Small Hydro Power Plant Automation

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ABSTRACT: Small Hydro Power (SHP) is one of the most appropriate options to meet increasing energy demand especially in a country like India, where a large power potential in this sector is available. It is clean and renewable way to development of SHP. Other way to generate electrical power by using fossil fuel based generation which pollute the environment and whose resources are limited or decreases fast. In Small Hydro Power plant control & operation system should be simple ,easy to control, reliable, and minimum operating personal interference. The main function of the controller are starting and shut down sequences under normal and emergency conditions execute automation. Hydropower is a renewable, non-polluting and environmentally being source of energy. It is the oldest renewable energy technique to change mechanical energy generation as well as electrical energy generation (electricity generation) this technique known to mankind. In this project an attempt has been made to elaborate the use of Programmable Logic Controller (PLC) for control and automation of SHP station, its advantages and cost effectiveness. Programmable logic controllers (PLC) can used for control & automation of SHP station. The PCL started to be used as a replacement for relay logic it performed the same functions of that relay but with much more flexibility. PLC is the one of the most powerful tools used for control in hydropower it can control and monitoring of the power station can be easily done. By making a communication link, governing can also be controlled to need of simplification of wiring between PLC and s For remote monitoring our pose, a personal computer can be interfaced with PLC and continuous data can be recorded regularly.

Keywords: Small hydropower plant, control system, automation, operation and maintenance.

INTRODUCTION

Small Hydro Power (SHP) the term "small hydro" which range in size from a few kilowatts to 50 megawatts. The range of small hydropower plant capacities range in size from 1MW to 50 MW internationally. If the range of project from 100 KW to 1 MW referred as "mini" hydro power. Which projects under 100KW referred as "micro" hydropower. On the other hand, Small hydropower can be built in less time and create less environmental problems. The control of operation and maintenance system for small hydropower plants have advanced in recent years. Small hydropower plants were using hardwired relays for semi-automatic operation of the turbine auxiliaries, and a mechanical governor for speed control. After invention of dynamo the electrical energy can be achieved only by the 19th century. The first small hydropower in India capacity 130 kV in Darjeeling which can be known as **Sidrapong small hydropower** station in 1897. The control and protection systems in small hydropower plants have advanced dramatically in recent years. Small hydropower plants were using relay for semi automatic operation of the turbine auxiliaries, and a mechanical governor for speed control.
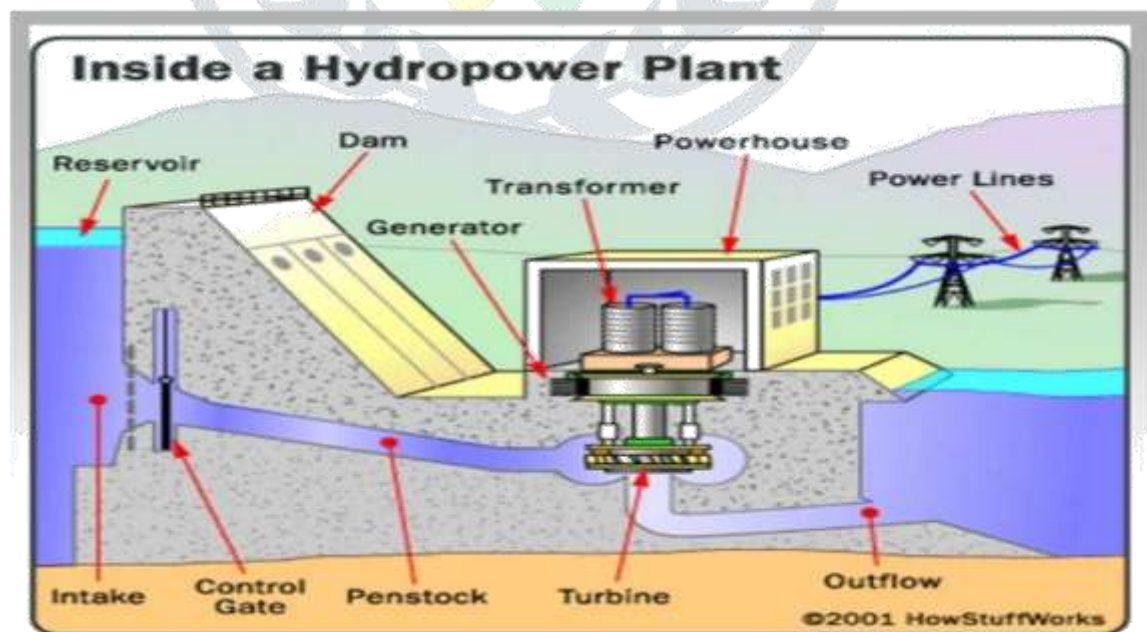

