

FILM STUDY GROUP

REPORT

T.O.M. REEL NO. 93

Prepared by

THE ATLANTIC REFINING COMPANY

Atlantic Refining Co.
F.S.G.

SCANNING OF REEL #93
(Orig. Ident. Reel 3-G)
U. S. Government Technical Oil Mission
F.K.F. Technical School, Stuttgart

REC'D..... APR 29 1946..
TIIC L.F. & L. S-C.

Item SCL2 Pressure and temperature measurements in a lubrication system and the main bearing of a DB-605 engine.

This F.K.F. report #44 was written by W. Kraep, June 22, 1943. Measurements of a DB-605 engine showed the oil pressure very quickly developed throughout the whole lubricating system from a cold start at 20°C. About two seconds after the start there is an undoubted rise in oil pressure on the bearing. No danger to the bearing is anticipated in this short time since the bearing is still at low temperature. The bearing temperature is affected very little by load upon the motor. Frames 1-53.

" SCL3 Improvement of Lube Oil by Chemical Additives.

Engine tests were performed with lube oil to which had been added compounds of Cl, S, S and proprietary substances identified only by I.G. numbers. Among this latter are included I.G. 591 and E.C. 1585/80 B.S., M-100 and M-401. An effort should be made to learn the nature and mode of manufacture of the proprietary additives before assessing the value of this report. Frames 54-75. By R. Klotz.

" SD1 Operating instructions for diesel test engine.

Specific instructions and numerous illustrations prepared for use of the staff. Frames 76-100.

" SD2 Apparatus for measuring ignition delay.

Equipment and method are described at length and are well illustrated in report by Steiger Mar. 30, 1943. Frames 101-119.

" SD3 Institute (IKF) Progress Report.

This material bears the number XLV, but it is uncertain whether this subject matter covers a specific period or is devoted to the reporting of several subjects upon completion. The following topics are shown:

1. Determination of tetraethyl lead in motor fuels by two methods. Written by Widmaier and Henninger. Frame 121-122.
2. Effect of lead bromide upon non-ferrous alloys. Written by Widmaier and Henninger. Frame 129.
3. Temperature measurements in air cooled rotors with the N.S. thermo color method. Written by R. Gussmann and G. Boudonfer. Frames 135-140. Color substances as temperature measuring indicators were studied. These substances when placed upon metal surfaces change appearance in a definite degree at known temperatures. The residual color substance may be removed.

3. cont'd.
from the metal by sandblasting. The accuracy of indication is very good; these color measurements afford a quick estimate of the highest temperatures on air cooled multicylinder engines; the method is less suitable for small differences in temperature.
4. Causes of valve stem breakage. Written by Stark. Frame 147.
5. Visual demonstration of fluid flow in cylinders by means of a tubular model. Frame 151. Written by Siegel.
6. Valve with guide protector. Frame 156. Written by Siegel.

Tenth SD4. Tenth Annual Report.

This is a highly condensed summary of the activities of the Institute for the period 1930-1940 and enumerates the problems upon which work was done. Listing (Frame 183) projects by name and number, contributions to the technical literature by personnel of the Institute; those who gave financial aid, and the official dealings with governmental agencies.

SD5. Eleventh Annual Report of the Institute.

The presentation of material follows that outlined in the Tenth Annual Report. Frames 199-210.

Diplom Thesis from F.K.F., Technische Hochschule, Stuttgart

- " SE1 Starting behavior of fuels using chemical ignition accelerators. Investigation and evaluation on F.K.F.S. test engines. Written by O. Benner. Frames 212-261. Ethyl nitrate, carbon bisulphide, acetaldehyde and a substance designated as KS-2 were used to improve the ignition characteristics of fuels. Ethyl nitrate appeared best. Acetaldehyde and carbon bisulphide corroded the motor surfaces and had an objectionable odor. The addition in vaporized form in each case brought about improved ignition characteristics as contrasted to injection in liquid form. Experimental data and numerous graphs presumably based upon this data are included in the thesis. This material is undated though subsequent to 1934.
- " SE2 Influence of operating conditions on the detonation properties of fuels examined by several methods. Thesis written (1937) by G. Kessler. Frames 262-304.

The octane number determined by the motor method falls off with benzol and alcohol blends as the mixture temperature increases. The electro-dynamic indicator proved to be a reliable means for measuring

knock intensity. It was shown that fuel-air ratio exerts a profound effect upon the octane rating. There is no original data given, but graphs plainly indicate the course of the experimental work.

