RECYCLE ADVANCED CONTROL PACKAGE

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ABSTRACT

An upper-midwest, multi-source, 250 TPD recycle tissue mill increased its capacity utilizing a distributed control system advanced control package (ACP) to optimize plant processes from the pulpers through the bleach plant. An application node on the plant-wide network was used for the implementation of the ACP. The main objectives of the package were to increase throughput, decrease chemical consumption, decrease quality parameter variability, provide operator decision support tools including automatic grade change, automatic tuning and correction of in-line sensors, automatic production rate change, and statistical process control (SPC).

Inherent in this Recycle Advanced Control Package is the premise that the plant operator knows the peculiarities of the process intimately and, in fact, better than anyone else. Furthermore, when given the most accurate, current information relating to this process in a timely basis; the operator can make the best and most informed decisions to assure the optimum quality of the final product, in this case, recycled mixed office waste..

An interface to the existing mill-wide computer via a personal computer to a distributed control system (DCS) link was used to enter and/or transfer data from the existing warehouse management system allowing for the matching of process and laboratory data for each batch. This information included the following: Supplier; Average Bale Weight; Purchase Order Number (if required); Grade; Pulper Number; Batch Number; on-line process sensor data; and laboratory test data.

Tracking of the dirt and stickies content to a particular supplier allowed for the quality feedback parameters to be available on a timely basis in order to match them up with each batch. Results of rapid handsheet analysis were entered into the system via a menu approach. Selection of general results by the operator allowed for a quick determination of possible corrective action and automatic addition of chemicals.

Data analysis tools allowed for changing and recording the effects of the pulper chemistry. Feedback from visual inspection as well as laboratory analysis was used to evaluate the effectiveness of each individual batch.

INTRODUCTION

The Recycle Deinking Advanced Control Package (ACP) is the culmination of many years of operational pulping and recycle experience by a collection of pulp staff engineers. This knowledge has been integrated with the most innovative techniques of process control and brought together in the Distributed Control System (DCS) Combined with the integration of specialized sensor technology, this solution is unequaled anywhere in the world.

Through the various process control computer graphic displays used in the package, the operator now has complete access to this information. By stepping through these graphic displays, each particular phase of the overall process can be optimized and this insures that high quality stock can be sent to the paper machine.

Special emphasis has been placed on developing a uniquely effective and efficient operator interface. Multi-layered windowing techniques allow quick and easy access between unit operations, regulatory controls, point details and all levels of Advanced Controls from a single computer graphic display. This approach greatly reduces the time required to learn how to operate the ACP. The concentration of important process data allows each operator to quickly select the configuration and combination of displays that best suit their personal preference, and permits easy access to information based on the present process condition. Input from both operations and engineering personnel was used during the design phase.

The Recycle Advanced Control Package also adds a Statistical Process Control graphic display and a Laboratory Test Entry overview graphic display to further inform the operator regarding trends of the process quality parameters.

The following document is a brief overview of the Recycle Deinking Advanced Control Package.

In the pages to follow, each of these graphic displays and overviews will be described detailing the method of access, features of each (including any calculations done), and interactions with other graphic displays and overviews.

Actual pictures of these computer graphic display and overview screens as seen by the operator will be included in the appendix of this report.

CONTROL FUNCTIONS

The Recycle Advanced Control Package was constructed in a modular format similar to the actual process flow. The functionality was built in levels of control ranging from simple valve control (MANUAL-mode) to the latest in advanced control concepts (PROGRAM-mode). The package was designed to allow complete integration of new technology, including smart sensor technology, or expert systems. Some manual valves were replaced with automatic valves to facilitate control through the DCS.

All chemicals included in the Recycle Deinking ACP will have three common levels of control.

> The lowest level is MANUAL. This permits direct control of the inferred valve position.
>
> The next level is known as AUTOMATIC. This allows the operator to enter a setpoint such as flow rate for a particular chemical.
>
> The final common control level allows the setpoint to be manipulated based on a calculated value such as percentage on stock, lb./ton, or a comparable measurement. This allows for example the chemical to be ratioed to the pulp without requiring additional manual calculations by the operator.

These control levels are provided as part of the ACP so that the operator has access to all control options without having to use more than one graphic.

