Mysterious magnetism in Process Air compressor train in KSFL

- Turbine make : M/s Siemens, Germany
- Type : NK 40/56-3
- Max. Speed : 7690
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- Rated speed : 7323
- Critical speed : 3600
- Rated output : 12940 kW
- Inlet steam pressure : 34.2 kg/cm²
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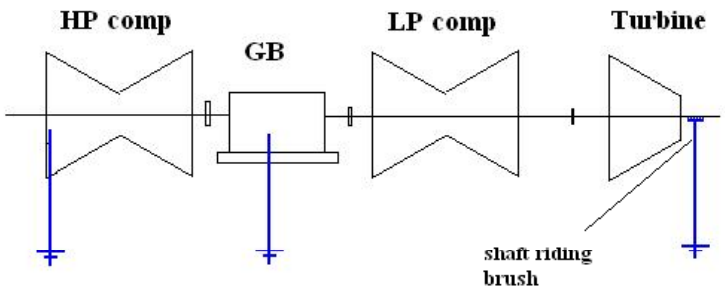
- Inlet steam temp: 420ºC

Schematic arrangement of PAC



Present configuration of casing grounding and shaft riding brush grounding

Failure mode in PAC Train

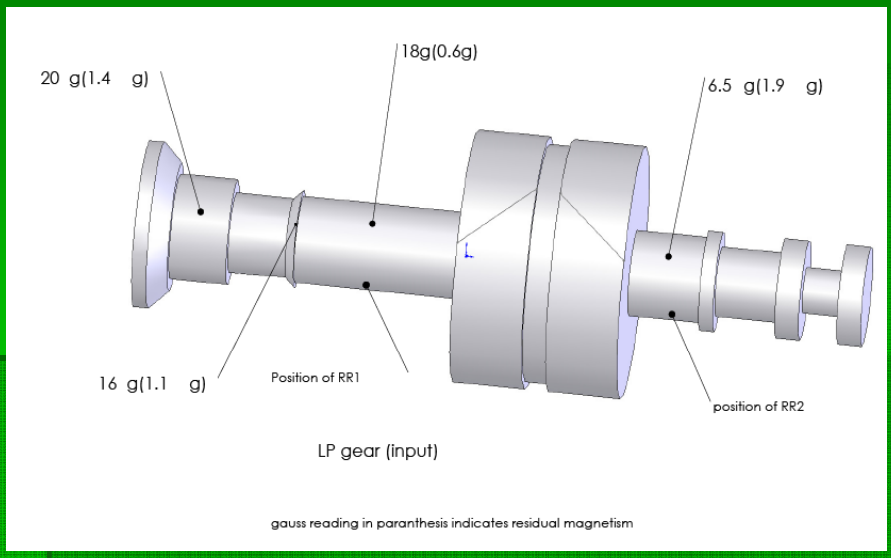
- False tripping of turbine
- Increasing gap voltage and bearing clearance of journal bearing of input shaft of Gear box
- Rapid wear of earthing brush mounted on turbine shaft.
- Wear on shaft journal (input gear)
- Eccentric wear pattern in Turbine rotor at riding brush location

Observation on 14.5.10 O/H

- Clearance values

LS shaft (RR1)	DE Journal dia = 119.82 mm Brg ID (avg)= 120.29 mm	Clearance = 0.47 mm
LS shaft (RR2)	NDE Journal dia = 119.815 mm Brg ID (avg)= 120.05 mm	Clearance = 0.235 mm
HS shaft (RR3)	Journal dia = 109.85 mm Brg ID (avg)= 110.04 mm	Clearance = 0.20 mm
HS shaft (RR4)	Journal dia = 109.62 mm Brg ID (avg)= 109.83 mm	Clearance = 0.20 mm

