FD2872,46140

B.I.O.S. No. X9.

TECHNICAL EXPERIMENTAL STATION - OPPAU.

List of the development work of the technical experimental station in the field of aeronautics

I. Fuel testing.

A. Continuous checking of the supercharge characteristic.

1) Continuous testing of production samples.

A check on the production is kept by routine testing of samples from the Ludwigshafen factory, from Oppau and from outside hydrogenation plants, e.g. Gelsenberg, Politz and Scholven. At the request of the Air Ministry, the production of the plants working under I.G. licence must be constantly controlled. Several BMW 132 Single cylinder test stands are already available for the purpose.

2) Testing of development samples.

New fuels or fuels produced by new methods are given supercharge tests on the BMW 132 as well as on the K test engine. This applies for instance to samples of synthetic gasolines, DHD gasoline, cracked gasoline, polymer gasolines as well as additives, vis: iso-octane, alkyl octane, ether, alcohols, alkyl benzene, etc.

3) Testing of Diesel fuels.

I.G. test diesel engines are available. The tests cover not only samples of newly developed diesel fuels, but in particular highly ignitable diesel fuels, that can be used as R fuels or as starting fuels.

B. Development of test methods and instruments.

1) Further development of the BVM supercharge method.

This work is concerned on one hand with improving the reproducability and comparability of the present supercharge method and on the other with the adapation of this method to the conditions of recent engines; e.g. as regards boost air temperature, valve overlap, compression ratio and r.p.m. Comparative tests between air and liquid cooled cylinders are also undertaken. Beside the BMW 132 single cylinder test stand, the series 2 I.G. test engine was used. The series 4 I.G. test engine, specially designed for this purpose, is being assembled.

2) I.G. test engine.

The Oppau method, which permits an evaluation of leaded aviation fuels similar to the supercharge mehtod, is quite complete. Comparative tests are carried out in other experimental institutes, equipped by the Technical experimental station. The Air Ministry was requested to authorize comparative tests between the Oppau method and the supercharge method.

3) I.G. k test engine.

In an attempt to apply the supercharge method also to small engines, the I.G. k test engine was developed on the basis of the I.G. test diesel; it gave comparable results to the BMW 132. This engine is already used continuously to record knock limit curves. In gasoline operation this test stand permits beside supercharge tests also many other tests, such as power and consumption measurements. Moreover all diesel tests can be performed

on it, including cetane number determination. It is intended to bring the drawings up to date, because probably the Air Ministry is interested in producing a large number of them, in order to avoid the construction of more costly test stations with large single cylinder engines.

4) Series 4 I.G. test engine.

The BMW 132 single cylinder engine with radial crankcase is mainly used for supercharge tests on aero engine cylinder, as laid down by BVM (engine specifications). Only the BMW 132 N-cylinder can be tested in this engine and the full size crankcase offers little possibility of fitting additional apparatus.

In analogy to series 2 I.G. test engine a steel crankcase with much additional equipment was produced in which normal BMW parts especially the crankshaft can be largely used. Other cylinders, such as BMW 801, DB 6001, Jumo 211 etc., can be mounted on the same crankcase. With this arrangement test-bed difficulties are eliminated by fitting a balancing system. It is intended to produce several of these engines after concluding the tests.

5) I.G. test diesel.

The development of the I.G. test diesel to determine the cetane number is concluded. At present tests are being carried out with a simplified dial instrument after Dr. Neumann.

6) Development of knock meters.

A knock meter based on the body vibration method was developed, which permits filtering of the knock impluses and their transmission to a loudspeaker or Cathode ray tube or alternatively to a counter mechanism. This instrument was developed with a view to later full scale engine tests. It is intended to continue this development in collaboration with Prof. A.W.Schmidt.

C. Research problems.

1) Tests on valve overlap.

Tests on liquid cooled cylinders with large valve overlap produced knock limit curves entirely different from those determined according to the BVM. Present tests have proved that under certain conditions similar curves can also be obtained on air cooled engines. It is intended to continue these tests with the object of counteracting by means of the fuel the power drop observed at rich mixtures.

2) Tests on mixture quality.

So far the tests have proved that the knock characteristic can be notably affected by the mixture quality. Present tests concern:

stratified charges,
divided injection
delayed injection
etc.

3) Tests on the combustion of aromatics.

With aromatic fuels higher temperatures have been observed which were supposed to have a detrimental effect on the engine. It is necessary to investigate more thoroughly than heretofore with which aromatics this occurs and under what conditions the heat balance is displaced.

4) Tests on methanol and water injection.

Tests showed that the injection of water in the boost air improves the knock characteristic as a result of a cooling action.

Similar tests are carried out on the effect of methanol.

5) Tests on T.E.L. corrosion.

Engine tests under different conditions should explain the corrosion of exhaust valves due to T.E.L. deposits. At the same time the effect of additions of other bromides, such as diethyl bromide, must be investigated. The research on the applicability of B4 fuels for automotive engines is also within the scope of these tests. The attempts to counteract the lead addition, partly at least, by chemical means which may be used at the front, can be considered as concluded with a negative result.

6) Tests on the variations of the gasoline engine indicator diagram.

The marked variation in the peak pressure is significant for the combustion process of gasoline engines. It is intended to elucidate the cause of the phenomenon, as it has apparently a considerable influence on the knock characteristic. Most of the apparatus required has been prepared.