Each unit operation has a dedicated controls page, with targets indicating the current level of controls. By touching the corresponding target an operator can quickly change levels. It was recognized that during periods of startup or shutdown, the operator needs immediate access to the regulatory controls.

The Advanced Controls graphics overlaps the regulatory levels so that the operator can perform any and all functions from a single schematic.

Control status programs are provided which record the usage of each of the control functions by stage. This was used to document the actual percentage of time that a particular function was used while the line was in operation. This was also included in the daily production summary report.

PULPER SEQUENCE CONTROL

The operation of the pulper is very important and is often referred to as the brains of the deinking operation. (2) The primary function of the pulper is to defiber the pulp and to detach as much of the ink as possible, however proper control of the chemistry at this phase is crucial.

The Advanced Control Package Pulping Module is responsible for all pulper operations as contained in the specific batch recipe. The design of this package is such that it is fully interactive and the terminology used will be consistent with standard batch software.

Batch pulping was scheduled on a "per-batch" basis and streamlined lessening the effect of the pre-existing bottleneck there. The pulper was optimized by including a more systematic addition of chemicals corresponding to the quality of the raw material per batch, optimizing the pulper pH, improving consistency control, and automatic filling, dumping, and flushing of each batch. Implementation of production rate control decreased process upsets which had a positive effect on lessening machine operation upsets due to fiber supply problems.

All phases of the pulping sequence were displayed on the main pulper graphic and included the following phases:

"Resetting Accumulators"
"Starting Water Pump and Opening Valves"
"Waiting For Initial Level"
"Starting Rotor"
"Starting Conveyor"
"Adding Bales"
"Waiting For Weight Target"
"Waiting For Conveyor To Stop"
"Starting Chemical Pumps and Valves"
"Starting Water Pumps and Opening Valves"
"Final Dilution"
"Stopping Chemical Pumps"
"Pulping"
"Waiting For Pulping To Finish"
"Starting Detrasher and Dump Pump"
"Opening Outlet and Dump Valves"
"Opening Dilution Valves and Starting Pump"
"Waiting For Pulper to Empty"
"Stopping Rotor"

The Pulper Module supports operator interactions with other sequence programs and interlocking. This allowed for intervention by the operator while still ensuring safety and process integrity. The sequence can be idled, stopped or aborted at any phase by the operator.

The process of deinking involves several different unit processes, but the chemistry of the pulper must be controlled to ensure maximum benefits. The principle method of chemical addition in the pulper will be based upon the recipe chosen for each particular grade.

For most additives this is primarily based upon a percentage of chemical on dry fiber. The amount of fiber, dilution water and the chemical strengths was carefully monitored and a material balance used to ensure proper dosages.

Consistency measurement in the pulper is often difficult and lacks accuracy. Measurement and totalization of all material streams into the pulper will be used to calculate the actual consistency in the pulper.

Manual samples were analyzed by the laboratory for consistency, and entered into the system with a time-stamp and used in conjunction with any available instrumentation to adjust the bias and gain of the material balance algorithm.

Quality data such as color, dirt count, and brightness were matched against each pulper batch number and used to adaptively adjust the recipes for each grade. This was done on a statistical basis and incorporated changes made directly to each specific batch keeping a history of all previous batches. A regression analysis of key operating values with a user-adjustable correlation coefficient was used to detect trends and changes in quality.

SCREENING AND CLEANING

The pulper operation was referred to as batch, but the rest of the process is continuous. The stock is pumped from the dump chest through the coarse liquid cyclones. These operate on the principle of centrifugal cleaning and are designed to remove heavy contaminants such as paper clips, staples, rocks, glass, sand etc.

In the screens and cleaners the key aim is to maintain the proper pressure drop across each piece of equipment by automatically flushing and/or purging of the individual screen or cleaner. The feed flow was related to production rate with the reject rates were held constant or changed based on lab dirt tests. Maintaining a constant feed pressure is crucial to the operation of the cleaners and screens.

The debris removal is proportional to the pressure drop across the equipment. This is maintained by manipulating the accept valves. As the screens and cleaners wear, the optimum ΔP shifts along the efficiency curve requiring a new control setpoint. This package automatically corrects for this shift.

Fig. 1

A reject ratio parameter is also used. The reject ratio was manipulated to improve the cleanliness of the stock while minimizing fiber loss. Tight tuning of all controls is a must.

