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EXPERIMENTAL INVESTIGATION OF THE HIGH-SPEED ROLLER BEARING ASSEMBLY LUBRICATED BY OIL MIST

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High speed bearing assemblies have been always challenging in terms of the heat removal and bearing lubrication. Evolution of these lubrication systems led to the oil-mist concept, which consists of the air under high pressure, together with oil droplets. Too high pressure combined with too much of oil would cause the additional resistance to the rolling elements' movement, while the low pressure with the small amount of oil wouldn't be effective in terms of the heat removal and lubrication. In this paper, it is analysed the influence of the air pressure and the amount of oil onto the bearings' temperature.

Keywords: *high speed bearings lubrication, oil mist lubrication.*

1. INTRODUCTION

For the high speed machines are typically taken the ones with rotational speed over 20,000 rpm. Some of the most common high speed assemblies are turbochargers (80,000 to 200,000 rpm), or jet engines (up to 150,000 rpm). The unit under test (UUT) of this paper is the subassembly of the turbo-jet engine, which runs on 60,000 rpm. For the bearings that operate on such high speeds, oil lubrication provides too dense environment, which results in high resistance to motion of the rolling elements. This consequently causes the temperature increase which can lead to the bearings malfunction. Hence, the alternative methods of lubrication are used for the high speed assemblies [1]. Some of the most common methods are the oil-mist lubrication [2], which combines the highly pressurized air mixed with oil droplets, and oil air lubrication [3]. The role of the air is to take away the heat generated by the friction between rolling elements and raceways, while the oil droplets lubricate the bearings. Determining the optimal air pressure and amount of oil is crucial for optimal bearing operation. In this paper there are presented the results of the experimental investigation of the high speed roller bearings lubricated by oil mist, combining different air pressures and amounts of oil. The effectiveness of the oil-mist lubrication depends on the rolling element material [4].

2. EXPERIMENT SETUP

The experiments are performed on a jet engine, on the regime of 45,000 rpm (3/4 of the full regime). During these tests, many parameters were measured (Fig. 1).

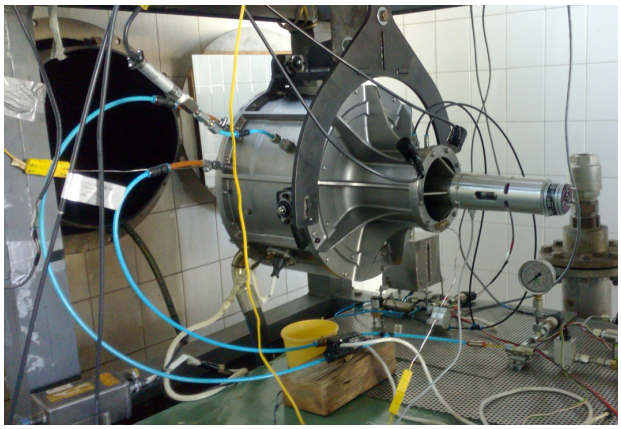

Figure 1. Test rig

The vibration of the whole assembly, by means of accelerometers, exhaust temperature and bearings temperature, air pressure, gasoline flow etc.

The key parameters for this analysis are the air pressure and oil contribution in oil mist, and the temperature measured on the support consisted of 3 angular contact ball bearings (Fig. 2). This support takes both, the radial and the axial load, which makes it more loaded support if compared to the other one. The objective was to find the optimal air pressure and oil amount, in order to decrease the bearing temperature as low as possible.

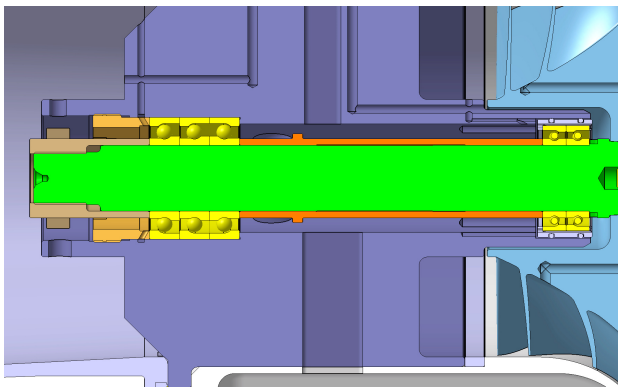

Figure 2. Cross-section of the UUT

3. RESULTS AND ANALYSIS

The test duration was approximately 3 minutes, unless it came to the unexpected heating of the bearings. In that case, the test was stopped immediately.

Some of the results are presented on Figure 3, showing that the best performances are obtained for the air pressure of 3 bar and oil amount of 1 drop/s.

Previous tests (not presented in this paper) showed that air pressure below 2 bar led to an increase of the temperature. The same happened for the tests with the air pressure of 4 bar and above. If speaking of oil amount, 2 drop/s showed worse results then the tests with 1 drop/s, for the same air pressure.

Analyzing the results, it is concluded that too high air pressure as well as too much of oil causes the increase in resistance to movement of the rolling elements, and consequently, the increase in temperature.

On the other hand, having low air pressure and low amount of oil, makes lubrication and heat removal insufficient. The optimum parameters for the UUT, determined experimentally, are air pressure of 3 bar and oil amount of 1 drop/s.

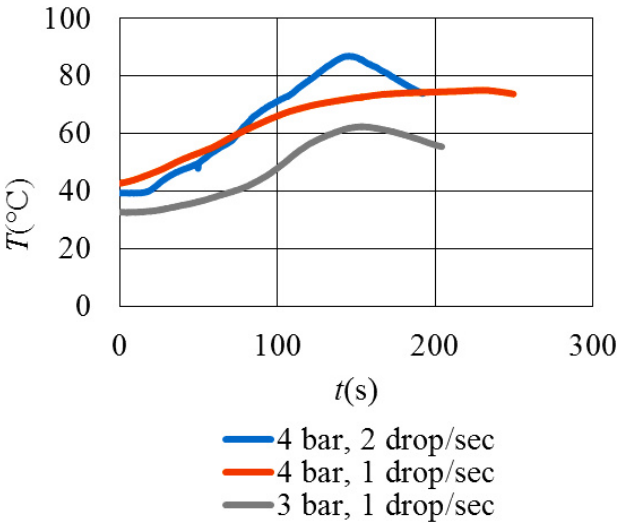

Figure 3. Bearing temperature with respect to oil mist mixture

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