FIIM STUDY GROUP

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T.O.M. REEL NO. 109

Prepared by

SUN OIL COMPANY

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Norwood, Pa.

UNITED STATES GOVERNMENT TECHNICAL OIL MISSION

MICROFILM REEL 109

SUMMARY

Reel 109 of the microfilms obtained by the United States Government Technical Oil Mission was examined in response to a request from A. E. Miller, Chairman of the API-TOM Study Group.

The attached report contains a table of contents and summaries of all the reports included in Reel No. 109.

3-26-47

INDEX TO TOM MICROFILM REEL 109

NOTE:--The summaries of the reports marked with an asterisk were translated by the English and were copied verbatim for use in this report.

COMPARATIVE TESTS ON AVIATION LUBRICANT MIXTURES A TO F

Report No.: N-1
Origin: I.G.Ludwigshafen
Date: 3/20/41

Report No.: 471
Author: Wilky and Lauer
Contents: 8 text pages
63 pages of illustrations

SUMMARY

A series of lubricating mixtures made up of different synthetic materials manufactured at Leuna and mineral oils of the German Vacuum Oil Company were tested and compared in motors with and without additive compounds. All of the oils tested behaved better than the standard oil (Rotring D) in regard to ring-sticking. The addition of an inhibitor resulted in a slight improvement in the case of new oils while reclaimed oils showed no improvement.

PART II: MEASUREMENT OF HEAT TRANSFER IN HIGH PRESSURE TUBES ON WHICH SPIRAL SHAPED FINS ARE WELDED

Ref. No.: N-2
Origin: I.G. Farben Ludwigshafen
Date: 8/1/41

Report: 469
Author: G. Kling
Contents: 11 pages of text
6 pages of illustration
and 1 table

SUMMARY

Spiral finned pipes with various pitches and diameters of fins were tested. For comparison the heat transfer of the ordinary tubes with rectangular fins were measured. The heat transfer numbers α_a of the finned pipes decline hyperbolically from the α_a value of the unfinned pipes with increasing surface area F_a and approach a limiting value $\alpha_a = 9$ Cal. per square meter per hour per degree centigrade ($w_{R\ (fin)} = 20$ m/sec). However, heat quantities which can be transferred are smallest in the unfinned pipe and then increase with F_a since α_a is proportional to F_a. It is worth mentioning that the results on all pipes, independent of shape of fin or distribution of the fins, fit the curves α_a vs. F_a and Q vs. F_a. Compared with the tube No. 4 as a standard, the following heat transfer quantities in per cent are given.

Tube No.	Shape of Fin	Dimensions in mm	Distance between fins in mm	Relative % heat transfer $Q/Q_{No.4}$
4	Rectangular	230 x 250	15.6	100
8	Spiral	125 I.D. 227 O.D.	19.8	73
9	"	126 I.D. 246 O.D.	19.8	79
10	"	126 I.D. 246 O.D.	16.1	91
11	"	126 I.D. 246 O.D.	12.1	104

The results show that a still greater increase in surface area (a greater diameter of the spiral) would further increase the heat transfer by an appreciable amount.

COMPARATIVE ENGINE TESTS WITH SYNTHETIC MOTOR OILS

Ref. No.: A.19 Report No.: 466
Origin: I.G. Ludwigshafen Author: Lauer
Date: 8/10/41

SUMMARY

Details of the manufacturing processes used in making the two synthetic oils are not given, but the oils are stated to come from I.G. Merseburg (Ammon-Werk). One of them, R.1., has a viscosity of 13.2 cs. at 99°C. and a V.I. of 102. The other oil, M.1, has a viscosity of 13.3 cs. at 99°C. and a V.I. of 92. On the basis of the 100-hour tests against Standard Oils* in an Open 4-cylinder bench engine, R.1. is considered unsatisfactory owing to instability and sludge formation, but M.1. is passed out for "practical testing".

*Wehrmacht Einheitsoel (Oppau production) was the standard oil and a blend of Deganol with Motanol S (old Deutsche gasoline production) was used as the low performance standard.

ROAD TEST ON DIESEL FREIGHT LORRY WITH FUEL TZ. 100

Ref. No.: A.17
Origin: I.G. Oppau
Date: 6/23/41

Report No.: 466
Author: Kohler
Contents: 4 text pages and 1 figure sheet

SUMMARY

A test has been carried out with TZ.100 in a 2½ ton Daimler Benz diesel freight lorry in order to examine the suitability of this fuel for road use. Except for changing the injection pipe from one of 1.5 mm. I.D. to one of 2.5 mm. I.D. no alterations to the engine were necessary. No difference in starting quality, or in the performance or fuel consumption of the engine was found to exist in comparison with gas oil operation. Hence TZ.100 appeared to be as suitable as the usual gas oil for the diesel engine.

COMMENTS

Fuel TZ.100 is a spindle oil with the following inspection data:

Appearance		Slightly blue
Sp.Gr. at 20°C.		0.853
Pour Point	°C.	-40
Flash Point	°C.	150
Fire Point	°C.	185
I.B.P. under vacuum	°C.	135
F.B.P. under vacuum	°C.	370
Conradson Test	mg/g.	0.032
Cetane Number		46.5

The safe nature of this fuel is shown by its high viscosity of 1.50 centistokes at 20°C., (cf. value of 12 cs/20° for usual diesel oil) and high flash point of 150°C. (cf. usual diesel oil value of 100°C).

The road tests were made at the prevailing temperature of -10° to -15°C. Fuel consumption: TZ.100 - 14.6 kg/100 km.
Gas Oil- 14.2 kg/100 km.

REFERENCE FUELS AND ACCURACY IN THE DETERMINATION OF THE OCTANE NUMBER

Ref. No.: A.16
Origin: I.G. Oppau
Date: 6/23/41

Report No.: 464
Author: E. Singer

SUMMARY

A large number of experiments shows that the accuracy of the octane number determination does not depend on the similarity of reference and test fuels; paraffinic reference fuels, such as "Z" (technical iso-octane), can be used for testing benzol mixtures.

PART I: A COMPARISON OF THE HEAT TRANSFER IN HIGH PRESSURE TUBES WITH WELDED AND PRESSED ON FINS

Ref. No.: N-3
Origin: I.G. Farben Ludwigshafen
Date: 7/14/41

Report No.: 463
Author: G. Kling
Contents: 16 pages of text, 8 pages of illustration and 3 tables

SUMMARY

An experimental plant was built in which finned high pressure pipes could be tested in order to investigate their external heat exchange. The conditions of the experiments used were the same as exist in actual usage.

In the first report on the very large experimental program, comparative measurements made on pipes with welded and pressed on fins are reported. The results of the experiments show the damaging effect of poor contact between the pipe and the pressed on fin as a result of which the heat transfer number of the whole pipe during normal conditions of use reaches only 75 per cent of that of the welded pipe. The α_a values of the pipes with pressed on fins become worse the higher the fin temperature because the contact between fin and pipe becomes poorer due to unequal expansion. With inwardly heated and outwardly cooled pipes, the contact improves so that, the α_a value for the pipe with pressed on fins almost reaches that for pipes with welded fins. Finally the temperature of the fins at different points was measured. This furnishes a confirmation of the measurements, and at the same time leads to important conclusions on the displacement effect.

MINIMUM AND OPTIMUM PILOT INJECTION QUANTITIES FOR THE "RING" OPERATION OF A JUMO 211A CYLINDER

Ref. No.: A.14
Origin: I.G. Oppau
Date: 5/1/41

Report No. 460
Author: H. Leib
Contents: 7 text pages
8 figure sheets

SUMMARY

The tests showed that the minimum pilot fuel quantity down to a quarter full load was 5 cubic millimeteres per stroke (equivalent to 2-10% of the total fuel quantity). The optimum quantity for performance and consumption coincided roughly with the minimum only in the full load region. In the part load region the best pilot fuel quantity was higher than the minimum quantity; at about half load it was 20-25 cubic m.m. per stroke (equivalent to 10-15% of the total fuel quantity); and at lower loads it increased to 50-55 cubic m.m. at an air excess of 2.5:1.

In practical operating conditions with air excess between 0.85 and 1.8:1, 20-25 cubic m.m./stroke (corresponding to 5-15% total fuel) was found adequate.

TESTING OF POLY-GLYCOL-ETHERS AS LUBRICANTS

Ref. No.: A.13 Report No.: 455
Origin: I.G. Ludwigshafen Author: Halder
Date: 4/23/41

SUMMARY

A poly-glycol-ether, LK.2200 (or LK.3/Ja), having a viscosity of 14.3 cs. at 99°C, V.I. 113 and specific gravity of 1.122, was tested in the 4-Ball Machine, the Wear Machine, an Open engine, a B.M.W.-132 aero engine and for corrosion properties at 100°C. in the presence of various metals, etc. (Rotring D was used as standard oil for comparison). The poly-glycol-ether generally shows very satisfactory properties as a lubricant and exhibits very good anti-ring-sticking properties in the B.M.W. engine. Owing to their insolubility in mineral oil, it is concluded that the poly-glycol-ethers would not be satisfactory for internal combustion engines in view of the difficulty of changing from mineral oil to the ethers and vice versa. Their solubility in water would make the poly-glycol-ethers satisfactory as torpedo lubricants since they would not produce oil patches on the surface of the sea. The report also concludes that the poly-glycol-ethers might find application as lubricants in textile machinery and hydraulic apparatus. Water solutions of the poly-glycol-ethers might also be used as low setting point coolants, since their freezing point falls from about -37° to -48°C. as the water content is increased from 0-30%. Further additions of water raise the freezing point of the mixture.

EXAMINATION OF AN AROMATIC AND A PARAFFINIC BLEND WITH RESPECT TO TEMPERATURE, LEAD, AND MIXTURE SENSITIVITY IN THE SUPERCHARGED SINGLE CYLINDER ENGINE

Ref. No.: A.12
Origin: I.G. Oppau
Date: 4/21/41

Report No.: 454
Author: Witschakowski

SUMMARY

Mixture response curves have been obtained over a range of boost air temperature using 60/40 blends of VT.705 with ET.100 (paraffinic) and CV2b aromatics, leaded and unleaded, and also with unleaded ET.100 and Aviation Benzol. The curves have been obtained on the B.M.W.132 single-cylinder test engine operating under the following test conditions:

Compression Ratio	:	8:1
R.P.M.	:	1600
Ign. Adv.	:	30°E
Inj. Begin	:	25° A.T.C.
Cooling Air P.D.	:	200 min. H_2O

From the results of these tests the following conclusions have been reached:

Aromatics are more sensitive to boost air temperature than paraffins, in respect of both rich and weak mixture detonation performance.

