

Final Report
LuBest Project



LuBest Project

Final Report

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| <i>Dissemination level</i> | | |
| PU | Public | |
| PP | Restricted to other programme participants (including the Commission Services) | |
| RE | Restricted to a group specified by the consortium (including the Commission Services) | x |
| CO | Confidential, only for members of the consortium (including the Commission Services) | |

APPROVAL

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Subject: Final Report for the LuBest project

Through the whole project, the objectives for the LuBest project between Techspace Aero (TA) and ULB-ATM have regularly been reviewed and finally approved between the different parties. All objectives are fully reached at the end of the project, even if with some delay¹ compared with the original timetable of the complete project. The project duration had been finally fixed at 51 months with an end date on 30 June 2015.

The main achievement is the availability of an updated test bench (called ATM-01) with a capacity for pure oil testing and a capacity for two-phase air-oil flow testing at a TRL5 / TRL6 level, depending on the lubrication system components to be tested.

The global objective of LuBest was to evaluate the technical feasibility of an upgrade of the oil flow test bench ATM-01 of ULB to an oil pressure of 27 bar and an oil temperature of at least 200°C with the standard Jet Oil Type II or an upgraded oil standard.

This had to be done for pure oil flow conditions and also for the challenging air-oil (two-phase) flow conditions representative of real aero-engine lubrication systems of new and future turboprops, turboprops and turboshafts. This final report relates the upgrades done for the ATM-01 test bench and the validation results obtained in the LuBest project.

The basic document for the LuBest project description is the technical specification document « 57DV184795.9003 » issued by TA to the attention of ULB-ATM.

In the previous reporting periods, the following tasks have been performed:

- New design of the test bench and selection of the components to increase the capabilities (oil pressure and temperature) of the test bench ATM-01 in order to run tests with a higher level of the oil (counter) pressure to mimic the behavior of the recent aero-engine developments in pure oil conditions.
- Implementation of this 1st upgrade in order to run some characterization tests and some endurance tests of aero-engine oil pumps in these updated pure oil conditions. All hardware and software modifications of this phase of LuBest have been implemented by ULB-ATM, after formal approval by TA. First real characterization tests in these updated working conditions have been successfully run on the upgraded ATM-01 test bench.
- Preparation of the 2nd update of the ULB test bench for an air-oil mixture at the entrance of the pump (type “scavenge pumps”) instead of pure oil (type “feed pumps”) in a large range of well-controlled air-oil ratio hot mixtures. This has been discussed between TA and ULB-ATM, the technical specifications fixed,

¹ This delay was due to the long discussions needed to take the final decision on the upgrades requested for the test bench and to fix the related test conditions.

the test plan discussed, fixed and approved and all technical upgrades proposed by ULB-ATM have been approved by TA.

During this last reporting period until month 51, we finalized the project by doing:

- Complete implementation of this 2nd update of the ATM-01 test bench for two-phase flow working conditions. This 2nd upgrade of the ULB ATM-01 test bench is intended to perform characterization and endurance testing of any type of new / innovative aero-engine scavenge oil pumps with a well controlled two-phase flow at the entrance of the pump.
- Extensive validation tests in two-phase flow working conditions at high oil temperature and counter-pressure with current state-of-the-art aero-engine lubrication pumps have also been performed during this final period of the project (see also D2.3 report).

The works performed in this final reporting period are now detailed.

Figure 1 shows the final implemented hydraulic scheme of the upgraded test bench ATM-01, capable to work at an oil pressure of 37 bar and an oil temperature of 205°C, with new electric oil heater and new high temperature oil mass flow meters.

