INCREASING EFFICIENCY OF TURBINE-GENERATORS BY APPLYING HYDRODYNAMIC, LEADING EDGE GROOVE, BEARING TECHNOLOGY

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ABSTRACT

Results of a study are presented which show a significant improvement in efficiency is obtainable in large turbine-generator applications by applying leading edge groove technology to the system's hydrodynamic thrust and journal bearings. Leading Edge Groove (LEG) is a method of lubrication that delivers cool oil directly into the oil film to lower bearing power loss and pad temperatures. The study is in response to an increasing demand for efficient machines in a growing, international energy market. The demand is also driven by Deregulation and Privatization where resulting competition now more strongly dictates advantages of efficient, cost effective equipment.

BACKGROUND

While direct lubrication of thrust bearings has been successfully implemented for more than fifteen years, tests on journal bearings have only recently been documented for small (100 mm) high speed journals with favorable results (1). Literature has also extrapolated this data to project benefits of LEG lubrication in large (546 mm) turbine pivoted shoe journal bearings (2). Most recently, data has been acquired from actual tests of 460 mm (3) and 510 mm LEG pivoted shoe journal bearings. Where each prior report and test focused on a particular bearing, this study assesses all large bearings in a typical turbine-generator.

STUDY

Fig. 1 tabulates flooded and LEG thrust bearing field data from large turbines (2). There is a noticeable reduction in thrust bearing power loss and oil flow. Note how large the oil flow and loss of the two flooded journal bearings are compared to thrust bearing.

Fig. 2 is test data from generator tests of flooded and LEG journal bearing designs (3). Significant reductions in flow and loss were obtained for the two large bearings.

Fig. 3 lists bearings typical in size for a typical 300 MW turbine-generator train, developed for purposes of this study. Smaller HP-IP and exciter journals are not included in the study. Flows and losses from the above test data are used where appropriate, and other bearings are calculated in proportion to the test data. In comparison of bearing losses for such a T-G set, flooded bearing oil flows are on the order of 4360 liters per minute, and power losses approach 2000 kW. Using LEG test data, it would be possible to reduce oil flows 50 percent, and to reduce losses from 1976 down to 1338 kW which represents a reduction on the order of 32 percent.

CONCLUSIONS

Test data supports that leading edge lubrication technology can be used to increase the operating efficiency of large, turbine-generator sets. The study indicates that power loss from the four large pivoted shoe journal bearings in such a turbine-generator train are great in comparison to the thrust bearing losses, and that significant reductions in power loss are obtainable from the journal bearings in addition to the thrust bearing. More detail is presented in the full report along with discussions of additional benefits in regard to reducing lubrication system size, and the implications of the increased machinery efficiency in terms of cost savings.

762 mm (12x12) thrust bearing. Two 546 mm 4-pad journal bearings.

	TURBINE					
	THRUST	PJ1	PJ2			
BRG TYPE	STD	STD	STD			TOTAL
Oil Flow (lpm)	1726	682	682			3090
Loss (kW)	646	377	377			1400

BRG TYPE	LEG	STD	STD			TOTAL
Oil Flow (lpm)	960	682	682			2324
Loss (kW)	500	377	377			1254

Fig. 1 Turbine Thrust Bearing Field Data.

				GENERATOR		
				PJ3	PJ4	
BRG TYPE				STD	STD	TOTAL
Oil Flow (lpm)				635	635	1270
Loss (kW)				288	288	576

BRG TYPE				LEG	LEG	TOTAL
Oil Flow (lpm)				318	318	635
Loss (kW)				181	181	363

Fig. 2 Generator Journal Bearing Test Data.

Thrust Bearing	762 mm (12x12) thrust bearing.
LP Turbine Bearings	Two 546 mm 4-pad journal bearings.
HP-IP & Exciter Bearings	Not included in the study.
Generator Bearings	Two 457 mm 4-pad journal bearings.

	TURBINE			GENERATOR		
STD bearing	THRUST	PJ1	PJ2	PJ3	PJ4	TOTAL
Oil Flow (lpm)	1726	682	682	635	635	4360
Loss (kW)	646	377	377	288	288	1976

LEG bearing	THRUST	PJ1	PJ2	PJ3	PJ4	TOTAL
Oil Flow (lpm)	960	341	341	318	318	2277
Loss (kW)	500	238	238	181	181	1338

Fig. 3 Typical T-G Bearings - Estimated Data.

REFERENCES

(1) Edney, S., "Profiled LEG Tilting Pad Journal Bearing for Light Load Operation," Texas A&M Proceedings, 1996
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(3) DeCamillo, "Performance Tests of an 18-Inch Diameter, LEG Pivoted Shoe Journal Bearing," IC-HBRSD Proceedings, China, 1997