

# SINGLE CYLINDER ENGINE TESTS FOR EVALUATING THE PERFORMANCE OF CRANKCASE LUBRICANTS

## **Part I:** Caterpillar IG2 Test Method

Not an ASTM Standard

STP 509A

**PART I**

04-509010-12



AMERICAN SOCIETY FOR TESTING AND MATERIALS

# SINGLE CYLINDER ENGINE TESTS FOR EVALUATING THE PERFORMANCE OF CRANKCASE LUBRICANTS

## Part I: Caterpillar IG2 Test Method

Not an ASTM Standard

Sponsored by Technical Division B on  
Automotive Lubricants of  
ASTM Committee D-2 on Petroleum Products  
and Lubricants

ASTM SPECIAL TECHNICAL PUBLICATION 509A (PART I)

List Price \$9.75

04-509010-12



AMERICAN SOCIETY FOR TESTING AND MATERIALS  
1916 Race Street, Philadelphia, Pa. 19103

Copyright © by AMERICAN SOCIETY FOR TESTING AND MATERIALS 1979  
Library of Congress Catalog Card Number: 78-74558

NOTE

The Society is not responsible, as a body,  
for the statements and opinions  
advanced in this publication.

Printed in Philadelphia, Pa.  
March 1979

## SINGLE CYLINDER ENGINE TESTS

### CATERPILLAR 1G2 TEST METHOD

## **Related ASTM Publications**

**The Relationship Between Engine Oil Viscosity and Engine Performance, STP 621 (1977), \$15.00, 04-621000-12**

**The Relationship Between Engine Oil Viscosity and Engine Performance, STP 621-S1 (1977), \$12.00, 04-621010-12**

**The Relationship Between Engine Oil Viscosity and Engine Performance, STP 621-S2 (1978), \$15.00, 04-621020-12**

**The Relationship Between Engine Oil Viscosity and Engine Performance, STP 621-S3 (1978), \$15.00, 04-621030-12**

**Multicylinder Test Sequences for Evaluating Engine Oils, STP 315G (1977), \$20.00, 04-315070-12**

## FOREWORD

The test methods described in this publication have not been subjected to the ASTM Standardization Procedure. They are not standards or standard recommended practices of the American Society of Testing and Materials. However, these procedures are developed and approved by ASTM Committee D-2 Technical Division B on Automotive Lubricants. The membership of both Committee D-2 and Technical Division B is balanced between producer, consumer and general interest members.

One of the most important uses of these test procedures is in the technical description of various oil classifications according to performance and type of service (accomplished by cooperative action of committees in SAE, API and ASTM). Details of the classifications are published in SAE Information report "Engine Oil Performance and Engine Service Classification—SAE J182," API Publication 1509 "Engine Service Classification and Guide to Crankcase Oil Selection" and ASTM Research Report D-2:1004 "Engine Oil Performance Classifications."

The diesel engine oils in use in 1939 or earlier served as a basis for the first diesel oil specifications. Caterpillar Tractor Company was the first diesel engine manufacturer to approve oils on the basis of performance in early versions of the laboratory engine tests. These early manufacturer specifications also served as the basis for the first military specifications for diesel engine oils which were introduced in 1941. Over the years, performance standards have been raised as necessary to meet new service operating conditions and/or new engine requirements.

ASTM Special Technical Publication 509 "Single Cylinder Engine Tests for Evaluating the Performance of Crankcase Lubricants (Abridged Procedures)" was published in 1972. This represents the first time complete test procedures have been published in ASTM format. This current edition of STP509A is offered in four separate independent parts as each becomes available. Specifically, Part I (1G2), Part II (1H2), Part III (1D2), and Part IV (L-38A) may be ordered individually in perfect bound copies or in 8½" x 11" three-hole punched reprints for insertion in loose-leaf binders.

These test procedures are continually undergoing changes to reflect refinements in procedure, obsolescence of parts or reagents, etc. These changes or updates, as well as general information regarding the tests, are issued as information letters by the ASTM Engine Test Monitoring Center. Copies of information letters pertaining to these tests may be obtained by contacting:

ASTM Engine Test Monitoring Center  
P. A. Bennett (Administrator)  
400 Fifth Avenue  
Pittsburgh, Pennsylvania 15213, U.S.A.