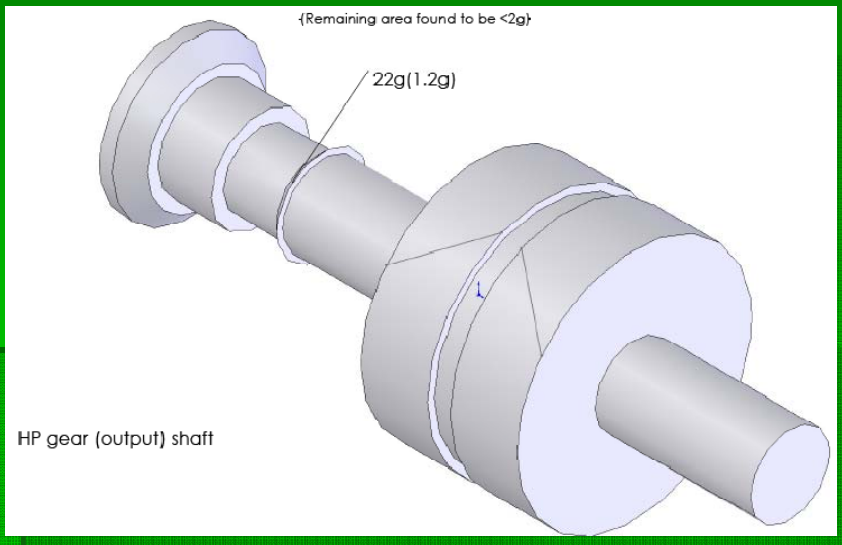
LP Gear Gauss values



LP gear (input)

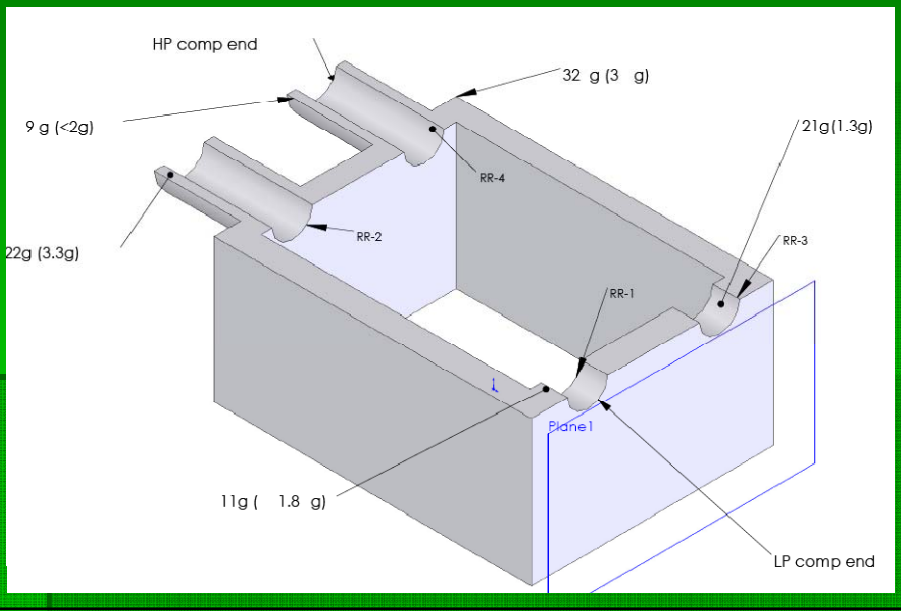
gauss reading in paranthesis indicates residual magnetism

HP Gear Gauss Values



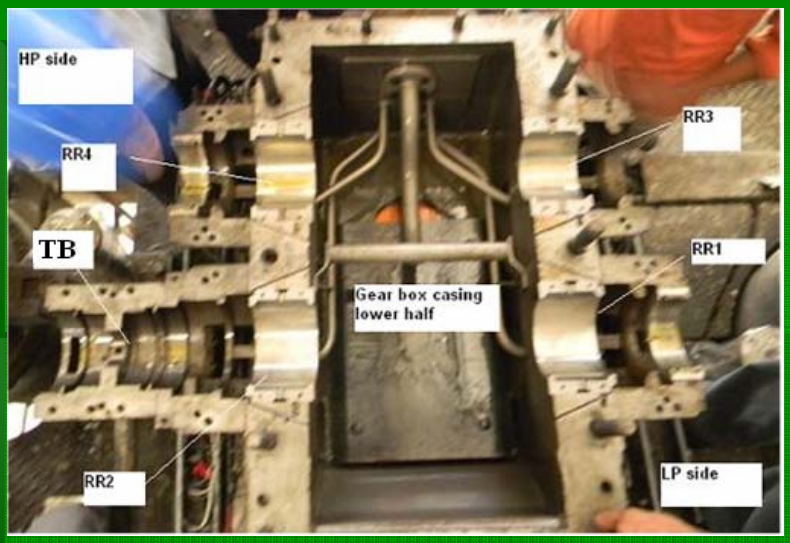
HP gear (output) shaft

Bottom Casing gauss values



Photographs (frosting marks)

