Turbine Lube Oil System Monitoring and Control using PIC Controller

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Abstract - The HP and LP Turbine Rotor of 60MW unit placed in the journal bearings which are being lubricated to avoid friction. The rotor shaft and bearings should not have direct contact with each other. By making an oil film layer in between shaft and bearing the direct contact is avoided. The lube oil header pressure should be maintained at 1.2kg/cm2 so that the oil film can be created. The separate lube oil system provides continuous lubrication to the bearings. Main oil tank level, header pressure monitoring, lube oil coolers and redundancy scheme for lube oil pumps are the associate systems for monitoring and control for lube oil system. The existing system for monitoring and control are relay logic and each function is working separately. In our project work we integrate the level monitoring of MOT, Pressure monitoring Lube oil coolers, redundancy scheme for lube oil pumps in to single system using PIC Microcontroller.

I. INTRODUCTION

PROTOTYPE OF LUBE OIL SYSTEM
1.1 WORKING OF PROTOTYPE

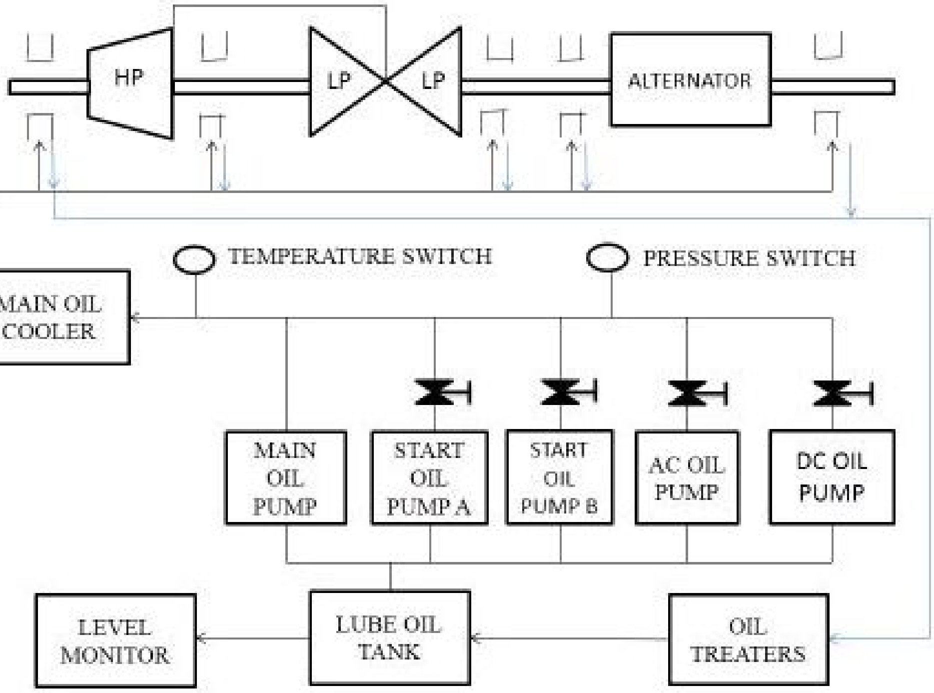

Figure 1.1 Layout of Lube Oil System

In thermal power plants, the high pressure and low pressure turbine of 60 MW are placed in journal bearing which has to be lubricated continuously to prevent wear and tear between the shaft and the bearing. Lubrication system used as far as now works separately with human intervention the lubrication system is controlled and the lubrication oil is sprayed at a pressure of 1.4 kg/cm$^{2..}$

Lubrication oil when sprayed at this pressure creates a protective oil film around the shaft to prevent friction. The journal bearing contains a soft coating of white metal to prevent the friction after application of oil. The lubrication oil system used in present plant does not integrate the different parameters available in the field. In our project we integrate the different parameters like pressure, temperature, and level of lubricant oil present in the system.

