Role of automation in controlling cost of HR

Over the years the demand for high quality, greater efficiency and automated machines has increased in the globalized world .Automation can play a vital role in cost saving as well as improved and continues production in a sugar industry. Though automation is not well introduced in sugar industries in Pakistan but this trend is changing rapidly. Installation of automation may have one time initial cost but it can save a lot over the period of time. The areaswhere Automation can be most effective are less manpower, controlled process flow, excess energy saving, reduction in accidents and better quality results. Looking over the process of sugar industry, automation increases efficiency in every step. These areas are:

Reduction in Labor:

A great deal of cost of labor can be reduced by implementing automation. Previously where a person was required for manually operating valves, giving feedbacks and controlling process; installation of control system has made the job easy. Now a single operator is required for monitoring all the process over an HMI. Starting over from where sugarcane or beet is fed, manual feeding would require more labor, more time and less control over the operation but installation of auto jacks will provide control feeding automation will provide a reduction in the cost of extensive labor controlled feeding as is further required in the plant.

Energy saving:

Automation has provided a great deal of energy saving. Increasing power where required and reducing where not by using a control system can save a lot of power. For example Installation of VFDs and control cards on motors and developing control logic for controlling designated process variable will reduce power where not required and will provide us to eliminate the loss of extra energy.

Our cutter Motor rating 900 KW was installed at Cutter No.1 and it damaged due to excessive cane feeding. We have removed it and install 600 KW HT motor with motor current interlocking. Vfd of cane feeding carrier No. 1 was directly controlled by the current of cutter Motor.

Output of cutter motor CT was converted into 4-20 ma signal and it was connected to carrier VFD as speed set point. Further same signal was inverted, scaled and filtered. Response time was adjusted to 0.2 sec and it worked fine during whole season.

Net saving of 300 KWH with giving relief to every shift operator as same speed was controlled automatically with better efficiency.

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Power saving in 24 hours = 7200 KW

Total power saving due to said automation for 100 days season at rate of Rs. 7.82

= 7200x100x7.82

Amount Rs. 5630400/- was save by converting single motor from manual control to auto control.

Improved Quality:

The automation improves the quality of production. Controlled and calculated dosing of materials and operation of every step over designed set points will improve quality, result in better precision and less stoppages will increase production as well.

Accidents:

Automation reduces the number of accidents. It notifies about the alarming situation and automatically trips or stops the process before causing any breakdown or serious accidents. The number of accidents that were previously caused due to carelessness of worker and human errors will be eliminated by using automated system.

Data recording:

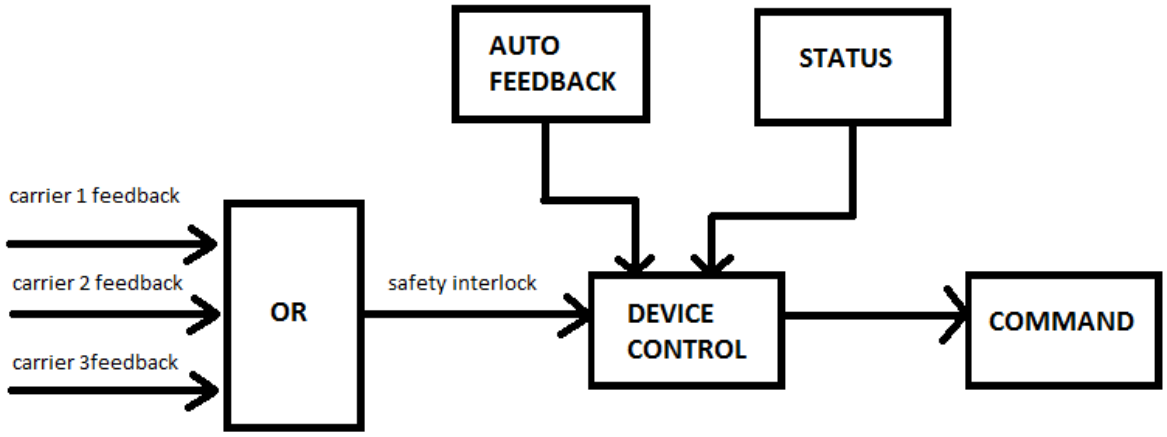
Automation does not only provide the control of a system but you can also constantly record data over a period of time. You do not require to manually record values at different times that is prone to human error. One can get complete trends of process variables and outputs from controller that does not only help in data recording but also be helpful in determining the problem at a specific time and troubleshooting it.

