FILM STUDY GROUP

REPORT

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Prepared by

THE STANDARD OIL COMPANY (OHIO)

THE STANDARD OIL COMPANY (OHIO)

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REEL II

NDEX TO REEL II

SUBJECT	ITEM NO.	PAGES
Collected papers from meeting on behavior and storage stability of fuels June 1941 Berlin.	71	
1. Fundamentals in the knock rating of fuels.		1-19
2. Physical Chemistry observation points for knock rating of fuels.		19-25
3. Chemical physical understanding in motor knock rating of fuels.		25-29
4. Knock determinations - D.V.L.		29-51
5. Reproducibility of results, D.V.L. knock rating.		51-55
6. Reproducibility and comparisons in knock rating of fuels.		55-65
7. Experiments with liquid cooled cylinders.		65-77
8. D.V.L. method with pressure pick up.		77-83
9. The prevention of knock with advanced valve timing and with single and multiple injection.		83-85
10. D.V.L. method comparison with N.S.U. motor, Ruhr gasoline A.G.		85-97
11. Fuel evaluation in small one cylinder motors.		97-105
12. Standard reference fuels.		105-107
13. Temperature sensitivity of motor fuels in octane number determination.		107-109
14. Knock motor testing in oil tests.		109
15. Discussion of the foregoing topics.		111-119
16. Practical storage stability of fuels and it's chemistry.		119-121
17. Formation of viscous materials during the storage of aviation gasoline.		123-135
18. Storage stability of fuels.		135-141

REEL II

Pages 1 - 30 Item 66

Determination of peroxides in fuel and their effect on engine behavior.

A method for peroxide determination with $TiCl_3$ is given. The chemistry of peroxides and their influence on decreasing the octane rating, increasing gum formation and corrosion is discussed.

Pages 25 and 38 illustrations - Item 67

Effect of tetraethyl lead in fuel on the construction materials of the engine.

This research was conducted to determine the effect of leaded and unleaded fuels on a Jumo 211H motor. It was shown that leaded fuels did damage the valves etc. The work was continued on a DB605 motor. Photographs of motor parts.

Pages 7 and 5 illustrations - Item 68 second section

This work was with a DB605A motor. A hundred hour test run showed that there was no difference in valves and pistons in using 0.09 volume percent and 0.12 volume percent T.E.L. The decrease in lead content did not increase the motor life.

Pages 269 - Item 69

Collected papers from meeting on lubricants (oxidation resistance).

1. The oxidation resistance of oils. Pages 5 through 26.

   Laboratory tests must be conducted in conjunction with the actual motor tests. The construction and type of test motor have important bearing on the data reproducibility. Complete motor tests are the only answer but they are difficult to run.

2. ~~The chemistry of oxidation resistance of lubricating oils.~~ Pages 29 through 41.

   No complete answer can be given for all the changes in oil at high temperatures and under various conditions in practice. The discussion is complete and thorough.

3. Oxidation resistance of lubricating oils in the aviation motor. Pages 41 through 57.

One cylinder motor tests are usually made because complete motor tests are too difficult and expensive. However, these cannot establish a clear judgment of the oils. Changes occurring in the oil during motor operation are enumerated and are discussed from a chemical and physical standpoint. It is the hope that engineers and chemists may, in the future, evolve more rapid and cheaper test methods for practical use.

4. Laboratory testing of oxidation resistance of oils. Pages 57 through 85.

The laboratory test methods must be in agreement with actual practice concerning the following items (1) temperatures, (2) quantity of air used (the use of oxygen instead of air cannot give comparable results), (3) aging since the use of glass containers does not occur in actual practice, the use of metal containers (WAC), the immersion of metal strips (Damian), and the use of several types of metals (D.V.L.) comes closer to the practical, and (4) the movement of air during testing (various methods are mentioned). The Indiana test method has been widely used. The reproducibility of these methods can only be secured with definite test conditions. The temperature and time conditions for the oil during the period between aging and laboratory testing should be established.