The lubricant oil will form a protective film coating around the shaft only if it is sprayed at a pressure of 1.4 psi , so it is important to maintain the pressure of the lubricant oil in the system. Since the shaft of the turbine are rotating in high speed the environment will be high in temperature. Hence the oil surrounding the rotor shaft will absorb heat in the environment and reduces the temperature in the turbine shaft. These resultant oil after passing through the shaft is collected and passed again to the Main Oil Tank (MOT).

This high temperature oil cannot be used again because the viscosity of the oil decreases with increase in temperature so to retain its viscosity the oil should be cooled again. For this reason the oil from the Main Oil Tank is passed through the cooling chamber. In the chamber the oil will exchange the heat to the soft water running in the chamber. Then the process is repeated.

The lubricant oil in the main oil tank should be maintained at a particular level in order to ensure the continuous flow of oil through the system. So it is important to measure the level of oil in the Main Oil Tank. The level decrement or increment will open or close the makeup solenoid valve. These parameters should be measured to maintain the lubrication off the shaft in turbines.

In the existing system these parameters are measured and the measured variables are sent to the control room where the human controller will send a control signal to field devices using relay board circuits.

In our proposed system the measured variables are sent to a controller and in the controller there are predefined programs burned which will do the necessary action for different measured signals. The controller will replace the human in sending the necessary control signal for different measured variable from the field devices. Since the lubrication is so important the system is provided with a number of redundant pumps.

Initially power supply is given in our prototype of lube oil system. The pressure is given manually by means of a cuff and the pressure value is indicated in the display. This pressure is related to oil pressure in actual lube oil system. When the pressure range is above 1 psi the starting oil pump goes
ON through relay which is driven by means of a driver circuit and is indicated using LED. When the pressure is between 0.8-1 psi the AC emergency pump goes ON and when pressure drops below 0.7 the DC emergency pump goes ON and its operation is indicated by means of LED. Thus it maintains the oil film in the turbine system. Simultaneously the level in Main Oil Tank is monitored by means of ultrasonic level sensor and the level is also indicated in the display. If the level goes below 20 cm the oil makeup goes ON by relay through driver circuit and the level is maintained. If the temperature of oil goes above 50^0C the cooler valve is opened which is sensed by the LM35 temperature sensor. The overall process is controlled and monitored using PIC controller. Thus the lube oil in turbine is controlled and monitored using PIC Controller.