Leaded fuels are more temperature sensitive than unleaded fuels.

Lead susceptibility is highest at low boost air temperatures, and decreases rapidly with increase in temperature.

The degree of mixture response, i.e. minimum weak to maximum rich performance, is greater for aromatic than for paraffinic blends, and also greater for leaded than for unleaded fuels.

TESTING OF AVIATION GREASES AT LOW TEMPERATURES

Ref. No.: A.11 Report No.: 453
Origin: I.G.Ludwigshafen Author: Halder
Date: 5/15/41

SUMMARY

This report deals with the low temperature torque testing of greases in bearings using the I.G. cold chamber and the Schwaiger low temperature viscometer. The latter is a rotating cylinder apparatus, the cylinder having a diameter of 80 mm. and a clearance of 0.06 mm. between it and the concentric outer cylinder.

Very discordant results were obtained in the comparative tests on a series of greases in the temperature range -10 to -50°C. The discrepancy was found to be due to the fact that different rates of sheer prevail in the two machines and their differences can be reduced by a suitable alteration in the rate of sheer in the Schwaiger viscometer. The greases tested were Aero-Fett blau (Rhenania-Ossag), Intava 1416 blau and 1417, Calupsol K and 129.

REVISED TEST METHOD FOR AVIATION FUELS (OPPAU METHOD)

Ref. No.: A.10 Report No.: 452
Origin: I.G. Oppau Author: Singer
Date: 4/10/41

SUMMARY

In the Oppau method, an I.G. test engine is operated at a fixed boost pressure and the compression ratio is adjusted to give a standard knock intensity measured on a piezo-electric knockmeter. Compression ratio is related to octane number, and tests are performed over the mixture range to give a curve of mixture strength against octane number.

TEST CONDITIONS

R.P.M.	600
Coolant Temp.	100°C.
Mixture Temp.	125°C.
Ignition Advance	22°
Boost Pressure	1000 mm. Hg. abs.

A large number of fuels has been tested under these conditions and the results compared with ratings obtained by the DVL supercharge method (BMW.132 engine). In the majority of cases the fuels were rated in the same order by both methods.

A photograph showing the I.G. engine and test equipment is included, together with mixture response curves for the fuels tested.

List of Test Fuels:

Blends of reference fuel with pure benzene and with a paraffinic reference fuel Z.
B4, C2, C3, CV2b, VT706, ET10C.
VT702 and blends of VT702 with diethylbenzene, mesitylene, toluene, aviation benzol, ET100, Cyclohexane, isopropylether, methanol, toluene, xylene, CV2b.
VT705 and blends of VT705 with ethylpropylbenzene monopropylbenzene, monoethylbenzene, methylethylbenzene, diethylbenzene
Blends of CV2b with ET100 and Aviation alkylate (?)

THE EFFECT OF TEMPERATURE ON THE RUNNING OF AERO ENGINES EMPLOYING THE RING SYSTEM

Ref. No.: A.9
Origin: I.G. Oppau
Date: 4/3/41

Report No. 451
Author: Leib
Contents: 8 text pages
12 figure sheets

SUMMARY

The tests showed that running was possible with comparatively low cylinder and air intake temperatures. Minimum tried values were: (a) for a BMW 132N: cylinder temperature 120°C., intake temperature 20°C; and (b) for a Jumo 211: cooling water temperature 30°C., intake temperature 20°C., which, in combination, give a reduced full load performance.

Lower intake temperatures gave improved performance down to half load (increase of maximum load of 10 - 15%). Lower cylinder temperatures also showed better performance in the full load region but in the half load region resulted in an earlier fall off in performance. At full load the consumption was little affected by low temperatures but at lower loads high consumptions were experienced.

Best values were:

BMW: 80°C. Intake Air, 210°C. Cylinder Temp.
Jumo: 50°C. " " 50°C. cooling water temperature down to half load and 80°C. from there to no load.

The best lubricating oil temperature was 90°C. as compared with the other investigated temperatures of 60 and 80°C.

COMMENTS

Power and consumption curves are given for both engines for the temperature range investigated.

THE DETERMINATION OF KNOCK INTENSITY

Ref. No.: A.8
Origin: I.G. Oppau
Date: 2/27/41

Report No.: 449
Author: Dr. Schuch

SUMMARY

Two forms of measurement of knock intensity are described. A piezo-electric pick-up is used, the pressure vibrations in the cylinder being amplified through one or two stages of an A.C. Amplifier. An indicator passage 40 mm in length was employed in the I.G. Prufstand engine, this length giving gas vibrations of the same frequency as the detonation waves. Hence, when detonation sets in, resonance occurs, and the vibrations are amplified mechanically. Both types of instrument utilize these vibrations direotly (i.e. they are not differentiated.). The indicator diagram is filtered out, so that only the high frequencies are amplified electrically.

In the first type, a diagram is given which is similar to that produced by the Sperry knock-meter, and by measurement of the amplitude of the vibrations, the knock intensity can be estimated.

In the second type, the vibrations either trigger a relay which flashes an electric lamp, or they operate an electro-magnetic counting machine.

The circuit diagrams for both types are given in Fig. 2 and 3.

TESTING OF LUBRICATING PROPERTIES OF OILS IN THREE DIFFERENT TYPES OF APPARATUS

Ref. No.: A.5 Report No.: 448
Origin: I.G. Ludwigshafen Author: Halder
Date: 2/18/41

SUMMARY

In this work the 4-Ball machine, the Wear machine and the Wieland machine (similar to the Almen machine) were used. Six synthetic hydrocarbon lubricants of similar origin but different viscosities were tested. Details of the origin and properties of the oils, excepting viscosities, are not given. The results of the three test machines show considerable lack of uniformity and the report concludes that further work is required to decide which apparatus gives results of practical value. The oils include 5 synthetic lubricants H_8, H_{16}, H_{32}, H_{88}, and H_{140} all of the same origin, and H_{426} an ester derivative.

RESEARCH ON INJECTORS, USING A "QUANTITATIVE STROBOSCOPE"

Ref. No.: A.4
Origin: I.G. Oppau
Date: 3/10/41

Report No.: 447
Author: Kohler
Contents: 5 text sheets
6 sheets diagrams

SUMMARY

By the use of a "Quantitative stroboscope" the amount of fuel coming from the injector per degree of crank-angle was measured. The "Quantitative stroboscope" consists of an injection pump and an injector which rotates, spraying the fuel into pockets provided with measuring glasses at their extremities.

The pintle injectors examined gave very similar results, in spite of variation in pattern.

A hole injector gave a somewhat longer injection time and somewhat smaller injection quantity.

Only when the viscosity of the fuel was above 10°E (75 c.St.) was the injection time somewhat increased, and the end of injection delayed. With a small pump piston the injected quantity was greatest shortly after the start of injection and then fell off markedly. When a larger pump piston was used, the quantity remained near its maximum longer. High injection-pressure decreased the injection time, but gave bigger variations than lower injection-pressures. The regularity of injection was tested by spraying the fuel on to a filter strip.

KNOCK CHARACTERISTICS AND KNOCK RATING OF FUELS

Ref. No.:	N-4	Report No.:	446
Origin:	I.G. Farben Ludwigshafen	Author:	Singer
Date:	2/3/41	Contents:	6 pages text and 1 page of illustrations

SUMMARY

The knocking properties of unblended light gasolines are generally determined by the octane number. However if these materials are blended with another gasoline, their knocking properties are designated in another manner. In order to avoid misunderstanding, in this case the expression "mischwert" (mixture value) is proposed. The method of carrying out this determination is given. The difference between the octane number and mixture value is illustrated by selected examples.

WEAR TESTS ON THE INJECTION SPRAY VALVE AND FUEL PUMP PISTON WITH FUEL R. 300 AND GAS OIL

Ref. No.: A.2
Origin: I.G. Oppau
Date: 1/24/41

Report No. 445
Author: Dr. Kohler
Contents: 4 text pages and 2 figure sheets

SUMMARY

In a continuous run of 700 hours with the special fuel R.300 no attack of the injection spray valve and piston of the injection pump was observed. The wear of the valve was insignificant. The parallel test with gas oil yielded the same result, except that a thin carbon coating formed on the valve whereby the sealing was a little better.

COMMENTS

R.300, according to Short Report No. 406 of 15.10.44 is diglycol-diethyl ether.

APPLICATION OF THE RING SYSTEM TO A BMW TYPE 132N CYLINDER

Ref. No.: A.1
Origin: I.G. Oppau
Date: 12/1/40

Report No.: 442
Author: Leib
Contents: 8 text pages and 6 figure sheets

SUMMARY

The Ring system showed the same advantages in the BMW cylinder, especially at part loads, as had been found with other aero engine cylinders. Control by mixture alone with constant speed down to no load was possible. The specific fuel consumption remained roughly constant for loads between 50 and 90% at the minimum value of 1850 k.cal./horse power hour (Otto operation 1900). Starting with R. material at room temperatures was possible without sparking plugs. The influence of cylinder temperature on performance and consumption showed that cooling air regulation was necessary. At speeds below 1000 r.p.m. the consumption was better if R material alone was injected. Shifting the R injector to a spark plug boss improved the starting a little but showed no gain in performance or consumption. The pre-injection angle could, at constant speed, be maintained constant over the whole load range, in contrast with water cooled cylinders. Further, with liberal R material injection quantity, this quantity also could be kept constant over the whole range if the very lowest consumptions were not expected.

COMPARATIVE KNOCK TESTS USING THE SECONDARY REFERENCE FUELS BENZOLE AND "Z"

Ref. No.: A.44 Report No.: 506
Origin: I.G. Oppau Author: E. Singer
Date: 6/13/42

SUMMARY

This report deals with the relative accuracy of knock tests on both the I.G. and C.F.R. engine using benzole and their "Z" secondary reference fuels.

