
Process Control And Data Acquisition For Pretreatment Washer Systems Utilizing Computerized Graphics

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ABSTRACT --- Process control, data acquisition, and statistical process control are familiar terms in the extrusion industry. Controlling the pretreatment process using a computerized *human machine interface* (HMI) is. The HMI approach to washer system control has many advantages most of which will be discussed here. The advent of sophisticated process controllers and PC-based, data-acquisition computer systems has offered the opportunity for what is referred to as *total process management systems*. Development of these systems using off-the-shelf components to provide a reliable, detailed means of collecting, monitoring, and alarming extrusion washer process data has become a reality. This system applies technology to ensure processes are controlled, documentation is up to date, managers are informed, and, most importantly, quality is maintained.

INTRODUCTION

Using the personal computer (PC) as a process controller, data acquirer and graphical display device has come a long way. In the few short years since its inception into the industrial arena, PC-based process control and human machine interface (HMI) data acquisition is here to stay. It can provide a relatively inexpensive and reliable means of controlling and monitoring a multitude of processes; for the sake of discussion, its relevance to the extrusion washer process will be explored. In addition off-the-shelf, Windows®-based PC use will be expanded to provide total process management from the extrusion washer right on through to the wastewater treatment facility system and, eventually, plant wide.

This presentation is twofold: firstly, to provide a concise methodology to establish the requirements and implementation of such a system; and secondly, to describe the details of its function. The off-the-shelf design approach of choosing components and integrating them into an HMI package is the engineering design technique we wish to tout.



Figure 1. One development system with many targets

EXTRUSION WASHER PROCESS CONTROL TECHNIQUES

The control of the pretreatment chemicals in an extrusion washer can be considered a mundane topic. Although it is the heart of any system, the rationale for process control will not be covered, but rather the techniques. The best results can be achieved using local pH, conductivity, temperature, and electronic level

controls, which is the industry standard. But, as most operators know, employing these instruments can sometimes be difficult, if not confusing. Local control is indeed the key. Why not use instruments that have been under development for years to provide a failsafe method of control? Microprocessor-based pH and conductivity controllers have come a long way. The incorporation of PID and other control strategies, in most cases built-in and transparent to the operator, allow these instruments to provide a suitable means of controlling a process well within the operating limits with very little operator intervention. Most of the newer microprocessor controlled devices include more functionality than anyone will ever use, but it is there if needed.



Figure 2. Operator interface

DEFINING MINIMUM REQUIREMENTS

While defining the requirements for a PC-based HMI system such as BDACS (Bulk Chemicals Data Acquisition and Control System), one must first understand what most operators desire. During the conceptual design of the BDACS HMI system, we conducted a poll. Almost all expressed their desire to have a simple means of gathering process data, displaying it in an easy to read fashion, alarming the processes that are out of tolerance, logging the data for future reference, and ensuring what is actually happening. The latter is the most difficult to achieve.

These are indeed only the basic requirements of any HMI system for the extrusion washer process. The following paragraphs present

relative findings, their relevance to process control and data acquisition, and details of their incorporation into a meaningful HMI system.

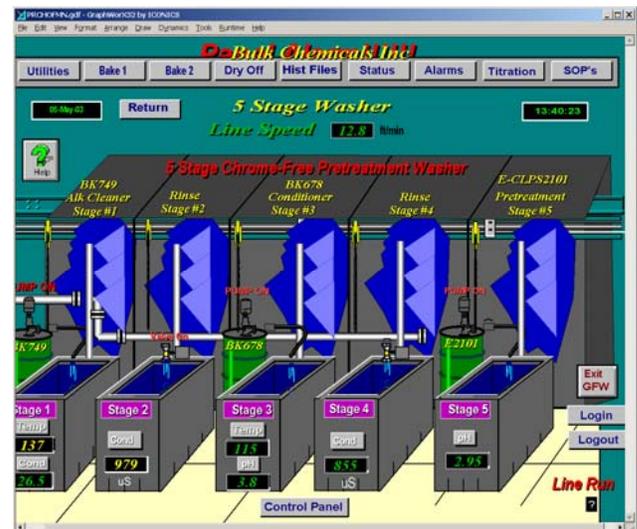


Figure 3. Graphic interface

Graphical Interfaces

Each and every process should have its own *operator graphics screen* depicting the real-time conditions of the line in an easy-to-read and perceptible format. For instance, the operator should have displays at his fingertips that allow him to monitor the conditions as they are happening. The displays should have readily available, by observation, real time process data. At a minimum these process variables should include, conductivity or pH as it is related to concentration, temperature of the solution, and level of the tanks. Additionally, an operator should know if the system is responding to a controller set-point by displaying the activity of the chemical feed pump. The level or inventory of the chemical drum he or she is drawing from would also be pertinent. Displaying the pressure of the risers is a way of determining if nozzles are clogged or a circulation pump is not functional. And any other relevant process variables with a sensor attached and integrated into a system could be displayed. All of the aforementioned can be easily accomplished with computerized graphics. Keeping the graphic interface easy to read and understand is a valuable troubleshooting aid in the event at conditions that may generate alarms. It also gives the operator all of the information, as it is happening, in real time. The following are some examples of graphics screens we feel are useful and pertinent to most processes.

