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ORGANIC CHEMICALS DIVISION RESEARCH Report

Special Report No. 2918

CONFIDENTIAL
RESTRICT CIRCULATION

MCS 153
Transfer Report

Transfer to Organic Development

Job No. 4013

January 7, 1963

Written by: J. D. Sullivan

Monsanto

ST. LOUIS, MO.

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MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS RESEARCH DEPARTMENT

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A. INTRODUCTION

This report is an attempt to bring together in one place all of the pertinent technology on the preparation and use of MCS 153. The publication of this report will formally transfer the responsibility for this product from the Research Department to the Organic Development Department.

Although OS 81, Monsanto's synthetic steam turbine lubricant, has served as a suitable gas turbine fluid, the lower viscosity MCS 153 is desirable to facilitate start-ups at low temperatures. MCS 153 is a shear stable functional fluid having the following formulation:

Aroclor 1242	75.31%
Aroclor 1232	12.84%
Tricresyl phosphate (TCP)	10.00%
Poly(Oxybutylene-MDI) Diol (FH-139)	1.80%
N-Phenyl-α-Naphthylamine (PAN)	0.05%
DC-200 Silicone	50 ppm

FH-139 is a shear stable viscosity index improver prepared by the reaction of polyoxybutylene diol (B-2000) with methylene di-p-phenylene isocyanate (MDI). This is a "long sought after" development in functional fluid research and its utility may be visualized beyond the current gas-turbine application. Shear stability is imperative for hydraulic fluids of the Aroclor and the Pydraul series and would prove extremely advantageous in the Skydrol fluids used in the aircraft industry.

An intensive effort was made to design a shear stable viscosity index improver which did not cause emulsification when the formulation was mixed with water. Non-emulsifying fluids are not a requirement for the gas-turbine application but it is an important property for fluids which could be contaminated by water by mechanical failures such as in steam turbine or shipboard installations. Water washing, followed by dehydration, is becoming a popular method for recovering used hydraulic fluids and increasing emphasis is being placed on formulations which will not emulsify in contact with water.

Of the viscosity index improvers prepared and tested, the most effective polymers, which also gave non-emulsifying fluids upon formulation, were ones prepared from polybutylene glycols (B-2000) and MDI. However, this polymer (FH-139) prepared in the plant from production size lots of B-2000 and MDI caused the resulting MCS 153 formulation to emulsify in contact with water. This emulsifying tendency was traced definitely to a contaminant, other than moisture and free acid, in the polybutylene glycol. Purifying this diol by customary techniques, prior to polymerization, failed to give non-emulsifying formulations.

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2. Addition of Reactants

a. Stepwise Polymerization - In order to obtain the desired polymerization, the diol and MDI were added in definite increments to supply the required excesses of each reactant, for various time intervals, during the reaction period. Specifically, two moles of MDI were added to one mole of the diol to form a poly-oxyalkylene diisocyanate. This diisocyanate was reacted with two more moles of the diol to form a poly(oxyalkylene urethane) diol. The cycle was repeated until a polymeric diol, having an approximate molecular weight of 10,000, was obtained.

b. Batchwise Polymerization - If the total MDI and poly-glycol required were added at the same time in a single reaction mixture, the desired order of polymerization cannot be attained even with prolonged heating. Under these conditions, the molecular weight of the polymer did not reach its maximum and optimum viscosity index improvement of the resulting formulation was not obtained.

C. PROPERTIES OF MCS 153

1. Fluid Properties

Table I lists the pour point, along with the viscosities of MCS 153 at various temperatures. Similar results are listed for OS-81, Monsanto's current steam turbine lubricant, for comparative purposes.

Table I

a. Viscosity (cs)	MCS 153	OS 31
at 20°F	3,681.0	200,000
at 40°F	468.6	3,200
at 60°F	120.0	-
at 100°F	22.6	34
at 130°F	10.7	-
at 175°F	4.9	5.5
at 210°F	3.2	3.1
b. Pour Point	0°F	+20°F

In Table 1c are listed viscosities of numerous formulations in which the shear stable viscosity index improver (FH-139) was added to various Monsanto base stock fluids.

