Instructional Pilot Plant

Introduction

The purpose of SMAR's Instructional Pilot Plant is to demonstrate the operation of several control loops using the same equipment, and software configuration tools developed for industrial control applications. In a compact assembly, all loop components are accessible to teachers and trainees. Instead of a structure for simple observation, this plant can operate realistically.

Using state-of-the-art technologies, the implementation of control loops is carried out using the same instrumentation control professionals deal with daily. In addition to the supplied loops, it is possible to add others without any mechanical changes. This is carried out through simple modification of the existing devices.

SMAR's Instructional Pilot Plants are monitored and operated from a control station comprised of a PC and supervision software. Data acquisition is carried out using several pieces of equipment and is subsequently presented using animated displays. Modifying internal values in the equipment can actuate data acquisition as well as initiate a modification of each control loops operational mode.

General Characteristics of the Pilot Plants

SMAR's Instruction Pilot Plants are easy to transport and include the following important features:

- Integral components requiring no assembly or disassembly.
- Light weight construction for easy movement.

All process tanks are constructed of stainless steel. Line pipes are of carbon steel, adequately painted in order to prolong their service life.

All electrical and control equipment is clearly visible to trainees. The panel includes a controller and graphic recorder installed side-by-side with switches, push - buttons and signal lamps. The control board includes the plant's identification, as well as information about the user and the main control strategies.

The AIMAX-Win supervision system includes software to monitor and actuate the control systems while the plant is in operation. This also provides tools for the creation of displays, graphic recording, handling of alarms, reports, and data banks. Information can be transfered to other applications and be visualized on multiple monitors. The supervision station is not physically connected to the plant allows remote operation.

There are three Fieldbus plant models available:

- PD2: Fieldbus Foundation Technology, including flowrate and level loops.
- PD3: Fieldbus Foundation Technology, including flowrate, temperature and level loops.
- PD4: Fieldbus Foundation Technology, grouping Plants II and III.

PD2 - Instructional Pilot Plant 2

PD2 includes Registered FOUNDATION™ Fieldbus devices for measuring flowrates and levels, as well as positioners for use with valves and actuators. Digital communication is accomplished with FOUNDATION™ Fieldbus protocol.

Equipment and Software

Programming Tools

Programming tool provide configuration, communication and maintenance functions for all Registered FOUNDATION™ Fieldbus products.

PCI - Process Control Interface

- Enables Communication and Data Acquisition of all FOUNDATION™ Fieldbus devices.
- Utilizes one (1) ISA PC Slot.
- High processing capability for individual Fieldbus Segments.
- RISC architecture.

Fieldbus Transmitters and Converters

LD302 Fieldbus Differential Pressure Transmitter

- Provides level measurement for the upper tank.
- Utilized with the Integral Orifice for measuring water flowrate.

IF302 4-20 mA / Fieldbus Converter

Converts up to three (3) independent, 4 - 20mA input signals into FOUNDATION™ Fieldbus protocol.

With Smars instruction plant, the IF302 receives a current signal from the magnetic flowmeter, and converts it for use in the control loop.

FY302 Fieldbus Positioner

Used for the control of pneumatic actuators with the systems water control valves.

Supervision Software AIMAX - Win

The HMI (Human Machine Interface) communicates with FOUNDATION™ Fieldbus Devices providing visual representation (screens) of the control process. It also provides complete control for each process loop including setpoints and manual or automatic control options. Software characteristics include:

- Windows NT operating system.
- Used with PC compatible computers.
- Simple database configuration.
- Historical and Trend graphing.
- AutoCAD graphics constructor
- ODBC connectivity.

Other Equipment Included

- Magnetic flowmeter.
- Rotameter for water flowrate indication.
- Manually operated valves.
- Hydraulic pumps.
- Control valves and integral orifice for flowrate measurement.
- Control board with push-buttons, signal lamps, terminals and safetys.

