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Energy Saving and Water Cooling Facility in an Industry Using Prgrammable Logic Controller

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ABSTRACT
This project gives the idea about how to reduce the power loss in an industry, which are being wasted by the fans and pumps in operating condition as well as to get water as per the necessity by an industry with proper quality. This can be done by proper switching and speed control of motors used in fans and pumps. As the power consumed is directly proportional to the cube of speed so by reducing the speed energy can be saved. An attempt is also made to connect the power factor improving capacitor for energy saving. By using this concept the industry can save huge amount of energy and can be able to reduce the electricity bill.
Keywords **–** PLC , Algorithm , speed control of motor, power factor improving capacitor ,KVAR

I. INTRODUCTION

The Cooling water facility in a Process industry offers great scope for energy efficient operation by way of selective switching and speed control of various equipments. As the power consumption of pumps and fans is directly proportional to cube of speed, a reduction in speed, based on quality and quantity of cooling water required, results in saving of huge quantum of energy. Incorporation of a Programmable Logic Controller (PLC) for automation of operation of plant is also aimed in this project. Switching of Cooling water pumps and fans, based on requirement can also be achieved by incorporation of PLC. Another attempt is also made to save the energy by connecting power factor improving capacitor as using this the customer can get power with good voltage regulation and can also reduce the electricity bill. Here PLC is used as maintainance is and operator can change the program as per his requirement. The analysis has been done as per the data in FACT in Udyogamandal, where the cooling water facility is examined from the energy conservation angle.

II. OBJECTIVE OF PROJECT

A. Selective switching and speed control of cooling tower fans for energy saving.
B. Selective Switching of cooling water pumps.
C. Techno-economic feasibility study of equipment-connected PF improving capacitors
D. Automation of operation of cooling water facility using PLC.

A. Selective Switching And Speed Control Of Cooling Tower Fans For Energy Saving.:

The objective of cooling tower is to supply water to the industry for taking away the excess heat from the plant. The existing facility meets the requirement as it continuously supply enough cooling water to various plants. But the disadvantages with the system is that it does not consider of saving the rapidly diminishing energy. The system does not take any advantage from the dropping temperature in night and winter season. In those times the temperature is low. So less power is required to cool the water. It can be achieved by selective switching of fans . Another way is to run the fan in reduced speed. Outlet temperature, flow and pressure are measured and monitored continuously so as to run the equipments in an optimum way. Based on these parameters the required fans are switched on for keeping the outlet temperature within the required value. When a fan at full speed is not required for keeping the temperature of water within limit, it is run at reduced speed by using a Variable Frequency Drive. Hence we can save huge amount of energy.

B. Selective Switching of cooling water pumps:

In any plant there may be some variation in the requirement of water. But the cooling water pumps are run without monitoring the actual requirement in the plants. The operation people at Cooling Tower run all the pumps as per the design parameters without monitoring the quantity of water required by other plants. This requires high operating pressure for water when some of the plants stop consumption. And, in order to compensate reduction in flow and rise in pressure,

the operators adjust the control valves so as to keep the pressure within limits. This results in wastage of energy at the valves. If switching of pumps is done based on requirement of plants, this energy which is being wasted can be saved.

C. Techno-economic feasibility study of equipment-connected PF improving capacitors:

The existing system in FACT looks improvement of power factor from maximum demand (MD) only. A techno-economic feasibility study of equipment-connected pf improving capacitor forms as the third objective of this project. The feasibility study comprises two parts viz. technical part for finding out the capacitance required for bringing the pf to unity and the economic evaluation part consisting of life cycle cost analysis. If the future value of the initial investment for the capacitor for better pf of the motor is less than the sum of future returns by way of energy saving, the investment is justified. Here, the value of capacitance required for bringing the pf of CT Fan to unity is found out by measuring the various parameters like active power, present pf, running current etc. The resultant saving in energy, by running the motor at unity, is computed by measuring the circuit resistances involved viz. cable resistance, winding resistance, switch, fuse and contactor resistances. The life cycle cost is then calculated to find out whether the investment is worth making.[2]

- **Size of capacitor**
  Size of capacitor connected to a motor should be such that the capacitor current should not exceed the no load current of the motor at normal voltage. Otherwise dangerously high voltages will be generated when motors may be damaged because after disconnection of motor from supply motor will be still revolving and act as generator by self excitation.
- **capacitor connection**

The connection of LT Capacitors to a direct starting motor or to an induction motor with slip rings and starting resistors involves no problems if output does not exceed consumed no load power of motor. But over voltages up to three times rated voltage due to self excitation could occur if switching from star to delta and a line is broken before neutral , it may damage motor and capacitor. The above difficulties are avoided if 6-terminal capacitor is used and connected in a single phase so that capacitor discharges across the motor winding while it is disconnected from the line