Fig. Layout of small hydro project

Programmable Logic Controller (PLC) is a digital computer based working abilities. These controllers are specially designed to survive in harsh situations and shielded from heat, cold, dust, and moisture etc. PLC is basically a digital apparatus which are used in small hydropower plant

automation. PLC was mainly used to replace hardwired relays, valves in control panels with much more flexibilities. Advanced PLCs are microprocessor based control system and can perform complex mathematical calculation and function as well as logic, sequencing, timing and counting. Components of PLC consists of – Central Processing Unit (CPU), Memory(RAM), Input/Output units & Power supply unit. The visual programming language known as the Ladder Logic was created to program the PLC. Hydro power plant generates high range of power and installation cost is very high so it's controlling and monitoring is necessary. Programmable Logic Controller (PLC) is used to control machines and processes. PLCs can be used with a wide range of control systems, which vary widely in their nature and complexity. After programming the PLC, before starting a real process, the operator has to verify if the program is correct, i.e. if the PLC correctly performs the predefined control task. Performed same function of the hardwired relays, and using this they are much more flexibilities. PLCs have only basic mathematical capabilities. Without this capability programming a routine like flow control will extremely hard or very complex. So in this project an attempts has been made to elaborate the use of Programmable Logic Control(PLC) for control and automation of SHP station. This is the advantages and effectiveness.

Components of Automation

Performance and reliability related components of a hydropower plant instrument and control system are based on the automation design. The components of automation are given as below-

- *PLC (programmable logic controller):* The function of a PLC is the heart of digital control system with programming capability that performs functions similar to a relay logic system. PLC consists of a CPU (central processing unit), memory, power supply and means of communications to I/O and other devices.

- *SCADA (Supervisory Control and Data Acquisition):* Over the decade, SCADA systems, PLC based systems and DCS (distributed control systems) have migrated towards being synonymous.

- *I/O (wired input and output to field devices):* The function of I/O is to send commands to devices or receive information from devices.

