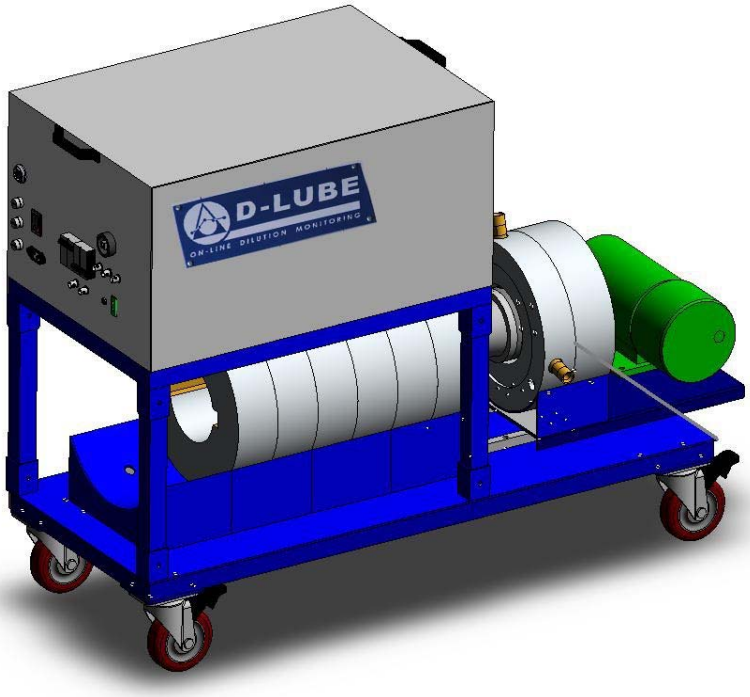
Delta Services Industriels

D-LUBE

REAL-TIME MEASUREMENT OF FUEL DILUTION ON I.C. ENGINES



TECHNICAL BROCHURE

INTRODUCTION

On-line measurement of oil dilution is of interest in light of new environmental regulations imposed on today's high-performance engines.

In particular, after-treatment devices such as diesel particle filters (D.P.F.) need to be periodically re-generated in order to eliminate their soot content. Such re-generation process is typically performed by using post-injection cycles that can induce a transfer of fuel to the lubricant, resulting in oil dilution.

Oil dilution has a negative impact on engine wear parts such as bearings, camshafts, cylinder sleeves, etc.

A new methodology was recently developed by D.S.I. sprl and TOTAL France for monitoring oil dilution on running engines. It is based on lubricant labelling using a new radiotracer compound, which is representative of lubricant.

Bearing Wear caused by oil dilution

MEASUREMENT PRINCIPLE

D-Lube operating principle is based on a patented methodology. As first step, engine oil is labeled using a radiotracer compound, which is directly added in the engine.

During engine operation a small volume of the engine oil is circulated continuously into a measuring chamber where specific activity of the oil is monitored.

The fuel dilution measurement consists in monitoring the signal (gamma-rays) emitted by the radiotracer, and in converting any variation in terms of oil dilution. Temperature effects are corrected automatically.

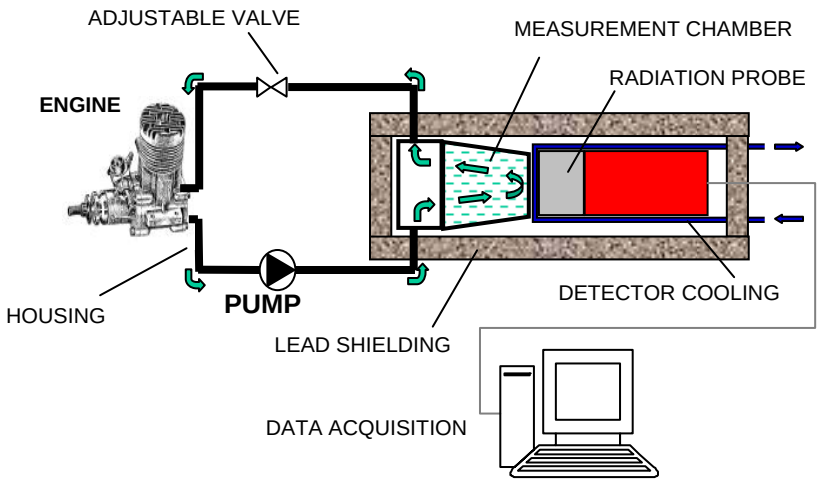


FIG.1: OPERATING PRINCIPLE

The methodology applies to both gasoline and diesel engines for optimisation of cold start procedures, for the development of post-injection strategies and evaporation cycles.

D-Lube offers significant advantages over other methods:

- **On-line / Real-time results**: Oil dilution is monitored continuously during engine operation, at a rate of 1 measurement per minute.

