Comparative laboratory performance of air brake cylinder lubricants

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Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/23000769
Michanical Engineering Report, 1966-08

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MECHANICAL ENGINEERING REPORT

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COMPARATIVE LABORATORY PERFORMANCE OF AIR BRAKE CYLINDER LUBRICANTS

BY

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OTTAWA

AUGUST 1966

N.R.C. NO. 9296

NATIONAL RESEARCH COUNCIL

Ottawa, Canada

REPORT

Division of Mechanical Engineering

Fuels and Lubricants Laboratory

Pages - Preface - 3		Report:	MP-43
Text - 4		Date:	August 1966
Tables - 5		Lab. Order:	15164A
Figures - 3		File:	M4-R7-S3

For: Internal

Subject: COMPARATIVE LABORATORY PERFORMANCE OF AIR BRAKE CYLINDER LUBRICANTS

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SUMMARY

A test method for measuring the low temperature release time and the high temperature cup wear preventive properties of air brake cylinder lubricants is described.

The results of comparative trials of reference and various proprietary lubricants are given. Again, a non-soap thickened polyglycol grease containing MoS_2 was best at 150°F., besides exhibiting good release time at -50°F. Two other proprietary products gave acceptable performance at both temperature levels.

General observations are offered on the relationship between composition and performance of the air brake cylinder lubricants tested.

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COMPARATIVE LABORATORY PERFORMANCE OF AIR BRAKE CYLINDER LUBRICANTS

1. INTRODUCTION

The present test program was initiated by the Canadian railways because of a requirement for air brake cylinder lubricants usable at -50°F. without loss of performance at higher temperatures. The basic air brake cylinder grease Specification, AAR 914-42, describes a calcium soap thickened mineral oil (550-700 SUS at 100°F.). In 1962, a low temperature Apparent Viscosity requirement was added, with an appropriate change in oil viscosity limits (150 - 300 SUS at 100°F.) and an Aniline Point requirement to control rubber swell. Subsequently, it was reported that the lubricants provided under Specification AAR 914-62 did not provide adequate lubrication at the highest summer temperatures, possibly 150°F., encountered. The Specification was therefore withdrawn for further study by the Association of American Railroads. The currently proposed detail specification requirements are given in Table 1.

An earlier report (Ref. 1) described the performance of a variety of specification and proprietary lubricants in 10-inch cylinders at 150°F. and -50°F. Generally, the low temperature greases were less effective at 150°F. than the reference grease (AAR Specification 914-42) in terms of test duration vs. cup wear. Additions of molybdenum disulfide solid lubricant to these greases did not appreciably improve their performance. A proprietary grease containing synthetic oil (polyglycol) and MoS_2 was much the best at 150°F., while having a -50°F. release time comparable with those of the experimental low temperature lubricants.

With the required performance level thus defined a little more clearly, several additional candidate lubricants were obtained from suppliers, for trial. The test performance conditions were modified to provide a more severe, and shorter, test. Some useful suggestions offered by Westinghouse Air Brake Division were also incorporated in the method. The comparative performance of reference and candidate lubricants are described in this Report.

2. MODIFIED TEST METHOD

A resistance to piston travel was provided by installing a spring of sufficient capacity to absorb about 60 percent of the piston force over the last $2\frac{1}{4}$ inches of total movement ($7\frac{1}{4}$ in.), i.e., the cup was flared against the cylinder wall with increasing force over this distance. The test assembly used is sketched in Figure 1, and the final arrangement of the test cylinder is shown in Figures 2 and 3. Air at 50 p.s.i. was supplied through solenoid operated air valves and a 90-second cycle was arbitrarily chosen.