- *Efficiency Optimization:* This is a program that runs on top of the control system to maximize efficiency of the plant.
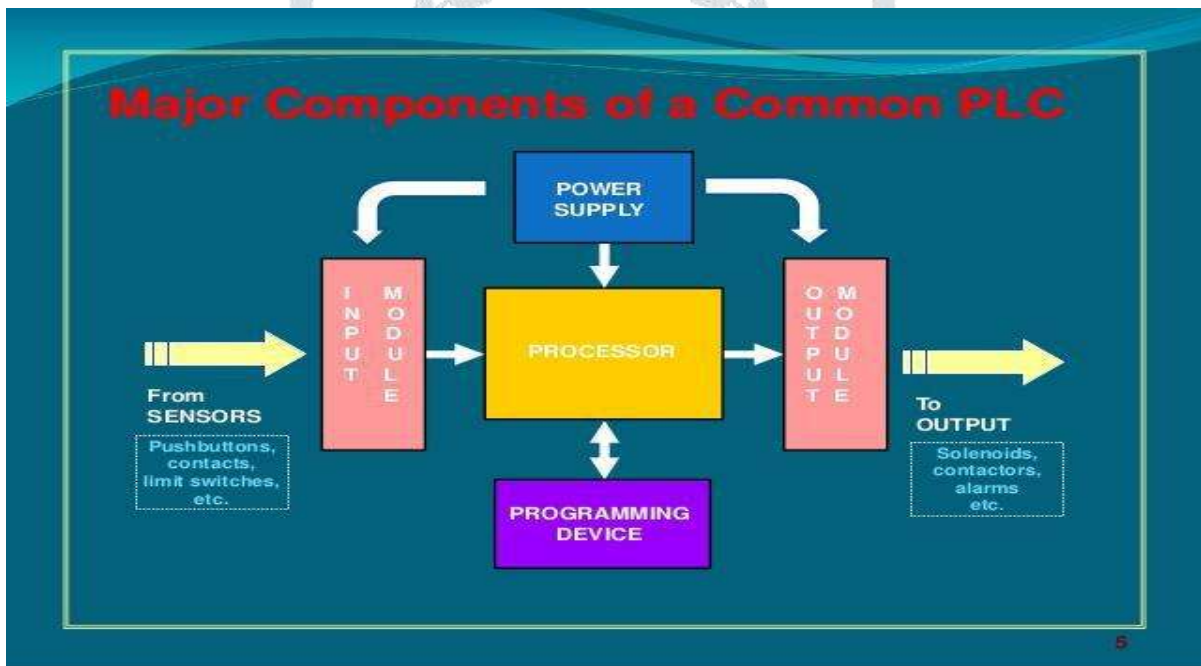

Fig. Component of PLC

Automation of SHP Plants

An automatic control system or automation system is to allow the automatic starting, stopping, safe operation, and protection of any equipment being controlled through computerized control. Before the automation , qualified personnel operated the equipment manually. So this system is called Manual System. An additional benefit of an automation system is the ability to operate the hydro generating unit in more efficient manner. Computer-based automation improves hydro power plant operation and maintenance activities. Control algorithms based on criteria such as efficiency, automatic generation control, and voltage control allow more cost effective and safe operation of plants and interconnected power systems. Maintenance activities are improved by the computer's ability to isolate problems, describe trends, and keep maintenance records. This one-point control has many advantages, including reduced operations staff, consistent operating procedures, and the capability to have all control and data available for reference during normal and abnormal conditions. Figure shows the automation system for SHP station. Plant control deals with the operation of plant that includes some operation like as startup plant, excitation control of the plant, synchronization, plant loading unit under specified conditions, normal shutdown, emergency shutdown etc.
An automation system consists of following system that's are: Protection System, Control System, Measuring System, Monitoring System
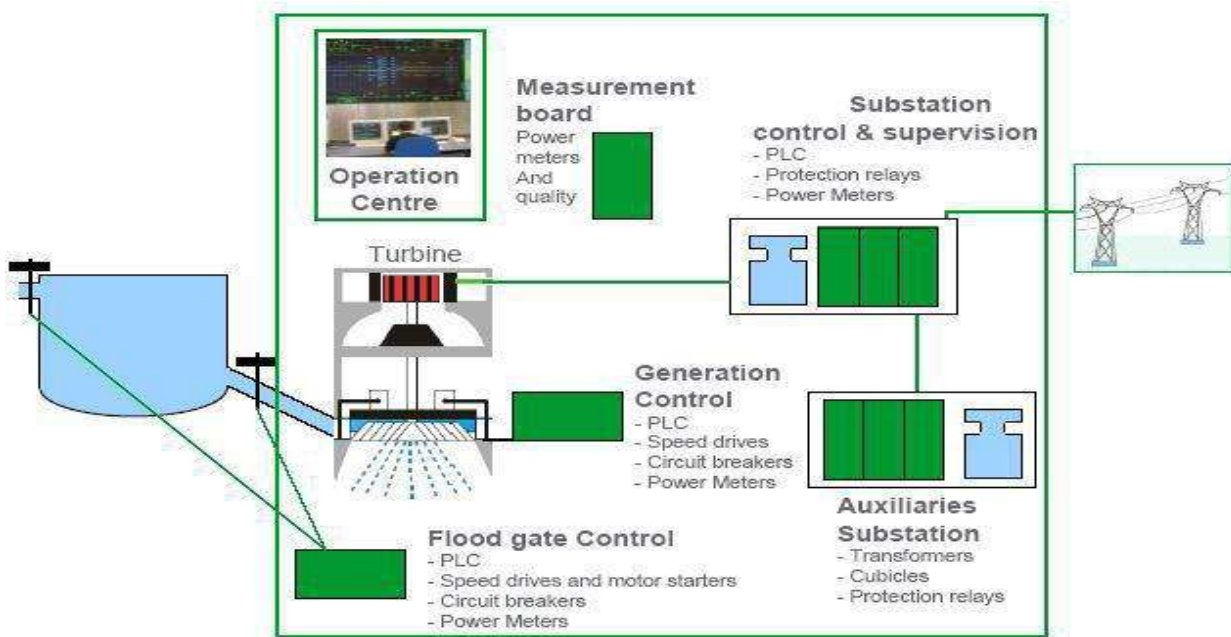
Computer Based Control of Operation and Maintenance of SHP Plants