5. Laboratory and motor testing of oils for oxidation resistance. Pages 89 through 103.

With all test procedures, the object has been to secure the results comparable to actual motor operation in the shortest possible time through the use of higher temperatures and the passage of oxygen for varying periods. The oils are then tested and judged for asphalt formation, viscosity, engine carbon, lacquer formation, neutralization and saponification numbers. Experiments were conducted with the Indiana, Noack, and DVL methods using various gases and temperatures. The von Noack and DVL method appear to agree. The comparison of laboratory and motor methods show no close agreement. ~~An agreement can~~ only be attained under circumstances when laboratory experiments are carried on in conjunction with definite operating conditions, test motor types, and fuels.

6. The fundamentals of tests of oxidation resistance of oils. Pages 103 through 111.

The oxidation resistance of oils for steam turbines and the relation of the running time with the neutralization saponification ratio is given. The use of accelerating agents such is oxygen, higher temperature, metals etc. is discussed.

7. The determination of asphalt content of used motor oils. Pages 111 through 129.

A discussion concerning the methods of asphalt determination according to D.I.N., D.V.M. 3660 and the simplified D.V.L. method. This latter method is similar to that described with the Indiana test method and is easily reproducible. Experiments were made with a precipitation naphtha SK 65170 (RCH normal hexane), a synthethic product of the Fischer Tropsch process which proved satisfactory. Asphalt determinations made with this product were in close agreement with ring sticking tests.

8. Observation of piston temperatures in motor oil tests. Pages 129 through 151.

A discussion of piston temperatures and the installation of a thermocouple to measure this temperature in a N.S.U. motor.

9. Experiments in lube oil test runs on ring sticking. Pages 151 through 173.

A description of the B.M.W. test motor is given with a complete and thorough treatment of all test factors.

10. The use of the I.G. test motor in lube oil testing. Pages 173 through 183.

A description of the I.G. Farben industrie test motor used for knock rating with some modifications. Comparison of test runs with various types of oils in the B.M.W. 132 and I.G. motors were made and were very satisfactory.

11. Experiments on piston ring sticking in the N.S.U. motor. Pages 183 through 191.

Since only very small quantities of synthetic lube oils were available, it was desired to obtain a comparison of results in the BMW 132 and the N.S.U. motors. Satisfactory comparisons of wear and oxidation resistance were as yet not possible. The variation were too large, the test period time and influence of stuck piston rings not comparable. It was hoped to obtain further observation on wear in connection with sludge formation.

12. The testing of aviation motor oils in the D.K.W. motor. Pages 191 through 205.

Cost and time elements render it desirable to obtain the results from B.M.W. motor tests with a smaller motor. The D.K.W. motor is described in detail. The motor operation time until ring sticking occurs with both types of motors is in good agreement. The influence of lead content of the fuel is so small as to be within the limit of experimental error.

13. Experiments on sludge formation N.S.U. motor. Pages 205 through 211.

A ten hour test run with the collection of 100 ml of sludge was made with modified N.S.U. motor operation. Sludge was analyzed for combustible material; iron, SiO_2 and other inorganic materials were determined in the ash. Types of fuel used influence the test results. In general there is a relationship between the wear loss and sludge formed that can be explained by the catalytic effect of the small particles of iron. The experience with this method as yet is not very comprehensive. In the development work on synthetic oils, other tests on wear, quantity of oil used and piston ring sticking must be carried on simultaneously with tests on sludge formation.

14. The motor testing of oxidation resistance of oils in the U.S.A. Pages 211 through 237.

In comparison with the German method, the Americans have followed through the same stages of evolution and to the same degree. Further work must be done. The work of vacuum; Neely, Baxter and Stewart; Willey and Prutton; Everett and Kaller; Rosen; Wiggins and Hunter; Nutt and Beall is classified and studied.

15. Test results considered with practical applications. Pages 237 through 243.

The effort has been made to obtain approximate complete motor results with a one cylinder test motor run with the following data for comparison of ring sticking, lubricating ability, engine deposits, sludge, oil consumption etc.

Ring sticking can be determined and avoided but sludging and lubricating ability during starting can not be so readily found by preliminary test methods. We are still far from explaining the course of complete motor operation in terms of preliminary tests. It will be necessary to exactly determine all the conditions of complete motor tests which, up until now, has not been the case.