Photograph (gearbox casing)



Gap Voltage Data

PAC Gear box Vibration And Gap Voltage Record							
Sr.No.	Date	Vi01(RR-1)	Gap Voltage(RR-1)		Vi03(RR-3)	Gap Voltage(RR-3)	
			Gl 01A	Gl 01B		Gl 03A	Gl 03B
1	30.04.2010	37.0/38.0			17.0/15.0	-9.1	-9.7
2	01.05.2010	40.0/41.0	-10.55		17.0/15.0	-9.1	-9.7
3	04.05.2010	40.8/40.5	-11.3	-8.7	16.6/15.0	-9.1	-9.7
4	06.05.2010	42.3/41.5	-11.54	-8.69	16.7/14.9	-9.1	-9.7
5	08.05.2010	42.8/41.5	-12.04	-8.6	16.5/14.8	-9.1	-9.7
6	10.05.2010	45.8/44.8	-12.57	-8.56	16.5/14.6	-9.08	-9.73
7	12.05.2010	47.8/45.9	-13.1	-8.64	16.8/15.0	-9.1	-9.75
8	13.05.2010	47.9/45.9	-13.16	-8.63	16.7/15.0	-9.1	-9.76

Earthing brush replacement History

- March 2005 to Feb 2006- 01 no
- March 2006 to Feb 2007- 04 nos
- March 2007 to Feb 2008- 03 nos
- March 2008 to Feb 2009- Nil
- March 2009 to Feb 2010- 07 nos
- March 2010 to May 2011- 07 nos
- May 2011 to Nov 2011-04 nos

Observation on 31.05.10 on shaft voltage

Open circuit Shaft voltage was measured by voltmeter and CRO. The readings were recorded as below:

- **AC VOLTAGE**
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- BY CRO 100 Volt (wave form is not perfectly sinusoidal)
- BY MULTIMETER 99-103 Volt

- **DC VOLTAGE**
- BY CRO -300 Volt(Peak)
- BY MULTIMETER -128 to -145 Volt

Analysis of Probable causes of bearing damage

Input

- The photograph of damaged bearing (RR-1) shows clear indication on frosting
- The photograph of corresponding journal area of bearing (RR-1) shows clear indication on frosting
- The clearance increased from 0.20 to 0.47mm.
- Input shaft, casing of gear box found to be magnetized (18 gauss at journal portion)
- Continuous discharge of AC through earthing brush
- Rapid wear of earthing brush.

Conclusion

- The above inputs clearly indicate bearing getting worn out due to stray current discharging through bearing, which may be primarily due to electromagnetic current. The assumption is reinforced with the observation of high potential difference (pl ref: observation on 31.5.10) existing between rotor and earth.
- After degaussing of gear internal and casing on 14.5.10, there should not be any electromagnetic current discharging through bearing. Thus rising gap voltage after gear box overhauling which was observed on 24.05.10 is due to electrostatic activity on rotor (It is likely that charge is being carried from compressor or turbine end)

Analysis of generating charge in compressor end

The following have the potential for generating charge in compressor:

- Filter media fiber breaking away and carried along with air at suction.
- Water droplet carried from separator to next stage.
- Air borne (charged) particle carried thorough inlet air

Recommendation (implemented)

- All the casing (lower half) should be grounded with insulated copper cable. Upper half and lower half can be connected with a wire in all casing. This will ensure no accumulation of charges in stationery component.
- All components in PAC train should be demagnetized in the next opportunity. However to save down time, turbine casing and rotor can be left if the magnetization value at the coupling end is found within permissible range. The turbine and its casing was last de-gaussed in April 2009.
- Suction filters replaced with new filters (SPX make).
- All air traps installed in intercoolers made functional.

Recommendation (still to be implemented)

- Two earthing brushes (in simultaneous operation) at same location (turbine front end) should be installed instead of existing one no brush. This will ensure contact at all time, (even at the time of replacement of brushes)
- A sacrificial sleeve shall be installed at shaft end with smooth ground surface, which may protect shaft as well as reduce brush wear due to friction.

Thank You