This second version was edited by Concept Engineering Services, Inc., P. O. Box 29265, San Antonio, Texas 78229, with the help of the test developer and the ASTM Single Cylinder Surveillance Panel, Chairman and members.

## TABLE OF CONTENTS

|       |  |    |
|-------|--|----|
| 1.    | Scope . . . . .  | 1  |
| 2.    | Summary of Methods . . . . .   | 1  |
| 3.    | Significance . . . . .   | 1  |
| 3.1   | Method . . . . .   | 1  |
| 3.2   | Use . . . . .  | 1  |
| 3.3   | Validity . . . . .   | 2  |
| 4.    | Definitions . . . . .  | 2  |
| 5.    | Apparatus . . . . .  | 2  |
| 5.1   | Test Engine Configuration . . . . .  | 2  |
| 5.2   | Cooling System . . . . .   | 2  |
| 5.3   | Fuel System . . . . .  | 4  |
| 5.4   | Intake Air System . . . . .  | 4  |
| 5.5   | Exhaust System . . . . .   | 4  |
| 5.6   | Blowby Meter . . . . .   | 5  |
| 5.7   | Thermocouples . . . . .  | 5  |
| 5.8   | Procurement of Parts . . . . .   | 5  |
| 6.    | Reagents and Materials . . . . .   | 5  |
| 6.1   | Fuel . . . . .   | 5  |
| 6.2   | Test Oil . . . . .   | 6  |
| 6.3   | Engine Coolant . . . . .   | 6  |
| 6.4   | Cleaning Materials . . . . .   | 6  |
| 6.4.1 | Solvent . . . . .  | 6  |
| 6.4.2 | Dispersant Engine Cleaner . . . . .  | 6  |
| 6.4.3 | General Cleaning Agents . . . . .  | 6  |
| 7.    | Safety . . . . .   | 6  |
| 8.    | Preparation of Apparatus . . . . .   | 6  |
| 8.1   | Supplementary Service Information . . . . .                                | 6  |
| 8.1.1 | Caterpillar Service Manual . . . . .                                       | 6  |
| 8.1.2 | Pre-Test Maintenance Check List and Continuing Engine Inspection . . . . . | 7  |
| 8.2   | Engine Modifications . . . . .   | 10 |
| 8.2.1 | Piston Cooling Nozzle . . . . .  | 10 |
| 8.2.2 | Engine Oil Level Gauge . . . . .   | 10 |
| 8.2.3 | Crankcase Pressure Control Valve . . . . .                                 | 10 |
| 8.2.4 | Oil Cooler Inlet Temperature . . . . .                                     | 10 |
| 8.2.5 | Fuel System . . . . .  | 10 |
| 8.2.6 | Intake Air System . . . . .  | 15 |
| 8.2.7 | Exhaust System . . . . .   | 15 |
| 8.2.8 | Cooling System . . . . .   | 17 |
| 8.3   | Auxiliary Equipment . . . . .  | 17 |
| 8.3.1 | Thermocouples . . . . .  | 17 |
| 8.3.2 | Calibration of Auxiliary Instrumentation . . . . .                         | 21 |
| 8.4   | Engine Cooling System . . . . .  | 21 |
| 8.5   | Engine Crankcase Cleaning . . . . .  | 22 |
| 8.5.1 | Additional Oil Filter . . . . .  | 22 |
| 8.5.2 | Flushing Procedure Components . . . . .                                    | 22 |
| 8.5.3 | Flushing Procedures . . . . .  | 22 |
| 8.6   | Cylinder Head . . . . .  | 35 |
| 8.6.1 | Valve Guide Bushings . . . . .   | 35 |
| 8.6.2 | Precombustion Chamber Inspection and Maintenance . . . . .                 | 35 |
| 8.7   | Measurements . . . . .   | 35 |
| 8.7.1 | Cylinder Liner Wear . . . . .  | 36 |



