Polymer Reactor Data Logging

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Category
R&D/Lab Automation

Products Used
LabVIEW version 6.0.2
PCI-232/16 16 port serial interface card
FP-2000 Ethernet controller card
FP-AI-111 16 Point 4-20 mA Analog Input Module
FP-AO-200 8 Point 4-20 mA Analog Output Module
FP-RLY-422 8 Point Relay Module
FieldPoint 3.0.2
NI PCI-6602 Timer / Counter Card

The Challenge
The development of a reactor data logging system to be integrated with multi-vendor devices with the ability to run reactor tests unattended and log test results to a file.

The Solution
DSA developed a flexible, recipe-based high throughput testing system to control the reactors, chemical selection, volumes, flow rates and durations and stirring periods, including data logging, alarm monitoring and emergency shutdown procedures. It can run unattended to accommodate experiments extending beyond normal business hours. The solution was developed using NI LabVIEW 6.0.2, NI FieldPoint modules, and 16 ports RS-232C serial interface card. Reactor temperature was monitored and controlled Watlow temperature indicators and power controllers and connected to FieldPoint modules for remote monitoring and control of the application.

The Problem Expressed
A polymer manufacturer needed to automate research experiments to optimize their production process and product characteristics. Independent operation of diverse, multi-vendor devices like reactors, syringe pumps, feed pumps, temperature controllers, and stirrers was intensely manual and complicated, requiring close and extended supervision by senior technical personnel. Also, the chemical reaction times vary and sometimes exceed the normal eight hour work days and necessitated the operators to extend their days. Also, logging of test data and evaluating test results were a significant challenge.

Our customer approached Data Science Automation to develop a fully automated and integrated solution meeting the following requirements:

- a low-cost, fully documented solution incorporating current technologies and off-the-shelf components
- a system that can accept test recipe written in a tab delimited text file.
- serial control of IKA stirrer
- serial control of Hamilton Syringe pumps
- Frequency control of Waters HPLC Pumps
- Control of VICI Valco valves
- Reactor temperature control
- Emergency shutdown procedures
- Display temp, stirrer torque and speed as the data is being acquired
- Log test results to a text file.

The Solution Offered

DSA developed serial drivers for the IKA stirrers to take them in to remote control, set the stirrer speed remotely and read stirrer torque while reactions occur in the reactor. For Hamilton syringe pumps, serial drivers are written to take them in to remote operation, start and stop pumps remotely and adjust flow rates on the fly. An action engine was also written to monitor the dispensing of chemicals while the pump is running. There were two syringes in the pumps. Code is written to automatically fill the left syringe while the right syringe is dispensing. Serial connections were made between the individual devices and the serial breakout module with 16 serial ports. Serial control of the pumps was achieved using NI MAX to configure the COM ports of the PCI card, and then using NI-VISA drivers and resource names to quickly and easily implement the LabVIEW drivers.

Waters HPLC pumps accepts a TTL 50% duty cycle signal in the range of 0 – 2KHZ frequency signal for adjusting flow rates from 0 – 20.00 ml/min. The high precision required necessitated the use of NI – PCI 6602 timer/counter card for connecting to the waters HPLC pump.

Reactor temperature is monitored using Watlow series 96 temperature monitor which can re-transmit 4-20 mA signal based on the remote set point. The recipe provided temperature set point is passed on to the temperature monitor, which in turn is fed to the Watlow power controller. The power controller can accept remote 4- 20 MA signal and can provide 0 – 100 Volts signal for controlling the reactor temperature. Valco Multi-port valves are controlled by FieldPoint relay modules and a LabVIEW driver is written to accept the inlet and outlet positions of the valve.

The application was developed using LabVIEW 6.0.2 using state machine architecture and an action engine executing some actions in parallel and others sequentially. The actions were obtained from importing the recipe during the start of the test. Once the operator initiates the test, individual devices were initialized and pumps were primed before starting the reactor for testing. A user friendly interface screen was developed to allow the operator view reactor temperature, stirrer speed and torque in a waveform chart while the testing is in progress. (See Figures 1 & 2).

The Reward Attained

The system requires operator intervention for test initiation only; and will automatically end or abort tests and log data to files for post-processing. Professional labor costs are reduced, scientists can spend more time on science than monitoring experiments, safety is enhanced, and a higher volume of experiments can be achieved. The system can be extended to control/operate multiple reactors running in parallel for even greater throughput.