In a typical test a cylinder is cleaned, a new cup is installed, and cup and cylinder walls are then coated with test grease. After re-assembly of the cylinder, the unit is cooled to -50°F. without any preliminary stroking and stored for a long enough period, usually overnight, to attain ambient temperature. The piston return time is then measured over a 4-inch distance after the piston is disengaged from the resisting spring. Next, the cylinder is brought to room temperature and stroked 50 times to distribute the lubricant. It is cooled again to -50°F., brought to equilibrium, and the piston release time again recorded. Finally, the unit is heated to 150°F. and stroked continuously on a 90-second cycle. At arbitrary intervals, the cylinder wall is inspected for the presence or absence of lubricant and rubber wear particles. Usually, tests are run in duplicate, using different cylinders to take into account differing characteristics of cylinders.

The method described was found to be easy to apply, with reasonably clear performance criteria and having an acceptable degree of repeatability. Test duration was quite short, usually less than a week.

3. SAMPLES AND IDENTIFICATION

Several reference greases - NRL 22051, NRL 22052, and NRL 23368 were brought forward from the previous test program (Ref. 1). The remaining samples are proprietary greases submitted or recommended specifically for these tests. The samples are described, and the results of selected tests are given, in Table 2. The Rust Preventive Properties are included in this Table without other comment, since these are susceptible to improvement through choice of constituents and additives. A rating of No. 2 max. is the generally accepted limit.

4. PERFORMANCE TEST RESULTS

The results of the performance tests are summarized in Table 3.

5. DISCUSSION OF TEST RESULTS

The limited specific service performance data at hand rate the reference lubricants in the following way:

NRL 22052 (representing Spec. AAR 914-42)	acceptable at high temperature (≠ 150°F.)
	not acceptable at low temperature (≠ -50°F.)
NRL 22051 (representing Spec. AAR 914-62)	not acceptable at high temperature
	acceptable at low temperature

Within this broad framework, it is possible to classify the samples tested (see Tables 4 and 5) as follows:

Low Temperatures - Categories I, II and III (with III possibly marginal)

High Temperatures - Categories I and II (with II possibly marginal).

Only samples NRL 23368, 24727, and 24810 fall within acceptable categories for both high and low temperature operation.

There are too few samples and too little specific chemical and physical test data available on the lubricants (constituents and processing) to generalize on the relationship between composition and performance. However, some possibly significant observations may be made from the data presented in Tables 4 and 5.

(a) Sample NRL 23368, a non-soap thickened polyglycol containing MoS_2, gave the best over-all performance at both temperature levels.

(b) Two of the three best over-all performers are non-soap thickened products containing MoS_2.

(c) Oils having viscosities less than 300 SUS at 100°F. were employed in acceptable low temperature petroleum oil greases.

(d) Rubber swell characteristics, using standard rubber specimens, were roughly in the same order as high temperature performance.

(e) There was no clear relationship between the apparent viscosity of greases at -50°F., at a shear rate of 20 sec.$^{-1}$, and low temperature release time. Spreadability tests rated the greases generally in the order of low temperature performance.

6. ACKNOWLEDGEMENT

The authors wish to acknowledge with thanks the assistance rendered by C.F. Hammer, Vice-President, Engineering, Westinghouse Air Brake Division.

7. REFERENCE

1. New, L.D.; Patterson, B.I. — The Performance of Proprietary and AAR Specification Brake Cylinder Lubricants at 150°F. and -50°F. NRC, DME Mech. Eng. Report MP-33, Jan. 1965.

TABLE 1

PROPOSED SPECIFICATION FOR BRAKE CYLINDER LUBRICANT

1.	Composition	Unrestricted
2.	Worked Penetration at 77°F.	265 - 310
3.	Apparent Viscosity at -40°F.	
	at 20 $sec.^{-1}$, poises	20,000 max.
	at 100 $sec.^{-1}$, poises	15,000 max.
4.	Solidification Point, °F.	-40 max.
5.	Spreadability on Cast Iron	Spreadable at -40°F.
6.	Oil Separation at 175°F.	None
7.	Free Water, percent	1.5 max.
8.	Free Acid, as Oleic, percent	0.3 max.
9.	Alkali, as Calcium Hydroxide, percent	0.2 max.
10.	Oxidation Stability, p.d./100 hr. p.s.i.	10 max.
11.	Rubber Swell	Not greater than ASTM medium swell oil
12.	Water Stability, penetration change, units	-10 to +30
13.	Rust Preventive Properties, rating	No. 2 max.