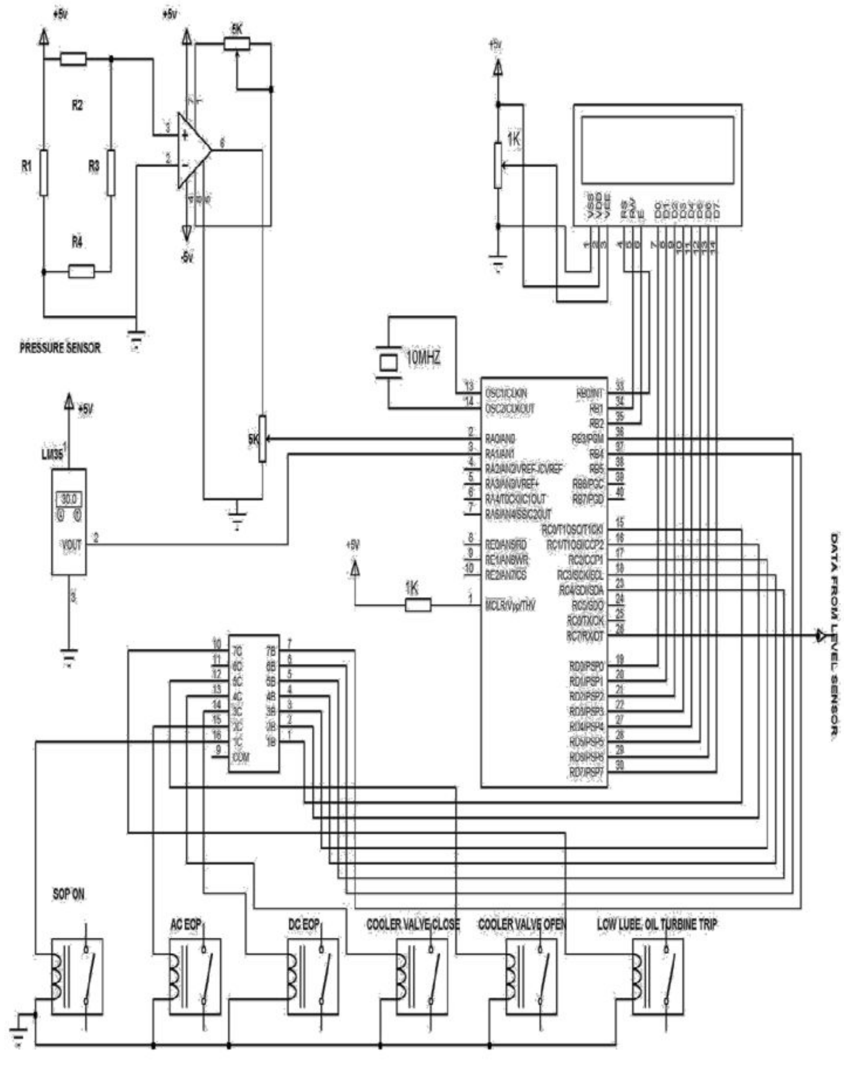

Figure 1.2 Circuit Diagram Of Lube System

1.2 CIRCUIT DESCRITION

The prototype model comprises of
1. Microcontroller board
2. Dual Power Supply circuit
3. Pressure sensor and signal conditioning circuit
4. Relay board
5. Temperature sensor and level sensor circuit .

1.2.1. Microcontroller Board

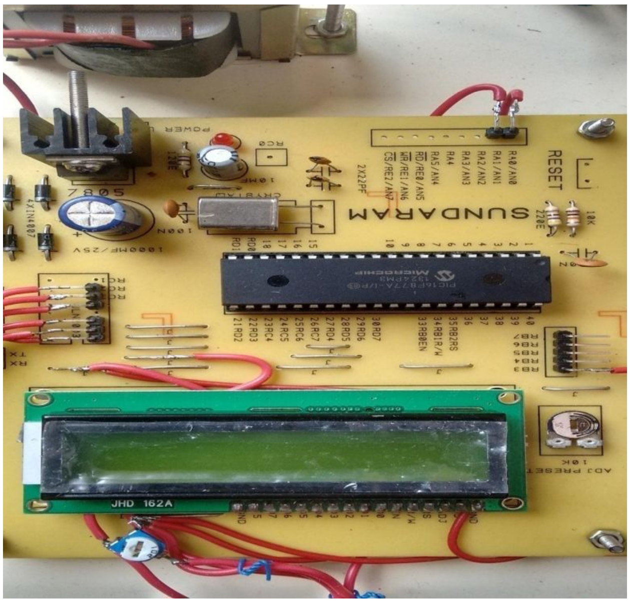

Figure 1.3 Microcontroller Board

The microcontroller board consists of power supply, microcontroller circuit and LCD interface circuit. The microcontroller board receive 12v ac supply from 23c/12v power supply transformer. A bridge diode circuit converts ac into rippled dc output. This rippled dc is again filter by the 35v/1000microfarad capacitor and regulated to +5v dc by using the voltageregulator IC 7805.The +5v is distributed to Microcontroller and LCD module for working .The reset pin of the microcontroller is connected to + 5v through 10k resistor. A 24MHZ metal crystal is connected to the microcontroller to the pin 11 & 12.

1.2.2. Dual Power Supply Board

The dual power supply is required for instrument amplifier for signal amplification. The 230/9-0-9v center tapped transformer is connected to the diode bridge there ac is converted to DC and filtered with 1000mF 25V capacitor to eliminate ripples in the DC voltage. Two voltage regulators were used for +5v & -5v regulated power supply LM7805 & LM7905.The voltage available is +5v with respect to Gndand -5V with respect to Gnd.