The accepts from the cyclones become the feed stream for the pressure screens. Coarse screens are used to remove particles that are larger in at least one dimension than paper making fibers.

The rejects are usually collected in a reject compartment then purged either continuously or intermittently. The rejects usually do not contain much fiber and yield losses are minimal.

The fine screens operate basically the same way as the coarse screens only that the openings or slots are much smaller, usually around 0.006". These are used to virtually eliminate all remaining contaminants. Again the reject ratio can be manipulated to improve the cleanliness of the stock without an appreciable fiber loss.

The accepts of the fine screens are then fed to the primary light cleaners also known as forward cleaners. Again the key feature here is to maintain the proper pressure drop. The feed flow is again related to production rate with the reject rates being constant or changed based on lab dirt tests.

The purpose of the cleaners are to remove contaminants that are lighter than water such as waxes and the hot melt bindings used in many publications such as telephone books. The final phase of cleaners are also centrifugal cleaners that are used to remove any remaining material with a density greater than that of water. This usually includes sand and some ink specs.

BLEACHING

The use of compensated brightness to control chemical addition is a very common practice. It has been chosen as an inferential way to measure the light absorbing substances in the pulp.

Old Strategy

Historically, controlling to an exact brightness has been very difficult because of the long dead time between chemical injection before the first stage tower, and the washer mat.

The control strategy must contend with many variables that affect the brightening process. These include pH, temperature, and consistency variations. The influence of the residual ink and dyes on paper color is quite significant. This absorption of light is in addition to that by any residual lignin. In order to compensate for incoming low brightness excursions, the chemical is often over-applied.

Technically this can be described as operating too close to the asymptotic limit of the process; practically this is described as a very expensive safety blanket.

Therefore, it can be concluded that the traditional approach of using optical brightness, and a residual sensor, and combining these two signals with or without the addition of other signals, such as temperature and consistency, to arrive at a feedback variable (compensated brightness), for a PID loop, is clearly not robust enough. The traditional PI (proportional/integral) controller is especially not suited for this application.

New Strategy

This Advanced Control Package uses an advanced control strategy which will allow the process to be operated closer to the economic optimum, without compromising on product quality. A predictive model based controller has been developed which calculates the predicted degree of brightening as the controlled variable, applied chemical as the manipulated variable and a number of other inputs as disturbance variables.

Once system identification has been accomplished, the feedforward mode uses the production rate and the incoming brightness number as its inputs. Feedforward control only would be capable of perfect control if all load variables could be defined, measured and incorporated. This is not entirely possible or practical.

In the bleach plant, a predictive, model-based controller and both feedforward and feedback techniques to control chemical addition was used which calculated the predicted degree of brightening as the controlled variable, applied chemical as the manipulated variable and related these to a number of other inputs, or disturbance variables. Lab feedback of spec counts and incoming brightness were used as part of the feedforward model. Integration of SPC tools allowed for the checking of variability of lab data with measured values.

The model based controller uses both feedforward and feedback techniques to control chemical addition. It has been shown that there is a linear relationship between the desired brightness increase and percent applied chemical. We like to refer to this relationship as "first principles" and is the primary goal of the feedforward mode.

The feedback mode therefore uses in addition to incoming brightness and production rate, variables that affect pulp color development such as pH, temperature, stock flow, raw optical brightness and residual chemical. The feedforward and feedback modes work in conjunction with each other with the feedforward "first principles" result being compared to the feedback result as a sanity check.

The ability of the operator to enter a real world number such as TAPPI wet brightness (T-)is a major improvement in itself over the traditional approach of compensated brightness, where a unitless percentage of range is entered and often adjusted based on a lab test.

Noise

Noise is a common phenomenon in the bleach plant and can be attributed to channeling, measurement noise, or just random "white" noise. To reduce the possibility of the controller acting on noise and inducing process disturbances, inputs to the model are filtered with statistical process control techniques. EWMA (Exponentially Weighted Moving Average) filtering was selected because of its predictive capability.

The model identifier program continuously collects raw filtered data, recalculates the model coefficients, determines if the current model is breaking down, and, if needed, downloads new coefficients to the controller. The raw data is stored into what is referred to as the "snapshot" buffer on a ten-minute frequency.

When a brightness or dirt test is entered into the system, the tester also enters a time stamp indicating when the sample was taken from the process. The model identifier program correlates the snapshot data with the test time stamp and stores correlated data into an observation buffer. Dead time must be taken into account because the location of the sampling point.