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3. Physical Properties

The following table lists the densities of MCS 153 at various temperatures along with the specific heat of this fluid at 77°F.

a. Density

Temperature	Gm/ml
20°F	1.3663
60°F	1.3452
100°F	1.3247
210°F	1.2674

	MCS 153	OS 81
b. Specific Heat at 77°F, BTU/lb./°F	0.30	0.31

4. Electrical Properties

Table II lists dielectric constants, power factors and specific resistivities for MCS 153, OS 81, DTE Oil 797 and Cellulube 220.

Table II

	MCS 153	OS 81	DTE 797	Cell. 220
a. Dielectric Constant at 25°C				
at 60 cps	6.52	5.95	2.22	-
at 1000 cps	5.94	5.84	2.24	6.91
b. Power Factor (%) at 25°C				
at 60 cps	52.0	17.6	0	-
at 1000 cps	3.45	1.08	0	17.5
c. Specific Resistivity (ohm-cm)				
at 25°C	1.7×10^{10}	5.0×10^{10}	1.4×10^{13}	2.0×10^{8}
at 100°C	2.0×10^{9}	3.3×10^{9}	3.9×10^{11}	8.6×10^{7}

Dielectric constants and power factors were measured at 60 and 1000 cycles per second at room temperature (25°C). Specific resistivity measurements were made at 25°C and 100°C with a megohm bridge.

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c. Shear Stability

FH-139 in formulations of Aroclor and/or tricresyl phosphate are exceptionally shear stable. After twelve (12) passes through the Diesel Injector, the viscosity of the fluid is decreased by only 0.5%.

7. Performance Tests

a. Oxidation-Corrosion Test

For purposes of comparison, MCS 153 is compared to the 7808 type fluid specifications along with OS 81 and WS-3777, an Esso candidate for a 9236 type fluid. The following table lists the results of comparable oxidation and corrosion tests after a 72 hour retention time at 347°F per Mil-L-7808C.

	Viscosity Initial		Viscosity Change %		Acid	Metal Attack					Wt. Loss
	100	200	100	210	Change	Mg	Al	Fe	Cu	Ag	%
OS 81	34.5	3.15	17.9	1.9	0.14	.01	.03	.03	-.11	-.01	3.4
MCS 153	22.9	3.28	-4.9	-13.7	0.15	.02	.02	.02	-.34	-.10	8.1
WS-3777	52.3	10.4	-4.3	- 5.9	0.54	.02	.02	.03	-.02	.01	2.3
7808C	11.	3.	-5 to +15		2.0	±.2	±.2	±.2	±.4	±.2	-

No sludge or coating was observed in the MCS 153 formulation after the test was terminated.

The following table lists the results of oxidation-corrosion tests on MCS 153 and OS 81 at 250°F for 168 hours.

	OS 81	MCS 153
Metal Attack, Mg/cm:		
Mg	0	-0.01
Al	-0.01	-0.01
Fe	-0.01	0
Cu	-0.05	-0.04
CD/Fe	-0.04	-0.01
Viscosity:		
100°F Initial	34.51 cs.	22.55 cs.
100°F Final	35.48 cs.	24.71 cs.
% Change	+2.8	+9.6
210°F Initial	3.15 cs.	3.24
210°F Final	3.11 cs.	3.31
% Change	-1.3	+2.1

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8. Heat Stability

Laboratory tests showed that large molecular weight polymers (20,000 to 30,000) made from MDI and polyalkylene glycols degraded when heated for prolonged periods above 200°F. On the other hand, lower molecular weight (approximately 10,000) polymers are still effective viscosity index improvers and are more thermally stable. In addition to shear stability and non-emulsification, this thermal characteristic of the polymer was another reason for limiting the chain length of the FH-139 going into the MCS 153 formulation. Table III (see page 10) lists the changes in viscosity and acidity in MCS 153 and OS 81 after long retention times in a severe (static) oven test at 300°F.

It will be noted that the acid build-ups and viscosity increases were only moderate at temperatures well in excess of the operating temperatures of a gas turbine.

9. Toxicity

The toxicity of MCS 153 is unknown at present, but it is anticipated that this fluid will prove to be relatively non-toxic and non-irritating to the skin.

10. Patent Status

A disclosure (No. 2451) has been filed by the Organic Division to cover the use of polymers, made from polyglycols and diisocyanate, as shear stable, non-emulsifying viscosity index improvers for various fluid base stocks.

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