16. Further individual discussion concerning these papers. Pages 243 through 269.

Pages 313 - Item 70

Collection of papers from the meeting on lubricants (wear and friction) Berlin 1941.

1. The problem of lubrication in aviation. Pages 1 through 15.

   An outline of all possible applications of lubrication in aviation is given with a rating for such lubrication requirements as cold test, oxidation resistance and corrosion. The maintenance of the purity of the lubricants during use is discussed. All the means to measure lubrication must be concerned with the wear loss of the moving parts, the factors in surface lubrication and the chemical and physical research which may enable better lubricants to be made. All of this must be the basis for proper judgment in lubrication tests and practice.

2. The fundamentals of lubrication. Pages 15 through 23.

   A method to determine "oiliness" must be developed. This must be considered from the basis of mechanics, physical chemistry and chemistry. The subject of friction is discussed and explained.

3. Molecular structure in fluids and relation to mechanical properties. Pages 23 through 41.

   Chemical thermodynamics is the only scientific basis of chemical reactions and has been of the greatest technical use. In the problems of technical lubrication there is a connection between the mechanical properties of a lubricant and its chemical structure. The molecular physics viewpoint can explain friction in its various forms. An excellent review of the subject is given.

4. Lubricant molecular structure in relation to bordering metallic surfaces. Pages 43 through 59.

   Lubrication is explained from the standpoint of molecular arrangement as it applies to border line lubrication. This explanation is an analysis of all possible friction causes with physical chemical methods applying.

5. Heat conductivity and specific heat of liquids. Pages 59 through 63.

Heat conductivity and specific heat of liquids in their relation to molecular structure is being studied at a laboratory at Dresden. Apparatus to measure these properties is being assembled for precision work.

6. The nature of wear. Pages 63 through 77.

The knowledge concerning the nature of wear of the moving parts of machinery is needed, especially during war time when replacements are difficult to obtain or when substitute materials must be used. This discussion takes up experiments of a number of different metals in contact with corresponding pressure and temperature curves.

7. Technical methods to determine the lubricating ability of oil. Pages 77 through 91.

At the Institute at Dresden, gear and contact surface friction apparatus was constructed to obtain friction indices of various oils and test run charts in lubrication.

8. Heat, friction and wear in relation to border line lubrication and their connection with lubricating ability. Pages 91 through 107.

At the Physick Tech.-Reichsanstalt a new research procedure was directed to determine the measurements of heat, friction and wear in connection with lubrication. It has been shown that oils of the same viscosity have different effects on friction. The apparatus for these measurements is illustrated and curves were obtained for steel and cast iron friction plates with lanolin and vaseline as lubricant.

9. Border line friction with chemically pure materials. Pages 107 through 113.

Surface friction numbers were obtained with the same steel and cast iron friction surfaces as described in the previous article. These numbers were obtained for cetane with various additions of an aliphatic acid $C_{17}H_{33}COOH$, homologous aliphatic acid and alcohols, the halogen derivatives of butyric acid and compounds such as C_4H_9OH, C_4H_9CN and $C_4H_9NH_2$. These measurements show that an oil must contain certain active substances whose action is similar to that of the carboxyl group of the fatty acids. It cannot be definitely said that it should be a free fatty acid and one percent should be an optimum. In mineral oils there are definitely no fatty acids or corresponding substances, but these contain some high molecular weight alcohols and esters and the esters differ in surface friction characteristics but not the alcohols.

10. Surface lubrication and Coulombs Law. Pages 113 through 119.

The author does establish the fact that in surface friction, Coulombs Law does apply.

11. The relationship of surface loading on surface finish. Pages 119 through 149.

It is known that experimental results from different loading test machines are not in agreement. It has been possible from a study of this subject, to develop surfaces which may be used in any test machine to obtain comparable results.

12. Static friction and lubrication. Pages 149 through 159.

These experiments confirm in a large measure the fact that viscosity plays a large part in lubrication. Besides viscosity there is that undefinable property of lubricants - oiliness. With static friction, an intergral part is concerned with the limiting factors such as temperature and types of contact metallic surfaces to which the oiliness is imparted. Friction numbers are given for steel-bronze contact surfaces dry with castor oil, a paraffinic oil and glycerine. A curve of the technical application of friction co-efficients as reciprocals of oiliness is shown.