The report shows that the accuracy is practically unaffected by changing from the one to the other reference fuel.

10 test stations using 10 I.G. and 9 C.F.R. engines contributed to the report.

EXPERIENCES IN LUBRICANT TEST RUNS ON RING STICKING BEHAVIOR

Ref. No.: A.43
Origin: I.G.
Date: 7/1/42

Report No.: 505
Author: W. Lauer

(Lecture, held in connection with the Lubricating Oil meeting of the D.V.L. in Berlin on May 7 & 8, 1942.)

SUMMARY

A review is given on the position of the engine testing of lubricating oil in the single cylinder BMW.132 and especially the deficiencies of the method are shown up.

In spite of many indefinite influences which contribute in part to the great spread of the accuracy of measurement, the method of lubricating oil testing is useful. There is some possibility of eventually improving the method described, so as to state the influence of temperature and power condition on the time of run.

THE USE OF THE I.G. TEST ENGINES IN LUBRICANT TESTS

Ref. No.: A.41
Origin: I.G.
Date: 7/1/42

Report No.: 504
Author: Halder

(Lecture held in connection with the Lubricating Oil meeting of the D.V.L. in Berlin on May 7 &8, 1942.)

SUMMARY

The I.G. Knock value test engine is used, after some unimportant alterations as an oil test engine for determining ring sticking. Test conditions, preparation and operation are briefly described.

A series of test runs using preliminary conditions, gave the same evaluation as in the BMW 132 single cylinder engine for four aero engine oils. The repeatability of the tests is satisfactory. The completion of the test is not always clear, as power drop and blow by do not always coincide in time. In this regard an improvement is still to be sought. As the tests are promisingly successful, it will be continued on two I.G. Test engines.

Oils Used: Red Band D
Aeroshell medium
SS 978 S_2 0.04
SS 902 F 250

AN ELECTRICAL APPARATUS FOR THE DETERMINATION OF INCIPIENT DETONATION BY ACOUSTIC AND OPTICAL METHODS

Ref. No.: A.40
Origin: I.G. Oppau
Date: 6/4/42

Report No.: 502
Author: Dr. Schuch

SUMMARY

This report amplifies report No. 475 from the same laboratory. An A.C. amplifier circuit has been developed to filter out the general engine vibrations, and by this means the onset of detonation is more easily noticed. Two sets of three mixture response curves are given, taken by ear, and by the knockmeter with and without the general vibrations filtered out. A circuit diagram is appended.

PEAK PRESSURES WITH THE "RING" SYSTEM

Ref. No.: A.39
Origin: I.G. Oppau
Date: 5/25/42

Report No.: 501
Author: F. Penzig
Contents: 8 text pages and 9 figure sheets

SUMMARY

Under optimum performance conditions peak pressures with the "Ring" system were the same as for the Otto cycle. With the Otto cycle the peak pressure increased continuously with ignition advance, while, with the greater pre-injection required for optimum performance with the "Ring" system, the peak pressures were falling.

Diagrams showed that with the "Ring" system by the location of the commencement of pressure rise near to top dead center and by a slower fall in pressure in the expansion stroke there was a gain in performance over the Otto cycle.

Cooling water losses were up to 25% greater with the Otto cycle than with the "Ring" system.

COMMENTS

Pressure and rate of change of pressure indicator diagrams are given.

The reason for reduced cooling losses with the "Ring" system is obscure and the author states that it is not accompanied by a corresponding increase in the exhaust temperature.

THE "RING" METHOD

Ref. No.: A.38
Origin: I.G. Oppau
Date: 9/1/42

Report No.: 500
Author: F. Penzig
Contents: 47 text pages and 4 figure sheets

SUMMARY

Development of the "Ring" method made it advisable to revise Report No. 394, dated August 1939, and to make certain additions.

A complete presentation of all existing data and developments being carried out at various centers would be left to a future date. The development had reached a definite stage when in May 1942 the first test flights of an engine operated by the "Ring" method were carried out by B.M.W. Spandau.

The fundamental principle of the "Ring" method is stated to be diesel ignition in the Otto cycle. Since the ignition had to be effected at low compression ratios the development of new highly ignitable materials became necessary whose characteristics are described and are designated R materials. On the mechanical side the metering and injection of the small quantities of R materials as well as the design of the nozzles is important.

A considerable advantage of the "Ring" method is the absence of high tension ignition which makes radio communication more difficult. A further advantage is the wide range of control possible, since very weak mixtures can be ignited. The "Ring" method had its origin in the endeavour to burn the weakest mixtures of high boiling safety fuels, but these experiments are a subject in themselves.

The diesel-gas method was finding increasing application in diesel engines for road transport, using power or producer gas, and it was considered useful to include a note on this method in an appendix.

COMMENTS

All of the figures and some of the text are missing from the available copy of this report and it appears to have been used as a draft for a further report.

The most favored R material, designated R.300, was di-ethyl-diglycol ether.

CONCERNING THE PRE-HEATING OF LUBRICATING OILS IN VEHICLE MOTORS BY MEANS OF ASH-FREE CARBON (STARTING CARBON)

Ref. No.: N-5
Origin: I.G.Farben Ludwigshafen
Date: 4/20/42

Report: 499
Author: H. Leib
Content: 4 pages text
3 pages illustration

SUMMARY

A device is reported which makes it possible to heat lubricating oils in the oil pan of a vehicle motor before starting and to keep it warm when the motor is not running. Experiments showed that it is possible to install this device in existing vehicles. The heating is done with ash free carbon developed by experiments at the technical testing laboratory at Oppau. At an atmospheric temperature of -20°C., 240 g. of carbon raised the oil temperature of 14 liters of oil to +40°C. The heater reached a maximum temperature of 146°C. after two minutes. In order to prevent the formation of coke in the oil pan it is undesirable to raise the temperature of the oil above 146°C. After 15 min. the temperature of the oil was 65-70°C. at the top of the oil, while at the bottom of the oil pan, the temperature after 36 minutes was +16°C. About 10-15 minutes were required to burn 240 g. of carbon. The carbon was used as tablets of about 20 g. each. It is important that the carbon burn uniformly and not too rapidly to prevent superheating.

The experiment was conducted on a DB-diesel type OM59 motor installed in a three ton truck and also in a type OM84 motor using a standard lubricating oil (Wehrmacht standard oil). The oil pan of both motors have a sump section from which the oil is sucked to the pump and circulated to the motor. The sump section is heated by a heating tube which is closed at one end. This tube was 60 mm. in diameter for the OM59 motor, while the OM89 motor had an oval shaped tube 80 x 43 mm. The heating tube was sealed into the wall of the sump. In the middle of the heating tube was installed a removable grate to hold the carbon tablets. The section below the grate served for the introduction of air while the section above was connected to a chimney to remove combustion gases. The grate contained holes which were more numerous near the closed end, to give uniform combustion. The chimney was sufficiently long to give a good draft. Apparently the grate is partially withdrawn from the tube to start combustion.

TECHNICAL LUBRICATING OIL TESTING

Ref. No.: A.36
Origin: I.G.
Date: 1/28/42

Report No.: 495
Author: Halder

(Lecture given on the occasion of the Inorganic Colloquium on January 28, 1942)

SUMMARY

The important question of lubricating oil testing is dealt with. After a general explanation of the various lubrication states, apparatus are described, as used in the Oppau Laboratory, for measuring friction coefficients and wear, and test results shown. Besides, the possible use of the Four Ball machine for testing E.P. additives is investigated.

Furthermore the low temperature behavior is dealt with. Thereby are shown certain advantages of a good viscosity temperature behavior. Test results in the I.G. cold chamber are shown, whereby the effect of low temperature on viscosity and the setting point is investigated.

The testing of ring sticking by testing oils in an engine is specially placed in the foreground, the effect of inhibitors being dealt with. In conclusion, tests are reported on sludge formation, oil thickening and oil consumption.

Oils used:- Red Band D, Aeroshell Medium, SS 902 F 25, P.174, TP57, Olive Oil.

Additives:- E mixture 11, S product T, S product J. P-Cl Product P.V.O. Inhibitors p and r_1

TESTS ON THE "RING" SYSTEM AT DIFFERENT COMPRESSION RATIOS

Ref. No.: A.35
Origin: I.G. Oppau
Date:

Report No.: 493
Author: F. Penzig
Contents: 14 text pages and 13 figure sheets

SUMMARY

It is shown that R.300 and gas oil in the diesel cycle give equal performances if care is taken to ensure that the choice of nozzle is such that the injection time roughly equals the ignition delay. The combustion of R.300 (Cetane No. 188) is slower than gas oil (Cetane No. 40) so that combustion must be started well before top dead centre and be earlier the higher the compression ratio.

The "Ring" system is equal in knock performance to the Otto cycle at a compression of 8:1; at higher compression ratios it is much superior. With fixed pre-ignition and pilot fuel injection, which occur in practice, it is observed that at 70% correct mixture strength a higher performance of 30% is obtained also at 8:1.

If the "Ring" system is operated at high compression ratios gas oil is equal to R.300 as a pilot fuel. Diesel engines can be improved considerably in performance if adapted to the "Ring" system using fuels of low knock quality.

RESULTS OF COMPARATIVE MEASUREMENTS ACCORDING TO THE OPPAU METHOD

Ref. No.: N-6
Origin: I.G. Farben Ludwigshafen
Date: 10/9/43
Report No.: 492
Author: Singer
Contents: 3 text pages
no illustrations

SUMMARY

Six test laboratories have tested two commercial aviation gasolines and one standard gasoline according to the Oppau procedure. Each testing laboratory repeated these tests on three separate days.

According to these experiments the repeatability is on the average ± 0.2 octane number whereas the reproducibility is on the average ± 0.5 octane number. Accordingly the accuracy of the Oppau procedure is as good as that of the customary octane number determination.