- **Short Test Durations**: dilution rates are accurately measured within short runs from <1 hour to max. 4 hours, depending on dilution rates. i.e. a rate of 1% per hour is accurately measured within 1 hour.

- **High sensitivity:** sensitivity is of 0.05% per hour (in terms of dilution rate).

- **No change in oil properties:** Less than 100 µl of tracer is added to the engine oil pan. It does not interact chemically with oil and additives.

- **Equipment is easy to install**: Oil is sampled directly from the sump at a rate of ~1 litre per min. Two hoses are easily connected between the engine and D-Lube equipment.

- **Applicable on test rigs and on vehicles**. Our standard equipment is dedicated to test bench applications. A compact version is also available for on-board installation on passenger cars and HD vehicles. It includes a data logger for acquisition during road tests.

Fig. 2: Standard D-Lube equipment for test rigs and R&D centres

EXAMPLE: REAL-TIME FUEL DILUTION MEASUREMENT

Hereunder is a typical set-up of D-Lube equipment in a test cell. Oil is sampled from the engine sump and it is circulated in the measuring device. Two ½ inch hydraulic hoses are installed between the engine and D-Lube system.

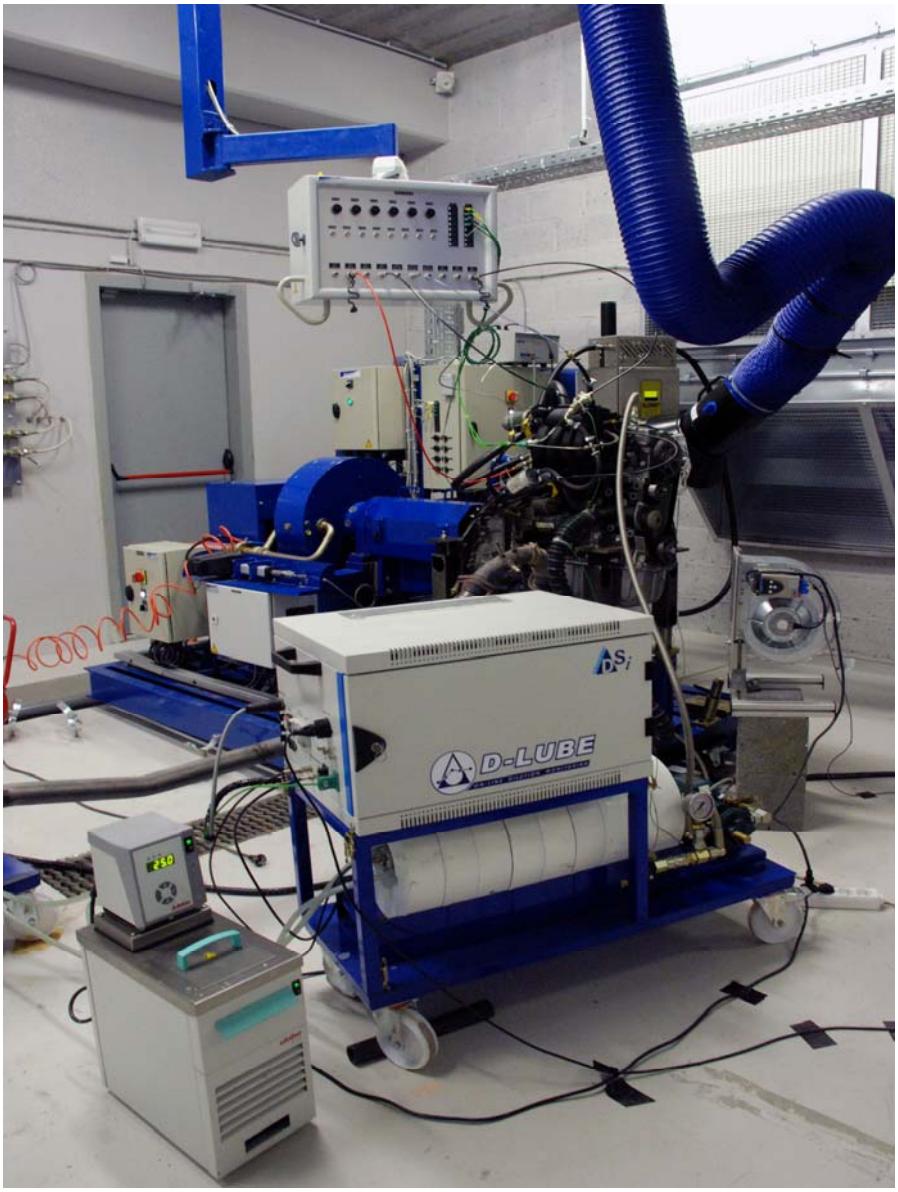


Fig 4. D-Lube installed in a test cell for real-time fuel dilution measurement on an I.C. engine

The graph hereunder shows typical on-line results obtained during successive dilution and evaporation phases performed on a passenger car diesel engine. The red curve shows oil temperature (right Y axis) and the blue curve the dilution level in %.