Graphics: Historical and Real-Time Trending of Process Data

Collecting data is an integral function of all HMI systems. Multiple backup options should also be considered to ensure data integrity of the PC. These include local automated streaming tape backup, remote downloading of historical data by the means of a modem, etc. By using Windows®-based HMI applications, it becomes possible to exchange data with other Windows® applications using powerful database tools such as Dynamic Data Exchange (DDE). This lends easily to those who desire to utilize Statistical Process Control (SPC) as a means of tuning and controlling a process. Additionally, one can enjoy direct database connectivity because Open Data Base Compliance (ODBC) and Software Query Languages (SQL) are typically built in. Implementing these features enables distribution of real-time data around the plant to other PCs, or around the world, using TCP/IP networking or modems as an avenue to share data. The possibilities are endless as to how the user can utilize and interpret the collected historical and real time data! Two types of data should be available: historical and real-time.

Historical. Every process data point displayed should be collected and stored on the hard drive. The price of storage mediums (hard drives) in PCs

is falling every day, thereby making it inexpensive to log and store large amounts of data. In the event a problem occurs and it becomes necessary to consult historical data for any particular day or time, the system should provide a means of viewing the evidence in either tabular or graphic format. Historical data analysis can be used as a means of preventing recurring problems. It is also a mechanism that can be used as evidence in the unlikely event that it becomes necessary to demonstrate compliance. It is possible to provide a means of tracking process data and extrusion production information simultaneously. Melding this information together into a single historical record allows for easy retrieval and sorting of data in other applications such as Microsoft's Excel. The concept is simple and painless. The end result being the operator's ability to sort by date, order number, die number, etc., as a means of displaying the line conditions during a particular run of metal.

Real Time. Along with the graphic representation of the process variables on the operator interface screen, the system should display data in multiple formats, such as strip-chart format, just as an operator would see it if he or she were looking at a strip chart recorder. The limits should also be displayed so the operator can get an immediate indication of where the process is relative to the limits specified in the standard operating procedures (SOPs).

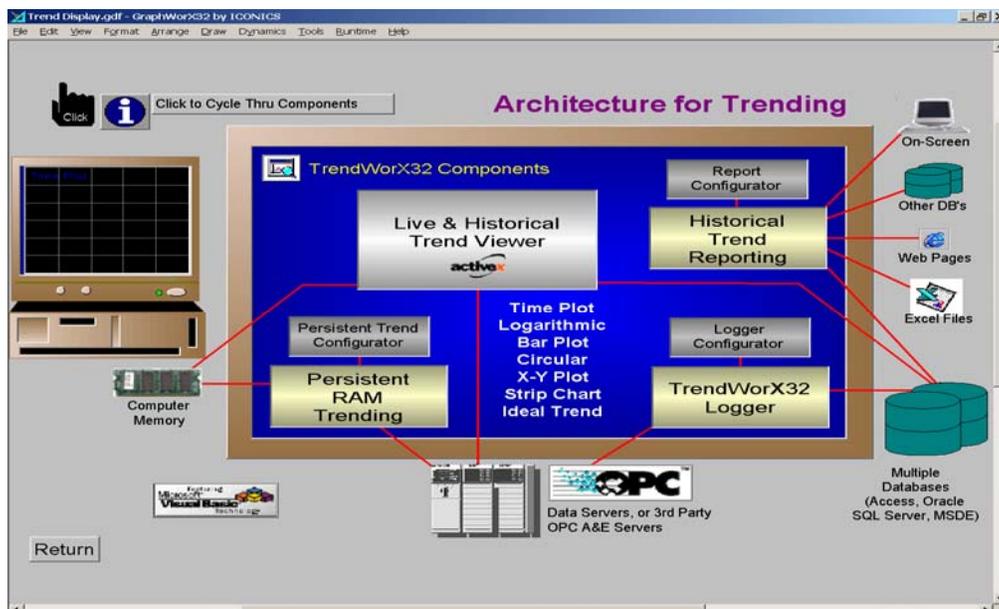


Figure 4. Sample trend display

Additional Graphics: Ovens, Inventories, Data Entry, Waste Treatment, Etc.

