A Siemens solution for tank farm monitoring

Situation

Refining of vegetable oils is essential to ensure removal of gums, waxes, phosphatides, and free fatty acid (F.F.A.) from the oil. It is also used to provide uniform color by removing coloring pigments and to eliminate unpleasant smells by removing odorous matter. Refining is carried out either by batch operation or a continuous operation.

A vegetable oil refiner wanted to automate their raw material level measurements and was looking for a monitoring system that would provide real-time product inventory and available freeboard per tank. (Freeboard is the volume between the actual liquid level and the design full level mark). When a rail car of crude vegetable oil arrives at the plant, it is important to know that the receiving storage tank will have sufficient room to accommodate the oil shipment. At this plant, storage tank levels were previously being measured manually. This required an employee to climb to the top of a tank and take a level measurement. Since product shipments are by weight, the freeboard needed to be calculated in pounds of product in order to determine if sufficient room was available for the oil transfer.

Challenges

Product measurement
The oil product inventory (both crude and refined) is measured in pounds. In order to calculate weight, the volume of oil in the storage tank must be measured and the density of the oil must also be known. With large straight wall storage tanks, the volume of the tank is affected by the height of the liquid. The greater the height, the more pressure is exerted on the tank walls. Therefore, the change in volume per change in level is not a constant, and a simple volume formula is not suitable. Strapping tables are developed to simplify the calculation; they relate outage liquid level to volume. Also, each oil product has a different density with different coefficients of expansion. Since they are stored in outdoor storage tanks, the density is not necessarily constant. The monitoring system needs to continuously read the outage level and product temperature. With these measurements, the system must calculate the product inventory per storage tank and determine the available freeboard in weight.

Inventory management
This vegetable oil refiner needs the ability to change the oil type stored in each tank without the need for continuous recalculations for varying densities. Vegetable oils come from domestic and international sources and are harvested at different times of the year. From a programming point of view, the oil type is independent of the storage tank. This means that the density calculations cannot be hard coded into the storage tank weight calculation. This is a challenge for single processor controllers that execute logic in a linear and sequential step program.

Instrumentation installation
The vegetable oil facility has over 90 storage tanks located in multiple tank farms distributed throughout the plant. This is a challenge for instrumentation installation. The installation and marshalling of all the instrumentation signal wires to the central monitoring station represents significant installation costs. In addition, the instrumentation upgrade project must be done in phases. The ideal monitoring system should be flexible and easily expandable.

Siemens solutions

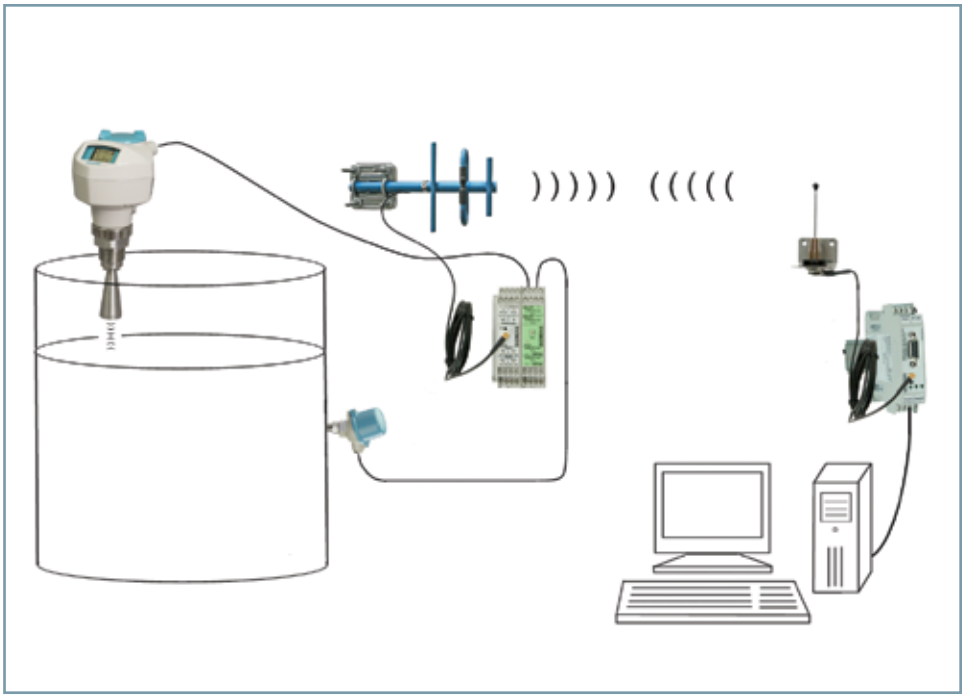
Level measurement
The level in each storage tank is being measured with a SITRANS LR250 radar level transmitter. The LR250 instrument provides continuous monitoring of liquid levels up to 65 feet with a 0.2 inch resolution. It is a loop-powered device available with either a 4-20 mA analog output signal, Foundation Fieldbus, or PROFIBUS PA digital communications. For this application, the 4-20 mA output with HART communications model was used and the transmitter was configured using SIMATIC PDM software via a HART modem. The output signal was configured to indicate the storage tank outage level in feet from the design full level mark, and the PDM software provides a record of the transmitter configuration setup.