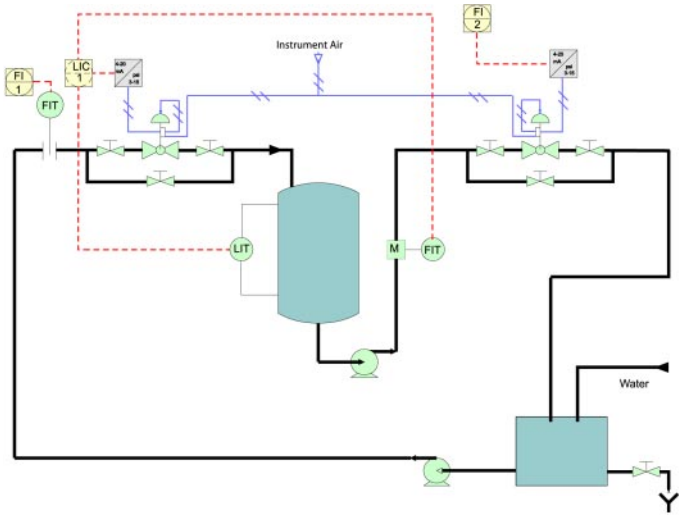
Experiments

There are several strategies, easily implemented through simple modification of the configuration software. Applications include two previously configured and tested strategies:

- Feedforward Control: level and outlet flowrate.
- Ratio Control.

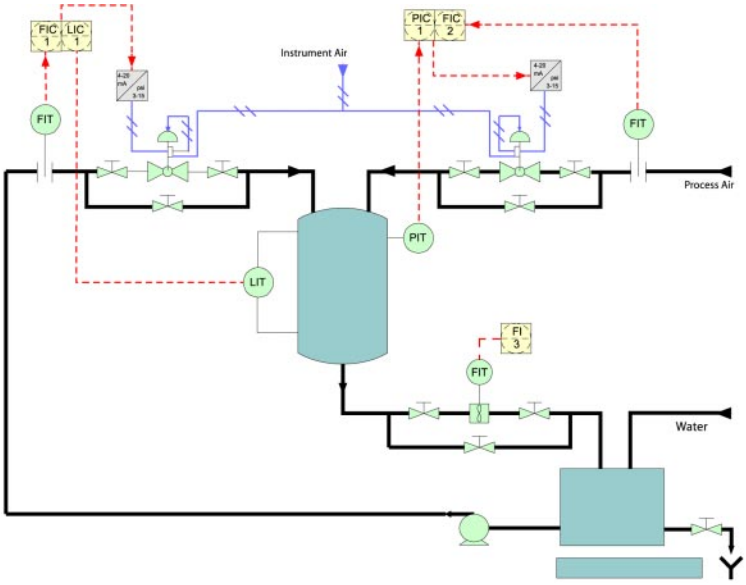
Feedforward Control (Level and Outlet Flowrate)

In this strategy, the level loop receives an increment after the control action. This increment is received from the outlet flowrate of the same tank, and increases the opening rate of the water inlet valve. This loop is formed with the level transmitter, the water flowrate transmitter and the control valve.



Ratio Control

In this strategy, level control is also used. The process variable is the level measurement; the control loop output is split and transmitted to each valve in the plant. One is the valve, which controls the water inlet into the tank, and the other controls the water outlet from the same tank. Each one of them receives the control output value multiplied by a gain. This ratio causes an opening synchronism, thus assuring the inlet and outlet control of water into and from the tank.



PD3 - Instructional Pilot Plant 3

Equipment and Software

PD3 includes Registered FOUNDATION™ Fieldbus devices for measuring flowrates, level, temperature, and positioners for use with valves and actuators. Digital communication is accomplished with FOUNDATION™ Fieldbus protocol.

Programming Tools

Programming tool provide configuration, communication and maintenance functions for all Registered FOUNDATION™ Fieldbus products.

PCI - Process Control Interface

- Enables Communication and Data
- Acquisition of all FOUNDATION™ Fieldbus devices.
- Utilizes one (1) ISA PC Slot.
- High processing capability for individual Fieldbus Segments.
- RISC architecture.