RESULTS OF CORRELATION TESTS BETWEEN THE OPPAU AND DVL METHODS

Ref. No.: A.33
Origin: I.G. Oppau
Date: 10/24/42

Report No.: 491
Author: E. Singer

SUMMARY

A further study of the correlation between the DVL - supercharge method of fuel rating (BMW 132 engine) and the Oppau method (I.G. engine) shows good agreement between the two methods with leaded fuels containing various blending components. However, with unleaded fuels and with blends of ethyl alcohol, di-isopropylketone and di-isobutylene, the correlation between the two test methods is poor.

List of Test Fuels:

Paraffinic base, B4, with various percentages of iso-octane, avaiation benzole, cyclohexane, isopropylether, ethyl alcohol, di-isopropylketone, di-isobutylene.

Napthenic base, "B" with various percentages of aviation benzole.

Various aviation fuels.

THE EVALUATION OF OCTANE NUMBER ACCORDING TO THE OPPAU METHOD

Ref. No.: N-7
Origin: I.G. Farben Ludwigshafen
Date: 2/17/42
Report No.: 490
Author: E. Singer
Contents: 25 text pages and 1 page of illustrations

SUMMARY

With the help of two variables, air-fuel ratio, and octane number, the knock curve can be given by the Oppau method. The accuracy with which these two variables can be determined is discussed. A simplified method for determining the air-fuel ratio also is described.

The results of the determination may be expressed by the Oppau octane number and the lean mixture value. The octane number gives the least knocking ability while the lean mixture rating gives the influence of air fuel ratio on the knock behavior. The evaluation is explained by an example.

INVESTIGATION OF LUBRICANTS IN THE I. G. COLD CHAMBER

Ref. No.: A.32
Origin: I.G.
Date: 12/12/41

Report No.: 487
Author: F. Penzing

(Lecture, given on the occasion of the Discussion on the Problems of Lubrication and Lubricating Oils of the D.V.L., December, 1941.)

SUMMARY

The I.G. cold chamber, developed in the Oppau laboratories, has proved useful in many ways for the investigation of lubricants. Thus, one can learn the delivery quantity and pressure of an oil pump at low temperatures and to appreciate the influence of pour point depressants. In combination with an indicator, which is influenced by the torque of a bush one can observe the whole process of the breaking free of an oil film. Further investigations concern the breaking free power of oils and its dependence on the extrapolated viscosity and the relation between the breaking free power and the Walther standard factor m.

Investigation of lubricating greases in the I. G. cold chamber show that the breaking free power increases considerably with reduction of the rate of shear. It demonstrates further that apparatus with unalterable torque and thus, variable shear rates, are unsuitable for the investigation of greases. As proof, tests with greases in the Schwaiger viscometer are discussed, which plainly illustrate the false evaluation. These are avoided by testing in the ring bush (bearing) in the I. G. cold chamber at constant shear rates.

TESTS WITH THE FOUR BALL MACHINE

Ref. No.: A.31
Origin: I.G.
Date: 12/12/41

Report No.: 486
Author: Halder

(Lecture, given in connection with the Discussion on Problems of Lubrication and Lubricating Oil, D.V.L. December, 1941.)

SUMMARY

The Four-Ball machine installed in the Oppau laboratories is described. The tests carried out therewith are concerned with all conditions and reasons for the spread (of results). Non uniformity of the balls cannot be established. By raising the speed of rotation from 800 to 1500 and 2000 r.p.m. a reduction of spread (of results) was obtained, nevertheless the repeatability is still not satisfactory. Certain oils, especially fatty oils and partly also mineral oils, gave marked spreading (of results), whilst with oils containing E.P. additives very little spread was observed. With certain oils, especially mineral oils, an instability in the (torque) running curve of the seizure delay in relation to load was established. It was observed that the addition of active effect additives to mineral oils giving little spread of results caused an increase in the spread and that an increase of the concentration again caused a reduction in spread. This phenomenon is shown with four examples of different oils with different additives.

The Four Ball machine can also be used for the testing of corroded (treated) metal surfaces. It is shown that by the use of balls phosphatised by the "Atrament" method, essentially higher seizure delay can be obtained.

Oils used:- H.8, H.16, H.88, H.140, H.426, Red Band D, Aeroshell Medium, Rape oil unrefined, Valvoline Hypoid, Army Standard Oil, Army Standard oil + 10% Valvoline Hypoid, Army Standard Oil + 2% and 0.1% CCl_4 Ice machine Oil (yellow), + 5% and 9% Sulphur product B, Gargoyle Motor Oil, + 17% and 9% sulphur product B.

STARTING OF DIESEL ENGINES WITH THE AID OF HEATING TABLETS

Ref. No.: A.30
Origin: I.G. Oppau
Date: 11/25/41

Report No.: 483
Author: H. Leib
Contents: 9 text pages and 5 figure sheets

SUMMARY

Heating tablets, which are ignited in a vessel connected to the inlet manifold are a convenient starting aid. The tablets burn practically without residue, and the gases given off consist of products of combustion and free oxygen. Tests on army utility engines showed that it is possible to start at -30°C. in about 3 minutes, while with standard electric heaters starting is impossible at -20°C.

COMMENTS

The exact composition of the tablets is not stated. Approximately a quarter of a pound of tablets was required for starting at -30°C.

MEASUREMENT OF THE EXTERNAL HEAT EXCHANGE IN A HIGH PRESSURE TUBE BY INSTALLING THE TUBE TO BE TESTED IN A GROUP OF PIPES SURROUNDED BY FIRE BRICKS

Ref. No.: N-8
Origin: I.G. Farben Ludwigshafen
Date: 11/3/41
Report No.: 481
Author: G. Kling
Contents: 9 text pages
5 pages of figures, and
2 tables

SUMMARY

Several arrangements have been tried in order to increase the external heat exchange on high pressure tubes without fins to obtain the highest efficiency in preheaters. The installation of conductor devices which should heat up the half of the tube which is not touched by the direct flow of gases is not recommended because of poor heat flow. The fire clay gives high heat conducting numbers but at the same time unnecessarily high resistance to heat flow. The arrangement of the tubes in a group results in the same heat efficiency as in standard tubes with fins. However, it has the disadvantage of a greater decrease in pressure and a greater use of alloy tubes.

SEMI-ANNUAL COMPARATIVE TESTS WITH KNOCK MOTORS (VV93)

Ref. No.: N-9
Origin: I.G. Farben Ludwigshafen
Date: 11/1/41

Report No.: 480
Author: E. Singer
Contents: 10 text pages
4 pages of illustrations

SUMMARY

The experiments showed increased use and accuracy of measurements. These investigations were carried out by 52 testing laboratories in April 1941-42, which provided a total of 84 test motors (66 had previously been used). A total of 634 individual determinations were made (504 previously).

According to the experiments an average accuracy of 0.6 octane number is obtained (previously 0.7). The accuracy of the research method is somewhat greater than that of the motor method.

81% of the testing laboratories kept within the limit of ± octane number (previously 78%). Here too the percentage is somewhat greater for the research method than for the motor method.

On the average the values of the I.G. test motor are lower by 0.6 octane numbers than the value for the C.F.R. motor (previously 0.5 octane number lower). The agreement between the two types of motors is better by the motor method than by the research method.

COMPARATIVE TESTS WITH GEAR OILS

Ref. No.: A.26 Report No.: 477
Origin: I.G. Author: Halder
Date: 10/10/41

SUMMARY

Four gear oils were tested in the Almen Wieland machine of the Daimler Benz A.G. and in that of Oppau laboratory and thereby agreement was established between both of these apparatuses. A further test was carried out with the Four Ball machine.

By a correction of the Almen Wieland machine results, the same order of evaluation of the oils could be obtained with both of these differently constructed apparatus. The results with the Four Ball machine were very definite, in contrast to those of the Almen Wieland machine, which gave a rather unsatisfactory evaluation of the oils.

Oils tested:

Shell HD.L
Shell HD.S
Kompressol (Ahrens, Koln)
Shell EP grease (red) (Hochdruckfett).

COMPARISON EXPERIMENTS WITH I.G. TEST DIESELS 1941

Ref. No.: A.25
Origin: I.G. Oppau
Date: 8/25/41

Report No.: 476
Author: Dr. Kohler
Contents: 7 text pages and 1 sheet diagrams

SUMMARY

The four Diesel fuels (Cetane Nos. 25-80) given below were tested in I.G. test Diesels at twelve different centers. The measurements were carried out using both standard samples of comparison fuels (cetane and α-methylnaphthalene) and samples already in stock at the individual test centers.

The results could be regarded as satisfactory, as the average straying was between 0.95 and 2.1 Cetane No. and 70% of the measurements were in a range of $\pm$ 2 Cetane No.

The fuels tested were:-

(1) Medium Oil from Lignite	D.369	Cetane	No.	about	25
(2) Gas Oil (D.A.P.G.)	D.510	"	"	"	45
(3) Gas Oil from Baden Crude	D.621	"	"	"	60
(4) R.C.H. Diesel Oil	D.509	"	"	"	80

THE ELECTRICAL INDICATION AND RECORDING OF DETONATION WAVES

Ref. No.: A.24
Origin: I.G. Oppau
Date: 9/1/41

Report No.: 475
Author: E. Schuch

SUMMARY

A detonation indicator is described, in which a length of steel wire is used to transmit the engine vibrations to a moving coil electric pick-up remote from the engine. After filtering and amplifying, the output from the pick-up is fed to a C.R.O. or a loudspeaker. Drawings and photographs of the indicator and the electrical circuit are included.

CONTRIBUTION TO TESTING OF KNOCK BEHAVIOR OF AVIATION FUELS IN SMALL TEST ENGINE

Ref. No.: A.23 Report No.: 474
Origin: I.G. Oppau Author: Witschakowsky
Date: 8/25/41

SUMMARY

This report deals with an attempt to obtain a fair amount of agreement in the mixture response curves obtained with two different engines, viz: the B.M.W.132 supercharged engine and the I.G. Test-Diesel adapted for petrol.

The boost pressure, and not the compression ratio, was varied to obtain the curves.