Item 883 Ignition properties of hydrocarbon-air mixtures in diesel motors under the influence of ethyl nitrate. Thesis by W. Schutze. Frames 305-342.

The ignition behavior of hydrocarbons varies with their chemical constitution. The autoignition point of paraffins and olefins is depressed as the chain becomes longer; ring compounds have a higher autoignition point. Fuels and their properties as regards autoignition characteristics were investigated. The influence of ethyl nitrate upon the autoignition properties was studied. These could be improved by preheating the air; by the use of vapors of fuel with an ethyl nitrate content of about 5% or by a combination of the two.

" Starting characteristics of hydrocarbons tested in a single cylinder diesel engine. Thesis of Staats. Frames 344-382.

Fuels stored in the presence of air undergo decomposition, and even greater alteration accompanies the effect of temperature and pressure upon fuel air mixtures in combustion. This tendency to decompose, especially in the presence of ignition improvers, is the subject of the present study. It was possible to improve the starting characteristics by the addition of chemical agents. Of these, ether was quite suitable. To prevent damage to the motor by violent knocking, fuel must be injected immediately following engine starting by ether. The addition agent used for starting should be employed in the vapor phase.

" Investigation on the influence of the chemical pre-reaction on the starting behavior in diesel operation. Thesis by H. Gerschler, Oct. 20, 1943. Frames 384-426.

A device was developed which took the exhaust before the engine was started, and which contained unignited yet already compressed gases from the combustion chamber, and again introduces these in order to take advantage of the chemical pre-reaction and to improve the starting properties. Comparison with normal diesel operation showed the possibility and efficiency of this utilization. The experiment showed that, qualitatively at least, an improvement in starting characteristics of diesel motors was obtained, and the author advocates continuation of the research work.

Item SM5 Examination of motor oil sludges formed by breaking in engines. A thesis by Heas (?) Sept. 16, 1934. DB Aero motors 603, 605 and 628 were used. The approach to this problem and the general scope of the investigation does not seem to present novel material to the American investigator. Frames 127-154.

Machine Tool Laboratory for Heat Engines and Compressors

" SM6 Investigation of a cylindrical bearing for high rotational speed. This bears the names of W. Dollhopf and H. Stephan and is dated Aug. 15, 1939. Bearings were intended for operation at 19,000 r.p.m., and the characteristics of the difference in materials in the shaft and the bearing shell were determined. Loss in power and the oil requirements of the bearing were measured. Temperature distribution on the bearing surface and the behavior of the moving parts were studied. Frames 455-509, 600-606.

State Material Testing Installation

" SM7 Wear behavior of chromed running surfaces (on Al base) running against aluminum alloy with oil lubrication containing added wear material. Report by Brockstedt and Siebel, June 10, 1941. Frames 607-637.

Wolcor and quartz were used as the addition substance to increase wear. The experiment showed that in spite of the severe conditions employed, the chromed surfaces offered a remarkable lessening of wear, especially at high loads. When the chromed surface was impaired by cracking and stripping, severe wear resulted, although remaining in relatively narrow limits.

" SM8 Influence of grain size of quartz dust added to engine lubricant on the wear behavior of different pairs of bearing materials. Report by E. Wellinger and H. Brockstedt, June 7, 1944. Frames 638-649.

Materials of grain size from 0 to 10 microns, 10-20 microns, etc. up to 60-70 microns were used. The working surfaces were, in one case, alloy against cast iron cylinder and in the second case the pair was cast iron rings against cast iron cylinders. The latter showed greater resistance to wear. The addition of quartz to the lubricant will be recognized as an attempt to obtain artificially the abrasive effect caused to the engine through fuel and air intake in road service.

" SM9 Influence of surface pressure, sliding velocity, the hardness of the bearing material, and the wear behavior with quartz dust in motor oil. Report by E. Wellinger and H. Brockstedt, Feb. 20, 1945. Frames 650-661.

The previously reported work was extended to include grade sizes 0-5 Mu and 5-7 Mu. The analysis showed that wear increased as the surface pressure increases; increase in velocity and in hardness of the bearing surface brings about a lessening of wear. It was recommended that these machine parts be hardened to as great a degree as practicable.

German Automotive Research by the Laboratory for Lubrication
Research of the Technical College, Dresden

Item SF1 Interim report on comparative tests of bearing shell material.
Report #71 by E. Heidebroeck and A. Döring, May 1939. Frames 662-684.

This appears to be a careful investigation and analysis upon the mechanics of lubrication and friction. The reviewer believes that engineers in the field of lubrication will find the material of value.

