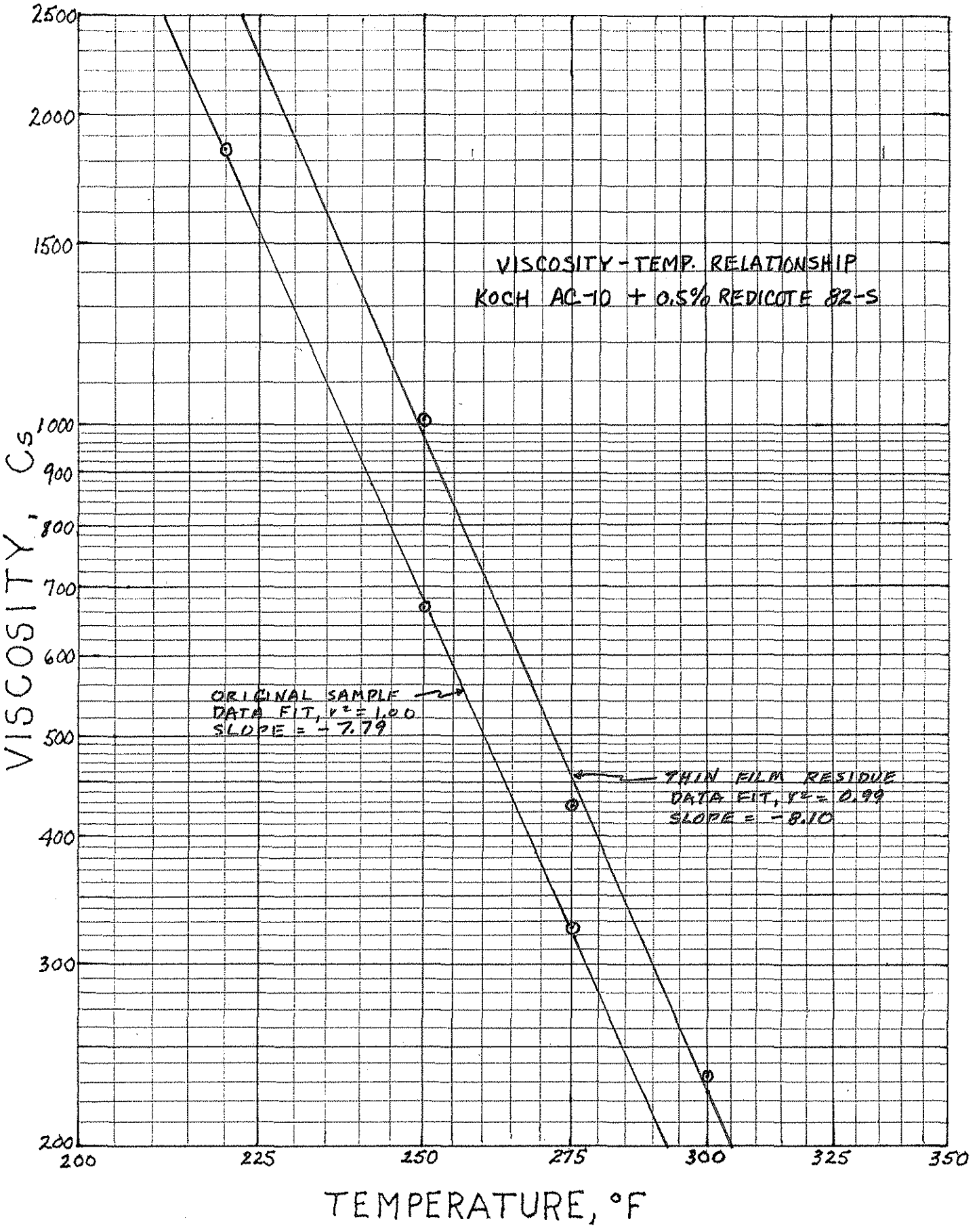

VISCOSITY- TEMP. RELATIONSHIP
AMOCO AC-10 + 0.5% PAVEBOND AP SPECIAL
ORIGINAL SAMPLE
DATA FIT, r² = 1.00
SLOPE = -8.01
THIN FILM RESIDUE
DATA FIT, r² = 0.99
SLOPE = -8.48
VISCOSITY, Cs
TEMPERATURE, °F
2500
2000
1500
1000
900
800
700
600
500
400
300
200
200
225
250
275
300
325
350


VISCOSITY-TEMP. RELATIONSHIP
AMOCO AC-10 + 0.5% REDICOTE 82-S
ORIGINAL SAMPLE
DATA FIT, r² = 1.00
SLOPE = -8.03
THIN FILM RESIDUE
DATA FIT, r² = 0.99
SLOPE = -8.59
VISCOSITY, Cs
TEMPERATURE, °F
2500
2000
1500
1000
900
800
700
600
500
400
300
200
200
225
250
275
300
325
350


VISCOSITY-TEMP. RELATIONSHIP
KOCH AC-10
ORIGINAL SAMPLE
DATA FIT, r² = 1.00
SLOPE = -8.35
THIN FILM RESIDUE
DATA FIT, r² = 1.00
SLOPE = -8.32
VISCOSITY, Cs
TEMPERATURE, °F
2500
2000
1500
1000
900
800
700
600
500
400
300
200
200
225
250
275
300
325
350


VISCOSITY-TEMP. RELATIONSHIP
KOCH AC-10 + 0.5% BA 2000
ORIGINAL SAMPLE
DATA FIT, r² = 1.00
SLOPE = -7.86
THIN FILM RESIDUE
DATA FIT, r² = 0.98
SLOPE = -7.33
VISCOSITY, Cs
TEMPERATURE, °F
2500
2000
1500
1000
900
800
700
600
500
400
300
200
200
225
250
275
300
325
350


VISCOSITY - TEMP. RELATIONSHIP
KOCH AC-10 + 0.5% PAVEBOND AP SPECIAL
ORIGINAL SAMPLE
DATA FIT, r² = 1.00
SLOPE = -8.07
THIN FILM RESIDUE
DATA FIT, r² = 1.00
SLOPE = -8.24
VISCOSITY, Cs
2500
2000
1500
1000
900
800
700
600
500
400
300
200
200
225
250
275
300
325
350
TEMPERATURE, °F


VISCOSITY-TEMP. RELATIONSHIP
KOCH AC-10 + 0.5% REDICOTE 82-S
ORIGINAL SAMPLE
DATA FIT, r² = 1.00
SLOPE = -7.79
THIN FILM RESIDUE
DATA FIT, r² = 0.99
SLOPE = -8.10
VISCOSITY, Cs
TEMPERATURE, °F
2500
2000
1500
1000
900
800
700
600
500
400
300
200
200
225
250
275
300
325
350