TEST OF THE LUBRICATION ABILITY OF R.200 AND R.300

Ref. No.: A.22
Origin: I.G. Oppau
Date: 8/16/41

Report No.: 472
Author: Halder
Contents: 3 text pages and 2 figure sheets

SUMMARY

R.200 and R.300 were tested by comparison with diesel fuel II and leaded aviation fuel in four different apparatuses for its lubrication quality (or wear characteristics). It was shown that the lubrication ability of R.200 and R.300 is inferior to that of diesel fuel II; being about equal to that of the leaded gasoline. A uniform evaluation of the remaining three substances is not possible because of the difference in results in these four apparatuses. The operation of an injection-pump with R.200 or R.300 will not be possible without a specific lubricant, just as with gasoline.

TESTING THE LUBRICATING ABILITY OF R.200 & R.300

TOP SECRET

Ref. No.: A.22
Origin: I.G.
Date: 2/16/41

Report No.: 472
Author: Halder

SUMMARY

R.200 and R.300 were tested in comparison with Diesel fuel II and leaded gasoline in four different apparatus for testing the lubricating ability or wear respectively. It appeared that the lubricating ability of R.200 and R.300 is lower than that of Diesel fuel II. It is roughly equal to that of the leaded gasoline. A uniform evaluation of the three remaining fuels on the basis of the different test results with these four apparatus is not possible. The operation of an injection pump with R.200 or R.300, and also with gasoline might not be possible without special lubrication.

LIGHT FACED BRICKS "K" AND "T" OF THE KRISTER PORCELAIN MANUFACTURING COMPANY OF WALDENBURG, SILESIA

Ref. No.: N-8
Origin: I.G. Farben Ludwigshafen
Date: 9/11/42
Report No.: 514
Author: W. Schenker
Contents: 13 pages text, 4 pages illustrations, 2 tables

SUMMARY

The light porcelain bricks "K" and "T" of the Krister Mfg. Co. at Waldenburg, Silesia were tested for their suitability as high pressure insulation. The most important test data are as follows:

		K	T
Greatest heat conductivity number in hydrogen at 70 atm. pressure	Cal/hm °C.	0.60	0.55
Porosity	Vol.%	78	90
Resistance to pressure	Kg/sq. cm.	19	13
Coeff. of thermal expansion at 20-50°C	mm/mm °C	4×10^{-6}	4×10^{-6}
Coeff. of thermal expansion at 150-200°C	"	6×10^{-6}	19×10^{-6}

The heat conductivity of the bricks in hydrogen at pressures below 70 atm. is favorable. However at pressures above 70 atm., the heat conductivity gives prohibitive high values. Therefore these bricks shall not be used for pressures of more than 100 atm. The thermal coefficients of expansion are sufficiently high for K but too high for T. The different change of these values with temperature is surprising. The pressure stabilities are rather low.

In order to improve the bricks the total porosity should be decreased by making single pores smaller and more uniform.

THE BEHAVIOR OF STARTING FUELS FOR DIESEL ENGINES WITH INLET MANIFOLD INJECTION

Ref. No.: A.51 Report No.: 513
Origin: I.G. Technical Test Establishment, Oppau Author: H. Leib
Date: 8/24/42

SUMMARY

From tests on starting fuels under cold conditions it was established that the vapor pressure and cetane number together control the starting behavior, high cetane number and high vapor pressure (low boiling point) being desired. With inlet manifold injection compounds show improvements in descending order as follows: ethylisopropyl ether, di-ethyl ether, di-isopropyl ether and di-n-propyl ether. Less effective are the following: methyl-n-butyl ether, ethyl-n-butyl ether and methyl-iso-butyl ether.

APPARATUS FOR MEASURING THE LUBRICATION PROPERTIES AT LIMIT FRICTION

Ref. No.: A.50 Report: 512
Origin: I.G. Ludwigshafen Author: Halder
Date: 8/26/42

SUMMARY

An apparatus is described which permits the measurement, with less spread (of results), of the friction coefficient at boundary lubrication. In construction, it is very simple, easy to service and therefore specially suitable for short tests. The apparatus allows good differentiation of individual lubricants and gives the possibility of investigating the behavior of different kinds of additives.

(Chain round a cylinder).

Oil	Description	Viscosity Est. 38°C.	99°C.
Shell AB 11	Mineral Oil	14.9	3.19
Red Badn reference oil	Aero engine oil	275	20.46
TZ 900/2	Synthetic lubricating oil	197	15.8
Essolube Break in oil	-	62.8	8.9
Army standard oil	Mineral oil	101.9	10.4
H.8	Synthetic hydrocarbon oil	60	8.55
H.32	" " "	247.3	23.2
H.40	" " "	1104.5	57.3
H.426	Synthetic ester	50.7	6.57
Bone oil	-	45.7	9.02
Rape oil	-	44.8	10.0
Castor oil	-	296.4	20.0
Elaol 4	Synthetic ester	27.05	4.92
LK 2200	Water soluble synthetic lubricant	116.8	13.9

Additives used:-oleic acid, sulphur product, Autokollag "Fischtran".

The idea and development of this instrument was inspired by the apparatus for measuring oiliness developed by Charron (Publications Scientifiques et Techniques de Ministere de l'air).

APPARATUS FOR MEASURING THE LUBRICATION PROPERTIES AT LIMIT FRICTION

(Contd.)

The apparatus consists of a polished steel roll 40 mm. in diameter and 20 mm. in width. The steel roll in a horizontal position is turned slowly by a motor. Around the roll is attached a brass chain which is weighted on one end with a 400 g. weight, while the other end is connected to a balance. The chain is a plain copper-zinc alloy link chain 12 cm. in length. At an angle of 180°C. 26 links touch the roll for a distance of 63 mm.

A measurement of the friction can be obtained directly from the balance for a given weight. In this manner various oils can be compared.

ENGINE FUELS

Ref. No.: A.49
Origin: I.G. Oppau
Date: 7/15/42

Report No.: 511
Author: F. Penzig

SUMMARY

This report is a general discussion of fuels for spark-ignition and compression-ignition engines and the relation between engine performance and various properties such as calorific value, volatility, octane number, ignition quality, etc. It is a summary of well-known facts.

RESEARCH ON FINNED TUBES PART IV-MEASUREMENT OF HEAT TRANSFER IN SPIRAL FINNED TUBES BUILT IN GROUPS

Ref. No.: N-9
Origin: I.G. Farben Ludwigshafen
Date: 8/1/42

Report No.: 510
Author: G. Kling
Contents: 6 pages of text
4 pages of illustrations

SUMMARY

According to one process developed in the main shop at Ludwigshafen, high pressure tubes are provided with fins by wrapping barrel iron on the tube on edge and welding it in place. The following construction for tubes of 120/171 mm. diam. were found favorable from a heat-transfer standpoint: height of strap, 50 mm., width of spiral 12 mm., thickness of fins 4 mm. In the center between two pins a sheet metal cylinder is installed as a displacer.

In comparison to the normal fins 270 x 320 mm., the heat efficiency is higher by 14.6%; in comparison to the rectangular ribs 270 x 300 mm., which have been found best up to date, the efficiency is 3% higher. The disadvantage is the higher differential of pressure which is 86 and 90 percent respectively. The saving of material of 15 and 10% respectively and the decrease of the production cost of 1/3 to 1/2 is advantageous.

RESEARCH ON FINNED TUBES PART III HIGH PRESSURE TUBES WITH RECTANGULAR WELDED FINS. THE INSTALLATION OF DISPLACERS

Ref. No.: N-10
Origin: I.G. Farben Ludwigshafen
Date: 7/3/42
Report No.: 508
Author: G. Kling
Contents: 16 pages of text
no pictures

SUMMARY

Measurements on high pressure tubes (diameter of 171 x 120 mm) with welded rectangular right angle fins at a pressure of 325 atmospheres are discussed. Investigated were the "mammoth" fin 380 x 325 mm, the normal fin 270 x 320 mm, and shortened fin 270 x 300 and 270 x 270. Furthermore the effect of using displacers was studied. In the experimental apparatus the heat exchange was measured under the same conditions as it was carried out in the preheater. Heat efficiency (Q) and the pressure loss (ΔP) gave at a gas velocity of 8 meters per second the following results:

		Q	ΔP
Normal fin	270 x 320	100%	100%
"Mammoth" fin	380 x 325	108%	112%
Shortened fins	270 x 300) with	111%	98%
Shortened fins	270 x 270) displacers	112%	186%

The fin 270 x 300 with displacer is therefore the most favorable considering heat efficiency and pressure loss. The measurement of the distribution of the fin temperatures and the gas velocities illustrates the heat gradient of the fins, especially the sides of the fins.

SEMI-ANNUAL COMPARATIVE KNOCK TESTS

Ref. No.: A.45
Origin: I.G. Oppau
Date: 6/19/42

Report No.: 507
Author: E. Singer

SUMMARY

This report is on the same lines as A.27, except that it stresses the large deviations from the mean octane number observed with synthetic fuel 9f. 60 test stations using 61 I.G. and 33 C.F.R. engines contributed to the report.

AN APPARATUS FOR THE DETERMINATION OF METAL ABRASION DURING LUBRICATION

Ref. No.: A.75
Origin: I.G.
Date: 6/21/43

Report No.: 542
Author: Halder

SUMMARY

An apparatus is described which permits the measurement of metal abrasion of lubricated surfaces. It gives good repeatable results, which allows different lubricants to be easily distinguished and indeed shows certain boundary active materials, as, for example, vegetable oil, to give the greatest metal abrasion. The influence of different metals is very important. A relation can be found between metal abrasion and the friction coefficient, whereupon it can be concluded in certain limits, that higher abrasion leads to a lower coefficient of friction and vice versa.

("Einschliff" apparatus)

Oils mentioned: BH 4, SS 1006, K 7, SS 906, AEM 3, SS 902 F 25, castor oil, E 426, LK 2200, M 620, E 515, S ester, E 515 + 10% ester, Rape oil, Ice machine oil, Army Standard Oil, + 2% "Autokollag", + 2% Oleic acid, + 2% H 268, Bone oil, H 16, H 140.

