



Tribological failure analysis of journal bearings used in sugar mills

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ABSTRACT

In present paper the premature failure of journal bearings encountered in sugar mills has been analyzed. The causes of bearing failure are identified by simulating the operating conditions and conducting controlled experiments on a fully automated Journal Bearing Test Rig with provisions for varied combination (i.e. load, speed, and lubricating oil) of operating conditions. The results of performance behavior (i.e. coefficient of friction, change in surface roughness and weight loss) of the bearings as observed in these experiments have been reported. The theoretical and experimental results indicate the existence of boundary lubrication conditions in sugar mill journal bearings. To mitigate the problem of relatively high wear, lubricating oil with boundary additives have been tried and results are reported.

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1. Introduction

The cane juice is extracted using cane crushing mills, which consist of 4 or 6 rolls. The mill with four roller comprised of three crushing rolls sitting on cheeks in triangular form. To optimize the extraction of juice these crushing rolls are designed with high coefficient of friction [1] and very low rotational (4–5 rpm) speed. The journals of the rotating rollers rest on the plain bearings which in turn rest on the cast steel headstocks rigidly grouted on the RCC pedestals. The top roller drives the bottom rollers (i.e. feed and discharge roller) and exerts nearly constant load on the cane blanket through a system of hydraulic ram and accumulator as shown in Fig. 1a. This system allows the top roll to float within 5–20 mm, depending upon the thickness of the cane blanket passing through the rolls. With this kind of arrangement, the top half of the bearing required to support the top roller bears all kinds of the reactive loads (as shown in Fig. 1b) induced in the system by virtue of compression of the cane blanket and pinion forces caused by transmission of power from top roll to the bottom rollers.

The premature failure of top half of journal bearings employed to support top roller is a common problem in Indian Sugar industries. Often these bearings fail within very first working season (4–6 months) of their installation. Failures of these bearings impact on the production loss and maintenance costs are usually high. Typical failures of the bearing surface are photographed in Fig. 2. Visual inspection of used bearings shows scratches in circumferential direction (Fig. 2), distinct cracks (Fig. 2b and c) in axial direction, and marks of excessive generated heat at various locations (Fig. 2a). All these observations lead to conclude the failure of bearings caused by lubrication breakdown. Long cracks in bearings often create confusion of “fatigue cracking”, which occurs due to repetitive stress cycle. But the bearings in the present case experience relative speed of only 5 rpm (bearing life <30,000 relative-rotations) and load does not fluctuate in rotation (fatigue cycles are much lesser than 30,000). In other words very high load is responsible for failure of the bearings. To confirm this observation made on photographs of failed bearings, it is necessary to investigate the formation of fluid film between bearing and

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