TABLE 2

INDENTIFICATION OF SAMPLES AND RESULTS OF SELECTED TESTS

Sample Number NRL	Identification	Composition	Approx. Oil Content % Wt.	Oil Viscosity at 100°F. SUS	Worked Penetration 77°F.	Apparent Viscosity, Poises -40°F. 20 sec.$^{-1}$	Apparent Viscosity, Poises -40°F. 100 sec.$^{-1}$	Apparent Viscosity, Poises -50°F. 20 sec.$^{-1}$	Apparent Viscosity, Poises -50°F. 100 sec.$^{-1}$	Rubber Swell 7 days % vol. 158°F. Standard Rubber*	Rubber Swell 7 days % vol. 158°F. Cup**	Rust Preventive Properties ASTM D1743 Rating	Spreadability on cast iron, Materials at -50°F.
22051 (Ref.)	Experimental Low Temperature AAR 914-62	Lithium soap Petroleum oil	90	290	250 - 300	2500	1000	4000	1700	55	48	-	Difficult
22052 (Ref.)	Proprietary AAR 914-42	Calcium soap Petroleum oil	80	530	250 - 300	(1)	(1)	(1)	(1)	32	31	#3	Difficult
23368 (Ref.)	Proprietary	Non-soap Polyglycol MoS_2	70(3)	410	265 - 295	13200	7600	33000	21000(2)	16	12	#3	Easy
24526	Proprietary Spec. 3-GP-682	Non-Soap Petroleum oil	90	180	275	13800	5400	23100	9100	56	36	#1	Marginal (easy)
24527	Proprietary Experimental	Lithium soap Petroleum oil	80	160	230	27000	8400	47000(2)	15000(2)	38	34	#1	Marginal (difficult)
24727	Proprietary	Non-soap Petroleum oil MoS_2	75	120	320	11600	4000	19500	6500	49	48	#3	Easy
24810	Proprietary	Lithium soap Petroleum oil	90	275	302	46000	15500(2)	(1)	(1)	29	22	#3	Difficult

* Westinghouse M-7000-00
** Wabco PC94800-A1

(1) Too high to measure
(2) Approximate extrapolated value
(3) Manufacturers' data

TABLE 3

PERFORMANCE TEST RESULTS

Sample Number NRL	Identification	Release Time at -50°F. sec. (4-in. travel)		Cycles at 150°F. to Appearance of Rubber Wear
		not "run-in"	"run-in"	
22051	Spec. AAR 914-62	48	8	3,200
22052	Spec. AAR 914-42	160 126 -	80 40 -	5,100 5,100 6,600
23368	Proprietary Non-soap Polyglycol, MoS_2	13 -	less than 1 -	more than 5,100* more than 16,000*
24526	Proprietary Spec. 3-GP-682 Non-soap Petroleum oil	2 1	less than 1 less than 1	3,000 3,700
24527	Proprietary Experimental Soap Petroleum oil	1 4	less than 1 1	3,000 6,600
24810	Proprietary Soap Petroleum oil	47	87	6,600
24727	Proprietary Non-soap Petroleum oil, MoS_2	3	less than 1	5,000 - 8,000**

*Discontinued before appearance of rubber wear

**Difficult to detect because of grease colour

TABLE 4

PERFORMANCE AT -50°F.