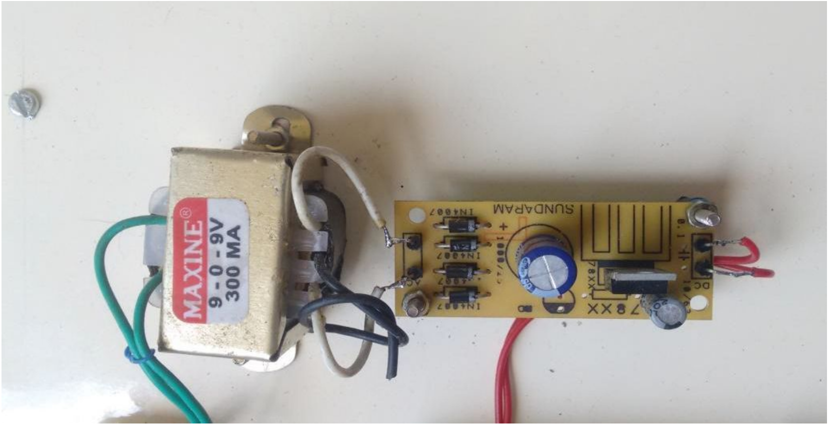

Figure 1.4 Power Supply Board

1.2.3. Pressure Sensor and Signal Conditioning Circuit

MP3V5050 pressure sensor is used to measure the lube oil pressure. This a Piezo-resistive transducer easily interface with microcontroller directly.