During a first run (t=0.5 to t=2h), the engine was operated with post-injection cycles for re-generating the after-treatment system. The selected post-injection cycles induced a high dilution level of ~8 % after 1 ½ hour operation.

During the second phase (t=2h to t=22h) post-injection cycles have been stopped and the engine was operated at nominal oil temperature (~85°C) in order to study evaporation. Selected operating conditions allowed evaporating partly the diluted fuel, at a low rate of ~3 p.c. within 20 hours.

The next steps consist in a new dilution cycle (22h – 24) followed by a new evaporation phase (24-44h). One can see that evaporation rate is higher in this case, because of the highest initial oil dilution value (12.5% instead of 8% during the first evaporation phase).

Such engine tests can be repeated with specific engine parameters that reduce oil dilution (improvement of injection strategy) and enhance fuel evaporation (i.e. increased oil and water temperature).

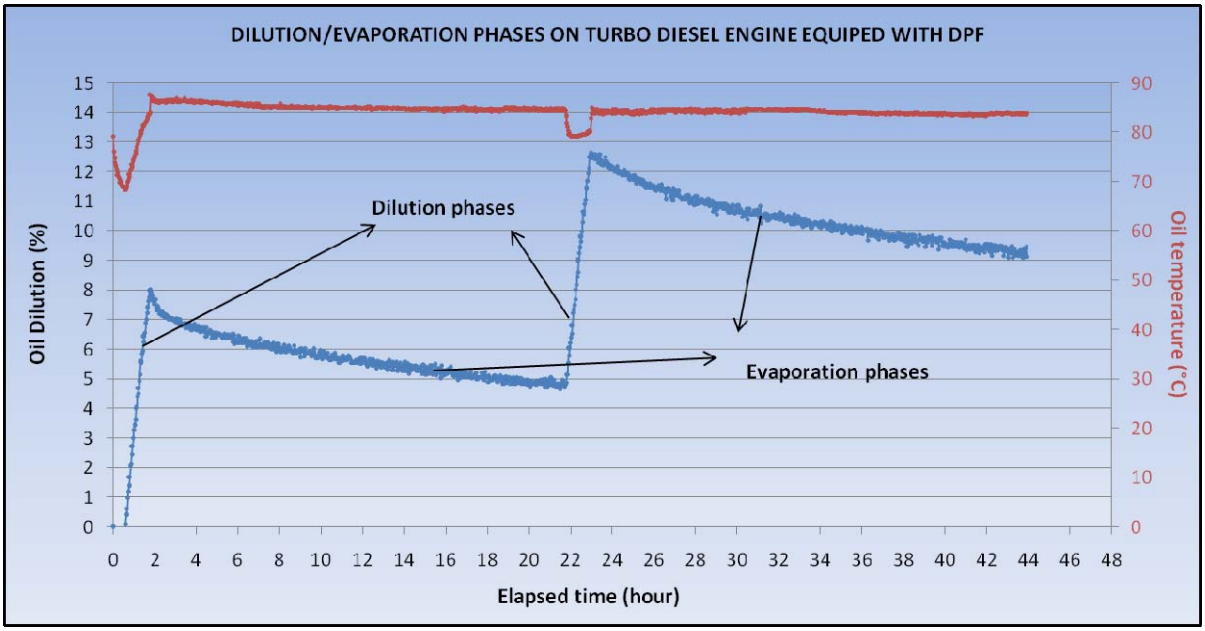


FIG.5 : ON-LINE FUEL DILUTION AND EVAPORATION MEASUREMENT ON A DIESEL ENGINE

D-Lube equipment reduces significantly the time needed for optimizing post-injection strategies, thus reducing development costs.

Therefore:

D-Lube is the right tool for studying the impact of engine parameters and post-injection strategies on the dilution process.

The main benefits associated to the radiotracer method are:

- Results are available on-line, during engine operation;
- It offers an high sensitivity of ~0.05% per hour (in terms of dilution rate);
- It offers an excellent discrimination between fuel and lubricant, which is the weakness of the GC method where superposition of the heavy fuel fraction and the light oil fraction can induce uncertainties;
- It can be combined to other radiotracer methodologies to study the impact of dilution on wear of critical components such as bearings, camshafts, etc.

For more information on this product: **SAE paper ref. SAE 2005-01-2170**

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