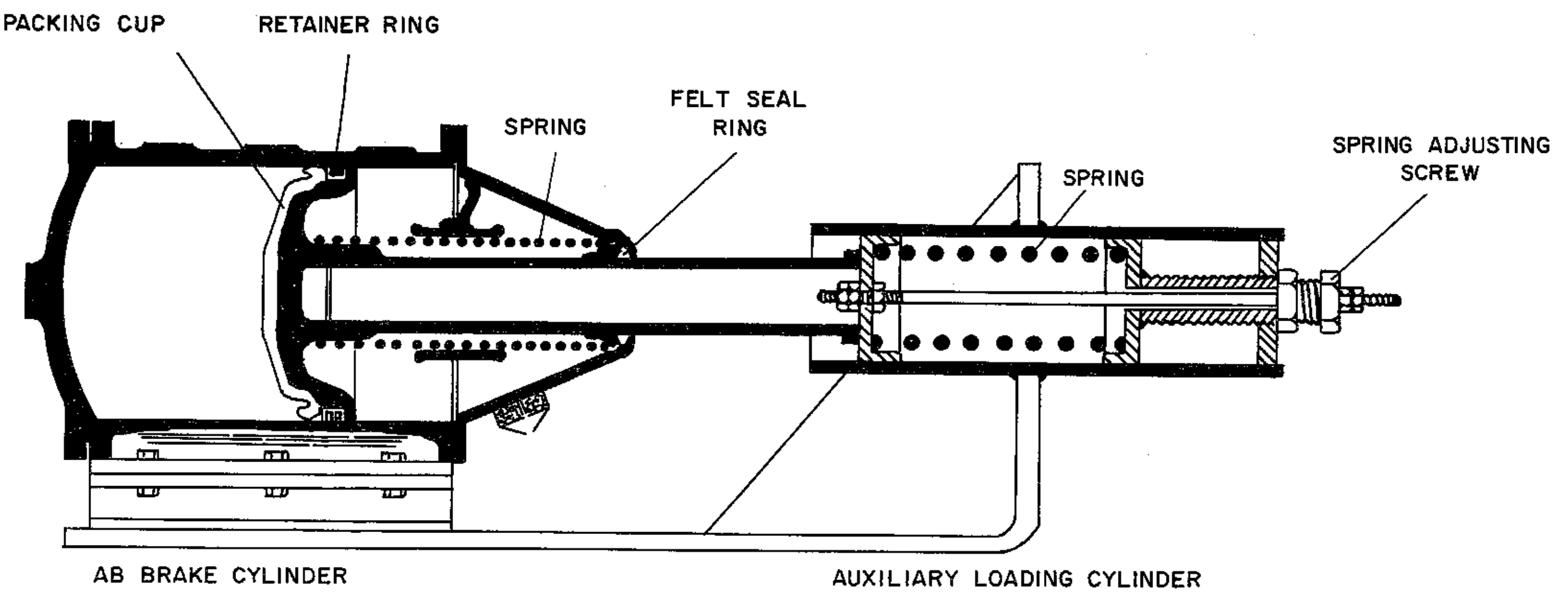
Category	Sample Number NRL	Highest Release Time at -50°F. sec.	Thickener	Oil Content % wt.	Oil Viscosity at 100°F. SUS	App. Visc. at -50°F. Poises, 20 sec.$^{-1}$	Spread-ability
I	24526	2	non-soap	90	180	23100	marginal (easy)
	24527	4	lithium soap	80	160	47000	marginal (difficult)
	24727	3	non-soap	75	120	19500	easy
II	23368	13	non-soap	70	410	33000	easy
III	22051	48	lithium soap	90	290	4000	difficult
	24810	47	lithium soap	90	275	too high	difficult
IV	22052	160	calcium soap	80	530	too high	difficult

These results may be compared with the compositional and selected test data presented in Table 1.

TABLE 5

PERFORMANCE AT 150°F.

Category	Sample Number NRL	Cycles at 150°F. to Appearance of Rubber Wear	Thickener	Oil Content % wt.	Oil Viscosity at 100°F. SUS	Swell Standard Rubber % vol.	MoS_2
I	23368	more than 16000	non-soap	70	410	16	yes
II	24810	6600	lithium soap	90	275	29	no
	24727	5000-8000	non-soap	75	120	49	yes
	22052	5000-6600	calcium soap	80	530	32	no
III	24526	3000-3700	non-soap	90	180	56	no
	24527	3000-6600	lithium soap	80	160	38	no
	22051	3200	lithium soap	90	290	55	no