Temperature measurement
The temperature in each tank is now being measured with a SITRANS TH300 temperature transmitter using an RTD sensor. The TH300 is a loop-powered transmitter that provides a 4-20 mA output signal and supports HART communications. The temperature transmitter was configured using SIMATIC PDM software via a HART modem and the output signal was configured to indicate the oil temperature in degrees Fahrenheit. Each storage tank is insulated and heated, and contains an agitator that ensures an even temperature distribution.

WiPS wireless system
The Siemens WiPS wireless system provides the transmission of 4-20 mA and discrete signals via radio frequency waves. The WiPS system is a good solution where running twisted pair wiring is not practical due to physical restrictions (for example an outdoors installation).

The WiPS wireless solution was recommended because it simplifies the wiring installation and reduces costs. It consists of a master radio transceiver (DR-301) in the control room and multiple remote transceivers (DR-300) strategically located throughout the plant. The remote transceivers are situated on high tank platforms to ensure an unobstructed path to the master transceiver antenna. The WiPS DR-300 remote radio transceiver supports up to eight (8) I/O modules and the WiPS-24 analog input module supports four (4) channels. Therefore, a DR-300 remote transceiver can support up to 16 tanks. In this installation, there were a total of 18 remote transceivers being used.

Data acquisition
The Siemens tank farm monitoring system consists of a PC running Procidia iWare Operator Interface software. Procidia iWare is a graphical software package that provides a dynamic interface and real-time data for process monitoring and supervision. The data collection is managed by the Procidia Modbus OPC Server, which is a component of Procidia iWare software package. The advantage of the Modbus OPC Server is that it eliminates the need for an interface controller. In a traditional system, the controller would read the level and temperature signals either directly as 4-20 mA analog inputs signals or via a network communications module. In addition, the controller would handle the volume, density and weight calculations, and the PC would be relegated to an operator interface. Eliminating the interface controller significantly reduces the cost of the monitoring system. It also eliminates the need for 4-20 mA input modules or a communications interface module.



Tank monitoring system using SITRANS LR250 radar level transmitter, SITRANS TH300 temperature transmitter. WiPS wireless radio transceivers, iWare software, and WebHMI software, all from Siemens.

