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2004-02-18		1CS39623	
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SYSTEM DESCRIPTION MBB	Respons. dept	Date 2004-02-10	Reg. M DB 101	
POWER TURBINE SYSTEM	Prepared B. Wassber	rg	YAMAMA	CEMENT

Purpose of the system

The power turbine converts the pressurized hot gas flow from the gas generator to mechanical energy, driving a load (in power generation via a gearbox).

General description of the system

Refer to P&ID 2046 019

The GT 10B gas turbine operates in a simple open cycle with straight air and gas flow through the turbine. It can be divided into two main sections, the gas generator and the power turbine. The two main sections are not mechanically interconnected, so the gas generator speed is determined by the output of the unit as well as ambient conditions, which allows a wider control range at sustained efficiency.

The power turbine is a two-stage axial-flow turbine.

Exhaust casing Bearing #3 Bearing #4 PT-rotor Fig.1 GT10 Power Turbine Archive HG Approved Latest revision 2004-02-19 Peter Lundin 9100 20 No. Checked 2004-02-18 1CS39623 Mathias Nilsson

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Rotor

The power turbine rotor is solid, built up from two discs and a rotor shaft. The rotor is fully electron beam welded. The PT blades are fitted in fir-tree grooves and have shrouds to minimize the interstage gas leakage. The rotor blades as well as the guide vanes are precision cast.

Stator

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The PT stator carries two guide vane stages. The first guide vane stage is permanently adjustable to obtain optimum efficiency at various climate conditions. The vanes in the first stage are also hollow to transport cooling air to the turbine disc. The stator surfaces above the blade tips are provided with honeycomb seals. Honeycomb is an abradable seal, which can withstand a blade tip rubbing.

Casings

The turbine casing houses the power turbine stages. The turbine casing is bolted to the diffusor casing. The purpose of the diffusor is to retard the velocity and gain static pressure, thereby increasing the pressure ratio across the power turbine. The bearing housings are attached to the diffusor casing.

The exhaust casing surrounds the greater part of the diffusor casing and directs the exhaust gases to the outlet duct. The casing is designed to provide a minimum back pressure, which is important in order to not affect the power output.

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Bearings

The bearings are of tilting pad design with a directed lubrication system.

The bearings are equipped with temperature sensors and vibration transducers.

Two journal bearings, no 3 and 4, numbered from the inlet to the exhaust carries the power turbine rotor. Bearing no 3 is a journal bearing and number 4 are a combined thrust and journal bearing. During operation, oil is continuously supplied to the bearings. Return oil from the bearing casings is led back to the lubricating oil tank by gravity. See also the Lubrication oil system, MBV.

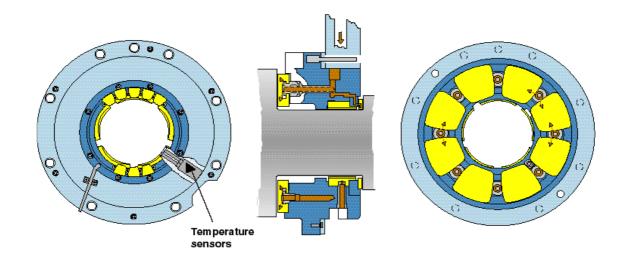


Fig.2 Combined journal/thrust bearing #4

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POWER TURBINE SYSTEM	Prepared B. Wassberg	YAMAMA CEMENT

Cooling and sealing air

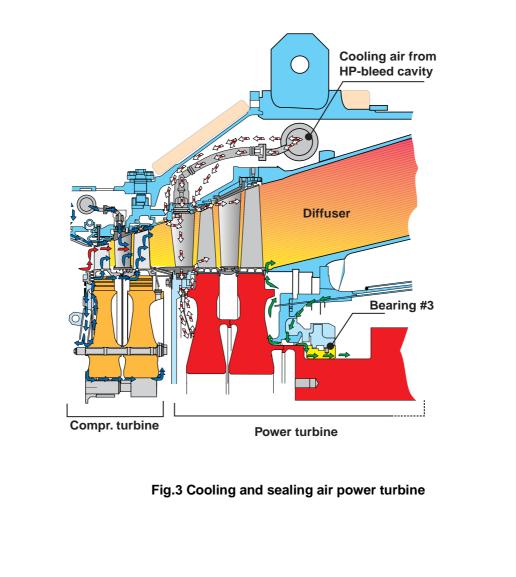
The cooling and sealing air are taken from the bleed cavities.

The first guide vane stage is hollow and transports cooling air to the first rotor disc before entering the gas path. The cooling air is led via an external pipe into a manifold located in the diffusor. From there, air is distributed via flexible hoses to each individual guide vane.