Fig. Automation system for SHP station

Need and Benefits of Computer Based Control for SHP
Although sophisticated control equipment are being used for the control and protection of large hydropower plants, the same does not apply to SHP due to the following .

- High cost of control and protection equipment. In the large plants, the cost of control and protection systems, compared with the total investment is not so significant, while its share is much higher in small hydro plants. Thus comparatively cheaper system which can still provide adequate control and protection requirements is needed in SHP stations.

- SHPs are usually situated in remote areas and are manned by operators without adequate skills. This often leads to a number of problems caused by operational mistake, or remedial actions are not taken in time, etc. The control system should be simple and easy to operate.

- Maintenance and repair of equipment becomes difficult as spare parts, tools, and skilled personnel are usually difficult to obtain in remote places. The system should be reliable and maintenance-free as far as practicable.

- The cost of operation has to be kept low in SHP. Hence the system must be designed to operate with minimum staff. Automatic/semi-automatic control saves operational costs. In view of the above, it is necessary to select simple, reliable and cheap control system for SHP. The conventional control system uses separate equipment for turbine governing, generator excitation control, plant control and protection. They tend to be costly and become complicated to operate and maintain. Control system should be such that remote operation can be performed easily.

An Automation System is more relevant in case of SHP due to following reasons.
- Hydro Plants are started & stop more frequently.

- Provides successful, efficient and smooth operation.
- Plants are situated in remote areas with difficult to access.

BENEFITS
Normally, an automation system is implemented to improve the efficiency, productivity and the operating management of the system. This automation will be better to the production needs and services. Followings are the major benefits of Automation System for SHP Station.
To make complete power plant information available at any time online.
- Efficient utilization of Manpower.
- Maintenance is easier and quick.

- Reduction in Manpower.
- Ability to integrate plant control functions in one hardware system.

- ☐ Reduced Panel space.
- ☐ Improved performance
- ☐ Provides security against wrong operations by the operator.

- ☐ Automatic starting and stopping of machine sets are faster than manual starting and stopping.

- ☐ Reliable operation
- ☐ Lower cost

An additional benefit of an automation system is the ability to operate the hydro generating unit in a more efficient manner.

CONCLUSION

In this paper, it represents an automatic controlling of a Stepper motor using PLC. This System model of Hydro power plant automation system which is the completely automated can control the level of the dam gates using backup of the water. Our energy demand continues to grow, while conventional resources are diminishing. Computer based control and automation has a number of advantages over other conventional types being used in SHP such as lower cost, simple operation and maintenance, operators can extend the serviceable life of their equipment while improving the efficiency, reliability, and safety of their systems. Cost reduction may be achieved because of PLC has thousands of software relays, so with a PLC based system, number of hardwired relay may be reduced.

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