Batching System Control

Created: 03/02/2018 **Last Revised:** 03/16/2018

Authors: Alex Cutsinger, Daniel Hinkle, and Korbyn Thompson

Electrical Engineers

University of Arkansas, PLC Class

Email: dhinkl01@g.uafs.edu, kthomp10@g.uafs.edu, acutsi02@g.uafs.edu

Attachments:

Functional Requirements; Design Details; PLC Program

Table of Contents

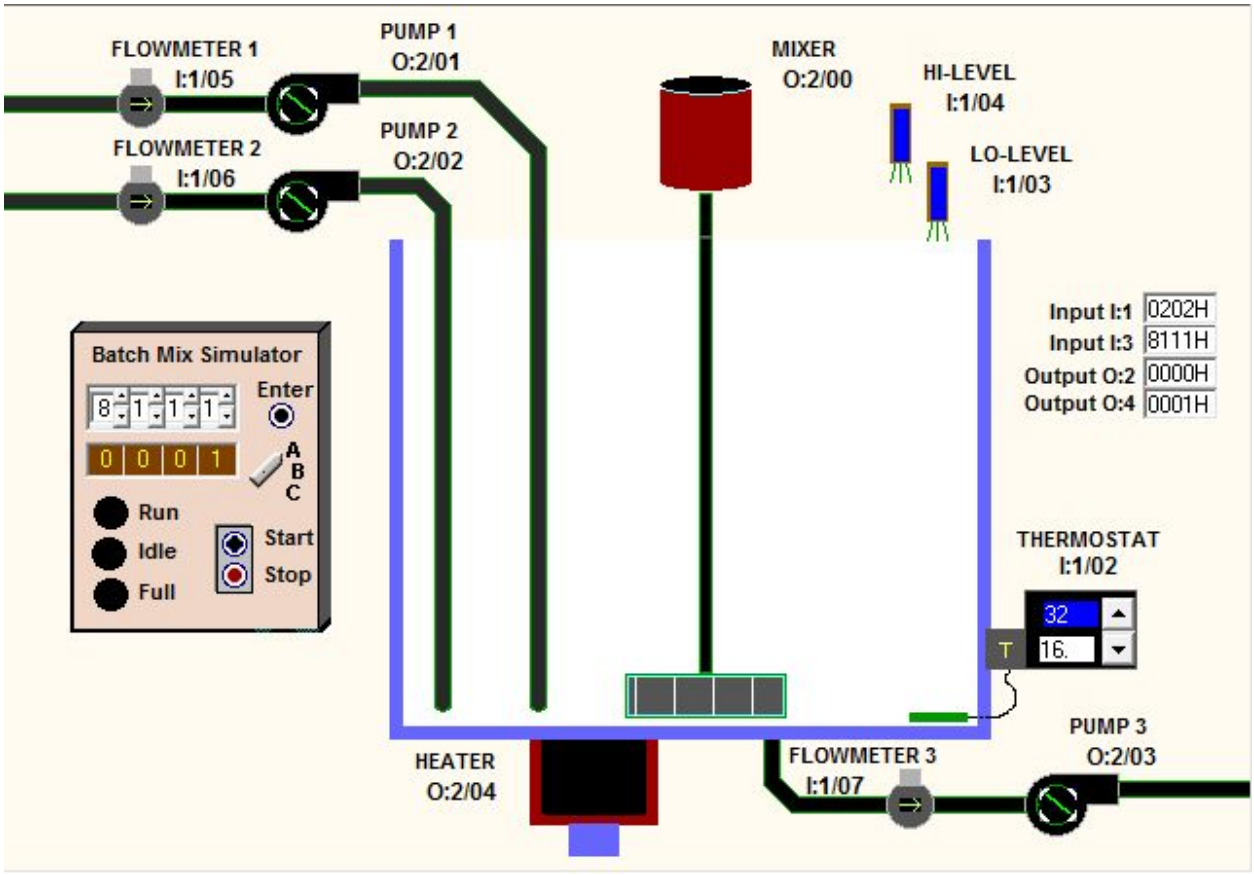

Figure 1: *Logix Pro Batch Simulator*

Scope of Work:

Provide software and documentation for implementation of PLC based control of the pumps, heating and mixing of the vat in the factory. The facility where this application is to be installed is essentially identical to that which comprises the "Batch Simulator" simulation model in the LogixPro software application. The PLC to be used is identical to that provided by LogixPro. The automation requirement is to pour in the first ingredient from pump one, pour in the second ingredient from pump two, and mix and heat them before pumping the mixture out through pump three when the user hits the "Start" push button. The amount of gallons for ingredients one and two are determined by user input, and whether on not to heat the mixture is determined by the user as well. When the user hits the "Stop" push button, the batching system will go into "Idle"

mode where the pumps will stop pouring ingredients into the tank, and mixing and heating will discontinue. However, when the “Start” push button is pressed in idle mode, the job will continue as normal. When the “Stop” push button is held for three seconds, the job is cancelled. When this occurs all pumping, mixing, and heating will cease and the tank will automatically drain. In addition, there are three different variations to this entire process, two formulas and a drain. When the selector switch in on “A” , the batching system will produce Formula A, who’s ingredient amounts, mixing time, and heating time are determined by the user using the BCD input. When the selector switch is on “B”, the batching system will produce Formula B. Formula B’s information is determined by the BCD input as well. Finally, when the selector switch is on “C” the batching system will drain the tank and do nothing else.

Functional Requirements:

This application comprises a PLC based control system that provides the following functionality:

1) The LogixPro “Batch Simulator” simulation model is being controlled using the LogixPro PLC.

2) The batching system must be able to run two separate batches independently, based on the selector switch.

3) While the program is in “Stop” mode users may input formula data for formulas A and B.

4) While the program is running and the “Stop” button is pressed the program will go into idle mode. No formula entry should be done here.

5) While the program is running and the “Stop” button is held for three seconds the program will go into “Stop” mode. The tank will automatically drain, and formula entry may be performed.

6) Before filling the tank, the "Run" lamp will blink for five seconds to alert users that the equipment will soon be in use.

7) For more in depth descriptions of the requirements, refer to the attached document, "AutoBatch-FunctionalRqmnts-2018.docx".

Enhancements:

- The job requirements did not address the possibility that the operator of the system might input a total amount that is greater than the physical capacity of the tank. This was fixed by not allowing the user to start a batch if the total value exceeds the capacity of the tank and an E001 will be displayed to signify an error.
- To avoid an inefficient process the batch was not allowed to begin mixing before the tank contained 40 gallons of fluid.

Concerns:

- If the operator tries to adjust the "active formula" while the batch is running the behavior of the machine will become unpredictable.

Implementation Design Details:

I/O Devices and Wiring Summary

Item	PLC I/O Point	Function Label	Physical Device Label	Comments
1	I:1/00	Start PB	PB-2	NO, momentary push to start.

2	I:1/01	Stop PB	PB-3	NC, momentary push to stop.
3	I:1/02	Thermostat	TT1	Heater interlock
4	I:1/03	LO-LEVEL	LI2	Tank empty interlock
5	I:1/04	HI-LEVEL	LI1	Tank overflow interlock
6	I:1/05	Flowmeter 1	FM1	Ingredient 1 measurement
7	I:1/06	Flowmeter 2	FM2	Ingredient 2 measurement
8	I:1/07	Flowmeter 3	FM3	Drain measurement
9	I:1/08	Enter PB	PB-1	Stores the entered data to the selected formula when in formula entry mode
10	I:1/09	Formula A	SS1-A	Selects to run a batch of Formula A
11	I:1/10	Formula B	SS1-B	Selects to run a batch of Formula B
12	I:1/11	Clear Tank	SS1-C	Selects tank empty mode
13	I:3	Formula/Job input	TWS	
14	O:2/0	Mixer	MXR	Mixer motor enable
15	O:2/1	Pump 1	PMP-1	Ingredient 1 pump enable
16	O:2/2	Pump 2	PMP-2	Ingredient 2pump enable
17	O:2/3	Pump 3	PMP-3	Drain enable

18	O:2/4	Heater	HTR	Heater enable
19	O:2/5	RUN	L1	Run indicator light
20	O:2/6	IDLE	L2	Idle indicator light
21	O:2/7	FULL	L3	Full indicator light
22	O:4	BCD display	BCD	Displays the entered formula data when in formula entry mode, displays tank fill level while running, and displays error messages for 3 seconds as they occur.

PLC Code Listing:

See attached PLC program file listing copy entitled, "***BatchByCHT***.rsl".

Error Code Descriptions:

E001		Stored formulas will overflow the tank.