An Intelligent Conveyor Control System For Coal Handling Plant Of Thermal Power Plant

By: Makarand Joshi
Email: makarandj@hotmail.com

1.0 Abstract: -

Conveyors are seen on virtually all in the Coal Handling Plant (CHP). CHP are having number of conveyors. The control systems used for these conveyors are important for operating safe plant. Basically conveyors are dumb, but once equipped with proper control system they yield efficient and safe plant operation. Electronic intelligent conveyor control technology is useful for complex conveying tasks. But in CHP for control of conveyer system still use of simple on/off switches and some forms of speed switches are used. These switches are only play roll of protection up to some limit. These conveyors control system are the biggest problem for the plant operator and maintenance engineer, being the cause of unsafe plant operation, which forced to plant breakdowns and interrupt coal supply to boilers results in loss of generation.

This paper has been focused on the required conveyor control system, which will fulfill requirements smooth, and safe plant operation.

2.0 Introduction: -

The efficiency of CHP is depending upon availability and reliability of conveyor system. If a conveyor system is working well, it is almost invisible to the CHP. A single conveyor can run at close to 100% reliability, but as the number of conveyor increases, the reliability of the conveyor system is mostly depend upon its control system. The control system should be capable to fulfill all the need of CHP operation.

The existing systems are designed to take care of only conveyor stoppage due to conveyor zero speed and sequential operation. They also ensured of auto operation of dust spray system. The measurement of coal transported is done automatically by this system. But improper system feature could not fulfill CHP operation requirement. At maximum places the simple relay control system with old style mechanical sensing devices are used.

For fulfilling the requirement Electronic intelligent conveyor control system has developed. This system will take all the constraints of old system and also having additional feature like feed rate control.

3.0 Existing Control System: -

The existing system has sensing device like zero speed sensing, receiving conveyor position sensing. It has also facility for selection to operate conveyor avoiding control system i.e. manual run mod. In some CHP there is facility of three type of selection. One is for start or stop plant with auto mode. In this mod each conveyor will operate sequentially after selecting the stream. Second which is in all CHP for start or stop of plant with manual mod. Third is operating the system without any protection or interlock.

3.1 Operating Principle: -

Before starting conveyor system it is necessary to start first receiving conveyor and then start feeding conveyor i.e. operating logic is from down stream to upstream. For stopping of conveyor system the operation will be opposite i.e. from upstream to down stream. So it is necessary if any conveyor is stopped in the system all the upstream conveyor should stop automatically. The existing system takes care of this logic. This is known as conveyor sequential operation. If due to any problem the rotation of conveyor becomes slow or towards zero its necessary to stop the conveyor. This is known as zero speed protection. Existing system takes care of it and stops the conveyor and further stop the upstream system sequentially. The dust suppression

system should be operating when there is coal flow. This is done by sensing via simple mechanical under belt switch. The measurement of coal flow is done by using load cell.
The block diagram of shown in figure no 1 will give idea about control system.

