A Comparative Study and Software Design of Asp Drives with Plc and Microcontroller

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Abstract-*Ash Disposal Pump Drives are simply called ASP Drives. It is one of the Important systems in Ash Disposal Pump House system in any Thermal Power Plant. Power Generation in any thermal Power plant is possible only when ADPH system functions normal. Failure in operation of ADPH system ultimately causes Generation side Power Reduction. Hence utmost care will be given to the system drives control design to have un-interrupted operation of transferring Ash slurry to distant location.*

I. INTRODUCTION

In any Thermal Power Station, Lignite is the main fuel from which Heat Energy is obtained by burning. In Lignite, Ash content is around 8-12% depending upon mining conditions. In general, one Tonne of Lignite is approximately required to maintain 1MW of Electric Power for 1 Hour. Assuming 8% of Ash content in Lignite, Ash generation from each Unit on daily basis could be approx. 400 Tons for 210 MW power per day.

Boiler Unit emits out major quantity of Ash through flue gas. Hence, Electrostatic Precipitators are used to separate Ash powder from flue gas and then this flue gas is vent out to Atmosphere via Chimneys.

Ash powder coming out Electrostatic Precipitator is converted into Ash Slurry (mixture of Ash and raw water) and then transported and collected in Slurry pits at Ash Disposal Pump House (ADPH). Ash powder will attain the quality of cementing property once mixed with water. Hence, it must be disposed to Ash Lake as fast as we can.

II. RELATED WORK

To do this job, there are networked ASP series drives are there in ADPH system. Each Unit has one series (consists of three 160 kw motors) and two back-up series for redundancy. The starting of any series may be done in Manual or Auto. This is possible only from Control Room of ADPH. The starting of ASP series drives number of interlocks to satisfy.

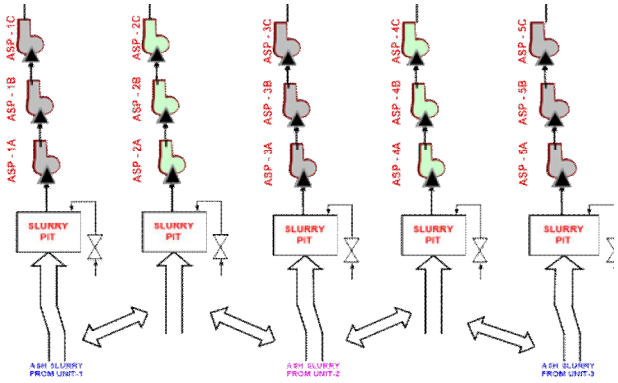
1. Any slurry pump series can be started if the following conditions are fulfilled.

a) Preset seal water pressure available at each pump.
b) The level of ash slurry sump is in sufficient level.
c) Suction valve is open

2. Each slurry pump series will trip in the event of following conditions

a) Any pump of the series is tripped.
b) Preset seal water pressure is not available at any of the pumps.
c) The level of slurry sump falls below low level.
d) Suction valve is closed.
e) Discharge valve does not open within a predetermined time from the starting of the slurry pump.
f) On applying local emergency
g) On Protection relays detection of electrical fault.

The first stage pump of the slurry pump series will be started from the panel. After a time delay of 30 seconds and 40 seconds, the second and third pumps are started respectively. If any of the seconorthird pump does not start within 50 seconds of the starting of the first pump, then the first pump automatically tripped.



Complicated interlocks and time delays with sequential control- including ADPH source protection activities – makes the present control technology to be “highly complicated and use of relays, timers make bulky circuits with more power consumption. So, at most importance is being

given to the drive control and interlocks to ensure safe and secured operation- thereby ensuring un-interrupted power generation.

The present way of drive control is being done through traditional Relays and timers based. This Original Manufacturer Design (OEM) called Hardwired control logic uses control relays and physical hardware timers for On/Off delay functions. Since the ADPH system involves more logics and facilities, the usage of relays, timers and associated wiring designs makes this system highly complicated and bulky.

This is the main drawback of this type of control. During problem times it requires more time for trouble-shooting. Without detailed circuits or drawing supports, the system recovery could be a question. On considering the above reasons and to enhance the "Control Logic Design" of ADPH system, another user-friendly reliable design is required.

III. HYDRO ASH DISPOSAL SYSTEM

Lignite has a lower ash percentage varying in between 6 to 12% and a quantity of approximately 15 T/hr (max) is produced while burning about 210 T of lignite. The ash disposed off at this stage is estimated to be about 5 to 10% of the total ash. However the bottom ash disposal system has been designed to handle 15% of the total ash in the fuel.