Fieldbus Transmitters and Converters

LD302 Fieldbus Differential Pressure Transmitter

- Provides level measurement for the upper tank.
- Utilized with the Integral Orifice for measuring water flowrate.

FI302 Fieldbus / 4-20 mA Converter

Converts FOUNDATION™ Fieldbus protocol to three (3) 4 -20mA output signals for use with field equipment.

In this control loop one (1) 4-20mA output is sent to the power converter.

TT302 Fieldbus Temperature Transmitter

This transmitters is designed to work with nearly all existing temperature sensors (thermocouples and RTD's) , as well as load cells , resistance position indicators and optical pyrometers. Up to two (2) sensors are possible per transmitter.

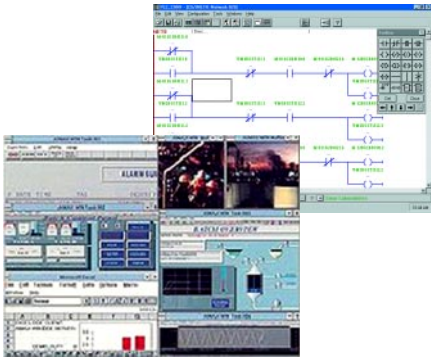
FY302 Fieldbus Positioner

Used for the control of pneumatic actuators with the systems water control valves.

LC700 Programmable Controller

- FOUNDATION™ Fieldbus compatable.
- Rugged modular design.
- Programmed via IEC-1131 Ladder Logic.
- Program storage via EEPROM.
- Communication via EIA-232C and EIA-485.
- Provides integration for user defined functions.

CONF700 Configurator Software



- Windows 95/98 compatible.
- Programming via IEC-1131 Ladder Logic.
- Communication via EIA-232C and EIA-485.
- Provides integration for user defined functions.

Supervision Software - System302

The HMI (Human Machine Interface) communicates with FOUNDATION Fieldbus Devices providing visual representation (screens) of the control process. It also provides complete control for each process loop including setpoints and manual or automatic control options. Software characteristics include:

- Windows NT operating system.
- Used with PC compatible computers.
- Simple database configuration.
- Historical and Trend graphing.
- AutoCAD graphics constructor.
- ODBC connectivity.

Other Equipment Included

- Power converter.
- Temperature sensor (RTD or thermocouple).
- Level switch.
- Conductive type temperature switch.
- Immersion resistor.
- Control valves.
- Integral orifice for flowrate measurement.
- Rotameter for water flowrate indication.
- Manually operated valves.
- Hydraulic pumps.
- Control panel with push-buttons, signal lamps, terminals and protections.

Experiments

Several strategies may be implemented through simple modification of the configuration software. The user will receive three previously configured strategies:

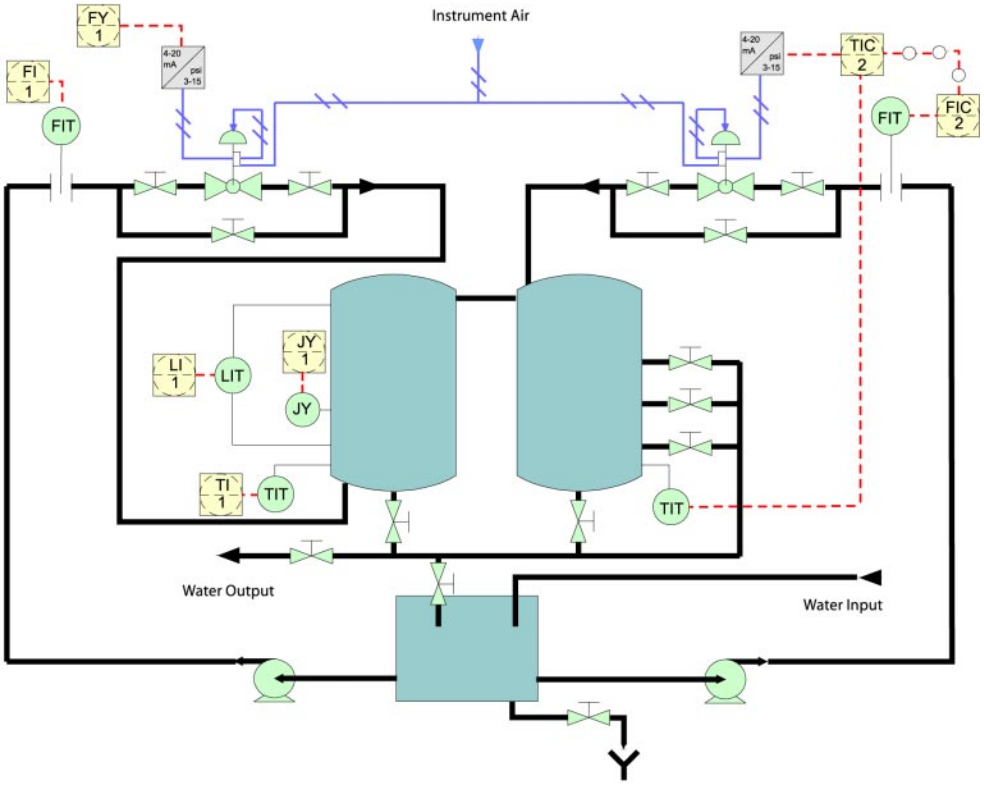
- Feedback Control: temperature.
- Cascade Control: temperature with cold water flowrate.
- Feed-forward Control in the heating tank : temperature with cold water flowrate.

Feedback Control (Temperature)

The process temperature in the mixing tank is kept constant by controlling the inlet of water to the tank. The process variable is the temperature in the tank, and the manipulated variable is the cold water inlet valve.

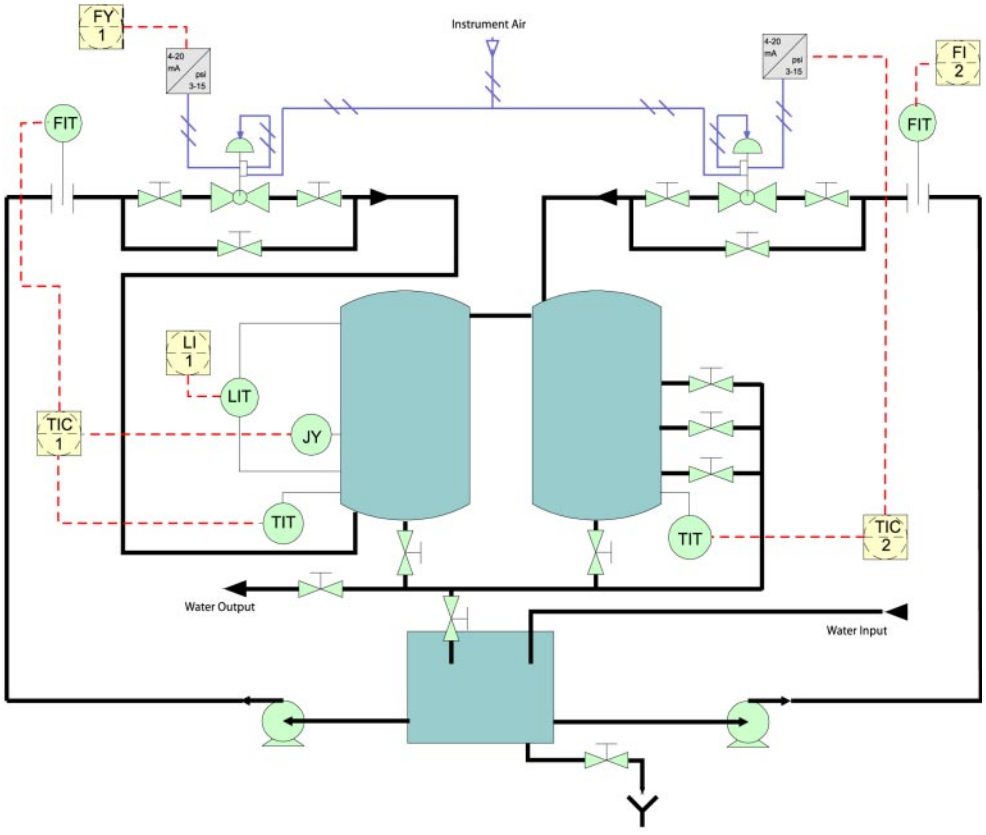
Cascade Control (Temperature with cold water flowrate)