|             |  |    |
|-------------|--|----|
| 8.7.2       | Ring Wear . . . . .                                  | 36 |
| 8.7.3       | Ring Side Clearance . . . . .                        | 36 |
| 8.7.4       | Compression Ratio . . . . .                          | 37 |
| 8.7.5       | Piston Ring Gap Location . . . . .                   | 42 |
| 9.          | Calibration Test Method . . . . .                    | 42 |
| 10.         | Procedure . . . . .                                  | 42 |
| 10.1        | Engine Run-in . . . . .                              | 42 |
| 10.2        | Operating Conditions . . . . .                       | 43 |
| 10.3        | Oil Addition Procedure . . . . .                     | 44 |
| 10.4        | Engine Oil Level . . . . .                           | 44 |
| 10.5        | Oil Change . . . . .                                 | 44 |
| 10.6        | Cool-Down Procedure . . . . .                        | 45 |
| 10.7        | Warm-up Procedure . . . . .                          | 45 |
| 10.8        | Shutdown . . . . .                                   | 45 |
| 10.9        | Soft Start . . . . .                                 | 45 |
| 10.10       | Exhaust Temperature Recorder . . . . .               | 46 |
| 10.11       | Air-Fuel Ratio . . . . .                             | 46 |
| 10.12       | Fuel System . . . . .                                | 46 |
| 10.13       | Periodic Measurements . . . . .                      | 46 |
| 11.         | Inspection . . . . .                                 | 50 |
| 11.1        | Preparation . . . . .                                | 50 |
| 11.2        | Intermediate Inspection . . . . .                    | 50 |
| 11.3        | Final Inspection . . . . .                           | 50 |
| Appendix A: | Procurement of Test Parts . . . . .                  | 52 |
| Appendix B: | Test Data Recording . . . . .                        | 54 |
| Appendix C: | Test Data Plotting . . . . .                         | 56 |
| Appendix D: | Report Forms . . . . .                               | 59 |
| Appendix E: | Precision Data . . . . .                             | 64 |
| Appendix F: | Test Fuel . . . . .                                  | 65 |
| Appendix G: | 1Y38 Surge Chamber and Air Heater Assembly . . . . . | 67 |
| Safety      | . . . . .  | 79 |
| Glossary    | . . . . .  | 81 |

## FIGURES

|                  |   |    |
|------------------|---|----|
| Figure 1         | 1Y73 Engine Arrangement . . . . .   | 3  |
| Figure 2         | Suggested Piston Cooling Nozzle Pressure Pick-up . . . . .  | 11 |
| Figure 3         | Bayonet Oil Gauge Lowering Spacer . . . . .   | 12 |
| Figure 4         | Crankcase Pressure Control Valve Installation . . . . .   | 13 |
| Figure 5         | Standardized Engine Fuel System . . . . .   | 14 |
| Figure 6         | Exhaust Back Pressure/Sampling Tap Installation . . . . .   | 16 |
| Figure 7         | Exhaust Bank Pressure/Gas Sample Probe . . . . .  | 18 |
| Figure 8         | Non-Pressurized 5-Inch Cooling Tower . . . . .  | 19 |
| Figure 9         | Recommended Cooling System . . . . .  | 20 |
| Figure 10        | Oil Flow Schematic 1Y73 Engine Arrangement . . . . .  | 27 |
| Figure 11        | Clear Plastic Cover . . . . .   | 28 |
| Figure 12        | Typical Flushing Pump Arrangement . . . . .   | 29 |
| Figure 13        | Crankcase/Governor Housing Sprayer . . . . .  | 30 |
| Figure 14        | Governor Housing Cover Modification . . . . .   | 31 |
| Figure 15        | Front Cover Sprayer . . . . .   | 32 |
| Figure 16        | Flushing Components Location . . . . .  | 33 |
| Figure 17        | Rocker Oil Line Block-Off Fitting . . . . .   | 34 |
| Figure 18        | Placement Location of Lead Shot . . . . .   | 38 |
| Figure 19        | Sample Compression Ratio Worksheet . . . . .  | 39 |
| Figure 20        | Compression Ratio vs Piston To Head Clearance . . . . .   | 40 |
| Figure 21        | Piston Ring Gap Orientation . . . . .   | 41 |
| Figure 22        | Exhaust Temperature, °F . . . . .   | 47 |
| Figure 23        | Caterpillar 1 G2 Data Log . . . . .   | 55 |
| Figure 24        | Caterpillar Test No. 1 G2 . . . . .   | 57 |
| Figure 25        | Laboratory Test Tabulation . . . . .  | 60 |
| Figures 26 to 55 | 1Y38 Surge Chamber and Air Heater Assembly . . . . .<br>(See Page 68 for detailed listing of components.) | 69 |