7) Tests on the starting characteristics of diesel fuels.

It appears that the cetane number is not sufficient to predict reliably the starting characteristics of diesel fuels. Beside the ignitability, vapour pressure and viscosity apparently have a considerable influence. It is intended to make more tests in the cold room to find an evaluation coefficient for the starting behaviour.

D. Special fuels

1) Safety fuels

a) TZ 900

Tests on TZ 900 have shown that it is fundamentally suited for engine operation. Its anti-knock value corresponds to that of B4. Present tests concern the design of a very small decomposer as well as the application of the TAL nozzle to our method of cooling the TZ after decomposition. It is intended to discontinue the tests for the time being.

b) Heavy oils.

Beside TZ 900 other high boiling point aromatics e.g. tar oils, are used as safety fuels, though not conventional gasoline engines. Tests on a Hesselman cylinder are contemplated, to elucidate the suitability of this design for supercharge operation in general, and in particular for the use of safety fuels. The equipment required is ready.

2) Ring process.

a) R fuels.

General work on R fuels is almost complete. The substance C 120 is a highly ignitable fuel particularly suited as starting additive for diesel engines.

b) Knock characteristic of the R process.

It is expected that the knock behaviour of R engines may be strongly affected by the use of a pre-combustion chamber. At the same time the process may be expected to be far less influenced by the external temperature. The development work concerns mainly the design of the chamber.

c) Heat balance of the R process.

The heat losses due to cooling are far lower in R engines. It is proposed to draw up heat balances under various operating conditions by accurate measurements, in order to explain the cause of this phenomenon. The test instruments are being developed.

d) Tests on the combustion process.

The combustion process in R engines is not yet sufficiently clarified. A test cylinder has been constructed which allows the combustion chamber to be observed through windows or investigated by ionisation measurements. These methods may also be used for the general study of combustion processes. The test stand is not yet fully equipped but the instruments are ready.

3) GM 1 Process.

a) Properties of the GM 1.

Report 529 contained a collection and critical discussion of all data appearing in the technical literature. Relatively little is known on the thermal and calorific properties of this fuel; P.V.T. measurements are therefore carried out between melting point and 200°C and up to 100atm. in an instrument of new design. Throttle tests must also be carried out. All data of practical interest can be computed from these tests.

b) Engine tests.

In its practical use GM 1 is injected as a liquid into the boost air, with the result that the knock characteristic is simultaneously affected by GM1 and by the temperature drop. It was found by tests that addition of GM1 reduces the knock tendency independently of the temperature drop. The tests are almost concluded.

4) TL fuels.

TL power units make demands on fuels quite different from conventional engines. It is probable that cheaper fuels may be used, as long as they meet the requirements which are mainly short combustion time and deposit-free combustion. Until a complete combustion chamber is available preliminary tests must be carried out on fuel burners.

II. Lubricants.

A. Lubricant tests on engines.

1) Ring sticking test on BMW 132.

The normal production of synthetic lubricants as well as the development of lubricants for special purpose of our works are tested by single cylinder endurance tests. Two test stands are ready for the purpose.

2) Small engine tests.

Ring sticking tests on BMW 132 are long drawn out and costly it should therefore be attempted to investigate ring sticking on small engines. Tests carried out on a I.G. test engine promise well but they still need further development.

3) Piston temperature measurement.

In ringsticking it is very important to check the piston temperature and special equipment was developed for the purpose. It is at present undergoing tests.

4) Sludge determination.

Not only ringsticking but also the observations of sludge and fouling are necessary closely to characterise aero engine lubricants. Centrifuges and filters are ready but the tests have not started yet.

B. Tests on laboratory equipment.

1) Low temperature lubricant tests.

The I.G. cold chamber and the Schweiger viscosimeter are used for the routine testing of development samples. A new instrument now being tested was developed to test greases at various rates of shear. A device was fitted in a I.G. cold

chamber to test the pump ability. A new arrangement which should very closely reproduce present practical conditions is being developed.

2) Friction and wear tests.

Beside the four ball machine and the Wieland-Almen machine, equipment of own development, e.g. the chain machine, is used and continuously improved. The tests cover mainly weapon and gear oils or additives to improve the quality of oils. In these tests the influence of surfaces of different nature is also considered.

3) Tests on sludge and foam formation.

To extend the engine tests it is necessary to develop apparatus for evaluating sludging and foaming tendencies. This work is in progress.

4) Tests of oil for metal machining.

Drilling and cutting oils having a great importance for metal machining were tested in the above mentioned instruments. An apparatus permitting the direct observation of the effect of these oils on a cutting tool is in development.

5) Test on lubricant drainage.

Daimler-Benz state that recently they have often observed lubricant drainage from bearings and cylinder walls of engines, which causes damages. This was thoroughly investigated by drainage tests, described in reports 360 and 364. The tests must be continued in order fundamentally to clarify the drainage of surfaces wetted with lubricant.

6) Measurement of the specific heat of oils.

An instrument was developed to measure the specific heat of oils by electric calorimetry. This instrument, mainly used up to now at room temperature, must be improved to allow low and high temperatures (up to 200°C) measurements.

III. Coolants

Report No. 528 described the cooling properties of glycols and oils in comparison to water. An instrument permitting exac determination of the heat transfer conditions is being produced.

RAB/ 25th. June, 1946.