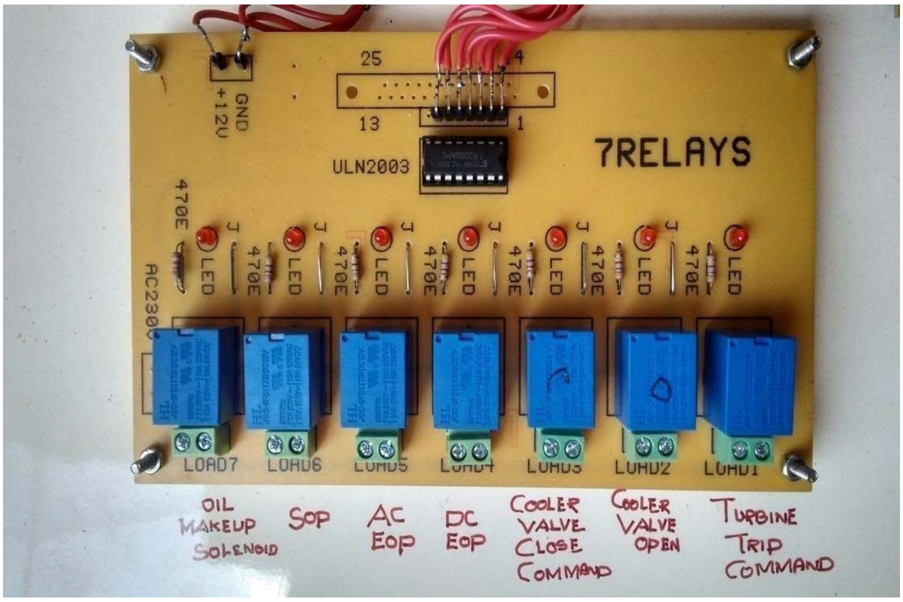

Figure 1.6 Relay Board

PRESSURE SENSOR CIRCUIT

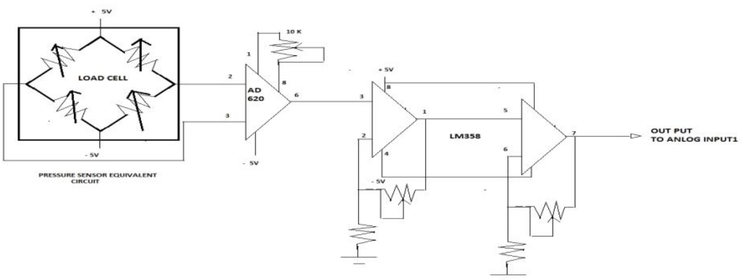

Figure 1.5 Pressure Sensor Circuit

The pressure input is from0-7.25PSI and the output voltage generate 0.06V to 2.82V.The output is proportionate to the input. This pressure sensor working with 3.3V and supply point pin are 2 & 3(Gnd) pin 4 is output. The out is connected to instrument transformer for signal amplification. AD620 is used for signal amplification and the gain fo this amplifier is varied with the help of 500 Ohms pot.AD620 working with dual power supply that is +5v & -5v.The final signal is connected to the microcontroller pin 2(AN0).

1.2.4. Relay Board

Microcontroller give start command to motors, open &close command to valves and trip signal to turbine through the relay which are interfaced with I/O. These relays are working with +12v power supply and ULN2003 High current driver IC drive all relay in this circuit. Because microcontrollercannot drive high current dive like relay,motors etc. hence a driver is required.This high current driver gets input signal from microcontroller and other side on the relay without any stain. All the relay are connected in the port C & port B

1.2.5. Temperature and Level Sensor

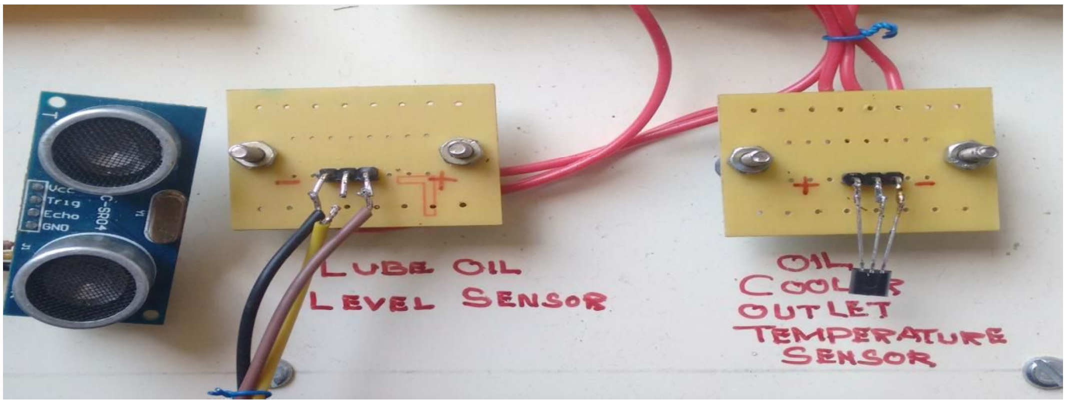

Figure 1.7Level and Temperature sensor Board

The temperature of lube oil is measured with help of LM35 sensor. It is a three terminal device have pin1 & 3 supply point and pin 2 is output is proportional with the heat applied to it. It is also directly connected to the microcontroller pin 3 (AN1).It measure the temperature form -55 DegCel to +150 DegCel range and generate the output 10mV/DegCel. It working with power supply range from 4V to 20V maximum. The main Oil tank level is measured with the help of ultrasonic sensor working with +5v power supply and the maximum distance it can measure is 10Centimeter.It gives output as serial data and it can be easily interface with Serial port of microcontroller.

II. CONCLUSION

In our project work we integrated all the sub-system into a single system and made it an overall supervisory control & monitoring using PIC microcontroller. For that oil level, temperature, pressure of lube oil system is made feedback to ADC of microcontroller mainly for parameter display. Using these feedbacks the pump change over scheme, oil temperature control using cooler and tank level control is achieved. In the existing Turbine lube oil system these systems are not inter – connected and each have separate control module & monitoring. This system has no overall supervisory control. The main disadvantage of this system is separate man power requirement for each sub system and there may be chances of human error. The lube oil pump change over scheme is based on relay logics (hardware) and it required periodical maintenance. This system is purely a manual process and it is time consume work. Thus our project overcomes these disadvantages.

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