Major amount of ash is carried along with the outgoing flue gases from the furnace as fly ash. Modern air pollution standards are stringent and call for highly effective ash separation systems. Hence electrostaticprecipitators find wide application replacing conventional mechanical precipitators due to oveerwhelming advantages in respect of pollution, operation and maintenace The ash separated out of the gas stream is to be effectively disposed off, taking care to keep pollution of the surrounding to the minimum. Hydro ash disposal systems, wherein one part of ash is mixed with 25 to 30 parts of water to disposal of the ash in a slurry form, is found to be an efficient and dust free method of disposal.

A hydro ash disposal system has been installed at Neyveli Thermal station-II steam generators for the above purpose.

IV. PROCESS & EQUIPMENTS:

The process and equipments related to the existing ash handling system of TPS-II stage-I are detailed under:-

To make slurry from Ash powder and then for transporting slurry first to slurry pit and then to Ash lake, raw water is mainly used as carrying medium. Low pressure pumps are used to form slurry and High Pressure pumps are used to transport it.

V. ASH MIXING VESSELS

Each boiler has been provided with 52 ash-mixing vessels. Out of which 48 are below the electrostatic precipitators at the rate of 8 per field. Two vessels are below the regenerative air pre-heaters, one per RAPH on gas side. One is below the 8-meter diameter flue gas duct and another is below the chimney.

The slurry is then transferred through a 200mm diameter discharge pipe to the channel below.

VI. CHANNEL ARRANGEMENT

Slurry channels in the form of open trenches are provided below each field of the EP. Eight ash-mixing vessels discharge their slurry to one channel. Thus there are six channels in the EP area.

The jet nozzles are located at intervals of 10 meters in the case of tunnels. The tunnels are located at a minimum depth of 2meters below ground and are covered with RCC slabs allowing 250mm wide path on one side and 750mm wide path on the other side. These paths are provided to facilitate cleaning.

VII. ASH DISPOSAL PUMP HOUSE COMPLEX

The ash disposal pump complex comprises an ash water pump house where H.P & L.P water pump are located and Ash slurry pump house where slurry pumps are provided.

Ash Water Pump House

The ash water pump house is located on the right side of ash pump house complex. 4 low pressure water pumps, 4 High pressure water pumps and 2 seal water pumps are located.

This pump house is built in with an underground pit of 5.6m and a water level of 4.6meters is maintained in this pit. The front right corner of the pit for an area of 4.6m × 4.1m is separately isolated and service water pumped by bore well pump is supplied here.

This service as the suction sump for the seal water pumps. The other portion of the pit, from which LP & HP water pumps have their suction, gets its water supply from the circulating water system

VII. LOW PRESSURE WATER PUMPS

Out of the four LP water pumps located in the right rear side, three will be running and one is standby. This is a four stage vertical turbine pump of capacity 650m3/hr capable of developing a pressure of 5.5kg/cm2 and runs at 1485 rpm. It is driven by a 415V, 140KW, 3ϕ motor. (Maximum current 252 Amps).

High Pressure Water Pumps

Four HP water pumps are located in the left rear of the ash water pump house. Three of them will be normally in service while the fourth one is a standby. The capacity of the pump is 450m3/hr and the discharge pressure is 8.5kg/cm2.

It is a six stage vertical turbine type pump driven by a 415V, 147 KW, 3ϕ electric motor (max. current 265 Amp).

Seal Water Pumps

Six seal water pumps each of capacity 75m3/hr are located. It is capable of developing a pressure of 11kg/cm2 (should be above AD pump discharge pressure of 10.2KSC by at least 0.7KSC) in order to ensure effective sealing. The pump is driven by a 415V, 3ϕ, 75 KW motor at 1475rpm (Max current 120 amps).Seal water is supplied for gland sealing of the following.

1) 1) Running ash slurry pumps (Normally 3 sets) - 36 m3/hr.
2) 2) 3 Numbers L.P pumps - 12m3/hr
3) 3) 3 Numbers H.P pumps - 12 m3/hr

Ash Disposal Pumps

The ash disposal pumps are designed with 50% extra capacity taking the ash content as 12%. The minimum ratio of ash slurry to ash by weight is 25:1. Specific gravity of ash slurry handled is 1.02. The ash slurry velocity in the pipeline is in the range of 2.5 to 3 m/sec, which is optimum to keep the pressure loss due to friction low. The pump is single stage centrifugal pump of capacity 1100m3/hr and is capable of developing pressure of 3.4KSC.