13. Loading and friction of sliding surfaces. Pages 159 through 169.

Theories, equations and references are cited in this discussion.

14. Experiments with the four ball machine. Pages 169 through 185.

This machine is mentioned for the test specifications for E.P. lubricants. Variations in test results have occurred. A number of variables were considered in a series of experiments which might eliminate the discrepancies in the test results.

15. The oil test machine at the gear factory at Friedrichshafen. Pages 185 through 191.

A machine for testing lubricants for simple spur gears was developed. The index of lubrication was based on the area wear loss of a gear tooth. Diagramatic measurements taken before and after testing were measured with a planimeter. The test conditions were at 80°C and pressure 7000 Kg/cm². The addition of 20% of a sodium soap and 2% of a fatty acid improved the lubrication index and stability. A full description of the test machine with drawing is given.

16. Scuffing of bearing races, test methods and effect of lubricants. Pages 191 through 203.

A testing machine is described and test results discussed. Reference is made to J.O.Almen, Mechanical Engineering 59 (1937) pages 415-422 on lubricants and false brinelling of ball and roller bearings and other authorities.

17. The testing of lubricants in friction and wear experiments with motors. Pages 203 through 223.

With experiments in the D.V.L. single cylinder test motor and a large single cylinder aviation motor B.M.W. 132, oils with similar viscosities were tested. It has been possible to evaluate the wear and friction preventive characteristics of lubricants. Photos of piston rings and curves from data obtained are shown.

18. Viscosity and cold behavior. Pages 223 through 227.

A discussion concerning the cold testing of oils, influence of their chemical composition and brief mention of several test methods.

19. Viscosity, "Poleheight". Pages 227 through 239.

The application of viscosity "Poleheight" in the measurement of temperature, viscosity relationship.

20. Anomalies in the cold behavior of oils. Pages 239 through 245.

The anomalies in the cold behavior of oils are discussed in detail.

21. Experiments with lubricants in the I.G. cold cabinet. Pages 245 through 271.

A discussion of the increase in viscosity due to lower temperatures. Various types of apparatus were constructed for these tests, cold boxes and viscosimeters. Curves were obtained to show the test results from various oils, fats, their combinations, and the use of paraflow.

22. Cold testing of lubricants. Pages 271 through 287.

Viscosity studies of oils at low temperatures using the Vogel Ossag viscosimeter were made. There is a discussion of the theory of viscosity at low temperatures with equations and curves.

23. Testing of temperature relationships of lubricants and greases. Pages 287 through 299.

Description of a ball bearing apparatus to measure the effects of lower temperatures on greases. Test results and curves are given.

24. Lubricant viscosity and motor starting at low temperatures. Pages 299 through 313.

Drawings are shown for various types of viscosimeters to measure viscosities at lower temperatures, capillary, Schwaiger, etc. Curves are given for test results, including those from the I.G. cold test cabinet. The practical answer to this problem is to construct an apparatus for motor use to warm up the water circulation, the lubricant and the battery to at least plus 10° previous to starting.

25. Summary of those discussions and further discussion of these various subjects. Pages 313 through 352.

Pages 181 - Item 71

Collected papers from meeting on behavior and storage stability of fuels June 1941 Berlin.

1. Fundamentals in knock rating of fuels. Pages 1 through 19.

The factors concerning the chemical, physical and motor testing of fuels for knock are explained. The deductions applying to laboratory test methods, motor procedures, motor characteristics and operating conditions are given.

2. Chemical and physical viewpoints in knock determination of fuels. Pages 19 through 25.

The explanation of knocking from a physico-chemical viewpoint particularly, reaction kinetics research is discussed.

3. Chemical and physical understanding in motor knock rating of fuels. Pages 25 through 29.

The goal of this study was to show the theory of the chemical and physical structure of various fuels and the relationship to the knock curves.

4. Knock measurements with the D.V.L. methods. Pages 29 through 51.

   Curves for the influence of operating conditions for various fuels are shown.