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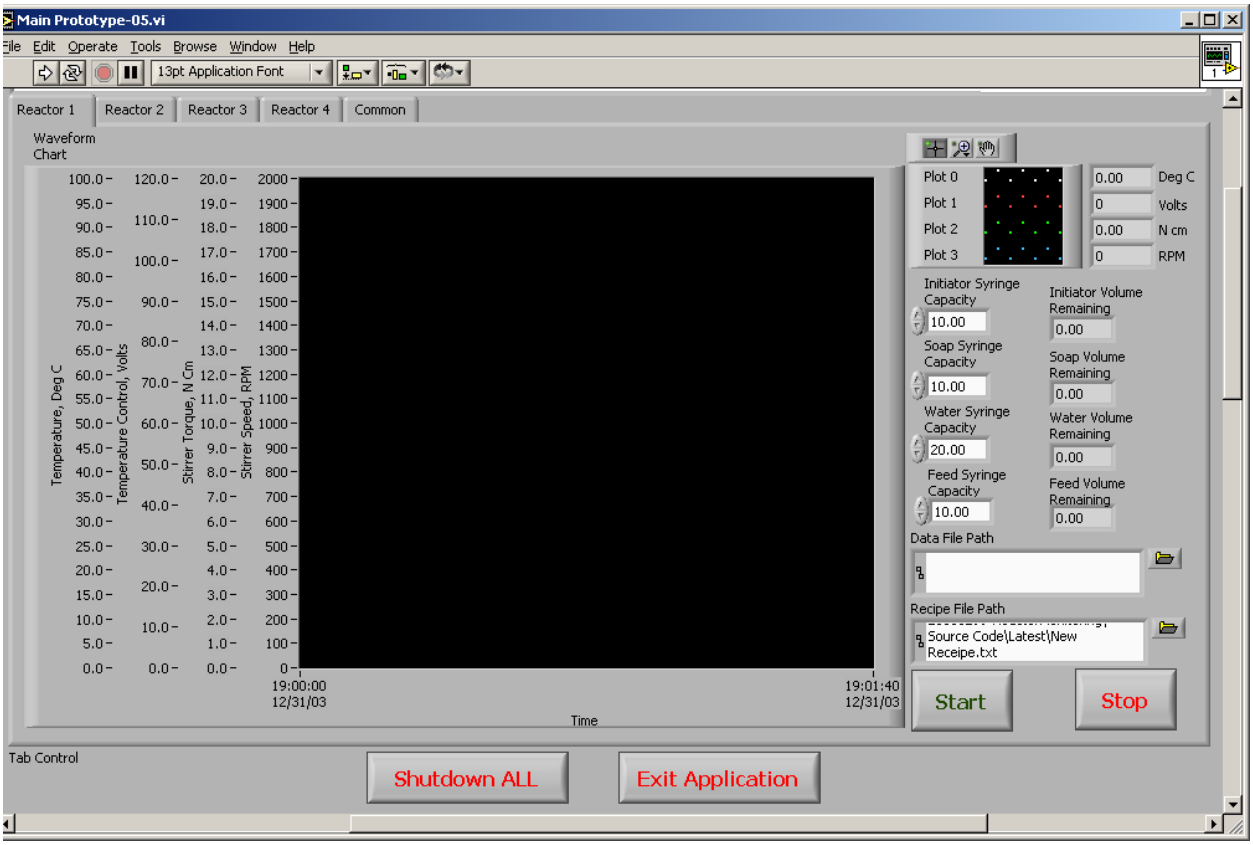

Figure 1: Reactor1 Operator Interface

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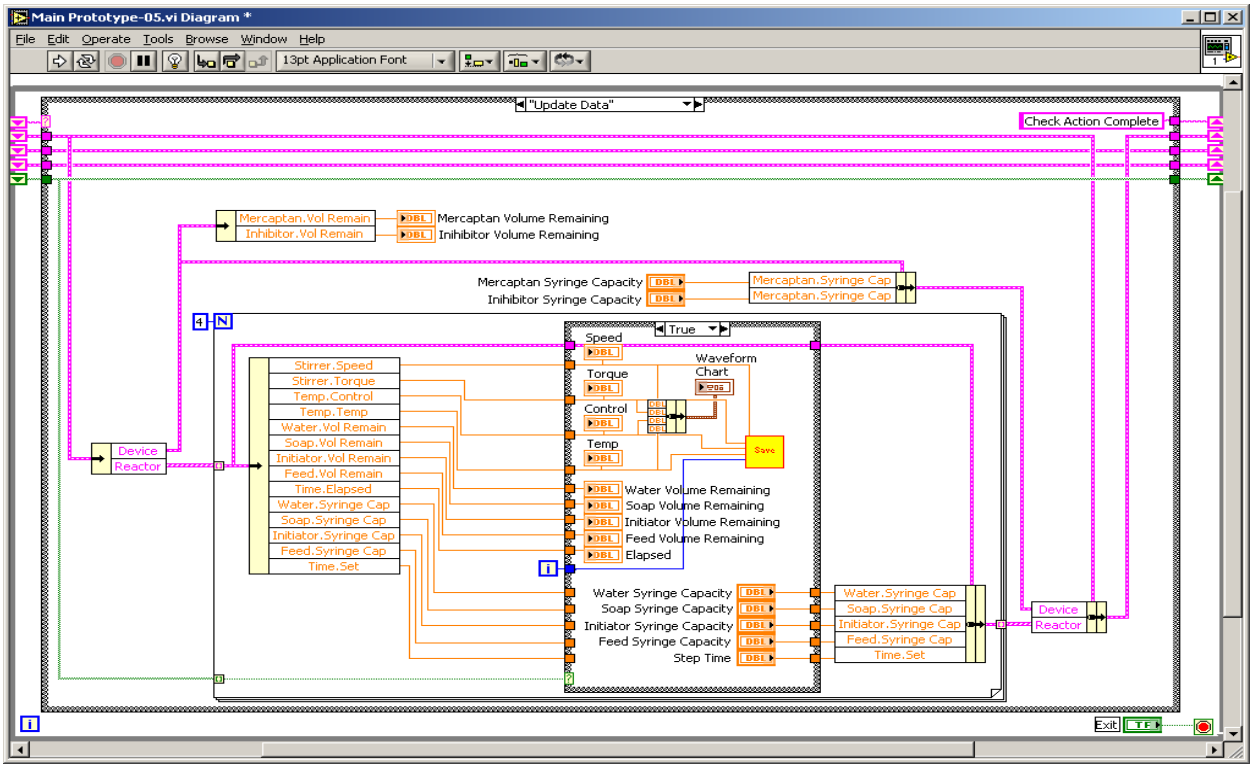

Figure 2: Main application state machine

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