REPORT ON TESTING MILITEC-1 IN A CITROEN ENGINE
TESTED BY UNIVERSITY INSTITUTE OF TECHNOLOGY, UNIVERSITY OF PARIS

Translation from the French -Note that MILITEC-1 is marketed in France under the trademark "96"---Graphs are available: Comparative Engine Power Test, Comparative Fuel Consumption Test

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Testing Agreement

Concluded November 17, 1992

Between: Dufour Pere, Fils & Cie.......
Represented by Mrs. Despointes

And: The University of Paris X
University Institute of Technology
of Ville d'Avray
Center for Continuing Training

Represented by the Director of the Center for Continuing Training, M.P. Peijus.

Objective: Characterization of the effectiveness of an oil additive for lubrication named "96", at the time of its employment in a four-cycle ignition engine, under the responsibility of P. Rochelle, Conference Master, in charge of the Thermal Engines laboratory of the Thermal and Energy Engineering Department of the Institute. This characterization will be in accordance with the testing program detailed in the technical annex.

Agreed terms from the Thermal Engines laboratory:

- bench testing of a four-cycle ignition engine.
- supply of all fluids except the additive "96" which will be supplied by Dufour.
- provision of a technician for the tests and the specific tasks on the engine (oil change....)
- provision of a researcher for the implementation and the analysis of the results.
- analysis of the oils, undertaken graciously by the company SNECMA (see technical annex).
- submittal of a copy of the test papers.
- submittal of an analytical report of the tests.

Maintenance and responsibility

The maintenance running the bench testing is assured by IUT.

Dufour takes charge of the coverage of risk relative to accidents and damages caused by the testing within the limit of recommended application. Dufour commits, in case of accident, to return materials and equipment to satisfactory condition in the shortest time.

Testing period

The testing times are defined in the technical annex. The characterization tests will be done in accordance with the availability of the test bench, used also by others for workshops which have priority. These should not take longer than 3 months.

Completed November 17, 1992
in two copies
The Director of the Center for Continuing Training of the IUT of Ville d'Avray.

I Objectives

These tests are to put in evidence the effect of the utilization of a lubrication additive, named "96", on performance (power, consumption) as it evolves, of a thermal automobile ignition engine (1360 cm3 cylinder displacement).

II Methodology

The Citroen engine K1G, completely broken in, has been tried without the additive at different intake pressures (300 mmHg, 450 mmHg, 600 mmHg and fully open) and at different RPM levels. This test (see reference sheet AXBIS5) is considered as being that which gives us reference values after the normal corrections of power and of torque permitting the gathering of performance data under standard test conditions (using an ambient pressure of 760 mmHg and an ambient temperature of 15oC).

The additive has been added to the lubricating oil in the ratio given by the supplier, from a bottle (8 ounces) for the contents of the crankcase. The new performance data have been taken after 1 hour, 5 hours and 25 hours of operation with the additive. The corresponding data are put onto the test papers that have the corresponding references AXBIS7, AXBIS9, AXBIS11. The calculated results are put onto the sheet SYNTH96N; they include the time of operation with the additive (in hours), the speed of rotation N (in RPM), the intake pressure _____ (in mmHg), the hourly consumption (in liters per hour), the corrected torque (in Newton meters) and the corrected average pressure (in bars).

The specific consumption is a measurement used by motorists to express the effectiveness with which the consumed fuel has been transformed into effective power; it is an inverse measurement proportional to the output of the engine and, in this manner, it is particularly representative of the effectiveness of a modification of this or of the conditions of operation (use of an additive in our case). The average effective pressure is equally a measurement used by motorists; it is proportional to the torque supplied by the engine.

When one studies the performances of an engine, it is interesting to get to know it at full load, but it is equally indispensible to know it at partial loads, at which the engine is most often employed. As a result, we have traced a complete ensemble of curves, analyzed later, capable of representing the immediate performances of the engine and their evolution.

III. Means of testing and precision of measurement

In order to complete these tests we have used a bench equipped with a Foucault air brake cooled by air. The torque reading must be corrected from the ventilation torque (cooling of the brake). The uncertainty of the torque can be broken down into a systematic possible margin of error of 1 Nm for each series of pulls and an uncertain reading error margin of 1 Nm. The speed of rotation is measurable in increments of about 25 RPM. The consumption timeframe is measurable in increments of about 0.5 seconds. The above measurements are those utilized to calculate power, average effective pressure, hourly and specific consumption. The errors committed are calculated within the possible extremes:

- from 0.6 kW at low power up to 1.3 kW at high power;
- from 10 g/kW.h on specific consumption at high power up to 25 g/kW.h at low power,
- from 0.2 bars on average effective pressure.