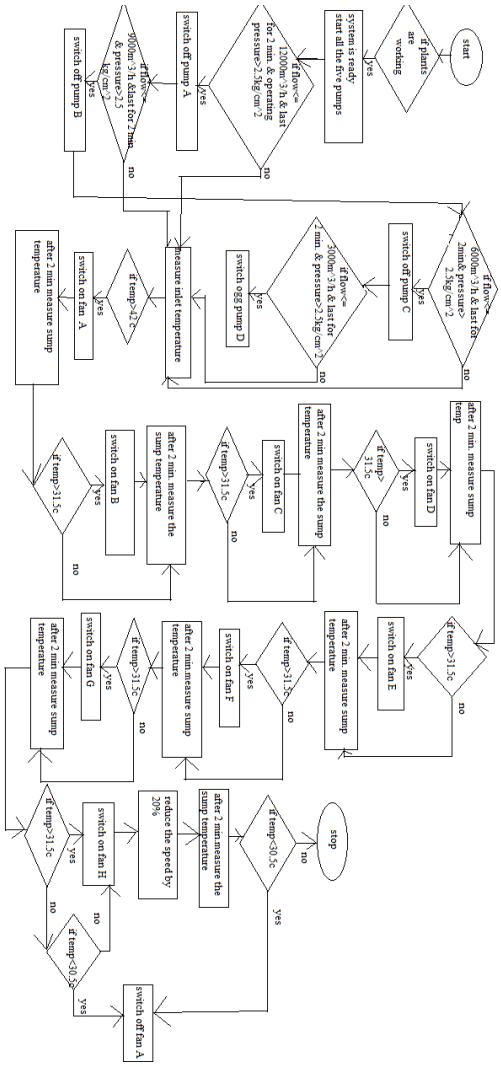
- **Advantages of pf improvement :**

i. KVA rating of the equipment is reduced.
ii. Smaller conductor size.
iii.Copper losses are reduced.
iv. Good voltage regulation
v. Reduction of electricity bill

D. Automation of operation of cooling water facility using PLC:

Today, automation is moving rapidly towards a true point of central control that resides in the system operator's office. It is becoming increasingly necessary for the system operators to have fingertip control of the process. This has been greatly fulfilled by the use of programmable devices. Programmable devices eliminate the need of complex components and discrete components. They are also more reliable , cheaper and it can withstand harsh factory environments, perhaps the biggest advantage of programmable devices is that their functions are easily changeable by merely changing the program stored in them thereby eliminating the need for replacing the whole system . Additional changes can be made incrementally. They also allow interaction with other systems and since their outputs are digital, their working can be easily monitored by computers. In world of automation, the programmable logic controller has become a standard for control. It now not only replaces the earlier relay controls but has taken over many additional control functions. PLCs are used to synchronize the flow of inputs from sensors and events with the flow of outputs to actuators and events. This leads to precisely controlled actions that permit a tight control of the process or machine .This project is devoted to the principle upon which PLCs operate.[3]

III. ALGORITHM USED



IV. ANALYSISANDINTERPRETATION

Capacitive kVAR to be added at the motor terminals for improving the present pf of 0.76 to unity is given by the formula;kVAR required = kW (tan<D, - tan 0_2)

Where O] is the power factor angle before correction and 0_2 is the power factor angle after correction

Considering a pf correction to unity,

kVAR required= 38.47 (0.86 - 0)=33.08 kVAR

However, the maximum capacitive reactance that can be added to the terminals of a motor should not be more than its no-load reactance. In this case: No-load kVA of the motor= 1.732 * 425.7 *30/1000= 22.00 kVAR

The various parameters of the fan, after connecting a capacitive reactance of 22.00 kVAR will be:

Active power=38.47kW

Reactive power = 40.54 - 22.00 = 18.54kVAR

Apparent power=42.6 kVA

Current drawn by the motor= 55 A

Reduction in current=35A

Power dissipation in cable for a current of 35 A35^A2*0.154 * 3= 565.9 W

Energy consumption considering 330 days of operation for fan= 565.9 *24 * 330 = 4482.3 kWh

Considering an energy cost of Rs.2.88/ kWh; total amount for one year

= 4482.3 * 2.88 = Rs. 12,909/-

Cost of capacitor (22 kVAR)= Rs.25,000/-

A. Economic evaluation of investment Return on investment method :

By evaluating the net present value of the total cash flows, decision can be made whether the investment is economical or not. A positive net present value indicates a good investment, and a negative net present value indicates a bad investment.

Net Present Value (NPV) is given by the formula

$CFO + CF1/(1+K) + CF2/(1+K)^2 + CF3/(1+K)^3 + CF4/91+K)^4 + CF5/(1+K)^5 + CF6/(1+K)^6 + CF7/(1+K)^7 + CF8/(1+K)^8 + CF9/(1+K)^9 + CF10/(1+K)^{10} = 0$

Where CF_n is the cash flow in each year. Negative sign is given to indicate cash outflow and positive sign is given for cash inflow (saving). K is the discount factor.

B. A ssumptions*:*

Cost of energy increases by 10% once in every 3 years

Discount rate k is taken as 12%

Year	Energy cost Rs.	Saving Rs.	Cash Flow Rs.
1	2.88	12,909	11,526
2	2.88	12,909	10,291
3	2.88	12,909	9,188
4	3.17	14,200	9,024
5	3.17	14,200	8,057
6	3.17	14,200	7,194
7	3.48	15,620	7,066
8	3.48	15,620	6,309
9	3.48	15,620	5,633
10	3.83	17,182	5,532
Net Saving			79,820

NPV = - 25000 + 79,820 = + 54,820. As NPV is a high positive value, this indicates that it will be an economical investment.

V. BENEFITS

i. More amount of energy can be saved.
ii. Water can be provided to the industry with proper quantity and quality.
iii. As plc is used it is easy to operate
iv. Maintainance is easy.
v. Operator can change the program as per the requirement

VI. CONCLUSION

This project titled ' energy saving and water cooling facility in an industry using plc' is a combination of software programming and hardware interfacing circuit designed for the automatic control and power saving of the cooling water in FACT. Our proposed system uses programmable logic controllers and variable frequency drives. Techno economical analysis shows that there could be a greater improvement in the power consumption and also in expenditure.

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