The three pumps running in series will develop a maximum pressure of 10.2KSC. The pump is directly coupled to a 3ϕ, 415V, 160 KW induction motor running at 740rpm, and the maximum current being 285 amps.

Seal water is supplied at the rate of 4m3/hr to each pump gland at two points at a pressure of 0.7 to 1.0KSC, higher than the discharge pressure.

Pressure gauges are provided at the delivery of each pump. The five discharge lines coming out of the pump house take a 90o bend to the left. From here there are five delivery lines for taking the slurry to the ash lake.

The ash bund is of capacity 3.25 million cubic meters-sufficient for 10 years. It is of shape approximately a square formed by walls varying from 11 to 15 meters height

Drain Pumps

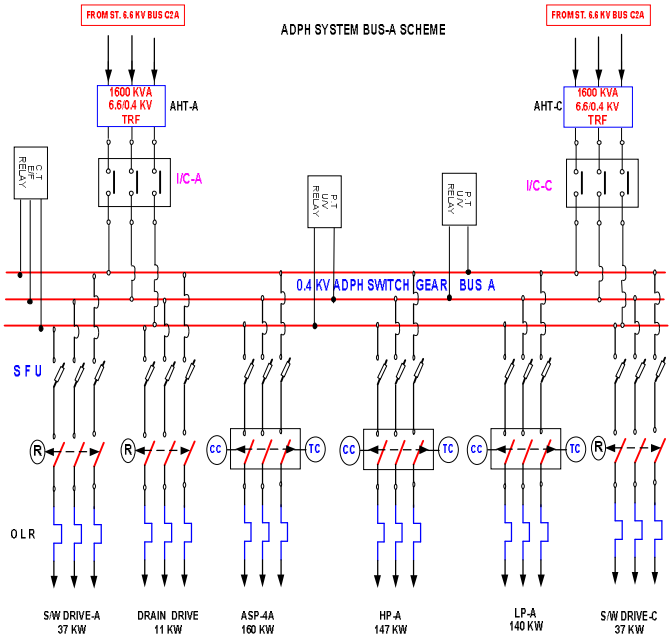
There are 2 drain pumps, located in slurry pump house. Each pump is driven by a 415V, 3ϕ, 10KW motor running at 1440rpm and is capable of developing pressure of 1.5KSC. Discharge line is connected to an open channel outside the ash disposal pump house.

Ash Pump House And Power Distribution

Three numbers 1600KVA, 6.6/0.4KV transformers take care of the power needs of Ash disposal pump house complex. Two independent buses are there through which power is fed to the various pumps. The breakers are provided at 0ML and the control panel is at +5ML.

The power system has three 0.4 KV buses. The main 6.6 KV supply tapped from Station source. There are four transformers A, B, C and D of capacity 1600KVA which will give 0.4 KV at its secondary.

The bus scheme for ADPH bus-A is shown here.



VIII. INSTRUMENTS, ANNOUNCIATIONS AND INTERLOCKS

Slurry Pit Level Protection System

The pit level protection system consists of a compressed air operated bubbler tube. The bubbler tube is supplied with compressed air at a constant pressure of 7.8KSC. The other end of the tube is immersed in ash slurry in the sumps. Continuously a small amount of air escapes from the bubbler tube bottom in the form of bubbles. The compressed air pressure in the bubbler tube varies according to the water level of the sumps because the resistance offered by the slurry to compressed air escaping varies with water level height.

There are six pressures tapping from the outlet of the bubbler tube. The tappings are meant for the following purposes.

1. Low level alarm
2. Low level trip
3. High level alarm
4. High level trip
5. Level indicator - 2 Nos

Pressure switches are provided in the first four tapping to achieve the required purpose.

SEAL WATER SYSTEM

Instrument Tappings

1. One pressure switch is provided at the common discharge of seal water pumps for annunciation of low header discharge pressure.
2. Level switches are provided in seal water pump for the provision of control indications for annunciations.

H.P WATER SYSTEM

Instrument Tappings

1. One pressure switch is provided in the seal water line of each H.P water pump.
2. One pressure switch is provided at the common discharge header of H.P water pumps for annunciation.
3. Level switches are provided on ash water sump.

L.P WATER SYSTEM

Instruments

1. One pressure switch is provided in the seal water line of each L.P water pum4.6 ASH SLURRY PUMPS

INSTRUMENTS

1. One pressure switch is provided in the seal water line of each slurry pump.
2. One pressure switch is there in each ash slurry sump for annunciation “low sump level” and another for “High sump level”
3. One pressure switch is there in each ash slurry sump at trip level for control & interlock.