Some Examples of automation in sugar industries

Interlocking of conveyer belts:

The interlocking of conveyer belts is one of the examples of automation in sugar industry. If there are multiple conveyer belts for carrying sugar cane or beet than interlocking between carriers can be used. This keeps us from appointing an operator with each carrier belt and saves us from any accidents that may be caused because of miscommunication, carelessness of worker or failure of any equipment. In this interlocking the command is generated by the controller and the feedback is taken by the starter of motors installed with each carrier. If any of the feedback is

broken in this chain of conveyers, all the carriers will stop to prevent choking and massive breakdown.



Control Logic of Carrier Interlocks

Control for Motor:

1. **Mutual Control:**

A self-intelligent system can be introduced in sugar industry with cutter motor, shredder motor or mill house motors that have high torque and work on high load when the cane passes through them for cutting or shredding. The cane is transferred to them by conveyer belts. The load on these motors can be controlled by installing VFD on conveyer belts. The current of these high torque motors are monitored by current transformers. This current signal is converted into a control analog signal using a current transducer for VFDs installed on conveyer belts. By scaling the current signal in VFD's and using inverse logic this system can control the load on these motors. As the current of the motors increase due to high load (over feeding of sugar cane) the speed of conveyer belts will reduce automatically, thus reducing feeding of cane. This self-intelligent system is energy efficient, more protective and requires less no of machine operators.

2. **Self-Control:**

A self-control system can also be installed with motor. In self-control system the motor's current will be measured, converted into control analog signal and will be fed back to the VFD or control

card of the motor. This system can be installed on motors of pressure feeders and mill house. When the load on the motor will increase the motor speed will increase to clear the cane from choking, and when the load will decrease the motor speed will reduce to extract more juice from the cane.

Motor Protections:

There are several kinds of motor protections and interlocks that can be introduced on motors using control systems. These protections/interlocks provide safety as well as automation of the process

1. Operation Interlocks:

Operational interlocks include the ongoing logics involved during operations. These interlocks are overruled when in manual mode.

2. Safety Interlocks:

These interlocks include any safety precaution installed with the motor. For example, If certain motor requires cooling water at its inlet to maintain its temperature then a pressure switch will be installed in water line to determine the presence of cooling water and its signal will be used to run the motor. The motor will not start unless signal is returned from the pressure switch. These interlocks cannot be bypassed in auto or manual mode.

Protection Interlock:

This interlock will provide protection to the motor in case of any unwanted scenario. These interlocks include motor temperature, emergency stop, MCC fault and motor overload. All these parameters are constantly monitored and motor will be operational if all these parameters are in their allowable ranges.

Automation of Exhaust Type Steam Turbine:

Introduction

Most Sugar industries are capable to generate power for its internal use and for export purpose. With bagasse obtained as a bi product it is used as a fuel for boilers. Most of the sugar industries have their own power plant. Over the years the demand for high quality, greater efficiency and automated machines has increased in the industrial sector of power plants. Power plants require continuous monitoring and inspection at frequent intervals. There are possibilities of errors at measuring and various stages involved with human workers and also the lack of few features of microcontrollers. Thus this paper takes a sincere attempt to explain the advantages the companies will face by implementing automation into them.

In order to automate a power plant and minimize human intervention, there is a need to develop a control system that monitors the plant and helps reduce the errors caused by humans. While the

HMI is used to monitor the system, PLC (Programmable Logic Controller)is also used for the internal storage of instruction for the implementing function such as logic, sequencing, timing, counting and arithmetic to control through digital or analog input/ output modules various types of machines processes.

