Design of Level Control Loop by Control Valve at BHOS Emerson Test Rig

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Level control loops are very common in industry as it is essential to assure the safety and profitability of the processes in the plant. Principally, level measurement is the determination of the position of a surface of a liquid, a solid, slurries or the interface of two liquids in tanks, silos, or reactors. Furthermore, level control is essential for safety reasons, leak detection and preventing an overfill. If the level of a liquid, a solid or a liquefied gas is not monitored and controlled properly, it can severely damage equipment and result in undesirable change in the product quality or loss of production.

In various industrial applications, control loops are the systems to maintain a process variable at a desired value - set point. They are important to maintain stability in the system and to consistently produce the desired outcome of the process. This system consists of the sensing device, the controller, and the final control element (FCE), which are all required for automatic control. The purpose of the project is to set up and configure a level control loop at the BHOS Emerson test rig. The loop devices used are “Radar Level Transmitter 5300” as a measurement device, “EZ control valve - 667 actuator- DVC6000” as a final control element, “DeltaV Hardware & Software” as a controller and “Variable Frequency Drive” as a disturbance source.

In order to have a proper, safe and accurate level measurement, measurement devices must be selected for the parameters of the given system based on analysis of the technologies and vendors. Level sensors can use contact or non-contact measurement principles. The temperature or pressure of the process material could affect the reading of the contact sensor, damage it or cause any other troublesome problems. As a non-contact type of level sensors is more adaptable to the system, radar level transmitter is chosen for the loop.

The controller is the component of the control loop that interprets the sensor readings and decides on the control action based on a comparison of that value to the set point. The PID Algorithm is a common form of the feedback control at which the combination of integral and derivative controls provides the decreased or zero offset and the addition of proportianal control provides a quicker response time. Most feedback control loops are controlled by this algorithm or its minor variations of it. As a derivative mode is complex for this basic loop, the PI control technique is selected as the controller algorithm for the given system.

Lastly, proper final control element must be selected for the system. The final control elements are the devices, which get the control action signals from the controller and adjust the process variable to the desired value. There are several common types of FCEs of the control loop, such as a control valve, Variable Frequency Driver, or a solenoid valve. Although VFDs has the economic benefits, they will not operate properly at very low speeds. Therefore, a control valve is chosen for the given loop to achieve a wide range of speeds in the system. The selected control valve will adjust a flow of fluid to compensate for the load disturbance and maintain the process variable near to the desired set point.

In the implementation stage, the program has been developed in DeltaV software provided by Emerson with the required logic and communication has been established between the control loop devices. The system can monitor and control all parameter values, as well as the final control elements. In order to achieve and ensure a successful level control, the controller has been tuned by the adjustment of control parameters, such as proportional and integral terms. During the implementation stage, necessary documents for the system, such as I/O List, P&ID, BOM, Cause & Effect Diagram, Electrical diagram, Interconnection diagram and Instrument index has been developed.

In conclusion, the level control loop for BHOS Emerson Test Rig has been developed by taking into account the considerations mentioned above and technology selection to satisfy safety requirements. As a contribution to the course curriculum, a laboratory work leaflet was prepared based on this project for the students.

References

[1] The Engineer's Guide to Level Measurement, Emerson, 2021.

[2] Thomas A. Huges, "Measurement and Control Basics", Third edition.