A part of the supplied air is also tapped from the manifold to form a heat barrier between the stator and the surrounding turbine casing. This air enters the turbine gas path.

Sealing air is also used to prevent hot gases from entering the bearing housing or oil from leaking out from the bearing housings.

See also cooling and sealing air system, MBH



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SYSTEM DESCRIPTION MBB	Respons. dept Date GRPD 2004-02-10	Reg. M DB 101
POWER TURBINE SYSTEM	Prepared B. Wassberg	YAMAMA CEMENT

Main components

- Pressure transmitter, pressure exhaust gas MBB10CP005
 The transmitter is continuously monitoring the absolute exhaust pressure. Used for calculation of the limit set value of the exhaust gas temperature.
- Pressure transmitter, pressure exhaust gas MBB10CP010 High diff. pressure (H1) over the casing wall initiates an alarm. (High diff. pressure (H2) over the casing wall initiates a turbine trip. -only when using a boiler). Protects the exhaust casing from being pressurized above design pressure.
- Speed transducer, PT speed MBB10CS005 The transducer is continuously monitoring the speed of the PT rotor. It protects the rotor from over-speed and is also for governing. High speed (H1) initiates a turbine trip. Low speed (L1) initiates a generator circuit breaker trip or if low speed is still present after a set time a turbine trip.
 - Speed transducer, PT speed MBB10CS010 The transducer is continuously monitoring the speed of the PT rotor. It protects the rotor from overspeed and is also for governing. High speed (H1) initiates a turbine trip.

Low speed (L1) initiates a generator circuit breaker trip or if low speed is still present after a set time a turbine trip.

- Axial position transducer, axial displacement PT rotor MBB10CG005 The transducer is continuously monitoring the axial position of the PT rotor. Axial displacement (L1) initiates an alarm. Axial displacement (H1) initiates an alarm. Big axial displacement (L2) initiates a turbine trip.
- Key phasor, PT rotor angle MBB10CG010 The key-phasor detects rotor angle at balancing of the PT rotor.

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SYSTEM DESCRIPTION MBB	Respons. dept Date GRPD 2004-	-02-10 Reg. M DB 101
POWER TURBINE SYSTEM	Prepared B. Wassberg	YAMAMA CEMENT
 Temperature transmitter, exhaust gas tem MBB10CT005-MBBCT080 The thermo couple is continuously monit point has got three thermo couples. The e system have got the following main purp - limiting the maximum allowed average - supervision of combustion The computer calculates the maximum - gets too large there will be an alarm (H1 High average exhaust temperature (H1) High average exhaust temperature (H2) 	oring the gas temperature exhaust temperature measure oses: e exhaust temperature. + and minimum - deviation) and in the worst case a initiates an alarm.	urement used by the control
• Temperature transmitter, journal bearing MBB10CT085 The PT100 is continuously monitoring th temperature in one of the bearing pads. High temperature (H1) initiates an alarm. High temperature (H2) initiates an alarm.	e bearing temperature. Th	he transmitter is measuring the
• Temperature transmitter, journal bearing MBB10CT090 The PT100 is spare for MBB10CT085.	(no.3) temperature	
• Temperature transmitter, thrust bearing (n MBB10CT095 The PT100 is continuosly monitoring the temperature of the escaping oil from the p High temperature (H1) initiates an alarm. High temperature (H2) initiates an alarm.	bearing temperature. The pads.	e transmitter is measuring the
• Temperature transmitter, thrust bearing (MBB10CT100 The PT100 is spare for MBB10CT095.	no.4) temperature	
• Temperature transmitter, journal bearing MBB10CT105 The PT100 is continuously monitoring th temperature in one of the bearing pads. High temperature (H1) initiates an alarm. High temperature (H2) initiates an alarm.	e bearing temperature. Th	he transmitter is measuring the
• Temperature transmitter, journal bearing MBB10CT110 The PT100 is spare for MBB10CT105.	(no.4) temperature	

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	POWER TURBINE SYSTEM	Prepared B. Wassbe	rg	YAMAMA	CEMENT
document is issued in Pulse.	 Vibration transducer, bearing (no.3) vibration MBB10CY005 The accelerometer is continuously monitoring the High vibrations (H1) initiates an alarm. High vibrations (H2) initiates a turbine trip. 	he vibration	S.		
ument	• Vibration transducer, bearing (no.4) vibration MBB10CY010				
	The accelerometer is continuously monitoring t	he vibration	s.		
This	High vibrations (H1) initiates an alarm.				
	High vibrations (H2) initiates a turbine trip.				