Advantages:
Higher productivity, centralized monitoring, improved safety in working condition.

Critical Parameters to measure and control:

1. Turbine RPM
2. Vibration and axial displacement of the shaft
3. Temperatures of (turbine + gear + generator) bearing
4. Temperatures of control oil and lubrication oil
5. Temperatures of Inlet and exhaust steam
6. Pressures of control oil and lubrication oil
7. Pressures Inlet steam and exhaust steam

Instruments and Controllers:

1. Siemens PLC S7-300 with I/O rack
2. Simatic Touch Panel (HMI)
3. Vibration Monitoring System Vibrometer VM600
4. RPM converter
5. RPM, Pressure, Temperature and Vibration Sensors

Turbine Control Operation:

The turbine is provided by a throttle control valve or steam valve that is either motorized or CPC supported. The CPC gets analog signal and provides path to the control oil to operate throttle valve for inlet steam to turbine. The throttle valve is guarded by solenoid valves that give path to control oil. In emergency cases these SOV's are operated to stop the control oil and thus stopping the turbine.

Safety Tripping:

Over speed Control: The over speed Limit is adjusted in speed controller and it generates output if that limit is reached.

Turbine Vibrations: The Turbines vibrations and axial displacements are constantly monitored by vibration monitoring system and their allowable set points are defined. They generate digital output when their limits are breached that cause tripping of turbine.

Bearing temperatures: The allowable bearing temperatures are fed into the PLC and it can cause tripping if the temperature rises from the allowable limit. They provide protection to the bearing from overheating.

Pressure Limits: The Control Oil and Lubrication Oil Pressure is constantly monitored by the PLC and it stops the turbine if the pressure falls outside the allowable limits.

Exhaust Steam Pressure: The maximum limit for exhaust steam pressure is adjusted and emergency tripping is set for it. Greater exhaust pressure will generate back pressure on turbine and can cause damage to the turbine.

Emergency Stop: An emergency stop button is connected to the PLC inputs. Pressing emergency stop will automatically stop the turbine.

Speed Control: The speed of turbine is directly controlled with opening of the throttle valve.

Results:

Turbine control is one of the most important aspects of any power plant. Several techniques can be implemented to control the boiler in power plant. The method that has to be used relies on varied objectives like advanced control, increased efficiency, high profit, improved safety and other such points depending upon the purpose of the company that implies it. With the prime objective of catering to these necessities and the needs of the industrial sector, significance has been given here to automation.

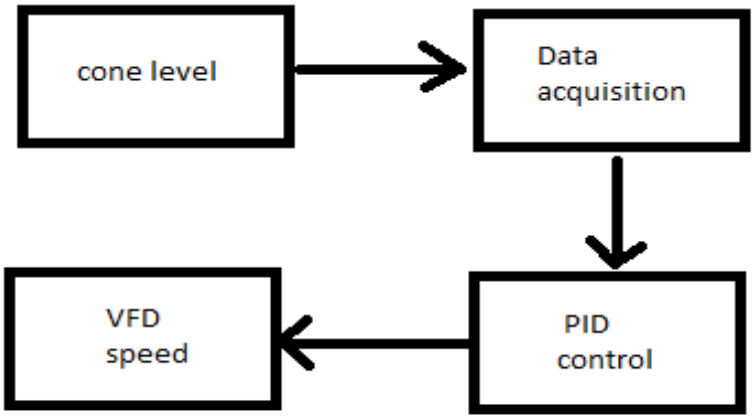
Control of falling Film evaporators:

Evaporation in falling film evaporators is automated by controlling the following parameters.

Key parameters to control:

1. Cone Level
2. Juice Flow
3. Line pressure
4. Temperature

The process is automated by controlling and monitoring these parameters. This control is achieved by installation of control valves in line and VFD's on motors. The operator sets the required cone level into the computer and the control system itself maintains this level by adjusting VFD speed and opening of control valves to the requirement. A complete control diagram is shown in the picture below.



Similarly the temperature is maintained by installation of control valves on steam lines.