THE USE OF A PRE-CHAMBER WITH THE "RING" SYSTEM

Ref. No.: A.74
Origin: I.G. Oppau
Date: 5/15/43

Report No.: 541
Author: H. Leib
Contents: 7 text pages and 11 figure sheets

SUMMARY

Tests were made to improve the knock behavior of the "Ring" system using a DB.6001 cylinder with a Hirt ante-chamber, several home-made ante-chambers, and an ante-chamber from a M.W.M. diesel engine. The home-made ante-chambers gave a general increase in the knock boundary mean effective pressures of from 1-1½ atmospheres, and, with aspirated fuel and air, the same high load was attained as with the Otto cycle and the "Ring" system with direct injection. In general it was shown that the ante-chamber fulfilled its task only to a limited extent, while at rich mixtures, due to lack of oxygen, the pre-combustion in the chamber was bad. On this account the attainment of best performance necessitated the pre-setting of the pilot fuel injection advance. With earlier injection the knock performance was worse, but nevertheless this type of ignition, as far as knock tests are concerned, is superior to the direct method. Further tests were needed to show whether, through suitable modifications, the performance at very rich and weak mixtures could be improved to equal direct injection which so far had only been attained by the Hirt ante-chamber.

EFFICIENCY MEASUREMENT OF THE "MOLE" PUMPS IN OPERATION

Ref. No.: N-11
Origin: I.G. Farben Ludwigshafen
Date: 5/14/43

Report No.: 540
Author: G. Kling
Contents: 9 pages of text
5 pages of illustration
1 table

SUMMARY

Measurements were made on an 800-mole pump, (Position 1,) and a 600-mole pump, (position 5), in operation in the Oppau plant No. 37 in order to compare the hydraulic behavior of both types. This report describes experiments and gives data on the amount of the circulated gas. The results are given as throttling curves on both pumps, and as efficiency diagrams. Accordingly the new 600 pump is superior to the 800 pump in regard to its throughput characteristics and its efficiency (maximum efficiency 60% compared to 57% for type 800).

THE TESTING OF LUBRICANTS IN LABORATORY APPARATUS WITH REGARD TO LUBRICATION

Ref. No.: A.70
Origin: I.G.
Date: 3/8/43

Report No.: 537
Author: R. Halder

SUMMARY

(Lecture, held on the occasion of the sitting of the Lubricating Oil commission in the Oppau Technical Test Establishment on 2/26/43)

An apparatus is described which has been found useful for the testing of lubrication behavior in the Oppau establishment.

The apparatus for measuring the friction coefficient at limit friction leads to a satisfactory agreement in the evaluation of lubricants. In wear measurement the results are largely dependent on the working ratio, the temperature and the surface roughness, thereby a uniform evaluation with regard to wear behavior of lubricant is very difficult to obtain. In a series of esters a relation can be found, under certain conditions between the friction coefficient and wear. Accordingly, a given oil may give low wear and a high friction coefficient and vice versa.

For testing extreme pressure lubricants the Four Ball machine and the Alme Wieland machine were used. With these apparatus the process of seizure is followed. This test on both machines leads to contradictory results.

Oils used: BH 4, SS 1006, K 7, SS 906, AEM 3, SS 902, F 25, Castor oil, E 426, LK 2200, M 620, E 515, S-ester, E 515 + 10% S ester, Rape oil, SS 970 R, Army winter gear oil, Gargoyle motor oil, + 0.5% benzoic acid, TP 57, + 5% S product T, + 2% CCl_4, + 10% oleic acid, SS 970 HH S 2.0.

THE DEVELOPMENT OF A GLOWING MATERIAL TO GIVE A SMALL HEAT-OUTPUT OVER A LONG PERIOD

Ref. No.: A.69
Origin: I.G. Oppau
Date: 3/1/43

Report No.: 536
Author:
Contents: 19 text pages
3 tables

SUMMARY

A glowing material was developed, using as a base coke from the distillation of Bruxer lignite (brown coal). The materials added were readily available in large quantities. The composition given is as follows:-

Coke from Bruxer Lignite	84 parts.
Rhenish Lignite	8 "
Potassium nitrate	4 "
Paper-waste (disintegrated)	4 "
mixed with	6 "
Sodium sulphite 50% soln.	

The material can be briquetted cold and pressed into any shape desired. By regulation of the air supply burning time can be controlled within wide limits (up to 12 hours) with a uniform heat output. The briquets burn without smoke or flame and during combustion are surrounded by a layer of ash, serving materially to reduce any fire-risk.

The small heat output over a long period makes the briquets useful for keeping accumulators and other equipment warm. The chief advantages over ordinary wick-lamps are:-

1. Smaller fire-risk, as there is no naked flame.
2. Insensitivity to draughts and changes of position.
3. Burning takes place without smoke or smell.
4. No attention is required once the material has been ignited.

HEAT TRANSFER EXPERIMENTS IN A HIGH PRESSURE PLANT FOR CATALYTIC POLYMERIZATION OF OLEFIN CONTAINING LIQUID GASES

I: DESCRIPTION OF THE PLANT AND OF THE FIRST EXPERIMENTAL RESULTS

Ref. No.: N-12
Origin: I.G.Farben Ludwigshafen
Date: 3/15/43

Report No.: 531
Author: G. Kling
Contents: 23 text pages
10 pages illustrations
2 tables

SUMMARY

The construction and design of a plant is described which makes possible the exact observation of the heat-transfer characteristics of catalytic reactions at pressures up to 200 atm. and temperatures up to 250°C.

Preliminary test results are given for the polymerization of olefin-containing liquid gases. The heat of formation of the polymer of n-butylene was found to be 240 cal. per kg. For propylene this value was 375 cal. per kg. These values were obtained from an exact heat balance of the plant. If the degree of polymerization of both materials is considered, the heat of reaction was approximately 160 cal. per double bond from either material.

Furthermore the distribution of heat in the contact zone was recorded and the heat transfer was recorded. The nature of the product mixture from liquid gas and gasoline at higher than critical presures is discussed from a theoretical standpoint. There can only be a purely gaseous or purely liquid state. There may be no mixed phase, therefore the separation of gasoline cannot take place.

AN INVESTIGATION OF VARIOUS MATERIALS WITH RESPECT TO THEIR SUITABILITY AS COOLANTS FOR LIQUID-COOLED ENGINES

Ref. No.: A.63
Origin: I.G. Oppau
Date: 1/4/43

Report No.: 528
Author: W. Lauer

SUMMARY

An experimental investigation has been carried out using a Daimler-Benz motor, and also an Adler 1.8 litre experimental engine. The liquids chosen for the tests, on the grounds of their suitable physical properties were glycol, G.A.-glycol (i.e. glycol-ether blend with the base $HOC_2H_4OC_2H_5$), ethyltriglycol ($C_2H_5OC_2H_4OC_2H_4OH$), diesel oil, a paraffin gas oil, and water as a comparison.

The results indicate that for thermally stable coolants the important factors are thermal conductivity of the coolant and correct design of the cooling system. The use of glycol is feasible in a correctly designed system, but the use of gas oil is discouraged on account of the tendency to form insolubles.

PROPERTIES OF "GLYSANTIN"-WATER MIXTURES

Ref. No.: A.60
Origin: I.G. Oppau
Date: 3/18/43

Report No.: 525
Author: Dr. R. Roth

SUMMARY

In connection with the operation of motor vehicles under winter conditions an investigation has been carried out into the crystallisation curves, crystal structure and changes in volume of water-"Glysantin" mixtures on freezing, "Glysantin" being commercial ethylene glycol plus a corrosion inhibitor.

In general it is concluded that solutions of "Glysantin" in water give a "mushy" mixture of crystals and solution on freezing, so that even if freezing should occur damage to the motor is unlikely. Under conditions of a low rate of cooling, a high viscosity and a small number of nuclei, ice crystals may be formed of sufficient size to interfere with circulation or possibly damage the circulating pump, consequently under these conditions care must be exercised in starting up a cold engine.

The effect of adding "Glysantin" to water containing "Akorol", a commercial corrosion inhibitor, has also been investigated. It was found that a small amount of sludge was produced by chemical reaction, but not in sufficient quantity to be harmful. The chemical composition of "Akorol" is not stated. Physical characteristics of pure ethylene glycol have also been determined.

Graphs and tables showing the experimental results are interspersed throughout the report and there is also a photograph showing the crystal structures developed.

INVESTIGATIONS OF KNOCK WITH ALKYL-BENZOLS IN B.M.W. 132 SUPERCHARGED ENGINE

Ref. No.: A.59
Origin: I.G. Oppau
Date: 11/21/42

Report No.: 524
Author: Bahr

SUMMARY

This paper deals with the variation of knock characteristics of alkyl-benzols with

(a) different methods of synthesis (catalysts, etc.)
(b) boiling properties
(c) chemical constitution.

the results arrived at can be summarized as follows:

(1) of those alkyl-benzols where sulphuric acid was used as the catalyst the iso-compounds show better knock characteristics than the n-compounds. In the case of aluminum being used as the catalyst the opposite applies.

(2) in the series mono- to tetra-ethyl benzol, di-ethyl benzol has the best characteristics, but with propyl-benzols, tri-propyl benzol has the best properties.

(3) with the exception of ethyl and propyl benzols increase in the number of C-atoms means deterioration in knock properties.