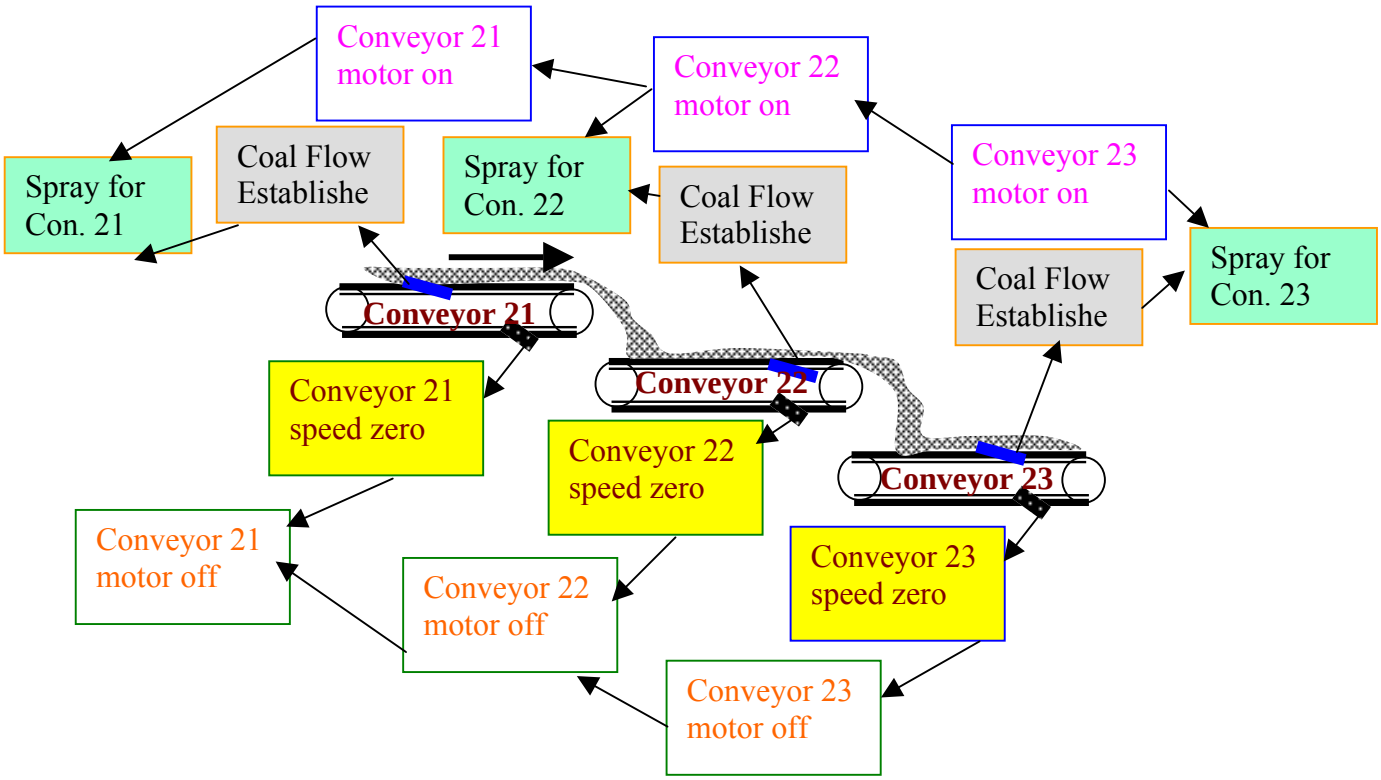

Figure No 1

For dust suppression system the spray header will be on when the contact of under belt switch is true and motor is in on. This two no of sensing is taken to avoid spraying when conveyor is not rotating but contact of under belt switch is true due to coal is laying on belt.

3.2 <u>Draw Back Of Existing System</u>: -

The main problem of this system is required to keep continuous watch on each conveyor current because of choking of transfer chute or jamming of conveyor. Many times it is required to reduce the feeding rate by adjusting feeder to reduce the current of conveyor. When current comes to normal again it is tried to establish the required feed rate, if it is not again establish by stopping the conveyor system the problem is identify and attended. This problem majorly occurs in rainy season when coal is in wet condition. Some times operate specially cannot identify the increase current it will cause heavy coal spillage from transfer chute. This will tend to interruption of coal supply to boiler.
For sensing of speed simple proxy switches are used. These switches many times causes problem due to coal spillage when they are mounted on tail end pulley. As proxy switches are basically on/off switches equipped with timer, they are less

reliable. Some of CHP used centrifugal switch, which is driven by the conveyor. The main problem of this witch occurs when the spring functioning is improper i.e. reduction of spring tension.
The major problem of this system when the conveyor motor power fuses blown off, it will stop the rotation of conveyor but will not stop the upstream conveyors as controller sense motor is running because the control supply does not pick up motor off relay. Because of this the logic of system fails.
The control of the system is not depending [1] on the quantity of dust emission and measurement of coal flow is not play any roll for controlling the system.

4.0 An Intelligent Conveyor Control System: -

The control system, which will replace the existing system, must overcome all the drawbacks of old system. The system, which is suggested, will work by only using tachometer, load cell and electronic cards in place of relays.

