PLC Controlled AHU

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Abstract- *This project deals with switching ON of AHU at fixed time one after another with appropriate delay between each switch ON time and also switching OFF only the 2 AHU motor at idle time and the entire AHU when work is completed for the day and again switching it ON 1 hour before starting of first shift. Presently, the AHU is operated by a hardwired circuit which requires manual switching ON and OFF of the AHU only at start and end time respectively. This project aims to minimize energy consumed during idle time and at shift end time. The proposed system makes use of a PLC which does all the automation tasks. Simple ladder logic programming using GX Works 2, Version 8 which is a programming and maintenance tool is employed. This system not only saves energy but also reduces manual involvement greatly.*

Keywords- AHU, PLC, ladder logic programming.

I. INTRODUCTION

A. *AHU (Air Handling Unit)*

Construction and Working: The AHU being used is hardwired. There are 3 AHU here. Each AHU has 3 motors: a) To pump water from the tank onto the wet pad. b) To run air blower. c)To run the secondary blower. Warm air/atmosphere air is sucked into the AHU and is passed through wet pad thereby cooling it. This air is then passed through a blower which blows it into the engine assembly, which is a closed and controlled environment, in order to prevent any dust entry into the assembly area, by maintaining a positive pressure inside the assembly. Between the blower and water pad some amount of air is heated due to heat generated by running of motor which is sucked and blown out to the atmosphere by the secondary blower. There is an external water tank outside of AHU which is used to supply water to the internal tank if it goes below a threshold limit. If door of AHU is opened it normally stops functioning and this is provided as a safety feature.

TABLE I AHU DETAILS

Model number	HMX24K
Sl No.	100543
BLOWER H.P.	15 HP
Air Volume	24000 CFM
RPM	1440
S.T Pressure	65 MM WG

B. *Panel*

External: The panel on outside consists of 2 types of push button switches along with stay put switches. The 2 types of

Fig. 1. AHU

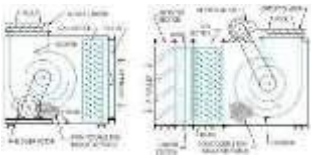

Fig. 2. Internal View of an AHU

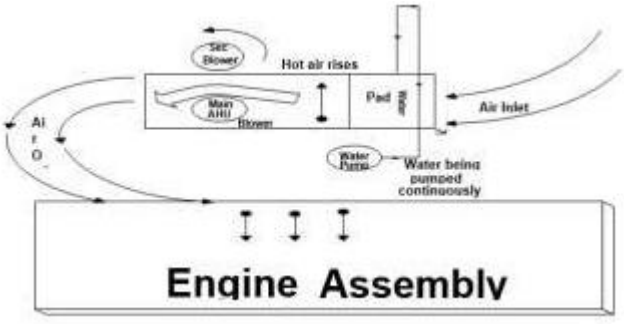

Fig. 3. Overlook

push button switches are:

1. Flush type with illumination

2. Mushroom head push button.

The flush type is of 2 types based on working and of 3 types based on illumination.

Based on working:

1. Push to make/ Normally open(NO)
2. Push to break/ Normally close(NC) Based on illumination:
   a. Green
   b. Red
   c. Yellow

Green switches indicate running. Red is to indicate that the particular switch in line with green switch is OFF. Yellow is trip switch which is ON only when the system encounters fault.

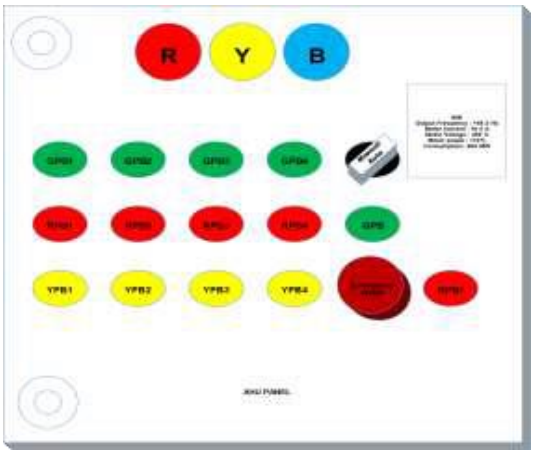

Fig. 4. Panel

Green flush push button is push to make. Red and yellow flush push button switch is push to break. The mushroom head push button switch is used for EMERGENCY STOP and is red color (not illuminated). The difference between the red push button of flush type and mushroom head is that, the mushroom head stops all activities at once but that's not the case with the latter. The mushroom head used here is latch type i.e. it stays in one state until the user himself changes its state. There are 2 more stay put selector switches which is another type of actuators. The stay put switch in line with green push button is to change state between Manual and auto modes. While the stay put in line with yellow push button is to switch light ON/OFF. If 1st stay put is in manual state, then operator himself has to operate each and every pushbutton switches to switch ON/OFF the elements of AHU as and when required. If it is in auto state, if the green push button switch after or at the end of 4th red push button switch is manually pushed then after a fixed time interval, sequential functioning of AHU starts automatically. Order of going high of green push button switch is 4—3-2-1. (See Panel Diagram). Water motors are first switched ON and running, only then after some time the air blowers are turned ON (First the secondary blower then the main AHU blower). The motor/pump used to circulate water can be placed internal to the AHU or external to the AHU. Panel has 2 locks to prevent unauthorized access to the panel as a safety precaution and also to prevent the dust entry into the panel elements, which may cause damage/failure to the elements.