" SF2 Interim report on a test of engine with synthetic resin bonded crankshaft. Report #76, probably in 1939, by E. Heidebroeck and A. Döring. Frames 685-693.

The title is somewhat misleading; the crankshaft bearing surfaces were built up with impregnated fabric and finished to a polished surface with specific shaft diameter. The intent of the experiment was to determine the utility of these nonmetallic surfaces which conceivably might give reliable service and if slightly damaged could be readily repaired. The crankshaft of a 4-cylinder automobile motor having the synthetic crankshaft surfaces in contact with cast iron static bearing surfaces gave over 100 hours in service on the test stand. The test gave valuable experience in lubricating practice for satisfactory service of this type of bearing.

" SF3 New method for estimating the lubricating value of oils and fats. Report #83, April 1940, by E. Heidebroeck and E. Pietsch. Frames 694-708.

The authors devised a method for measuring resistance to separation of two lubricated surfaces (Abreissfähigkeit). They next examined values obtained on standard surfaces with different lubricants and extended this to include variables of temperature, load pressure, and surface conditions. This report also deals with the authors' investigations of the lubricating value of different substances when used on gears.

" SF4 Methods for determining the technical value of lubricants. The report #104 by E. Heidebroeck, Oct. 1941. Frames 709-734. This material is in the form of a general discussion summarizing developments in the past few years.

" SF5 Hydrogen as motor fuel. Report by M. Cohnichen, 1942. Frames 735-753.

The possibility of using hydrogen engines was examined theoretically and compared with available information. The properties of this fuel under varied conditions of load were studied in a motor specifically

Item SF5 cont'd.

designed to use hydrogen as its fuel. Application to automobiles is handicapped by the weight of the fuel container. There appears to be greater possibility in using hydrogen for locomotive (railroad) fuel. It might also show to advantage in stationary engines located close to large sources of the material, or where storage and cheap hydrogen production has been established. This report appears to be a valuable contribution. It considers in great detail the mathematical and thermodynamic approach to the utilization of hydrogen, and it is the reviewer's opinion that the information, while not necessarily applicable to known installations in the United States, nevertheless should be reviewed when such applications are considered here.

Institute for Brown Coal and Mineral Oil Research of the
Technical College, Berlin

" SF6 Lubricating Oils from brown coal tar. Report #109 by R. Heinze, M. Hender and H. Feichtinger, 1942. Frames 754-763.

There is no original data in this report, and there is no means of assessing its probable value as compared to parallel information obtained in commercial laboratories. The principal features of the experimental work were (1) production of alkyl benzines by reaction of olefins with benzol using sulphuric acid as catalyst. Examples were the experimental reaction of normal cetane and heptylene with benzol to make the corresponding alkyl benzenes; (2) the production of unsaturated hydrocarbons from paraffin derived from brown coal. The reorting of brown coal yields solid paraffins which may be chlorinated and the resulting chlor-paraffins are then subjected to heating to split out hydrochloric acid, yielding olefins. The experimental work was performed upon cetane, and with this experience the investigators proceeded to make unsaturated hydrocarbons from the brown coal paraffins themselves.

The next phase (3) of the investigation was the cross-polymerization of unsaturated hydrocarbons derived from chlorination of paraffins with brown coal tar oils. This work pointed to the particular use of brown coal diesel oil fractions as one of the reactants. The characteristics of the residual diesel oil were improved for conventional use, and the resulting lube oils were said to be good.

" SF7 Interim report on the recovery of lubricating oil from brown coal tar. Report #120 by R. Heinze, 1944. Frames 764-773.

This material is obviously a continuation and expansion of the subject matter set forth in item SF6. The conditions of acid concentration, reaction time and temperature were investigated to explore their effects upon the quality and yield of the resulting lubricating oil and diesel fuel. The inspections are both more numerous and extensive than in the previous report and the experimental results have been presented as lucid graphs.

Item SF6 Interim Report on production of lubricating coal from
byrom coal tar. Report #92, written by R. Heinze, M. Hardor
and G. Martin, 1941. Frames 780-798.

This report now enables the previously discussed report,
SF6, to be regarded in its proper light. We can now see that the
early work was of an exploratory nature, and upon results derived,
sulphuric acid was selected as the most promising catalytic agent.

" SF9 Employment of ignition improvers for diesel fuels. Report
#93 by R. Heinze, M. Hardor and G. Veidt, 1941. Frames 799-814.