4.1 Operating Principle: -

Belt speed is measured by a tacho-generator, which may be attached to any non-drive pulley. This speed measurement is used for weighment of coal, which is with conveyor. In new system tachometer is main part, which helps for controlling system smoothly. This will sense non-drive pulley speed. The output of this will be compared continuously with current drawn by conveyor motor and load cell [conveyor weighbridge} output. This will govern the feeder rate.
For tachometer, which is mounted on non- drive pulley
Let E_{t1} = generated voltage, K_{T1} = the constant, $ş_{(t1)}$ = the speed of non-drive pulley.
Then $E_{t1} = K_{T1} . ş_{(t1).}$ ……1.
For load cell which is mounted below conveyor
Let E_c = generated voltage, K_c = the constant, $W_{(c)}$ = the weight of coal at that time.
Then $E_c = K_c . W_{(c).}$ ……2.
For calculating feed rate it is required to compare by comparator of weighbridge (Wb)
Let E_{ct} = out put voltage of comparator, K_{ct} = the constant, $W_{(ct)}$ = the feed rate of coal
Then $E_{ct} = K_{ct} . W_{(ct).}$ ……3.
And $E_{ct} = E_c / E_{t1.}$
Let S_R = Reference single, S_E = Error single, S_F = Feed back signal, S_O = Out put signal (for feeder speed adjustment),
$S_F = E_{ct}$ …… As the out put voltage of weighbridge is same as feed back signal.
Putting value in 3.
$S_F = K_{ct} . W_{(ct).}$ ……4.
The current transformer Mc senses the current drawn by motor.
Let E_m = equivalent output voltage with reference to motor current transformer Mc
T.F. = Transfer function, it depends on the type of regulating system.
The comparator Cml compare current transformer output signal with out put signal of comparator of weighbridge (Wb)
Let E_{ml} = out put voltage of comparator Cml, K_{ml} = the constant, $W_{(ml)}$ = the feed rate of coal per motor power
Then $E_{ml} = K_{ml} . W_{(ml).}$ ……5.
And $E_{ml} = E_{ct} / E_m$
$S_{ml} = E_{ml}$ …… As the out put voltage of comparator is same as feed back signal.
Putting value in 5.
$S_{ml} = K_{ml} . W_{(ml).}$ ……6.

The feed rate is to be decided and then it is to be set for controller by adjusting pot position. The speed of feeder is change as per feedback received from weighbridge. Then at same time feedback is received for feed rate per motor power. As the feed rate per motor power is reduced the speed of feeder will be reduced and will protect the system. At the same time it will alert the operator by blowing alarm. The block diagram shown in figure no 2 will give idea about the same.

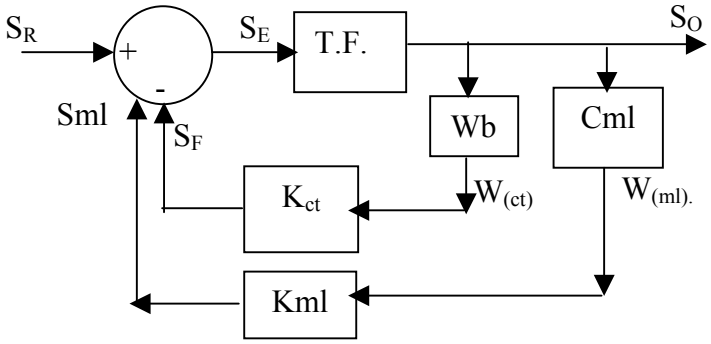

Figure No 2

For spraying the water on the belt the signal will receive from the weighbridge. As flow of coal is established the no of nozzles mounted on belt will operate in proportion to the coal feed rate. The feedback will take by measuring dust emission and corrective action will be taken. See figure no 3.

Let S_{R1} = Reference single, S_{E1} = Error single, S_{F1} = Feed back signal, S_{O1} = Out put signal (for no of nozzle opening),

From 4

$S_{F1} = S_F = K_{ct} . W_{(ct)}$…..7.

For measuring the dust emission the Sensitive phototransistor type device used. This device Md will transfer signals.

Let E_{md} = out put voltage Md, K_{md} = the constant, $W_{(md)}$ = dust emission rate.

Then $E_{md} = K_{md} . W_{(md).}$ ……8.

$S_{md} = E_{md}$ …… As the out put voltage of comparator is same as feed back signal.

Putting value in 8.

$S_{F1} = K_{md} . W_{(md).}$……9.