5. Reproducibility of results D.V.L. method. Pages 51 through 55.

   The agreement of results with different motors was unsatisfactory. When tests were run in the same motor on the same days the reproducibility was ± 5% from the mean value.

6. Reproducibility and comparability in knock rating of fuels. Pages 55 through 65.

   Reproducibility has been unsatisfactory. It is possible to evaluate fuel if the same reference standards are used. The error tolerances are too close. Specifications concerning exhaust, mufflers, piston temperatures must be given in greater detail.

7. Experiments with liquid cooled cylinders. Pages 65 through 77.

   Experiments using the I.G. experimental motor with Daimler Benz 6001 cylinder on a Jumo 211A. Comparison curves of test results with the BMW 132 motor are shown.

8. D.V.L. method with pressure pick-up. Pages 77 through 83.

   Description of the D.V.L. - Zeiss-Ikon knock motor and its use.

9. The prevention of knock with motors with advanced valve timing and with single and multiple injection. Pages 83 through 85.

   Experiments conducted with different standard motors showed that with a surplus of air the knock curve varied according to the valve timing and fuel between 2-4 kg/cm^2 mean pressure and the course of the knock curve levels off more than with the normal mixture.

10. D.V.L. method comparison with the NSU 501 OSL motor, Ruhr Gasoline A.G.Oberhausen-Holton. Pages 85 through 97.

    For a period of two and a half years a small motor has been in the development stage which could give comparable results with the D.V.L. and B.M.W. motor. Comparisons between these motors with five standard reference fuels were made satisfactorily.

11. Fuel evaluation in the small one cylinder motor. Pages 97 through 105.

Comparative tests were made with the I.G. test motor and the BMW motor (D.V.L.). The results were easier to obtain with the I.G. motor (Oppau method).

12. Standard reference fuels. Pages 105 through 107.

This subject concerning reference standards is very briefly discussed.

13. Temperature sensitivity of fuels in octane number determinations. Pages 107 through 109.

In octane number determination of fuels containing aromatics, the standards should likewise be aromatics.

14. The use of the D.V.L. method in oil tests. Page 109.

Much work must yet be conducted to obtain reproducible results with fuel evaluation and it may be this type of motor which should be used in the testing of lubricants.

15. Discussion of the foregoing topics. Pages 11 through 119.

16. Practical storage stability of fuels and its chemistry. Pages 119 through 121.

In unleaded gasolines unstability is due to large amounts of olefins or the presence of unstable diolefins. With saturated hydrocarbons, the stability was exceptionally good. In mixtures of highly aromatic gasolines, leaded, the stability was poor, the nature of the fuel and probable contamination causing decomposition of the T.E.L. and gum formation. The chemistry is not clear. Bomb and storage tests do not agree. D.V.L. experiments with the use of definite quantities of antioxidants expecially for unstable leaded fuels show good results. Leaded gasolines should be used soon after of the lead addition.

17. Formation of viscous materials during the storage of aviation fuels. Pages 123 through 135.

There are two classified types of gum formation (1) the oxidation of unsaturated hydrocarbons with subsequent polymerization (2) the formation of new compounds through polymerization and condensation. In the absence of light, oxygen or foreign substances, T.E.L. does not change in gasoline. If oxygen is present, the T.E.L. does change into di and triethyl compounds and these with CO_2 from the air and acids present or formed in the gasoline react to form salts. This breakdown of lead is accompanied by an accelerated oxidation of the fuel and formation of viscous materials. These simultaneous complex reactions occur in a different order and manner in practice than in the bomb at 100° and explain the fact that a fuel may prove good in bomb aging and not in practice. A series of experiments were made in bomb aging and recommendations are given to insure better reproducibility. Data to correlate bomb tests with actual storage must be obtained. There must also be an understanding of the mechanism of oxidation and fuel composition as well as the present usage of antioxidants in practice.