The variety of graphics screens available is limited only to one's imagination. Most HMI software packages allow display of thousands of active process data points on an endless number of screens. Standard symbol libraries make it easy for configuration and screen construction. There are several screens we have found to be particularly important to the pretreatment washer process. Of course there is the operator graphics screen, discussed previously. Screens depict multiple areas of the dry off and bake ovens. Other screens representing current inventories of totes or large reservoirs of pretreatment chemicals could be monitored. Manual data-entry screens could be used for logging titrations, coating weights, and other important data that cannot be collected via automatic means. Waste treatment screens could depict the processes via an operator interface graphics screen to ensure EPA reporting functions. Cooling tower or boiler status could be presented; the possibilities are numerous.

Graphics: Alarms Generation and Recording

Alarming the processes is as important as collecting their data. Having an alarm graphics screen can accomplish this important requirement. There are several features any HMI system should have. Accomplished HMI systems should contain all, and a multimedia alarm management system capable of voice annunciation, remote paging, telephone interfaces, operator prompting, historical alarm analysis, and more. An informative summary of what alarm screens should provide follows.

Real-time Alarm Display. The Alarm Status Display should neatly summarize all active alarms on one screen, where the user may quickly view and acknowledge them. Filtering, sorting, and coloring of alarms should be customizable. An operator help window should provide multiple pages of user-defined text for each selected alarm. For instance, when operators acknowledge an alarm by simply moving a cursor and clicking it, they are provided with several features. These include help instructions to alleviate the alarm condition and a text area for documenting how they did it. From one screen, the operator should have full knowledge of all alarm conditions.

Multimedia Alarm Configuration. Announcing alarm messages using speech and sound can also

be employed. By connecting into a plant public address or wireless headset system, operators are freed up from having to monitor the alarm panel, enabling them to perform more productive work.

Alphanumeric Paging. Using a standard modem, the alarm module can relay alarm messages to alphanumeric pagers. Using a built-in scheduler, the alarm module even handles multiple people having different work schedules. A special feature permits the user to send free-formatted text messages to anyone's pager on demand.

Telephone Interface. The alarm module should also act as a voice-mail type system for alarms. It can be configured to automatically dial out when an alarm occurs. Or one may dial in to get the current alarm status and data values. Using any touch-tone telephone to control playback, one can listen to alarm messages, acknowledge alarms, and even get live data information.

Historical Analysis. All alarms and events should be logged to an ODBC database. The alarm module helps users to analyze the alarms by displaying those that have occurred most frequently. Pareto charts, tally reports, frequency graphs, shift reports, daily summary reports, and more should all be accessible. Exporting alarm data as ASCII text or in ODBC format, providing integration with in-house information systems is also helpful.

Universal Connectivity. The alarm module can connect directly to the HMI software through an software interface. Signals from any HMI data server can be used to trigger alarms. Connections to other Supervisory Control and Data Acquisition (SCADA) software, Visual Basic and C programs, or other applications are accomplished via DDE or direct DLL calls. The alarm module should also connect to non-PC-based systems via serial ASCII links. PLCs, instruments, monitoring stations, lab equipment, and just about any other device capable of sending out an ASCII string can communicate with the alarm module. The basic intent of an alarm screen is to keep the user informed of the status of the alarms, wherever the user may be.

Graphics: SOPs and Other Documentation

Most credible vendors of pretreatment chemicals supply documentation outlining the operating envelopes and maintenance procedures

for keeping their chemicals under control. It is a distinct advantage to make this data available to an operator for easy referral. Providing SOPs, material safety and data sheets (MSDS), product data bulletins, controller manuals, and any other pertinent documents is not only a feature any HMI system should have, but is necessary to ensure that operators have the information readily available. A modem interface allows immediate updating of these documents should they change.

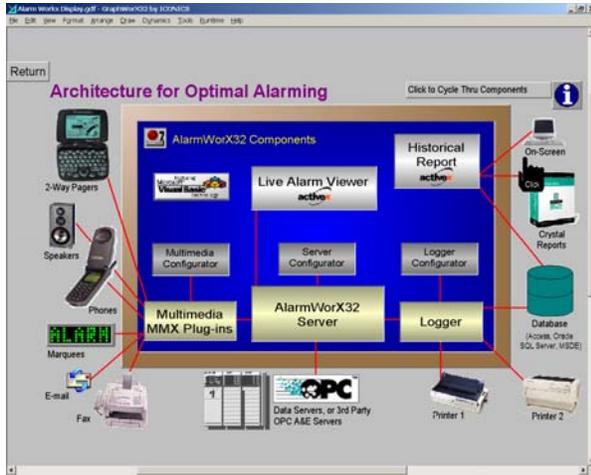


Figure 5. Alarm display

Graphics: Expandability

The limits of expansion are endless. Screens can be configured to provide operators with pictorial or graphics of any process deemed important.

HARDWARE REQUIREMENTS

There are several hardware requirements to ensure that data collected is indeed accurate: a good reliable personal computer, process controllers from reputable manufacturers, such as Great Lakes International and Yokagowa, I/O hardware for interfacing with the control mechanisms, chemical feed pumps, and good reliable sensing devices that are easily maintained and calibrated. There are hundreds of reliable manufacturers of these devices available, most of which meet industry standards for quality, reliability, and functionality.