SECTIONAL VIEW OF AB BRAKE CYLINDER WITH AUXILIARY LOADING CYLINDER
PARTIALLY EXTENDED POSITION

FIG. I
MP—43

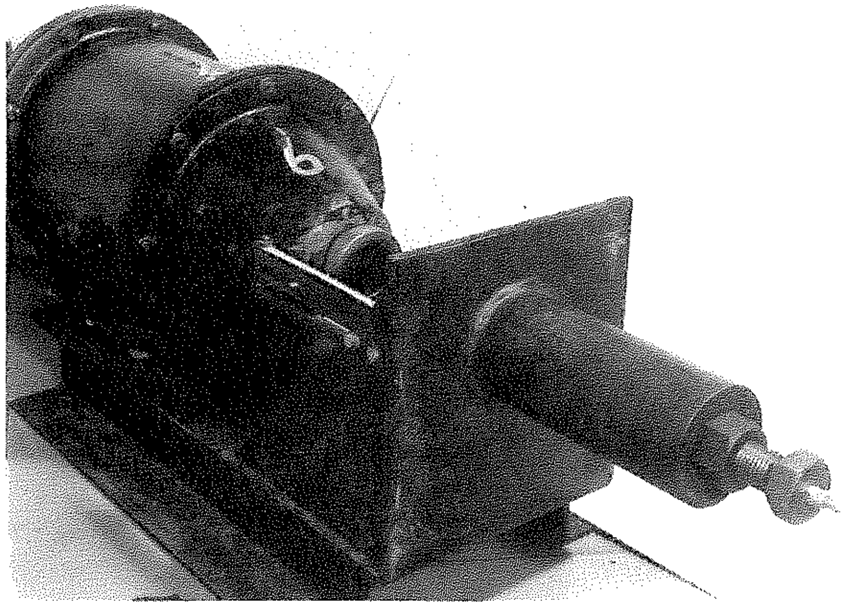


FIG. 2 SINGLE CYLINDER MOUNTING

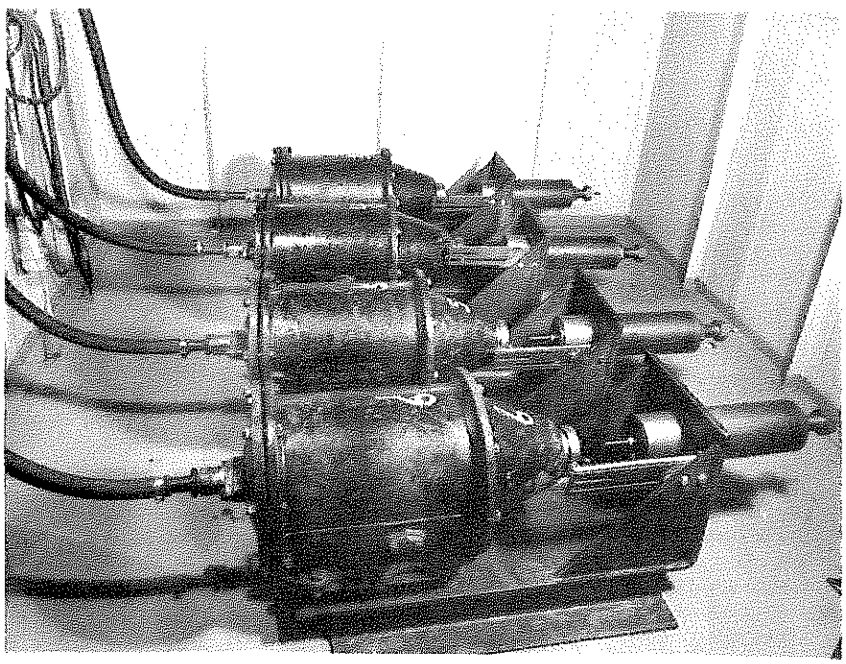


FIG. 3 MULTIPLE CYLINDER ARRANGEMENT IN CONTROLLED TEMPERATURE ROOM

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L.D. New, B.I. Patterson, August 1966, pp. 11, figs. 3

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