ANNOUNCIATIONS

1. ‘Set of slurry pumps tripped’ - One window provided for each series.
2. ‘Slurry sump level high’- One window provided for each sump.
3. ‘Slurry sump level low’- One window provided for each sump.

CONTROL & INTERLOCKS

For Auto starting from control room of ADPH system.

1. Any slurry pump series cannot be started if the following conditions are not fulfilled.
   a) Preset seal water pressure available at each pump.
   b) The level of ash slurry sump is not below the trip level of the pump.
   c) Suction valve is open

2. Each slurry pump series will trip in the event of following conditions
   a) Any pump of the series is tripped.
   b) Preset seal water pressure is not available at any of the pumps.
   c) The level of slurry sump falls below trip level.
   d) Suction valve is closed.
   e) Discharge valve does not open within predetermined time from the starting of the slurry pump.
   f) On applying emergency switch of any running drive
   g) On detection of any fault in the drive by the protection relays.

3. The first stage pump of the slurry pump series will be started from the panel. After a time delay of 30 seconds and 40 seconds, the second and third pumps are started respectively. If any of the second or third pumps does not start within 50 seconds of the starting of the first pump, then the first pump automatically gets tripped.

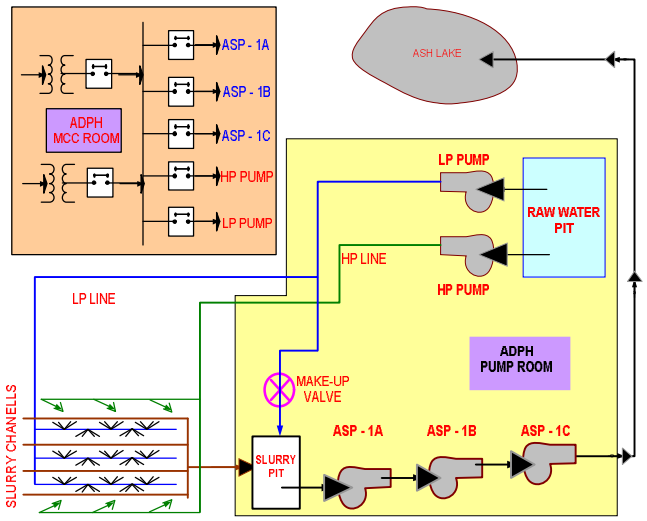
ASP DRIVE CONTROL & INTERLOCKS

The following operation sequences are to followed to keep ASP series

The below conditions or interlocks are highly required to start and run Ash slurry pump drives. It is valid for auto and manual options.

1. Ensure Raw water level in the Raw Water Sump. This condition is used as one electrical interlock for the starting and auto tripping of HP, LP, SW Pumps.
2. SW Pump (any one) is brought into service.
3. Start one HP and One LP Pumps for each unit.
4. Ensure sufficient level in Ash Slurry Pit. If sufficient level is not there, open make-up water line to keep pit level sufficiently. This condition is used as one electrical interlock for the starting and auto tripping of first Ash Slurry Pumps.
5. Ensure that at the time of every time of stopping of ASP series, Line Flushing valves are opening for some time to admit raw water to the Ash Slurry lines upto lake point and then valve closing. This is to flush out any stagnation of slurry within the pipe line till next operation.

All these above operations are applicable to all other ASP series. In case of non-availability or tripping of any working ASP series, other back-up series can be taken for service in place of faulty series. This facility is also available at site. These are all the details from operation point of view.



8051 MICROCONTROLLER

While studying microprocessor based system design ,a stand alone microprocessor is not a self sufficient device to form a minimum workable system configuration .so we have going for microcontroller.

A Microcontroller has a CPU (a microprocessor) in addition to a fixed amount of RAM,ROM,and a Timer are all embedded together on a chip.

A Microcontroller is a device which integrates a number of components of a microprocessor system on to a single microchip and optimized to interact with outside world through on-board interfaces i.e it is a small gadget to house a microprocessor

REPLACE CONTROL LOGIC BY MICROCONTROLLER

In recently nowadays control logic is work under the combination of relays and timers.So for this construction the circuit shown as to be a hard physical wiring circuit.so we have to replace control logic which is composed of relays and timer by means of microcontroller on a single chip.

