ATM 2012: Automation Training Module

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Introduction

Automated systems are integral in everyday operation of nearly every major system in a modern society infrastructure. From ships to offshore structures, even the air conditioning in our homes, automated systems are key in the smooth and efficient operations of daily life. This project demonstrates the basics of two types of automated control processes; a liquid level control process and a temperature control process. The purpose of this project is to act as a training aid for cadets and students. The system exhibits the concepts studied in Fluid Mechanics, Statics, Machine Design, Heat Transfer, Electrical Power, Automation, Welding and Fabrication courses taught in the Marine Engineering Technology program.

Objectives

•To demonstrate automated system process control
•Training aid for concurrent use in MARE 402 Shipboard Automation
•Allow MARE students to get hands on experience installing, calibrating, and operating automation equipment
•Incorporation and demonstration of various courses taught in the MARE curriculum
•Operational in lab or shipboard classroom (summer training cruise)
•A system that is durable, mobile, and practical for student operation for many years to come

Design Parameters

•Flow Rate: fluid level control process – 17 GPM
•Flow Rate: temperature control process – 14.5 GPM
•Power Source – 240 voltage, 60 amps
•Heat sump temperature – 110 ^{0}F
•Domestic cold water temperature – 70 ^{0}F

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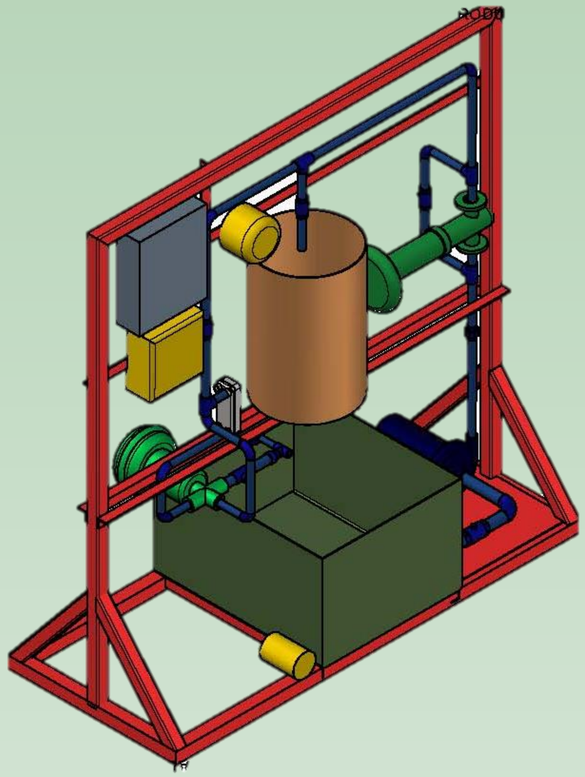

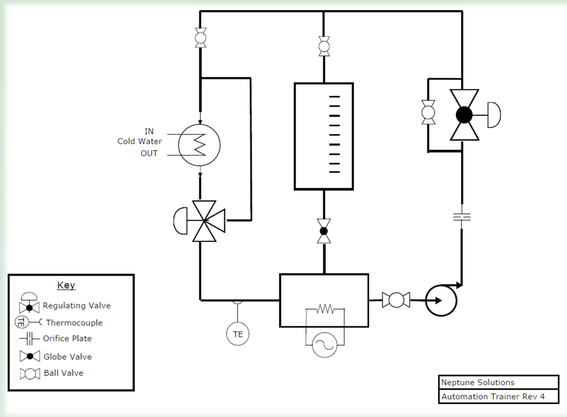

Process Overview

Our project is essentially a *plant process automation control training device* that has two types of control process loops. The system features a **liquid level control process** as well as a **temperature control process**.

Liquid Level Loop

The liquid level control process is achieved by pumping water from the sump with a centrifugal pump through a 2-way control valve to the level tank that then dumps back into the sump. A pressure transmitter measures the level in the tank and transmits a signal in the form of an electrical current between 4-20mA. This current signal is converted into a pneumatic signal between 3-15psig by way of a signal transducer. The pneumatic signal is then sent to a mechanical PID Controller which compares the measured tank level value against its set point and adjusts the control output to maintain a constant level. The controller outputs a pneumatic signal (3-15psig) to actuate the control valve.

Temperature Control Loop

The temperature control process is achieved by adding heat in the sump through a 1500 Watt electric immersion heater and then proportionally rejecting it through a heat exchanger. The amount of heat rejected is regulated by diverting the flow of heated water either through or bypassing the heat exchanger. Control of the water diverted is achieved by a 3-way regulating valve at the convergence of the pass-through and by-pass lines. After the 3-way valve, the water temperature is measured by a thermocouple which transmits an electrical current signal (4-20mA). The current signal is then converted by the transducer into a pneumatic signal (3-15psig) that is sent to the mechanical PID controller. The controller compares the measured temperature value against the set-point and will output a pressure signal to the 3-way valve to regulate the diversion of water through our around the heat exchanger to achieve constant temperature.

Control Signals

% Output	Electric Signal (psi)	Pneumatic Signal (mA)
Fault (dead)	0	0
0%	3	4
25%	6	8
50%	9	12
75%	12	16
100%	15	20

The table above contains standard values for automation control signals. Control signals are designed with a “live zero” to distinguish between a signal fault an zero output value.

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