Scuffing of spiral bevel gears

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Introduction

Bevel gears are commonly used in all area of industry, in which there is a need of change of the power transmission direction. This concerns heavily loaded ship drivetrains, wind turbines, derricks, and also industry machines such as machine tools, printing and textile machines.

The need for tribological tests on gears is connected with the three main aspects: the proper selection of materials, machining technology and oils that can improve the scuffing resistance. On the other hand, there is a tendency to decrease the power consumption by the reduction of friction. Thirdly, there is a growing ecological aspect, especially important when considering the EU requirements concerning the need to reduce the toxic oils additives concentration: the extreme pressure (EP) additives are mainly based on sulphur-phosphorous compounds.

The problem equally important is that, there are only few solutions in the area of bevel test rigs available, with the main disadvantage of their high price. Thus, the most of bevel gears producers and users could only rely on the research results performed on traditional back-to-back FZG type test rigs (using spur gears), putting forward the postulates of the lack of correlation between spur and bevel gears due to i.e. geometry and load distribution differences.

As an answer to aforementioned problems, at the Tribology Department of ITeE-PIB, a new test rig for bevel gear testing has been developed.

In the paper, there are the results presented concerning the verification tests of the newly elaborated test method for investigation of scuffing of spiral bevel gears.

The main aim of the research was the investigation of the utility of the test method and the device in the area of gear oils classification with respect to anti-scuffing properties. For this task, the gears made from 18H2N2 steel were used, and gear oils of various API GL performance levels were tested.

The second aim was to investigate the method utility in the area of an effect of gear materials on the scuffing resistance. For this purpose, the additional tests were performed on spiral bevel gears with the bigger wheel coated with a-C:H:W thin hard, low-friction coating and the pinion uncoated.

Experimental

The test method consists in performing the set of test runs, each under load gradually increasing from 1 to 12th load stage. After the test run under particular load stage, the teeth of the pinion are examined for the signs of wear, such as grooves, polishing and scuffing. The load stage is then increased up to the moment when the size of damaged area reaches the area of one pinion tooth. The load stage under which the aforementioned criterion is reached is called the Failure Load Stage (FLS) and describes the resistance to scuffing of the particular gear lubricated with the tested oil.

Results

As a results of research, for each of the tested friction couples the FLS was obtained - Fig. 1. After the tribological tests, the surfaces of the most damaged teeth were analysed by means of SEM, EDS, stylus and optical profilometer.

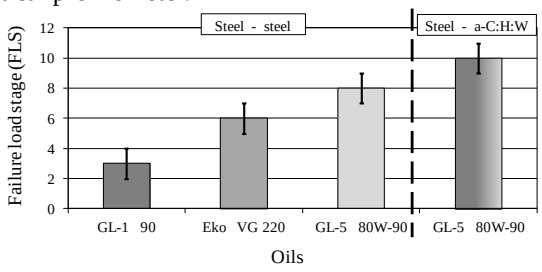

Fig.1 The values of FLS obtained for the tested spiral bevel gears

Conclusions

The obtained results indicate that by means of elaborated method, it is possible to differentiate between gear oils in respect of their extreme-pressure (EP) properties.

The outcome obtained from the comparison between the uncoated pair of gears and gear with one of the wheels with a-C:H:W coating deposited, confirm on one side the good resolution of the developed test method and, on the other side that by the deposition of the low friction coating the resistance to scuffing can be improved, as in the case of spur gears [1].

References

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