SOFTWARE REQUIREMENTS

Similar to hardware, there are a multitude of software packages available. Products such as Wonderware, the Genesis for Windows® product

from Iconics and Intellution are just a few HMI software packages you can configure to your liking. In choosing a package there are some requirements you should keep in mind. Almost all HMI and SCADA software packages feature a suite of independent applications or modules for graphics, trending and data logging, alarm management, I/O scanning, control logic, and more. Following are several features we perceive to be necessary and that represent a good choice for any application and are worthwhile requirements for any HMI system.

Modularity. Choose a modular system, constructed of fully independent client and server applications. The client is the device using the data and the server the device making the data accessible. A customized MMI/SCADA system can be assembled by combining these components with other Windows® software. Always ensure the software is Windows® compatible, and for the greatest connectivity to other applications.

VBA Compatible Scripting. There are times when the chosen software package does not contain standard functionality or formulas for a required operation or task. A simple example is calculating alkalinity by inputting A and B titrations. Visual Basic Scripting makes it easy. Many HMI software packages come with Visual Basic scripting capabilities. Based on the world's most popular macro language, Microsoft Visual Basic for Applications, the script language is both powerful and easy to learn. Some applications have more than 600 commands available to perform almost any function imaginable. Use scripts to perform calculations, read and write files, and much more. For non-programmers, there are applications with script wizards that make programming easy.

Real-time Performance. This is an extremely important requirement. A reliable real-time server (RTS) employs a prioritized, preemptive, multitasking kernel that ensures the integrity of data coming from the plant floor. The RTS should always execute its highest priority tasks first; making it so dependable and responsive that you can actually use it to control a manufacturing process from a PC. The real-time interface is the heart of the software package. Most software packages allow interfacing with a multitude of data collection, or I/O devices, currently available. Keep this in mind when choosing a reliable package.

On-line Configuration. Choose a package that supports a variety of ways to present data. A

complete set of drawing and animation tools make graphic displays simple and fast to design and are minimum requirements of any package. Dynamic symbols and symbol dictionaries speed up the drawing task by enabling the reuse of portions of displays in many places.

Recognized Standards. Considering today's fast changing technology, choose a software package that is designed to stay current by adopting widely recognized standards. Exchanging data with other Windows® applications using Windows® DDE and ODBC is extremely important. The ability to distribute real-time data around the plant, or around the world, using TCP/IP networking is essential. Standards save engineering time and protect the company's valuable software investment.

Software Application. HMI software benefits any manufacturing process where there is a need to gather and record plant operating data, provide a graphical operator interface, or perform real-time supervisory control. Typical HMI software users include plant technicians and engineers, control system integrators, operators, production supervisors, and plant managers.

RATIONALE FOR IMPLEMENTATION

While considering any capital purchase, one must contemplate several points. What is the payback and how soon does it occur? What are the immediate benefits to installing such a system? The first question is a very difficult one to answer. The payback occurs when a problem is solved before it happens. Citing an example may be appropriate. Someone who chose to monitor his circulation pump on an important chemical pretreatment stage realized, via an alarm, that the pump was not functioning properly. The pump was repaired immediately and he did not paint material without the pretreatment being applied, thus avoiding costly scrapping of painted untreated metal. This saved both labor and material dollars. There are countless instances of problems being solved before they manifest themselves. The immediate benefit of any system is its ability to *watchdog* the process. Of course there is operator intervention. But if applied correctly, it could potentially free up operators to perform other tasks related to their job.

Total Process Management

The term *total process management* (TPM) applies to the plant-wide implementation of the HMI system. We have taken the TPM approach to include not only the extrusion washer processes, but other elements of the industrial process affected by pretreatment chemicals and their application. Bake ovens, dry-off ovens, manual data entry, wastewater treatment, boilers and cooling towers are just a few. The ability to effectively manage interconnected processes is the goal, thus providing instantaneous data at the user's fingertips. A system dynamic enough that allows expansion in any direction should be considered.

SUMMARY AND CONCLUSIONS

As stated in the abstract, Bulk Chemicals has taken a different approach to industrial process data acquisition for extrusion washers and expanded it to TPM. It merits noting that systems such as BDACS are not intended to take an operator's place, but rather it should be used as a tool whose purpose is to improve the quality of the process by providing the data to do so. Using and interpreting the data become paramount. Diligence and training will pay dividends.

The intent of this paper is to enlighten others with some of the pertinent and worthwhile information we have spent years gathering. For those who wish to approach HMI on their own, it may help. For most, subcontracting is the only solution to incorporating such a system. A picture is worth a thousand words and graphics certainly apply.