The difficulty of these tests to put in evidence the improvement, light in general, brought about by the use of an additive appears clearly here, because the errors committed in measurements obtained with a classical test bench have values similar to those of the differences to detect. Consequently, one will be led to a statistical confidence in the obtained results in making the hypothesis that the relative volume of uncertain errors is clearly above that of systematic errors.

IV Analysis of results

IV-1. evolution of specific consumption and of power at full load. (fig. 96PCSPO)

On this graph, 2 series of curves are traced;

- The curves of power as a function of the speed of rotation after 1 hour, 5 hours and 25 hours of operation with "96"; with 0 hours being the reference curve without "96".
- The curves of specific consumption as a function of the speed of rotation after the same duration of operation as above.

With the uncertainties of measurement (estimated at 10 g/kW.h for the specific consumption at high power and up to 25 g/kW.h at low power) one can state:

- the power of the motor is stable or slightly degraded after one hour of operation with the additive "96"; an improvement of 3 to 4 percent as compared to the baseline (0 hours) is obtained after 5 hours and maintained after 25 hours.
- specific consumption climbs by 5% after the first hour of operation with the additive, which translates into a reduction of output, but falls back down to the baseline values after 5 hours and decreases to 6% (N=4800 RPM), measured against the baseline, after 25 hours of operation. The average improvement in specific consumption is of the magnitude of 4% across the full RPM range.

IV-2 evolution of specific consumption as a function of the fixed speed of rotation (fig. 96CS27 to 96CS54)

each series of curves describes the evolution of specific fuel consumption as a function of the average effective pressure for a fixed speed of rotation, at the start (without the additive) then after one hour, 5 hours and 25 hours of use with the additive "96". Some common characteristics for all of the series can be broken out:

- a gain of specific consumption is systematically shown between the reference curve (0 hours) and the corresponding curve obtained after 25 hours of operation with "96". It is generally the case with the curve obtained after 5 hours but the difference is clearly less noticeable and falls within the margin of error. This gain after 25 hours can reach 20 g/kW.h (5400 RPM at high load) but is most often of a magnitude of 10 g/kW.h.
- at high load one can see a systematic increase in specific consumption after one hour of operation with "96" followed by a progressive decrease until after 25 hours; it is not certain that the effect of "96" is already completely acquired [bonded?] at high load at this limit;
- at low load, this tendency does not appear; the values obtained after 5 hours and 25 hours are for the most part quite close: the complete effect of "96" would already be obtained at the end of 5 hours.

IV-3 Calculation of the results obtained taking into account the margins of error.

With the values of uncertaintly expressed above, it is certain that the comparison of the data obtained with and without the additive is difficult since the margin of error of the curves is mixed; however, the fact that the errors can be considered for the most part as uncertain and that the curves of specific consumption after 25 hours of operation with "96" are systematically below those of the baseline, one can assure without risk that the addition of the product "96" brings about an overall improvement of specific consumption and equally of power at full load since, for this, similar statements can be made. From the fact of the mix of the margins of error, it is impossible to calculate exactly these gains; one can however place them in a fork of 10 to 15 g/kW.h for specific consumption, being a gain reaching 5%, and of 1 to 2 kW for the power at full load, being a gain reaching 4%.

IV-4 Attempted explanation of the results obtained

Supposing that the additive has an action that is limited to modifying the characteristics of the engine associated with its lubrication, knowing to modify its torque of rubbing and consequently its average pressure of rubbing (p.m.f.), a reduction of the p.m.f. will be linked to an identical increase in the average effective pressure. This increase, for thermodynamic conditions maintained at a constant and a constant hourly consumption, will be associated with an increase in the power and a reduction of specific consumption in identical proporations; it is that which we have approximately shown at high load (4% and 5%). At low load the relative uncertainties are more important and impede putting into evidence with certainty this type of relationship.

We have attempted to detect this modification of average pressure of rubbing utilizing the Willan method. This method consists of tracing the curves of hourly consumption as a function of the average effective pressure at a constant rotation speed and to obtain, by extrapolating the obtained curves, the average pressure of rubbing. The utilization of this method is reputed to be very hazardous for ignition engines and gives only values approaching the p.m.f.; we have found an average value in the magnitude of 2 bars but the dispersion of the individual values does not effectively permit putting clearly into evidence a reduction of the p.m.f. between the series of curves "0 hours" and "25 hours" (fig. 96CHN0H and 96 CHN25H).

V-Conclusions

The use of the lubrication additive "96" brings about an improvement of consumption and of power reaching 4% after 25 hours of use. This can be attributed to a reduction of the torque of rubbing due to an improvement of the lubricity of the lubricated parts in relative movement. It can be seen at the start of using "96", after about one hour, a slight degradation in performance followed by an improvement, already clear after 5 hours of use. Some additional tests are desirable in order to follow the evolution of the effect of "96" with time (after fifty hours of use, for example).

Done at Ville d'Avray, January 13, 1994