18. Storage stability of fuels. Pages 135 through 141.

The changes during storage are possible decrease in O.N. and increase in gum content. Two year storage tests in iron and galvanized barrels were made with cracked straight run gasoline and 0.2g/l cresol and 0.5 cm^3/l T.E.L. blends. Inhibited gasolines showed practically no decrease in O.N. In galvanized barrels, T.E.L. acted as an inhibitor for both cracked and straight run gasolines. Cresol did not inhibit cracked gasolines as well as straight run. Under all conditions straight run and inhibited cracked gasolines were stable in gum content. Leaded gasoline in galvanized barrel storage was stable in induction period, that in iron barrel storage was unstable.

19. Storage stability of fuels. Pages 141 through 143.

Two year storage tests were made at Travemunde with aviation gasoline, catalytic cracked gasoline and mixtures with aviation benzol; Czech aviation gasoline and mixtures of Czech aviation ~~benzol; Leuna motor gasoline in mixtures with motor benzol;~~ T.E.L. and iron carbonyl. All unleaded gasolines and leaded gasoline with low aromatic content stored well. Leaded highly aromatic gasolines were not stable and there was no definite correlation between the degree of aromatic content and aging.

The lead content had an important influence on stability, higher lead content gasolines showed decreased storage life. There was not a good agreement in the results of the bomb and storage test and further storage tests must be made.

20. Antioxidants. Pages 143 through 145.

The presence of T.E.L. accelerates the oxidation of fuels in the presence of air and this is dependent upon the fuel type. Special inhibitors from D.V.L. were bomb tested with leaded fuels and showed very good results. Corrosion tests with iron, zinc, aluminum and electron strips were made, all were good with the exception of zinc.

21. Experiments with the determination of aromatic and iodine number. Pages 145 through 149.

With mixtures containing olefins and aromatics, the Kattwinkel reagent is not suitable and the volume decrease should be termed S.P.L. (surfuric phosphoric solubles). The Kattwinkel reagent does however, give good results with gasolines containing only aliphatic olefins and when the acid product ratio is 4:1 (not 3:1). The difficulties with iodine numbers is discussed. For olefin determinations in straight run aviation gasoline the method of Rosenmund and Kuhnhenn is recommended, using a solution of bromine in pyridine sulfate with back titration with arsenious acid. Where there are heavily branched chain olefins, the Kaufman method results were good but further work is being done to obtain a better method.

22. The determination of aromatics according to specifications 1940. Pages 149 through 153.

The reproducibility with the results from the D.V.L. The Riesenfeld and Bandte method was poor. Experiments conducted with the B.V.M. method using a phenol analyzer (Kattwinkel) and Kattwinkel acid (conc. H_2SO_4 and P_2O_5) were made. Comparisons of both methods are shown and the reproducibility of B.V.M. was excellent.

23. Aromatics and olefin determinations in gasoline. Pages 153 through 157.

In the specifications (1940) the volume percent decrease after using the Kattwinkel reagent is the sum of aromatics plus olefins. The olefins are determined by shaking with 90% H_2SO_4 and the aromatics are determined by difference. It has been attempted to obtain olefin values using other methods and iodine values. In olefin free mixtures of aromatics and straight run, olefin percentage values were found. Factors such as temperature, time of shaking etc., make for possible errors and there is no good agreement between the analysis by different laboratories.

24. Determination of aromatics in gasoline according to the aniline point method. Pages 157 through 165.

Reference is made to Tizzard and Marshall, Jour. Soc. Chem. Ind. Vol. 40 - 1921 page 20 in the determination of aromatics with the aniline point depression method. The work here was done with gasolines boiling range 40°-165°C (30-50% at 100°C). Synthetic mixtures were made using an aromatic mixture of 20% benzol 41% Toluol, 27% xylol, 3% ethyl benzene and 9% higher aromatics. Curves from these mixtures were obtained. With olefin containing gasolines, the olefins must be removed first with 80% H_2SO_4. The results of this method with the limiting factors given in this report are of practical value.

25. F.K.F.S. rapid method for the determination of lead in aviation gasoline. Pages 165 through 175.

Three methods were given. For a non-olefinic or peroxide containing gasoline the following method is given. Twenty-five ml gasoline shaken five to ten minutes with 5 ml 0.10 N alcoholic (98% EtOH) iodine. The unreacted iodine titrated with 0.10 N $Na_2S_2O_3$. The ml of 0.10 alcoholic iodine used for the lead multiped by 0.0391 gives the volume percent of T.E.L.