Each motor or pump is guarded by an ON/OFF valve. When the pump starts the valve opens up and the flow is passed by the pump. It provides safety to the pump in case where pump does not start the valve will remain close and the back pressure will not occur at the pump.

There are several safeties of motor itself that prevent in causing any damage to the motor. These safeties include temperature safety, MCC fault and emergency stop. If any of these alarms is acknowledged by the controller it will stop the motor to prevent any damage.

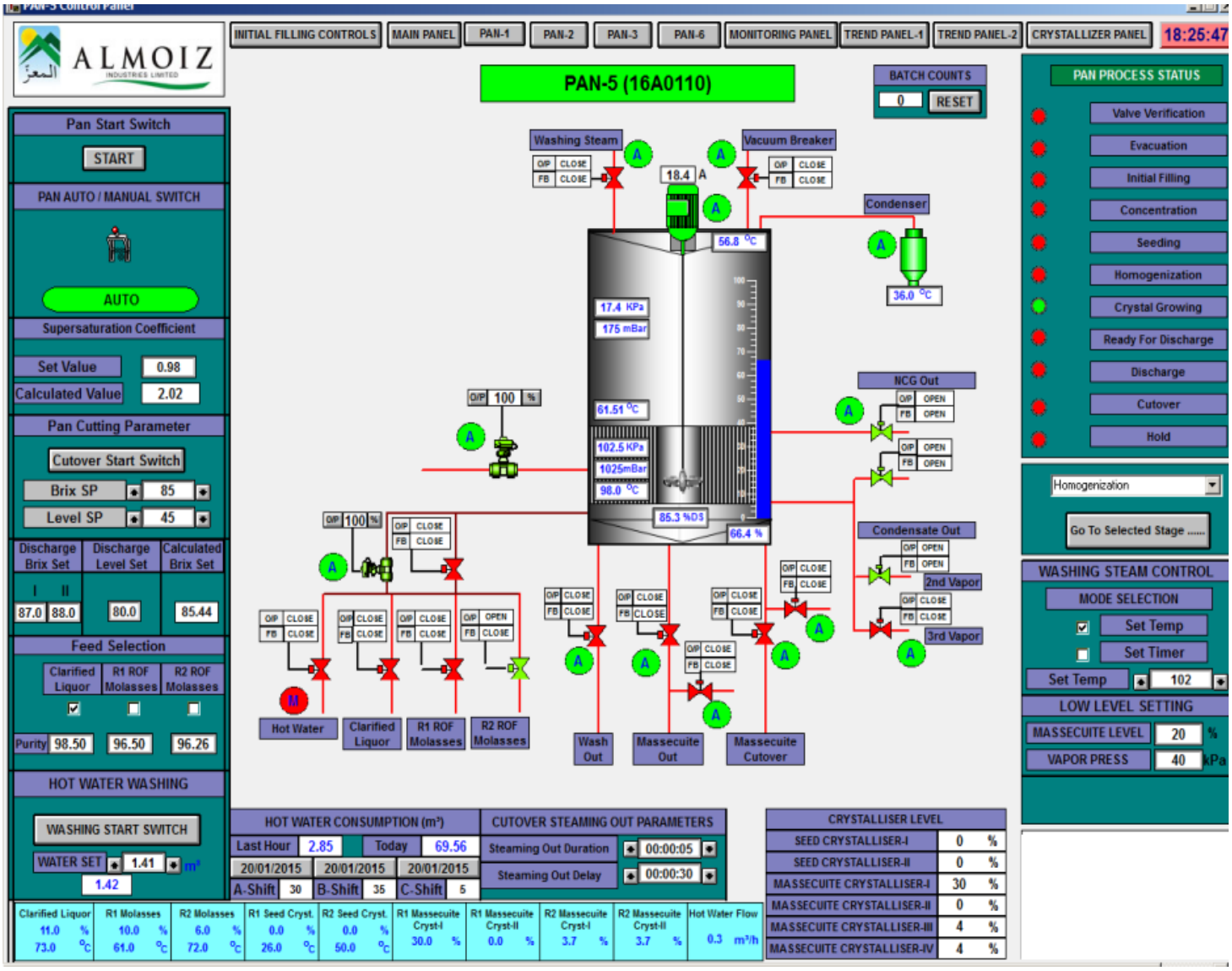
PAN automation:

Another example of automation in sugar industries is batch pans. It is a fully automated process from the start to the end. It saves the extensive labor and provides better efficiency and productivity.