Substances described in the literature as ignition improvers
were checked. Among those found effective were alkyl nitrates and
nitrites, peroxides, alkyl halogen nitrates, nitroso compounds and
poly-sulphides. Experiments to improve the effectiveness of nitrates
and nitrites by the addition of butyl bromide, benzyl bromide, copper
stearate, etc., showed no practical difference from the nitrates and
nitrites themselves. Amyl nitrate and tetralin peroxide resulted in
deposit on storage, with consequent loss of effectiveness. Some of
the additives imparted corrosive properties to the fuel to such an
extent as to preclude their use. Other substances had an adverse
effect upon the tendency to deposit carbon. The text contains a
number of tables which relate specific effect of these additives upon
storage stability, the cetane value, change in ignitability, the
Conradson value of the fuel, and loss by corrosion when the additives
were used in amounts up to about 3% by weight.

Research and Official Test Installation for Road Transport, Berlin.

" SF10 Investigation of dust filters for combustion engines. Report #85,
June 1940, by O. Schone and U. Schmidt. Frames 815-824.

The characteristics of four filtering devices were investigated,
and air resistance curves were plotted. A filter in which the layers
of screen are slightly separated from one another gave prolonged service.
The effectiveness of the filters was determined on the test stand by a
blower system with appropriate meters and the introduction of dust
particles at known rates.

" SF11 The effect of additives and their combustion products on engine
metals. Report #73 by G. Schikorr and K. Alex. Frames 825-833.

This report describes experiments in which the attack of flowing
fuel or combustion gases upon cast iron and copper at about 400, 180
and 70° was studied. With cast iron at 400°, the corrosion was esti-
mated to be 0.06 mm. per year. At 180°, the attack was immeasurable.
At 70°, the corrosion was estimated to be of the order of 1.4 mm./year.

Item SF11 cont'd.

With copper at 400°, strong attack was observed amounting to about 1 mm. per year. At 180° and 70°, the loss of metal is estimated to be 0.03 mm. and 0.06 mm. per year. Sulphur appears to have very considerable effect upon the corrosion of iron at 70° and of copper at 400°.

As the title of this report suggests, the intent of the experiment was to determine the corrosive effect of fuel additives and their combustion products. The series of experiments described in the present report might be called the blank runs, i.e., corrosion caused by the fuel itself without the addition of additives. It was said that the effect of the additives would be reported at a later date.

Department for Industrial Construction, Berlin
Four Years' Plan Institute for Road Transport at the Technical
College, Berlin

- " SF12 Testing of a fiber oil filter. V.f.K. report by H. Schwarz,
Mar. 15, 1944. Frames 834-852.

These studies conducted on a large number of engines were pointed toward reducing the damage to rotors. In some instances, it was recommended that the filter be changed more frequently. The general observation was that the filters effect a satisfactory cleaning of the oil even under severe conditions.

F.H.F. Technical College, Stuttgart

- " SG1 Experiments on the Otto engine behavior of synthetic fuels.
Report #74, by H. Kawa, L. Huber and G. Widmayer, June 12, 1939. Frame
853.

A single-cylinder test engine was operated for 50 hours with three synthetic fuels of the same knock value. At intervals, a sample of the circulated lubricating oil was withdrawn and its physical-chemical properties determined. Carbon formation in individual runs was observed, and a relation established between the fuels and lubricants. The three fuels under examination were Fischer-Tropsch gasoline, a leaded hydro-gasoline and a hydro-gasoline containing alcohol. An important part of the study was the determination of tendency toward vapor lock, the chemical attack of the fuels upon engine metals, gum formation, and the stability of the fuels in storage. These types of fuel employed are unfamiliar to American practice, but the tests and conclusion appear to have been made with care.

- " SG2 Tests on a carburetor type engine with self-ignition. Report #99
by L. Huber, H. Ernst and E. Dörr. Frames 867-876.

The purpose of the experiment was to expand information upon operation of compression rotors with self-ignition and to clarify the operating conditions for self-ignition. Combustible mixtures at low pressure and temperature undergo decomposition with correspondingly low velocity. The heat released by this reaction is absorbed in part by the mixture and by the combustion chamber walls. A progressive self-heating of the mixture is

Item SG2 cont'd.

possible, which in turn raises the speed of decomposition. The released heat finally cannot be taken away quickly enough and autoignition results.

The first experiments on development of the autoignition operation according to the proposals of Daimler were performed on a 4-cycle engine with the following results: Self-ignition operation was possible even from a cold start. To increase the tendency to ignite, 10% of ethyl nitrate was added to an alcohol-free Leuna gasoline and mixed with the regular fuel. Power, fuel consumption and combustion pressure were observed at compression ratios between 6.3 and 13.2. The addition of ethyl nitrate increased the fuel consumption and lessened the performance to a certain degree. Under the most favorable conditions, performance and fuel consumption showed about 10% less favorably under autoignition conditions than with customary ignition.