Internal: The existing panel (Before this project) consists the following:

a. Timers(Multiple)
b. Switching Mode Power Supply (SMPS)
c. Miniature circuit breaker (MCB)
d. Motor productive circuit breaker (MPCB)
e. Relay
f. Choke
g. Variable Frequency Drive (VFD)
h. Contactors

The timers are used to operate the green flush push button switch after the set time. These are only used in hard wired circuit. SMPS is used to convert the 3 phase AC power

Table II Key

Push Button	Operation
GPB1	AHU Main Blower ON
GPB2	Secondary Blower ON
GPB3	Water Pump 1 ON
GPB4	Water Pump 2 ON
RPB1	AHU OFF
RPB2	Secondary Blower OFF
RPB3	Water Pump 1 OFF
RPB4	Water Pump 2 OFF
YPB1	AHU Trip
YPB2	Secondary Blower Trip
YPB3	Water Pump 1 Trip
YPB4	Water Pump 2 Trip
GPB	Automatic ON Sequence
RYB	3 Phase Input

supply to DC voltage. Here, it's input is 230 VAC and output is 24 VDC and it uses PWM principle for this AC to DC conversion. VFD: The VFD is used to vary frequency using PWM technique so that motor speed is varied as and when required to suit the climatic changes. The VFD here is set to 50. E.g. case: Let us consider ambient temperature is 350 C. We want temperature inside the engine assembly to be 250C. There is a gap of 100. We run the motor at high speed or frequency due to which the temperature dip happens faster. now let us assume the ambient temperature is at 270C and required should be 250C. We run the motor now at low speed or low frequency. This is done so that the temperature gap of

20C does not go negative which will happen if the motor is run at high speed. If inside temp (Engine Assembly) ambient temperature, then the motor is turned OFF. The internal temperature is automatically increased by heat generated by workers and machines inside the engine assembly. Above said procedure is followed manually, when there is a change in climatic condition changes. This project also proposes to automate the change of blower motor speed with respect to the ambient temperature proportionately using PID controls. As this proposal involves new elements need to be added into the system like, temperature sensors and controllers and analogue PID modules in the PLC and the lead time is high, this is not implemented as of now. But will be taken up for future. MPCB is used to trip when the motor is overloaded or there is an incoming voltage variation and also when there is an imbalance in the motor load to prevent the motor winging failure. Contactors are used for control purpose to feed or brake the supply to the motor MCB is used to trip down entire circuit under abnormal conditions say, Short circuit or abnormal increase of instantaneous current. E.g.: If current rating limit is 10A and if the supply goes beyond 10A then MCB trips to protect the circuit. It is only used in hard-wired circuit. Relays are used to as intermediate switching elements between control and power, so that any operation sequence can be controlled and interlocks can be taken. Electrical connection of Panel with PLC: 1. Supply is taken from mains (3 phase AC 440 V) and given to isolator. 2. The output of isolator is given to a terminal block (TB) which acts as distributing unit of incoming supply for the AHU panel. 3. From TB supply is given as input to 3 MPCB via an MCB (for safety purpose). The AHU has 3 motors, each MPCB protects each motor according to its specification. The MPCB specification is selected based on the motor current specification. Generally, MPCB setting is set at 804. There are 3 contactors for the 3 motors of AHU. Output of 2 contactors which control the secondary blower and water pump are directly given to the secondary blower and water pump as input. 5. The contactor controlling main AHU blower gives its output to a choke. 6. Choke is used to remove any ripples in voltage before passing to the main motor. 7. Output of choke is given as input to VFD. 8. Depending on frequency set in VFD via HMI the VFD gives a proportional output voltage and output frequency, which is fed to the main AHU blowers motor. 9. Input control signals from push button are given to PLC. The PLC output is given to each of the contactor (single wire). This is to control the switching of the contactor and thereby running of motors based on delay specified in ladder logic diagram. 10. Before input is given to contactor all output of PLC which are going to contactor pass through a relay(EMR). 11. The push button's & PLC all require input voltage supply to function. For this purpose, we use an SMPS which is supplied with 230 V AC input voltage and gives output 24 V DC which is required to run the PLC and push button (Control Voltage).