LIMITATIONS OF RELAY BASED CONTROL

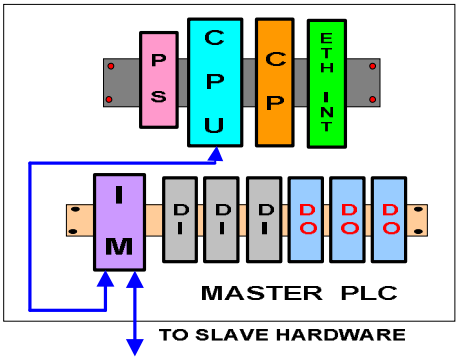
- For any automation in power plant, large number of relays will be required. The increase in number of relays/timers makes the wiring complex.
- In electromechanical relays, if damping force, spring balance are not accurate, the time setting and current setting may changes.
- Physical wiring of system is complicated and difficult.

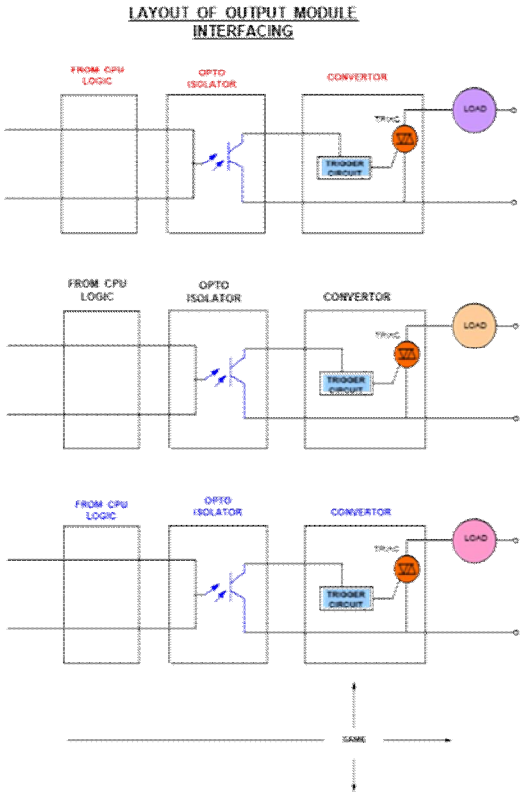
- Panel board arrangement occupies more space. The arrangements also require proper ventilations. The arrangement is not simple and neat.
- Their parts can wear out as the switch contacts become dirty high voltages and currents cause sparks between the contacts.
- Their coil need a fairly high current to energize, which means some micro electronic circuits cannot drive them directly without additional circuitry.
- They cannot be switched on and off at high speed because they have a slow response and the switch contacts will rapidly wear out due to the sparking.
- Relay has slow communication speed and turn around time of the protective relay.
- In the case of hard-wired logic required frequent maintenance and occasional replacement of contact. The maintenance cost will be more.

XI. PROGRAMMABLE LOGIC CONTROLLER

DEFINITION

Programmable logic controllers, also called programmable controllers or PLCs, are solid-state members of the computer family, using integrated circuits instead of electromechanical devices to implement control functions. They are capable of storing instructions, such as sequencing, timing, counting, arithmetic, data manipulation, and communication, to control industrial machines and processes.





Advantages Of Plc Over Other Available Technologies

1. The process inputs are connected directly to the PLC input module. Hence it doesn't require any additional interfacing agent like the other available technologies.
2. The executed results of our process activities are also taken directly from PLC, through its output module.
3. More than 80% of physical wiring will be avoided using this intelligent hardware, whose operation purely depends on software.
4. No limitation for the auxiliary contacts as in the case of hard-wired logic. We can use thousands of NO-NC for a programmed coil or register (solid memory)
5. It does not require physical Timers, Counters. All these will be availed as software. It just need the delay time.
6. PLC proves its talent in Power plants, Chemical Plants, Cement factories, Aircrafts. Hence any level of complications can be solved in real-time.
7. It will support for Real- Time monitoring of electrical and Instrument Process.
8. Power consumption is very minimum.
9. Accommodates very less space.
10. Supports well for further expansion.
11. User-friendly software – easy to understand.
12. Trial running is possible. This is very useful because we first check our logic for results that we need for our process requirements. If the results are correct or our

program is correct then we will command PLC to run our program.

X. CONCLUSION

PLC makes the system control with high reliability, relatively at faster speed of data transfer compared to other available technologies and consumes very less power, for its operation. . It is a rare chance to know automation concepts but we had and we use it well. During odd events, it requires more time for trouble-shooting. Without detailed circuits or drawing supports, the system recovery could be a question. On considering the above reasons and to enhance the "Control Logic Design" of ADPH system, another user-friendly reliable alternate technology is required. Micro-Controllers and PLCs are the fastest upcoming control technologies in the area of control applications. We are very much interested to do our presentationt iSn this area of ADPH system, to design hardware and software requirements for One ASP series automation with the help of Micro-Controller system and PLC.

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