Fuel	Boiling Range	Motor O.N.	pe (Atm.)	Tanδ
n-Butyl benzol	170-200	91.2	9.2	0.759
i-Butyl benzol	150-200	90.4	10.2	1.105
n-Dibutyl benzol	200-250	92.8	9.1	0.715
Hexyl benzol	210-215	86.0	7.1	0.443
Octyl benzol	240-250	70.0	4.3	0.258
Ethyl propyl benzol	140-237	91.8	9.9	1.185
Ethyl n-butyl benzol	200-250	89.6	9.0	0.955
Ethyl dipropyl benzol	220-260	89.6	8.8	0.544
Ethyl di n-butyl benzol	230-274	87.4	7.2	0.369
Diethyl propyl benzol	200-240	90.1	8.7	0.889
Diethyl n-butyl benzol	210-260	87.4	7.9	0.655
Diethyl i-butyl benzol	200-250	90.6	9.1	0.698
Diethyl di n-butyl benzol	260-300	86.2	6.5	0.481
Diethyl di i-butyl benzol	250-350	85.2	6.2	0.476
Propyl n-butyl benzol	200-267	93.9	10.3	0.900
Propyl i-butyl benzol	200-230	95.0	10.4	1.500
Propyl di n-butyl benzol	250-300	89.8	7.8	0.597
Propyl di i-butyl benzol	220-280	89.4	7.2	0.540
Dipropyl n-butyl benzol	250-300	89.9	7.3	0.549
Dipropyl i-butyl benzol	220-280	92.3	8.3	1.106
n-Butyl i-butyl benzol	220-260	92.6	9.8	0.773
i-Butyl n-butyl benzol	210-250	92.3	8.6	0.818
i-Butyl di n-butyl benzol	250-305	89.6	7.2	0.390
n-Butyl di i-butyl benzol	240-300	88.5	7.6	0.562
	Catalyser for the above:-		H_2SO_4	
Ethyl benzol	130-140	90.0	10.4	0.980
Diethyl benzol	170-182	92.2	10.8	0.881
Triethyl benzol	210-220	89.0	8.1	0.570
Tetraethyl benzol	220-280	82.8	7.3	0.333
Tetraethyl benzol	280-320	81.0	6.1	0.406
Tetraethyl benzol	190-320	81.9	6.5	0.333
Propyl benzol	155-165	92.8	10.2	1.148
Dipropyl benzol	186-210	94.2	11.1	1.125
Tripropyl benzol	225-230	98.3	12.8	1.000
Tripropyl benzol	230-240	96.8	11.7	1.138
Tetrapropyl benzol	260-280	93.6	9.7	0.983
n-Butyl benzol	170-175	90.8	9.5	1.158
i-Butyl benzol	165-185	92.1	9.4	1.284
Di n-butyl benzol	220-260	94.2	9.3	1.024
Di i-butyl benzol	200-240	88.0	8.6	0.889
Di i-butyl benzol	240-280	84.5	7.3	0.447
Tri i-butyl benzol	280-320	83.0	6.3	0.267
Hexyl Benzol	200-220	86.5	6.8	0.421
Octyl benzol	230-250	75.2	5.0	0.360
Ethyl propyl benzol	150-230	94.2	10.4	1.790
Ethyl i-butyl benzol	160-200	90.8	9.0	1.078
Ethyl di i-butyl benzol	180-240	90.6	9.6	1.309
Propyl n-butyl benzol	200-255	93.6	10.4	0.863

Fuel	Boiling Range	Motor O.N.	pe (atm.)	Tan α
Propyl i-butyl benzol	170-220	91.8	8.7	0.745
Propyl di n-butyl benzol	155-266	95.4	10.4	0.983
Propyl di i-butyl benzol	200-270	89.0	7.9	0.559
Dipropyl di n-butyl benzol	195-287	93.0	8.0	1.032
Dipropyl n-butyl benzol	230-256	96.2	9.9	2.579
Dipropyl i-butyl benzol	200-270	92.3	8.2	1.304
n-Butyl i-butyl benzol	220-265	90.1	8.1	0.635
i-Butyl n-butyl benzol	220-270	91.8	8.9	0.754
i-Butyl di n-butyl benzol	250-305	90.9	5.3	0.200

Catalyser for the above:-$AlCl_3$

pe is the minimum m.e.p. on the mixture response curve.

α is the angle between the air ratio axis and the line joining the two points on the mixture response curve, corresponding to pe and to the pressure at an air ratio of 0.25 less than that at pe.

AN INSTRUMENT, BASED ON THE CARRIER WAVE PRINCIPLE, FOR THE MEASUREMENT OF (SMALL RAPID) MOVEMENTS

Ref. No.: A.58
Origin: I.G. Oppau
Date: 10/20/42

Report No.: 523
Author: Dr. Schuch
Contents: 21 text pages
7 sheets diagrams

SUMMARY

An apparatus is described for the measurement of small, rapidly fluctuating movements, especially those occurring in the needle-stroke (Nadelhub) of injectors. The motion is reproduced on the screen of a cathode-ray tube. The apparatus was tested using calibrating equipment and found to be suitable for measuring the size and duration of the movements under consideration. The best working conditions were found using purely static measurements.

In the case mentioned (needle-stroke) the greatest deflection of the ray for a movement of 0.1 mm. was about 40 mm.

Experiments varying both injector and quantity injected showed that under certain conditions the needle vibrates strongly.

Further photographs show the dependence of the stroke period of a hole-injector (Lochduse) on the r.p.m., the injection quantity remaining constant.

Finally more photographs of stroke changes with the corresponding pressure changes show that no reliable prediction of one from the other can be made.

TESTING LUBRICANTS BY MEANS OF WEAR MEASUREMENT

Ref. No.: A.56
Origin: I.G.
Date: 1/5/43

Report No.: 518
Author: Halder

SECRET

SUMMARY

An apparatus is described that permits wear measurement by reciprocating motion. A series of lubricants were investigated, whereby the influence of test duration, load, temperature, the bearing materials, and the roughness of the rubbing surfaces were shown of importance. A variation of these test conditions gives in many cases concurrently, a variation in the relative evaluation of the lubricants, so that a uniform evaluation appears very difficult.

(Wear Machine)

Oil	Description	Viscosity in Cat 38°	99°	V.I.
Red Band No. 723	Aero engine oil	272	21.5	100
" " reference oil	" " "	257.7	19.04	89
Army Standard oil	Auto engine oil	101.9	10.4	81
TZ 900/5	Synthetic lubricant	742	38.7	95
TZ 900/2	" "	197	15.8	85
Aeroshell medium	Aero engine oil	276	18.2	75
Aero W	" " "	246.2	17.6	81
P.174	Synthetic engine oil	207	21.7	120
SS 902 F 25	" " "	121.8	15.5	125
WIFO Standard Oil	Auto engine oil	120.0	11.5	81
Essolube Break-in oil	" " "	62.8	8.9	112
LK 2200	Synthetic lubricant water soluble	116.8	13.9	117
Rape oil (refined)	-	44.8	10.0	156
Ice machine oil, red	-	16.3	3.2	-150
H.8	Synthetic hydrocarbon oil	60	8.55	110
H.426	Synthetic ester oil	50.7	6.57	63
E.515	" " "	15.5	3.48	20

TZ 900/5 + 2% and 10% Oleic acid, Red Band 723 + 10% Oleic acid TZ 900/5 oxidized, + 0.01% S, TZ 900/5 + TZ 900/5 oxidized, TZ 900/5 + 0.5% 0.1% and 0.01% S, Red Band, + 0.2%, 0.05% and 0.01% S Product SS 902 FM 25.

EXPERIMENTS WITH THE PHOTO-CELL TIME SWEEP APPARATUS OF DR. NIER

Ref. No.: A.5[illegible]
Origin: I.G. Oppau
Date: 10/[illegible]/42

Report No.: 516
Author: Dr. Schuch
Contents: 8 pages + 9 sheets text diagrams

SUMMARY

A short descr ption is given of the mode of action of the photo-cell time swe p apparatus. Its purpose is to produce stationary combustion diagrams on the screen of a cathode ray tube.

The usefulness of the apparatus is discussed with reference to the voltage-time curves. The size of the aperture between the light-source and the photo-cell is found to have a critical effect on the curves produced.

The reason for the divergence between the theoretical curves and those obtained in practice is found to be the difficulty in obtaining even illumination of the slit through which light passes to the photo-cell.

A disadvantage of the apparatus is that, up to the date of publication, 30 watts at 6 volts, direct current was required for the light-source.

ON A METHOD FOR INVESTIGATING FLAME PROPAGATION IN INTERNAL COMBUSTION ENGINES

Ref. No.: A.53
Origin: I.G. Oppau
Date: 9/25/42

Report No.: 515
Author: E. Schuch

SUMMARY

Flame propagation in an engine cylinder was followed by the ionisation gap method, fundamentally similar to that of Schnauffer, but using a cathode ray tube for the purposes of recording.

THE PROCEDURE FOR THE DETERMINATION OF OCTANE NUMBERS ACCORDING TO THE OPPAU METHOD

Ref. No.: N-13 Report No.: 489
Origin: I.G. Farben Ludwigshafen Author: E. Singer
Date: 1/22/42 Contents: 16 pages of text

SUMMARY

By adding additional equipment to the I.G. testing motor aviation gasolines may be tested by the Oppau method. The additional equipment and the method of carrying out of the determination are described. For the evaluation of the results, reference is made to Report #490.

OBSERVATIONS ON WEAR AND FRICTION TESTS

Ref. No.: A.99
Origin: I.G.
Date: 8/5/44

Report No.: 574
Author: Halder

SUMMARY

(Lecture, given on 9/13/44 before the Lubricating Technique Working Group of the Technical Committee for machine (engine) materials of the V.D.I.

On the basis of tests of metal abrasion it will be already known that not only does the abrasion vary with the roughness of the metal, but that also it may cause a shifting in the relative rating of the lubricants. Furthermore, it was shown that a relation exists between metal abrasion and seizure. The greater the metal abrasion the less the tendency to seizure.

Tests with lubrication additives in motor oils show that the relation between practice and experiments in test apparatus is satisfactory only under certain conditions. Good agreement can only be obtained by using approximately the same bearing materials and the stated practical temperatures.

(Results are given of tests on piston ring wear in the BMW 132 Single Cylinder engine and of tests of the same lubricants on four laboratory machines. The best correlation is with the Four Ball machine. For bearing wear correlation is not good with any machine).

Oils used: Red Band D
" " " + 0.6% 1586/80
" " " + 2.0% 1586/80 BS
" " " + 0.6% 891
" " " + 1.2% M.1

INVESTIGATION OF THE PUMPABILITY OF MOTOR OILS

Ref. No.: A.97
Origin: I.G.
Date: 7/20/44

Report No.: 572
Author: Halder

SUMMARY

Pump tests with 10 different motor oils were carried out under conditions, which corresponded closely to the behavior in cold engines. They lead to the result, that the quantity pumped out from a container in a certain length of time is largely dependent on the setting point. The influence of the extrapolated viscosity is not established. Tests on the speed with which the pumped oil flows back in the pump allows neither a relation with the setting point nor with the extrapolated viscosity to be detected. A relation between practical behavior and the viscosity can be formulated if instead of the extrapolated viscosity, the measured viscosity at low temperatures is used: however the viscosity measurements must be carried out at various rates of shear. (Use the Schwaiger viscometer).