In the mixing tank, hot water from the heating tank is mixed with cold water in order to heat it. The purpose of this control is to maintain stable water temperature in the mixing tank, in response to water temperature changes in the heating tank. The cold water flowrate control loop's setpoint is the temperature control output signal from the mixing tank. This causes the actuation of the cold water valve when the temperature is other than that requested.



Feedforward Control in the Heating Tank (Temperature with cold water flowrate)

This control is intended to maintain temperature in the heating tank at a stable value. A power converter is used as the final control element. It is responsible for powering a group of electric resistors used to heat the water in the tank. The main loop is the temperature control loop, After performing the control action, it receives a gain from the water flowrate loop, in order to increase the power demand required to keep the temperature at a constant value. This strategy assures that changes caused by the admission of cold water in the heating tank are quickly responded to.



PD4 - Instructional Pilot Plant 4

PD4 is a more complete option, and is formed by the following modules:

- PD2, includes Registered FOUNDATION™ Fieldbus devices for measuring flowrates and levels, as well as positioners for use with valves and actuators. Digital communication is accomplished with FOUNDATION™ Fieldbus protocol.

- PD3, includes Registered FOUNDATION™ Fieldbus devices for measuring flowrates, level, temperature, and positioners for use with valves and actuators. Digital communication is accomplished with FOUNDATION™ Fieldbus protocol.

The System302 supervision system is capable of controlling both plants simultaneously. This increases the configuration options, creating an environment very similar to an actual industrial plant.

Computers and Peripherals (Supplied by the Client)

Our scope of supply does not include the computer or its peripherals, such as the video monitor and printer. These items can be easily purchased from your usual supplier.

The fastest microprocessors and highest RAM will provide the best system performance. Smar's minimum recommendations are as follows:

- Operating System: Windows NT and Windows 95/98 (Dual Boot);
- CD - ROM
- 1 spare ISA slot;
- 1 unused COM port.
- INTEL PENTIUM Microprocessors (minimum);
- 64 MB RAM (minimum);
- Hard - disk capacity greater than 500MB;
- SVGA Video Monitor of 17" (minimum).

Basic Requirements

The basic requirements for the adequate installation of the Instructional Plants are as follows:

- Power Supply :

  PD2:

  127 VAC, 60 Hz

  Consumption: 300 VA

  PD3:

  220VAC and 127VAC, 60 Hz

  Consumption: 5,200 VA

- Air supply : 20 - 100 PSI (for positioners)

  24 PSI (for valve actuators)
- Water inlet installation ;
- Air inlet installation;
- Water outlet installation.

Software and hardware configuration manuals, as well as installation and maintenance manuals are supplied with the Plants. This coupled with courses offered by Smar, grant autonomy and make the instructors fully capable of developing changes and modifications to the systems.

Assistance to Start-up

Smar may provide the following installation check-out and start-up services:

- Conformity check-out of the installations and Instructional Plant.
- Pre - operational tests.
- All required adjustments.
- Technical instructions.
- Clearing - out for operation.

Training

Smar's Training Department offers specialized courses covering all aspects, from design to maintenance, to fulfill the requirements of your technical staff. These courses may be carried out at the Client's facilities or at our Training Centers worldwide.