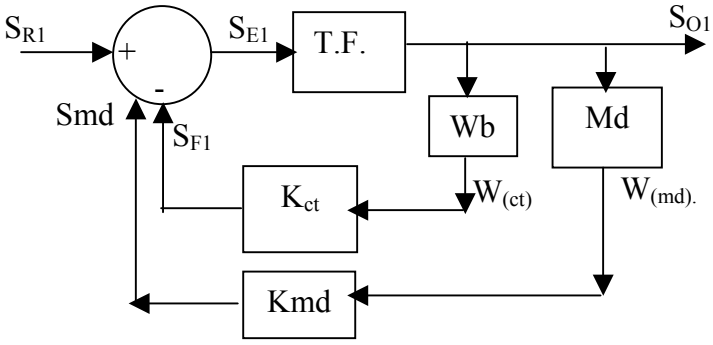

Figure No 3

This two controller will ensure the conveyor system operation very smooth. The block diagram shown in figure no 4 will give clear idea about this system. Using analog to digital converter all the data can be easily recorded in computer.

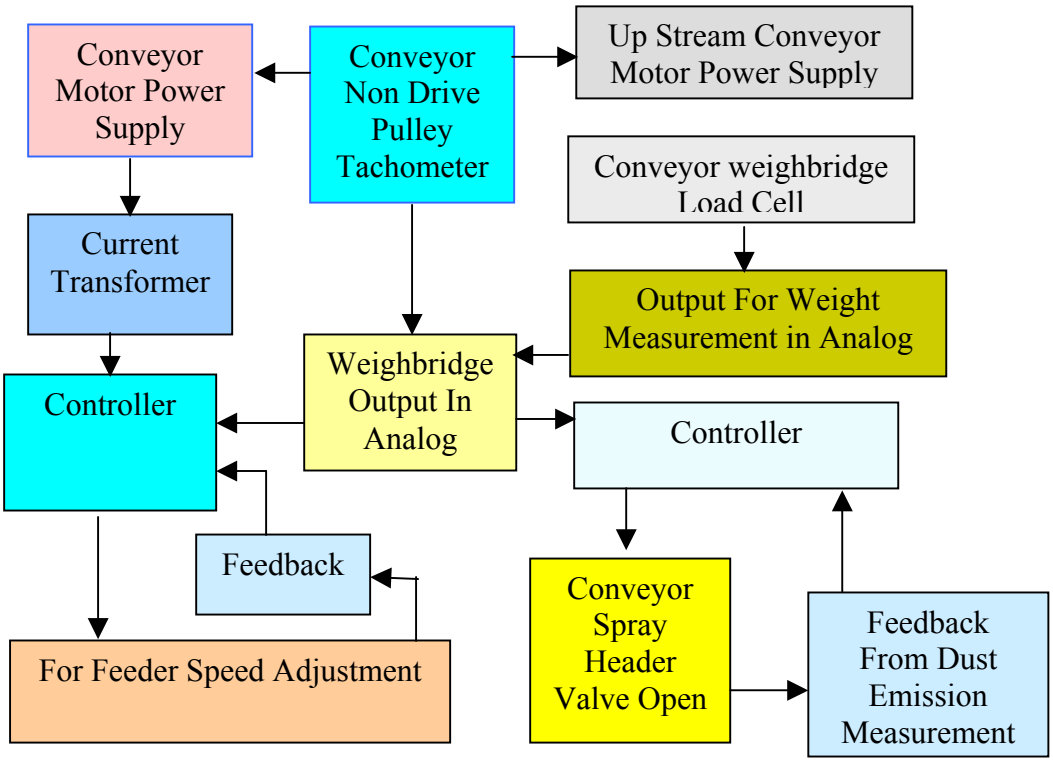

Figure No 4

5.0 Conclusion: -

The system suggested is easy to install. The system is having greater reliability and protection. The system does not require any complicated sensors. All the drawbacks of existing system are removed in the suggested system.

6.0 Reference: -

1. Technical paper on "Failure of Dust Suppression Systems in Coal Handling Plants" by Makarand Joshi, in M-News Edition 19 of Plant Maintenance Resource Center [Industrial Maintenance Portal] at web site www.plant-maintenance.com/articles/dust_suppression.pdf