Periodic Report Summary:
ELUBSYS (Engine Lubrication System Technologies)

Abstract: Project context and objectives:

The overall objective of project ELUBSYS is to research, develop and validate a new architectural approach towards the design of high-performance aircraft lubrication systems with the aim of reducing fuel and oil consumption by focusing on four key goals:

1. Reduce the air bleed with high performance seals and improve thermal management of housings.
2. Reduce the oil quantity rejected overboard by 60 %.
3. Reduce mass of lubrication system.
4. Improve the oil quality monitoring.

Project results:

WP1 - Advanced brush seals for bearing chambers

The MTU rig used to measure performance of Kevlar and steel made brush seals and observe flows in scavenge pipes via a high-speed camera and including measurement of the rotor temperature at the bristles contact zone using a pyrometer has been defined. The tests will start in February 2011.

The adaptation of SN rig to measure the endurance of carbon brush seals and measure geometrical/physical parameters' influences on seals performance including new instrumentation (thermocouples, pyrometer) is in progress. Tests are planned to begin in February 2011.

RRUK had to perform a Computational fluid dynamic (CFD) model and a thermomechanical model of a real engine Tail bearing housing (TBH) namely to check effect of brush seal compared to labyrinth. Meshing and analysis with a Discrete phase model (DPM) has been carried out. ITP is developing a thermomechanical Finite element method (FEM) model of a real TBH and has delivered preliminary inputs for RR CFD models.

FIT is modelling flow in scavenge pipe with brush seals and vent pipes removed. Following tasks have been performed: a two phase flow simulation survey and literature

analysis, numerical results from the CFD simulations including a sensitivity analysis either for straight and curved pipe segments and a parametric investigation regarding heat transfer between pipe's wall and two phase mixture for various air-oil volume fractions.

WP2 - Bearing chamber flow and heat transfer

UNIKARL and RRD have agreed on geometries, air and oil flow conditions, test plan and bearing chamber design of the scavenge and vent port performance rig. The rig is commissioned and testing has started.

For the modelling of bearing chambers, prototype code of commercial CFD using physical models such as Volume of fluids (VOF) and Euler / Euler are currently tested by RRUK and Smoothed particles hydrodynamics (SPH), are applied by UNOTT to simulate the complex two-phase flow and account for the high proportion of oil (up to 80 % by volume). Progress on technical challenges such as representation of wall boundary conditions, density and surface tension has been achieved. At RRD, the focus of work was on an efficient procedure to import engine typical three-dimensional (3D) geometry data from Computer-aided design (CAD) into CFD, including meshing procedure. Oil interruption tests will be carried out on a test rig at TM. The results will be used to validate the transient thermal models of the bearing, housing casing and shaft that are developed by INSA. So far the achieved tasks are:

- start of analysis and modification of BEDALE software used to calculate power losses in Rolling element bearings (REBs) including CFD analyses. Coupling between BEDALE and thermal network;
- definition of high speed ball bearing test rig to analyse power losses and temperature rise including bearing friction torque measurements.

WP3 - Externals

SN has prepared specifications taking into account advanced sealing as well as ambitious objectives on oil consumption reduction. Based on this, TA has defined a test plan to study influence of supply systems (air concentration in inlet oil, supply pump and inlet circuit pressure drop) on the oil pump performances. The ULB test rig has been modified accordingly. A gas concentration measuring device has been developed by ULB & TA. Test campaign has started.

Progresses on simplified scavenge architectures driven by the main goal of mass reduction:

- WSK has completed the design of a light and reliable scavenge system using a single oil pumping element to ensure oil evacuation from two separate bearing chambers simultaneously. Test rig modifications and instrumentations are nearly finished. Test plan is under review and testing will take place in 2011.
- MTU has created a two phase one dimensional tool for calculating an ejector pump to replace the set of volumetric pumps and is currently finalising its design.

WP4 - Oil quality and coking

SN has provided to partners data's on physical and chemical changes during ageing of Mobil Jet II as the reference oil, and BP2197 as a high capability one.

USFD has commissioned the Lubricant system interaction test facility (LSIS) (with the

help of RRUK) to perform chemical analysis of ageing lubricant including development of a 0D computer package for modelling oil behaviour.

Development o following oil health sensors are in progress: Optical particle detector (OPD) and near-infrared (NIR) water content sensors by TK, magnetostrictive sensor by laboratory scale and Quartz micro balance (QCM) sensors UMons. OPD and NIR are ready to start with the validation tests in hostile environment (oil and temperature) at ULB facilities. Development of anti-coking coating started at USFD and UMons. They can be applied for testing purposes with the LSIS test facility.

WP5 - Scientific coordination and benefit evaluation

WP5 is dedicated to the scientific coordination of the project and the evaluation of benefits achieved by the project. 0D model in EcosimPro started to perform comparison between the performances of the current architectures and the new ones developed in ELUBSYS will allow assessing the gains brought by these improvements.

Potential impact:

At this stage of the project, expected results from the overall innovations in Elubsys can yield a reduction of: 0.7 % in fuel burn, 60 % in oil consumption and 4-5 % in direct operating cost. The objectives and results targeted for the ELUBSYS project will produce significant technological advances for Europe in term of competitiveness (reduced fuel flow and maintenance costs) and reliability in the area of lubrication for aircraft engines which will fully support the needs of future engine generations.

Subject Descriptors: Transport; Civil engineering

Subject Index Codes: Transport; Construction Technology

Collaboration Sought: N/A

Remarks: Source: SESAM