(Physical tests of oils used (known only by numbers) given in test)

THE PRACTICAL LUBRICATION INVESTIGATION OF ELEVEN AVIATION ENGINE OILS

Ref. No.: A.95
Origin: I.G.
Date: 4/20/44

Report No.: 567
Author: Halder

SUMMARY

This report deals with tests of eleven oils (aero engine) on five different test machines. The oils used are divided into three groups - group I and II are natural and synthetic oils and group III oils (probably natural and synthetic) with lubrication additives (names not given).

Viscosities and V.Is of these oils are given - one mixture is called "Running-in oil". The metals used are steel, "Aeterna VL22", light metal "Mahle 124 vergutet" and "unvergutet", Fe/steel, Cu/steel, Al/steel, Brass/steel, red brass, cast iron and lead bronze.

It is concluded that it is not possible to rate all bearing pairs in a sequence; but if one chooses one particular pair of metals, it is possible to rate the oils.

Oils used: SS 607, SS 707, SS807, SS903, SS960, M.P. oil, Red Band D, SS 1593, Synthetic Running-in oil, ASM, SS 960 + 2% KSE

THE FALEX OIL TESTER IN COMPARISON WITH THE FOUR BALL MACHINE AND THE ALMEN-WIELAND MACHINE

Ref. No.: A.91
Origin: I.G.
Date: 2/1/44

Report No.: 562
Author: Halder

SUMMARY

The Falex oil tester is an apparatus for testing extreme pressure lubricants. The test conditions employed are milder than those of the Four Ball machine but somewhat more severe than those of the Almen-Wieland machine. The test conditions given in the instructions assume that the lubricants show at least certain extreme pressure properties. Two further test methods beside the original one were used experimentally, the last enabling each lubricant to be tested. The results with this are similar to those obtained with the Almen Wieland machine, but are in contrast to those of the Four Ball machine. The test pieces of the last apparatus being more closely related to the materials used for gear wheels coupled with the results obtained give due preference to the Four Ball machine.

Oils used:
- Valvoline Hypoid gear oil
- Veedol Hypoid gear oil
- Army Standard Oil + 10% Clophen A 30
- Army Gear Oil Winter
- Red Band Reference Oil
- Rape Oil

(1) SEMI-ANNUAL COMPARATIVE TESTS.
(2) VAPOR PRESSURE DETERMINATION BY MEANS OF REID BOMB (TREIBSTOFFWERK RHEINOREUSSEN)

Ref. No.: A.90 Report No.: 558
Origin: Joint Report I.G. Oppau Authors: E. Singer and
and Treibstoffwerk Rheinpreussen W. Dannefelser
Date: 12/1/43

SUMMARY

The comparative tests were carried out by 61 test stations yielding:

233 research method determinations
752 motor " "
301 " " "

using cooling temperature of 140°C. Again the largest inaccuracies occur in the case of synthetic benzenes where a variation between extreme values of 11.1 (Motor) octane number is recorded. Reduction in cooling temperature leads to an increase in octane number of approximately 4.

In the 2nd part of the report various types of errors encountered with the Reid bomb are discussed e.g.

(1) inaccurate measurement of temperature of air chamber.
(2) leakage.
(3) faulty manometer readings.

METHANOL AS A MOTOR FUEL

Ref. No.: N-14
Origin: I.G. Farben Ludwigshafen
Date: 1/3/44

Report No.: 557
Author: Penzig
Contents: 12 pages of text and 1 appendix
131 pages of illustrations

SUMMARY

The summary is illegible. Parts of the general text are legible and deal with a study of the general qualities of methanol as a motor fuel such as explosion qualities, corrosion, solubility, and effects on the spark plugs in different motors. A number of references are given.

MEASUREMENT OF CHANGE OF POSITION, OR LIQUID LEVEL BY THE USE OF AN INDUCTION INSTRUMENT

Ref. No.: A.83
Origin: I.G. Oppau
Date: 9/20/43

Report No.: 549
Author: Dr. Schuch
Contents: 18 text sheets

SUMMARY

A short survey is given of the better known induction instruments and their principal uses, e.g. determining liquid levels.

A new arrangement is then discussed, using 3 coils with the usual movable iron core. The three coils are arranged coaxially and the iron core alters its position following the difference in level, etc., to be measured. The middle coil carries an alternating current and the induced currents in the two other coils vary with the position of the iron core. This induced current is utilized to make the required measurements of change in position.

To obtain a linear relationship between core-movement and the electrical measurement it is found best to arrange the circuit to show the difference in the two induced currents by connecting the two outer coils in opposition.

LUBRICANT TESTING BY MEANS OF WEAR MEASUREMENT

Ref. No.: A.82
Origin: I.G.
Date: 6/29/43

Report No.: 548
Author: R. Halder

(Lecture, delivered on June 29, 1943, before the "Lubrication Technique" Working Group of the Technical Committee for machine (engine) materials of the V.D.I.)

SUMMARY

It was shown, that the evaluation of a lubricant by means of wear measurement is closely dependent on the bearing materials. A variation of the bearing materials pairs can bring about an important displacement of the relative rating of the lubricants.

It is difficult to differentiate between the continuous metal abrasion and the wear by seizure (corrosion). It appears that high metal abrasion gives a certain safety against the destruction of the surface by metal particles formed by seizure. On these grounds metal abrasion is, to a certain extent, to be valued as favorable.

Oils mentioned: BH 4, SS 1006, X 7, SS 906, AEM 3, SS 902, F 25, Castor oil, E 426, LK 2200, M 620, E 515, S-ester, E 515 + 10% S ester, Rape oil, Bone oil.

THE "KYBOL VALUE" AND ITS ESTIMATION

Ref. No.: A.81
Origin: I.G. Oppau
Date: 7/1/43

Report No.: 547
Authors: Witschakowski
Schutze
Contents: 5 text pages and
13 diagram sheets

SUMMARY

A variety of benzines and homologous organic compounds were investigated from the viewpoint of improvement of the overload knocking behavior on the addition of 40% vol. Kybol (techn. diethylbenzene). This sensitivity of fuels to the addition of technical diethyl benzene was designated the "Kybol value", k and the following formula developed:-

$$k = Pme_{min} \quad \triangle Pme$$

where: Pme_{min} is the minimum on the knocking boundary curve of the fuel tested (without addition of Kybol)

$\triangle Pme$ the improvement in mean effective pressure (vol. of Kybol) of the fuel on addition of 40%.

According to the values found, di-isopropyl ether and iso-octane have a high "Kybol sensitivity", whereas n-heptane is low in sensitivity.

Comparison of the Kybol values with the octane numbers (engine determined) shows no agreement in the order of the values.

In general, it is not possible to find a close agreement of the Kybol value with the lead sensitivity of a fuel.

INVESTIGATION OF THE CRITICAL STATE OF A MULTI-COMPONENT MIXTURE

Ref. No.: A.78
Origin: I.G. Oppau
Date: 7/1/43

Report No.: 545
Author: G. Kling

SUMMARY

The report describes the laboratory determination of the critical state of the residual gas from a high pressure polymerisation process (200 atmospheres) using a butane/Butylene feed.

A diagram of the apparatus is shown on sheet 1 and graphs of the results are shown on sheets 2, 4, and 5. The appearance of the meniscus in the capillary tube used is shown for various conditions on sheet 3.

The report does not seem to be of general interest, although the laboratory technique might prove of value to anyone undertaking similar work.

ETHERS OF HIGH CETANE NUMBER

Ref. No.: A.77
Origin: I.G. Oppau
Date: 7/15/43

Report No.: 544
Author: Dr. Roth
Contents: 8 text pages
8 tables
1 figure sheet

SUMMARY

Whereas ethers from two secondary alcohols or from a primary and a tertiary alcohol have high octane numbers, ethers from two primary alcohols or from a primary and a secondary have high cetane numbers. Multivalent ethers of the primary-primary type have exceptionally high cetane numbers of 130-200. In comparison the values of acetals as carbonyl-derivatives are low. The influence of double bonds, ring formation and the introduction of other groups are indicated. Further mono-valent thioethers, which possess cetane numbers as high as the oxy-ethers, and other sulphur compounds are discussed.

COMMENTS

Tables are presented giving the cetane number and octane number of various classes of oxy-ethers. The former are based on Egloff, I.I.P.T. 1937. 23. 657. The influence of other groups present in the molecule on cetane and octane numbers does not give any noteworthy information. The theory of the effectiveness of ethers is considered to be complicated and is not merely due to the ease with which the ether forms a peroxide. Reference is made to Townsend's work on the ignition of mixtures of air and diethylether, and of air and di-iso-propylether.

INVESTIGATIONS ON FINNED TUBES. PART V. MEASURING OF THE HEAT TRANSFER OF A PIECE OF HAIRPIN TUBE AFTER TWO YEARS OF OPERATION. HEAT CONDUCTIVITY OF THE CRUST. INFLUENCE OF THE FINNING ON THE MEASUREMENT OF THE WALL TEMPERATURE

Ref. No.: N-14
Origin: I.G. Farben Ludwigshafen
Date:

Report No.: 543
Author: G. Kling
Contents: 8 text pages
8 pages of illustration
1 table

SUMMARY

A piece of finned tube cut from the hairpin tube G72, which had been used in a gas preheater in Gelsenberg for 1540 hours, was studied for heat transfer. The crust was firmly attached to the heater in a thickness of 8 mm. and decreased the heat transfer about one-half. The part of the heat resistance of the crust on the total heat throughput had become so great that the finning of the hairpin tube had only little influence on the heat transfer. With sliding thermo elements the temperatures were measured in the walls of the high pressure tubes. The loss of temperature was determined in pieces of tubes without finning. The error in temperature measurement plotted in the curve is dependent on the number of missing fins. After several determinations the heat conductivity of the crust was found as

λ = 0.9 cal. per meter per hour per degree centigrade.