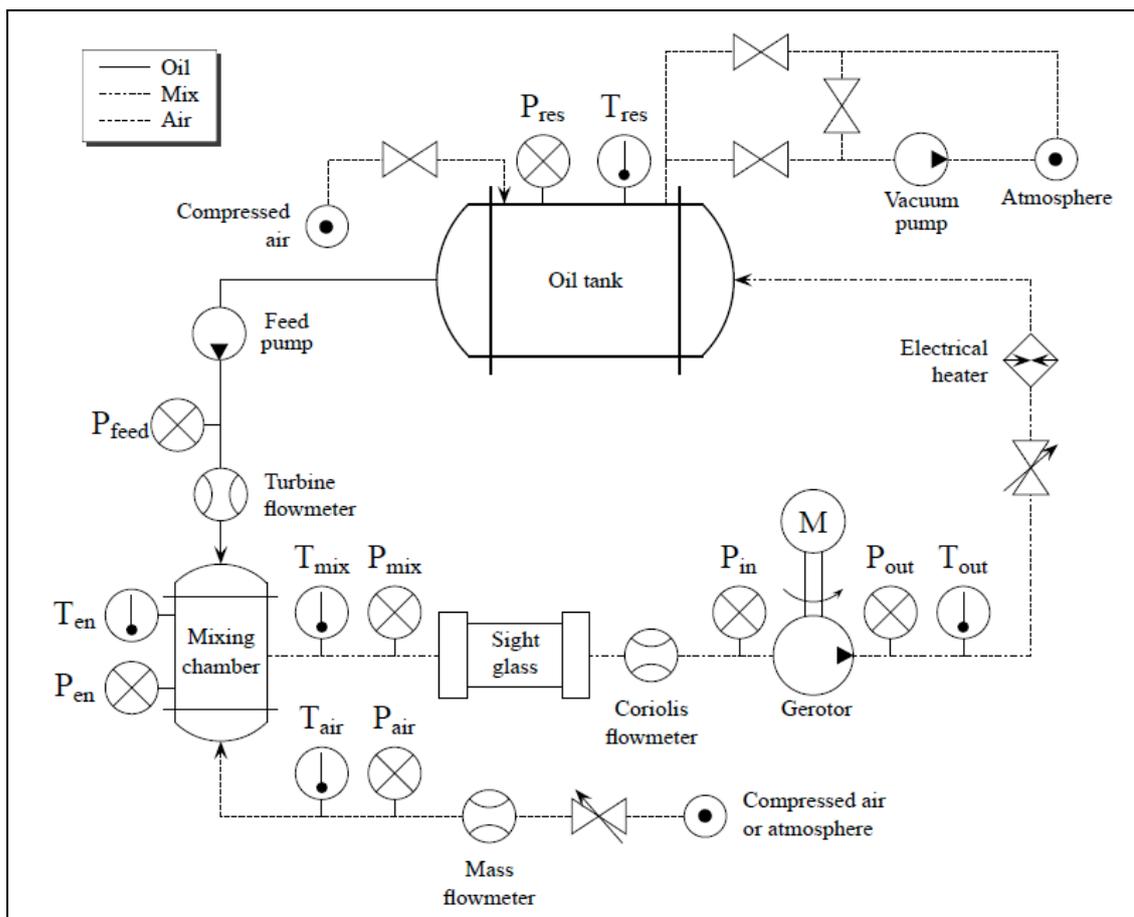


Figure 1 – New hydraulic circuit scheme for two-phase oil+air flows

To test the quality and in accordance with the TA specifications of the new ATM-01 test set-up, an extended test campaign has been realized at the end of the final reporting period by ULB in these new two-phase flow conditions.

The main parameter to characterize a pump is its efficiency, defined as the ratio of the measured flow rate over its theoretical flow rate.

During the characterization tests of the pump in the new two-phase flow conditions, on top of these volumetric pump efficiency measurements, a check was done, at the same time, to observe:

- The stability of the operating conditions;
- The accuracy and reproducibility of the measurements;
- The feasibility to obtain the right mixture of oil and air flow;
- The feasibility to control a fixed ratio air/oil;
- And the feasibility to warm up the mixture of oil and air.

These validation tests were performed for two different values of the rotation speed of the pump, for a fixed oil temperature and a fixed air/oil ratio. The oil pressure at the inlet and outlet of the pump (referred as PA1 and PA2 in Table 1) are variable parameters. These tests were performed several times to test the reproducibility of the measurements. Table 1 summarizes the two-phase flow test working conditions.

| N_{pump} (rpm) | PA1 (kPa) | PA2 (kPa) | Oil temperature (°C) | Air/Oil ratio |
|-------------------------|-----------|-------------|----------------------|---------------|
| 4500 and 5250 | 120 | 200 and 350 | 117 | 1,3 |
| 4500 and 5250 | 80 | 200 and 350 | 117 | 1,3 |
| 4500 and 5250 | 50 | 200 and 350 | 117 | 1,3 |
| 4500 and 5250 | 35 | 200 and 350 | 117 | 1,3 |
| 4500 and 5250 | 20 | 200 and 350 | 117 | 1,3 |

Table 1 – Two-phase flow test conditions for the final LuBest pump testing

These validation tests have been performed very successfully and without any technical problems on the ULB-ATM test bench in these new two-phase flow conditions. This means a quite significant upgrade for the ATM-01 test bench of ULB and mainly for its industrial users who want to characterize state-of-the-art and innovative lubrication system components and to accelerate their process in qualifying and certifying these products for aero-engine manufacturers. These two-phase flow test results are further described in Deliverable D2.3.