The following parameters are monitored and controlled:

1. Tank levels
2. Vacuum pressure
3. Temperature
4. Brix

The vacuum is created in the pans by using control valves on the line from condenser. Then process starts by auto feeding of liquor in the pans to the desired value. Then auto seeding is performed. The homogenization is achieved by to stirrer motor that gets the command on auto at its designated sequence. The brix and level of pan is constantly monitored by the controller and when the desired value is achieved the pan will be ready for discharge. The operator just has to monitor all the process from the computer screen. All the safety parameters are measured to prevent any harm. Stirrer motor and discharge valve motor current is constantly monitored. Similarly the feedback of all the valves is received by controller to monitor any malfunctioning. The levels of seeding tanks and massecuite tanks are also constantly monitored and alarm is generated when the levels are out of the allowable spans.



Advantages and disadvantages of automation

Advantages commonly attributed to automation include higher production rates and increased productivity, more efficient use of materials, better product quality, improved safety, shorter workweeks for labour, and reduced factory lead times. Higher output and increased productivity have been two of the biggest reasons in justifying the use of automation. Despite the claims of high quality from good workmanship by humans, automated systems typically perform the manufacturing process with less variability than human workers, resulting in greater control and consistency of product quality. Also, increased process control makes more efficient use of materials, resulting in less scrap.

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Worker safety is an important reason for automating an industrial operation. Automated systems often remove workers from the workplace, thus safeguarding them against the hazards of the factory environment. In the United States the Occupational Safety and Health Act of 1970 (OSHA) was enacted with the national objective of making work safer and protecting the physical well-being of the worker. OSHA has had the effect of promoting the use of automation and robotics in the factory.

Another benefit of automation is the reduction in the number of hours worked on average per week by factory workers. About 1900 the average workweek was approximately 70 hours. This has gradually been reduced to a standard workweek in the United States of about 40 hours. Mechanization and automation have played a significant role in this reduction. Finally, the time required to process a typical production order through the factory is generally reduced with automation.

A main disadvantage often associated with automation, worker displacement, has been discussed above. Despite the social benefits that might result from retraining displaced workers for other jobs, in almost all cases the worker whose job has been taken over by a machine undergoes a period of emotional stress. In addition to displacement from work, the worker may be displaced geographically. In order to find other work, an individual may have to relocate, which is another source of stress.

Other disadvantages of automated equipment include the high capital expenditure required to invest in automation (an automated system can cost millions of dollars to design, fabricate, and install), a higher level of maintenance needed than with a manually operated machine, and a generally lower degree of flexibility in terms of the possible products as compared with a manual system (even flexible automation is less flexible than humans, the most versatile machines of all).

Also there are potential risks that automation technology will ultimately subjugate rather than serve humankind. The risks include the possibility that workers will become slaves to automated machines, that the privacy of humans will be invaded by vast computer data networks, that human error in the management of technology will somehow endanger civilization, and that society will become dependent on automation for its economic well-being.

These dangers aside, automation technology, if used wisely and effectively, can yield substantial opportunities for the future. There is an opportunity to relieve humans from repetitive, hazardous, and unpleasant labour in all forms. And there is an opportunity for future automation technologies to provide a growing social and economic environment in which humans can enjoy a higher standard of living and a better way of life.

Conclusion:

It is believed in sugar industries that installation of automation will cost them a lot of money and process can be carried out without it. It is true to an extent that installation of control system will have some initial cost but this cost can be recovered in no time once its beneficiary results, fast response, improved efficiency and safety provided by it is taken into account. The calculated use of water, chemicals and other essentials for the process prevent wasting of these materials and exclusion of extra labor will save a lot of cost in long run for a sugar industry.