• Vibration transducer, bearing (no.4) vibration MBB10CY010 The accelerometer is continuously monitoring the vibrations. High vibrations (H1) initiates an alarm. High vibrations (H2) initiates a turbine trip.

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SYSTEM DESCRIPTION MBB	Respons. dept Date GRPD 2004-02-10	Reg. M DB 101
POWER TURBINE SYSTEM	Prepared B. Wassberg	YAMAMA CEMENT

Function

Start up

The starting procedure is generally described in the Starting system description, MBJ.

During start up, which is after purging period and combustor ignition, the power turbine accelerates to nominal speed. The start up is finalized when the generator is syncronized and/or minimum continuous load is obtained.

Continuous operation

The speed is constant during normal operation (power generation). The power output is determined by the characteristics of gas flow entering the power turbine.

Shut down

As the gas generator is shut down, the power turbine output is decreased and the generator is disconnected from the grid at minimum load. Then the power turbine is coasting down. During the subsequent gas generator cooling down period, when the gas generator is turned by the electrical starting motor, the power turbine may also rotate due to windmilling from the rotating gas generator.

Stand still

The power turbine is kept at stand still.

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Disturbances

Gas turbine trip

A gas turbine trip shuts off the fuel flow to the gas generator. The power turbine is coasting down.

Generator breaker trip

The generator breaker trip causes a slight over speed before coasting down.

Loss of power supply

Loss of main AC power supply trips the gasturbine.

System faults

If there are any damages on turbine, compressor, bearings or combustion chamber the system may not be started or has to be shut down.

Other faults

The gas generator is dependent of its auxiliary systems for proper function. Faults in any of these systems may restrict or interrupt continued start up or operation.

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SYSTEM DESCRIPTION MBB		espons. dept	Date 2004-02-10	Reg. M DB 101
POWER TURBINE SYSTEM		^{epared} . Wassbe	rg	YAMAMA CEMENT
Technical specification	l			
Design criteria and standar	rds			
Direction of shaft rotation	Anti-clockwise	looking i	n the reverse di	rection of flow.
Dimensioning data				
• Pressure ratio	3.52:1 at ISO-co	onditions		
Nominal speed	7700 rpm			
• (MD speed	3850 – 8085 rpr	n)		
Engineering data				
Figures given below might differ Nominal flow	r somewhat from proj 80 kg/s	ject to pro	oject	
Installation				
The power turbine is bolted by a	flange connection to	the gas o	enerator The	complete unit is mounted
on the main base frame by a fix j support in the front of the gas ge The power turbine section can be maintenance.	point and pendulum s enerator.	supports a	t the power tu	bine end and a flexible

Installation

Materials

•

• Discs	NIM 901
• Blades Stage 3 Stage 4	IN 792 IN 792

Vanes	
Stage 3	IN 939
Stage 4	IN 738

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	POWER TURBINE SYSTEM		Prepared B. Wassberg		YAMAMA CEMENT	
This document is issued in Pulse.	 Component data Number of turbine stages Thrust bearing type Journal bearing type Rotor design Rotor weight (incl. blades) See the system lists. 	2 Tilting Tilting Electr 975 kg	g pad on-beam we	elded		

Weight

The weight of the power turbine excluding the exhaust casing is 4900 kg. Total weight of the power turbine including the exhaust casing is 6700 kg.

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SYSTEM DESCRIPTION		Respons. dept	Date 2004-02-10	Reg. M DB 101	
MBB POWER TURBINE SYSTEM		Prepared	2004-02-10		
FOWER TURBINE STSTEM		B. Wassbe	rg	YAMAMA CEM	1EN7
Testing and service					
Testing during normal operation					
N/A					
Accesibility during normal operati	on				
N/A					
Index of components					
MBB10CG005		MBB10)CT090		
Axial position transducer, axial displac				o.3) temperature	
PT rotor	6)CT095		
MBB10CG010	6		st bearing (no.)CT100	4) temperature	
Key phasor, PT rotor angle MBB10CP005	6			4) temperature	
Pressure exhaust gas	6		St bearing (110.) CT105	4) temperature	
MBB10CP010	0			0.4) temperature	
Pressure exhaust gas	6)CT110	, , , , , , , , , , , , , , , , , , ,	
MBB10CS005		Jour	nal bearing (no	o.4) temperature	
Speed transducer, PT speed	6	MBB10)CY005		
MBB10CS010	_			er, bearing (no.3)	
Speed transducer, PT speed	6		bration		
MBB10CT005-MBB10CT080	7		OCY010	n haaring (no. 1)	
Exhaust gas temperature MBB10CT085	7		bration	er, bearing (no.4)	
Journal bearing (no.3) temperature	7	VI	oration		

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