Influence of oil level on gearbox thermal behavior: application to a helicopter tail gearbox

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Oil level value is of primary importance on thermal behavior of oil sump lubricated gearboxes. In this study a thermo-mechanical model of a helicopter tail gearbox is presented. The numerical model is based on the thermal network method and takes into account power losses due to teeth friction, rolling elements bearings (*REB*), seals and oil churning. Some calculations underline that a major part of heat generated inside the gearbox comes from pre-loaded *REBs*. Moreover, the predicted *REB* temperatures appear to be very sensitive to the oil volume introduced in the gearbox.

Keywords: helicopter gearbox, mechanical transmission, power losses, heat generation, thermal behavior

1. Introduction

In mechanical transmission lubricant is used mostly for two reasons: (i) to separate the contacting surfaces and (ii) to cool down the parts while operating. In helicopter tail gearboxes due to mass considerations heat exchangers are not used (Fig. 1). The whole heat generated is evacuated "naturally" from housing to external environment. Thus, in the context of optimizing temperatures of oil bath, rolling-element-bearings (*REB*) and gears, oil volume introduced in the gearbox is of primary importance.

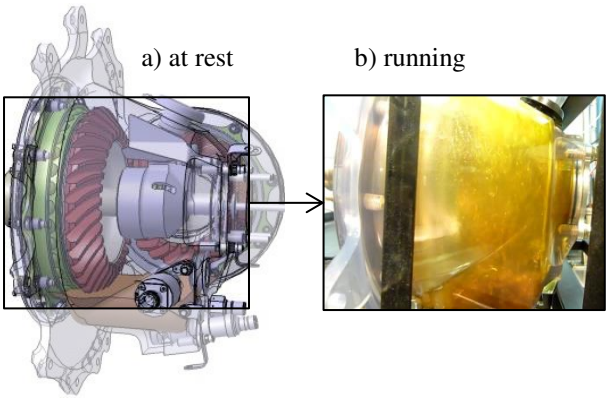

Fig. 1 Oil flow inside the oil sump lubricated gearbox

A clear understanding of the heat generation and lubricant cooling mechanisms is therefore required to reach a compromise between a sufficient lubrication and cooling capacity. There are various sources of power losses inside gearboxes (gear meshing, gear churning, *REBs*, seals, etc.). Their levels depend on bulk temperatures of elements, especially in *REBs*. Besides, some heat sources are thermally connected. Therefore, a thermal network can be used to model this type of gearbox as this is done for other ones [1,2].

2. Results

In this study, a model to predict temperature distributions in a helicopter tail gearbox is presented. Numerical results are compared with experimental ones [3]. It is found that a major part of heat generated inside the gearbox comes from pre-loaded *REBs*. Moreover, the predicted REB temperatures appear to be very sensitive to the oil volume introduced in the gearbox (Fig. 2).

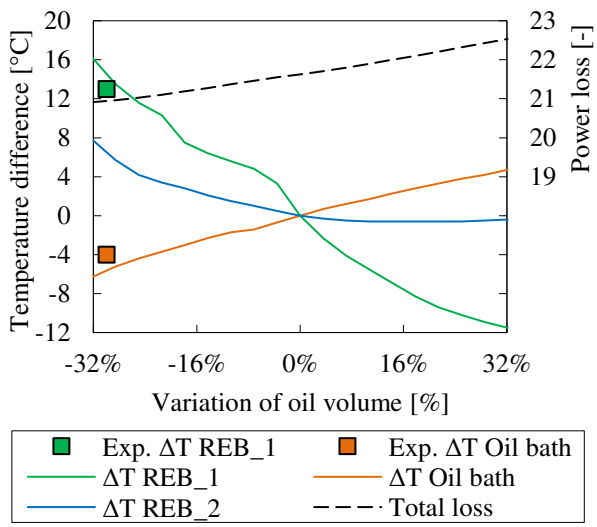

Fig. 2 Evolution of total loss, oil bath and REB temperatures versus oil bath volume

3. References

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