C. Programmable logic controller(PLC)

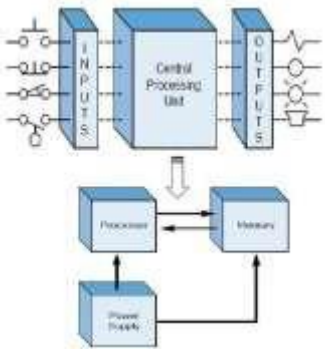

Fig. 5. Programmable logic controller(PLC)

Programmable logic controller (PLC), or programmable controller is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnosis.

TABLE III PLC DETAILS

Manufacturer	Mitsubishi
Series	FX1N-60MT
Input	12-24 VDC
Output	100-240 VAC
Output Type	Transistor or Relay

The most basic function of a programmable controller is to emulate the functions of electromechanical relays. Discrete inputs are given a unique address, and a PLC instruction can test if the input state is on or off. Just as a series of relay contacts perform a logical AND function, not allowing current to pass unless all the contacts are closed, so a series of" examine if on" instructions will energize its output storage bit if all the input bits are on. Similarly, a parallel set of instructions will perform a logical OR.

D. Variable-frequency drive

Fig. 6. Variable-frequency drive

A variable-frequency drive (VFD; is a type of adjustable- speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage. System description and operation Electronic VFDs are speed control devices which vary the voltage and frequency to an induction motor using a technique called Pulse Width Modulation (PWM). The entire process is controlled by a microprocessor which monitors the:

1. Incoming voltage supply, 2. Speed set-point, 3. DC link voltage, 4. Output voltage and current to ensure operation of the motor within established parameters.

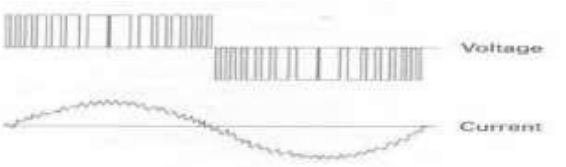

Fig. 7. Waveform

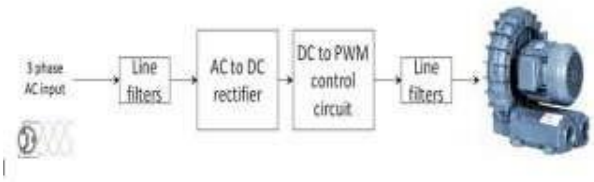

Fig. 8 Variable-frequency drive working

II. PROBLEM DEFINITION

A. Problem Overview

Plant 1 consumes on an average 59500 units per day. By interfacing PLC to run the AHU we are saving 63 units per day which comes to Rs. 1,32,000 per year. This project helps in the cause of saving energy consumed by the plant at idle time & stop time.

B. Importance of the problem

By saving energy not only is the money of the company is saved we are also helping in conserving resources and saving environment.

C. Theme

To interface a PLC to existing hardwired AHU control panel and to write a ladder logic program to do all the required sequential tasks automatically with appropriate delays in between and also to auto shut down the AHU at idle time so as to reduce energy consumed by the AHU.

III. OBSERVATION

TABLE IV VFD DETAILS

Manufacturer	Schneider Electric
Model	ALTIVAR 61
SL No.	8B 1222.205 001
Output	380/480 V AC

Existing AHU control panel as seen is hardwired circuit consisting of many electrical elements and numerous wires which makes diagnostics difficult. This is the present AHU Control panel interfaced with PLC. All Timers, most of the relays have been removed and the wiring is drastically reduced. Diagnostics are done easily now using PLC. The ladder logic program has been uploaded to the PLC and its functioning as it should be. Here, all switches have incoming

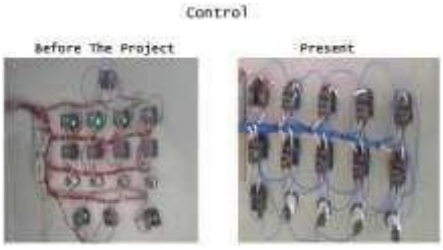

Fig. 9. Control

230 VAC. Lot of wires are used here because of presence of timers, relays in the hard wired circuit. From previous circuit most of the wiring is removed and the input to the switches is now 24 VDC from SMPS.

IV. CONCLUSION

We have successfully completed the conversion of hardwired AHU control panel to a PLC controlled panel and implemented auto shutdown at idle time. Through the course of this project I have learnt about different electrical elements such as MPCB, relay, timers etc. I have also learnt about:

1. Construction, Function, & Applications of VFD.
2. Construction, Function, & Applications of PLC.
3. Construction, Function, & Applications of AC Motor.
4. To write a basic ladder logic program and upload it to a PLC.
5. The various process involved in manufacturing of a 2 wheeler.

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