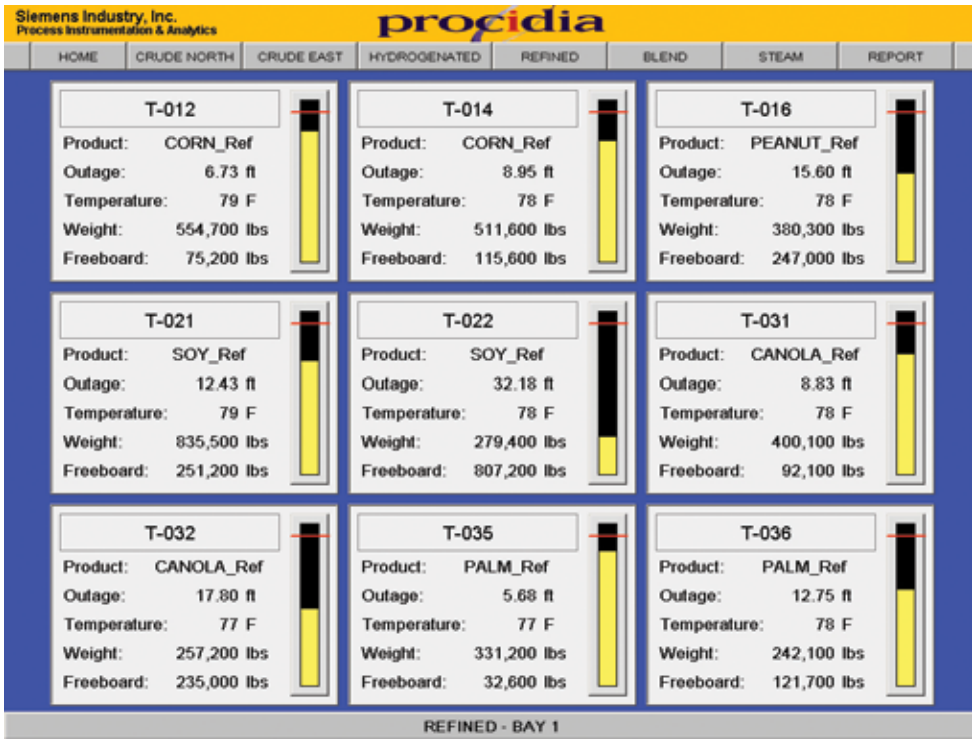
In this application, the monitoring system PC is connected to a WiPS DR-301 transceiver via an RS-232 serial connection. The DR-301 tranceiver is installed in the control room, and it is connected to a WiPS Omni antenna mounted above the control room. The WiPS DR-301 is programmed as a Modbus master. The Modbus OPC server periodically issues Modbus data request commands through the DR-301 master transceiver to all the WiPS DR-300 remote transceivers in the field. Each WiPS DR-300 transceiver in the field is programmed as a Modbus passive device and assigned a unique Modbus device address. In this application, the WiPS DR-300 uses the WiPS-24 Analog Input expansion module which supports four (4) 4-20 mA input signals. The WiPS DR-300 is capable of supporting up to eight (8) I/O expansion modules. Therefore each WiPS DR-300 can support a total of thirty-two (32) analog inputs or sixteen storage tanks. The WiPS DR-300 transceiver maps data from each I/O expansion module to specific Modbus register and coil addresses. In Modbus communications, all passive devices listen to each command issued by the master; but only the device to which the command was addressed to replies. When a WiPS DR-300 receives a Modbus data request, it replies with the current storage tank outages and temperatures. The system update rate is governed by the tank farm monitoring system application.

Inventory management

The Procidia iWare software supports Visual Basic programming which enhances applications and provides a sophisticated operator interface. The heart of the tank farm monitoring system is the Visual Basic program that runs in the background. The program establishes a connection with the Modbus OPC Server and continuously reads the storage tank outage level and temperature. It calculates the volume based on the storage tank's strapping table profile and calculates the density based on the oil type. In addition to the product weight, it calculates the available freeboard and manages the high level alarming. Finally, the Visual Basic program exports all tank measurements, calculations, and high level alarm status information to the project OPC server which provides real-time data to the Procidia iWare graphical displays and remote monitoring stations.

Monitoring system

With the Procidia iWare graphical operator interface, each storage tank is represented by a storage tank faceplate symbol. The faceplate displays the tank level and temperature measurements, inventory and freeboard calculations, and high level alarm status. The symbols connect to the project OPC server for real-time data. The Procidia project provides navigation buttons for locating storage tank faceplate symbols and provides an interactive display for changing the storage tank product.



Remote monitoring stations

The facility's plant manager wanted multiple employees, located throughout the plant, to have access to the tank farm monitoring system. WebHMI is an add-on option to the Procidia iWare software. It is a web server that runs in conjunction with Procidia iWare and allows remote clients to connect to the web server using a standard internet browser. The server provides these remote clients with a local viewer and copies of the graphical displays. The WebHMI also manages the connection between the remote client and the project OPC server which provides real-time data to the remote users. The basic web server package supports two remotes clients, but an optional expansion license is available for an additional 5 clients.

Benefits

Cost Savings – Wireless transmission means lower installation and labor costs than a "hard-wired" solution.

Cost Savings – Using the OPC server instead of a stand along interface controller means considerable saving on no additional hardware and software.

Easy to Install – Wireless transmission means no hard wires to run, and use of OPC server means no separate interface controller to install.

Easy to install – Small narrow beam on the LR250 radar level transmitter allows installation practically anywhere on your vessel. Infrared handheld programmer allows for local set up or use of SIMATIC PDM via HART® or PROFIBUS PA. The Start Wizard guides the user during setup.

Increased Productivity – Using the Siemens automated solution vs. a manual measurement allows decisions based on easy access to real-time data. Alarming options allows user to ensure that the correct tanks are being filled or emptied as needed.

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