SG3 Mixture formation and combustion. Status of research in the field of diesel motor operating methods.

This report, #91, written by a working group which met in July 1940, consists of a series of nine papers presumably collected and edited by Panzer under date of Oct. 1, 1940. Frames 877-952. The separate titles of the papers are as follows:

- (a) Application of dual fuel operation to diesel engines, by Potthoff. Frames 883-886.
- (b) Experiment with liquid and generator gas operation of diesel engines. Summary of knowledge to date, by W. Rilmann. Frames 887-894.
- (c) Efficiency and combustion results in diesel engine, by List. Frames 895-901.
- (d) Overloading of automobile diesel engines, by Ernst. Frames 902-904.
- (e) Bomb test in mixing and combustion (of fuel-air mixtures) to improve and control combustion conditions in injection engines, by Blume. Frames 905-916.
- (f) Research in mixing and burning in engine: consideration of engine speed, by Ullmann. Frames 917-933.
- (g) New knowledge on (fuel jet stream) formation and stream jet dispersion, by W. Oschatz. Frames 934-945.
- (h) Measurement of the tendency of fuels to ignite; and fuel evaluation, by Ernst. Frames 946-949.
- (i) Diesel engine with side controlled valve, by Ernst. Frames 950-952.

Item 804 Second meeting of the working group for questions on engine combustion.

This report, #111, contains a series of papers presented in Oct. 1941, extending from Frame 953 to 1016.

- (a) Influence of injection nozzle design on the jet shape and formation, by W. Oschats. Frames 958-968.
- (b) Influence of air motion and stream jet formation through the nozzle on the power and fuel consumption in a high speed diesel motor, by K. Ullmann. Frames 969-981.
- (c) Conversion of Nirkalkammer engines to diesel service using wood gas, by Kohlopp. Frames 982-987.
- (d) Engine combustion in diesel type equipment using gaseous fuel, by W. Rixmann. Frames 988-997.
- (e) Examination of tendency to knock in multicylinder Otto engines, by Schulso. Frames 998-1000.
- (f) Theory of ignition reaction front in engines, by F. Dreyhaupt. Frames 1001-1008.
- (g) Combustion of liquefied fuel gas in pure diesel process, by F. Dreyhaupt. Frames 1008-1012.

Item 805 Third meeting of the working group for questions on engine combustion.

This meeting called in Dec. 1942 witnessed the presentation of seven technical papers which are listed below as part of report #114.

- (a) Investigation of the overall heat loss in bombs resembling combustion chambers, by K. Just. Frames 1022-1028.
- (b) Highly refined electrical measuring methods for engine studies, by K. Ullmann. Frames 1029-1030.
- (c) Fuel consumption in the carburetor-type engine, by H. Richter. Frames 1031-1032.
- (d) Investigation of the intake lines of multicylinder carburetor equipped engines, by H. List. Frames 1033-1041.
- (e) Advances in the (fuel-air) mixing in Otto auto engines, by H. v. Eberan. Frames 1041-1048.
- (f) Influence of air filters on the power and fuel consumption of engines, by U. Schmidt. Frames 1048-1051.
- (g) Thermodynamics of assembled combustion engines, by F. Dreyhaupt. Frames 1052-1068.

~~Item SC6~~ Research plan 1939-1940.

This report enumerates the problems by title together with the person or persons in charge and the status of the work presumably at time of writing. Frames 1069-1086.

D.V.L. Berlin

- " SH1 Instructions for use of the DVI exhaust gas tester for combustion engines. Report by H. Broicher, Aug. 1942. Frames 1087-1102.

This device depends upon the relative heat conductivity of the exhaust gas compared to a stream of moist air. The advantage of the device is that it gives an instantaneous and continuous indication of the combustion effectiveness; the fuel and air may be adjusted with instant response; it shows whether excess air is being used or whether incomplete combustion is being secured. The description of the device, its operation and use in interpreting combustion conditions is described in great detail.

- " SH2 Investigation of the running properties of radial loaded segment bearings with lead, bronze and light metal surfaces. Report Nov. 4, 1942, by W. Siedenburg. Frames 1103-1117.

Running tests were made with Michell bearings which are loaded radially. The load imposed for a 100 hour period on lead-bronze segments was 340 kg/sq.cm., and for light metal bearing segments of aluminum, magnesium and lead alloy it was 450 kg/sq.cm. The results are analysed mathematically at great length.

(This ends scanning of Reel #93)