The second method which could be used for any gasoline is 10 ml gasoline refluxed five minutes with 5 ml trichloroacetic acid separated with a separatory funnel, the gasoline washed twice with 5 ml portions of trichloroacetic acid. Carefully heat the solution to remove the trichloroacetic acid and neutralize with NH_4OH, then 5 ml of 5% acetic acid containing sodium acetate is added, brought to a boil, then 5 ml 0.05 NK_2CrO_7 added and boiled for a short period then cooled and filtered. To the filtrate add 0.2 gm KI and 5 ml HCL and back titrate with 0.05 N $Na_2S_2O_3$. The ml of 0.05 N $K_2Cr_2O_7$ reacted with lead multiped by 0.0324 equals the volume percent T.E.L. The lead content of fuels has also been rapidly determined using an x-ray absorption method but there are no details.

25. Discussion. Pages 175 through 181.

This took up the fundamentals and chemical characteristics of gasoline storage, the practical phase of it are inhibitors and methods.

Page 5 with table - Item 72

Ring sticking tests with light metal pistons in the Siemens test engine. German Aviation Research.

1. A report on the replacement of gray cast iron pistons with those of an Al-Si alloy. Two lubricants were tested (B6 and C1) and test runs were made to determine ring sticking. The results of B.M.W. 132 motor were similar to those of the Siemens test engine with cast iron pistons if in both cases similar thermal conditions occur at the rings. Piston sticking is a function of the temperature in the vicinity of the piston rings and not of the piston material.

IV Report on lube oil tests in the B.M.W. single cylinder engine carried out at the Rhenania-Ossag Laboratory.

Pages 001981 - 001991 - Item 73

Experimental synthetic oil blends SS1006.

1. This report is about motor test runs with various types of synthetic oil blends and complete laboratory data.

Pages 001992 - 001996 - Item 74

SS1006 further tests with B.M.W. single cylinder motor with a synthetic oil mixture.

1. A mixture of 50% synthetic oil SS1006, 50% mineral oil components SS607 and 0.02% I.G. inhibitor gave a critical running period of 11-1/4 hours as compared with the 8 hours with standard Rotring D.

Pages 001998 - 002005 - Item 75

A series of lubricant mixtures containing "TTH paraffin", synthetic oil components and various percentage additions of sludge oil were tested. Test run periods and conclusions are given.

Pages 002006 - 002022 - Item 76

Effect of the addition of inhibitor on ring sticking and sludge formation.

1. Data on ring sticking and sludge formation for Rotring D, Rotring D plus 0.2% OT inhibitor and the addition of 4% Special Voltol was obtained.

Pages 002024 - 002030 - Item 77

SS1006, 200 ton batch.

1. A report on a blend of 50% synthetic oil SS1006 and 50% mineral oil components SS607 and 0.02% I.G. inhibitor. The test run period, 8 hours was the same as for Rotring D, piston ring wear, sludge formation etc. were normal.

Pages 002030 - 002044 - Item 78

Army winter oil with and without the addition of Oppanol.

1. The addition of Oppanol had no influence on the wear but did decrease sludge through its sludge solvent property.

Pages 002045 - 002063 - Item 79

Summary of all previous test reports.

1. A summary of test reports on a large series of synthetic oil mixtures.

Pages 002064 - 002081 - Item 80

Rotring oil with and without special voltolized oil.

1. Tests on a mixtures of aviation lubricant SS1060/61 and the addition of 4% Special Voltol. The effect on sludging was not unfavorable, however, the test runs were not fully conclusive.

V Synthetic lube oil manufacture at Politz.

Item 81

An analysis from Dr. Hartmann (Stettin) of two tanks of special steam cylinder oil.

Item 82

Flow sheet diagram of the Politz plant with throughput capacities of various products.

Pages 002085 - 002090 - Item 83

Memorandum on plant operation.

Pages 002090 - 002096 - Item 84

Improvement on plant during 1942 - 1943.

Pages 002096 - 002110 - Item 85

Reports on cracking various waxes.

NH:dr