When enough data is collected and correlated into the observation buffer, the model identifier program calculates new model coefficients. The predicted brightness correlation calculation is performed each time a new lab test is entered. If it is found that the current model brightness prediction is not correlating to the actual lab test, then new coefficients are automatically loaded to the controller.

Bleaching Chemicals

Hydrogen Peroxide is one of the most widely used chemicals for bleaching recycle. The reaction mechanism is well understood and requires fairly rigid pH control in order to maximize the oxidative effect. Over addition of sodium hydroxide will cause alkali darkening of wood containing furnishes such as newsprint.

The accuracy of in-line pH is often suspect. As a result of this an on-line sensor correction module has been incorporated. The sensor correction feature accepts laboratory tests either entered directly through the operator console or from a MIS system, and compares them to the corresponding sensor value. Inaccuracies in the sensor are then adjusted for so that control can be based on a more reliable value. Integration of SPC tools allows for the checking of variability of lab data and is also alarmed appropriately.

Reductive bleaching agents are also required in the recycle deinking process. Their main function is to color-strip dyes which are quite unaffected by oxidative agents such as hydrogen peroxide. They are also very effective where a trim of a few (1-5) brightness points are required. The traditional approach using compensated brightness is not as efficient as our model based approach. Savings of 5-7% of the bleaching cost are expected.

One of the most common reductive agents used is formamidine sulphinic acid (FAS) and is particularly suited to the alkaline conditions following the peroxide stage. FAS is also a very expensive chemical and needs to be properly controlled. Lab feedback of spec counts and incoming brightness are used as part of the feedforward model.

Ratio Control vs. Sensor-Based Control

The package can be used with any of the pulp brightness/residual sensors on the market. All of these devices come with some sort of microprocessor that contains the compensated brightness algorithm that is not dynamically updated. We successfully integrated the raw signals into the Distributed Control System and bypassed the third party microprocessor.

The exiting transient brightness curves for a given incoming brightness under Ratio Control and Sensor-Based Control show the advantage of Sensor-Based Control.

Ratio Control Sensor-Based Control

Fig. 2a Fig. 2b

Color, as expressed in the 1976 CIE L*a*b* coordinate system, is becoming an increasingly important parameter in the control of recycle deinking plants. You can have a very bright yellow pulp that will obviously be off grade due to the presence of the yellow dye.

FEATURES

In addition to the Advanced Controls as described in previous section, the Advanced Control Package offers a complete range of features which are integral to the package. These features (or modules) perform complicated dedicated functions such as automatically changing grades, automatically tuning and correcting in-line sensors, automatically changing production rates, and statistically monitor the process.

Automatic Rate Change

The Automatic Rate Change feature changes the stock flow according to a new desired production rate setpoint and a given ramp time. During the ramping of production rate, all critical control loops in the cleaning and screening areas or in the bleach plant are monitored. Any defined alarm condition results in suspension of the rate change, and if not corrected, will lead to a cancellation of the attempted rate change. The alarm limits associate with this feature are independent of the distributed control system alarms.

Sensor Correction

The Sensor Correction feature accepts laboratory tests either entered directly through a operator console or from an MIS system and compares them to the corresponding sensor value. Inaccuracies in the sensor are then adjusted for, so that control can be done based on a more reliable value. Typical uses for this feature include correcting pH probes, optically derived values, like Brightness, or viscosity derived values, like consistency.

Because of variable shear (viscosity) or optical effects of different wood species, the sensor correction feature was used to correct the consistency and brightness measurements for grade changes.

Integration of SPC tools allow for the checking of variability of lab data and is alarmed appropriately. A linear regression technique is used to adjust both gain and offset based on time stamped lab tests.

Statistical Process Management

The Advanced Control Package uses several advanced statistical process control techniques in two main ways. First, critical process variables from sensors and manually entered lab data are charted and filtered. This reduces the noise and possible process instability. Second, control charts are used to detect true process changes and to assist the operator in assigning probable causes to truly significant process events.

Stock Tracking

Stock tracking provides the ability to send and receive data and instructions from other controls and features within the control package.

Both for control and for statistical evaluation, stock tracking historizes real time operating conditions and effectively shifts those values, so that specific physical and chemical properties can be compared to each other without the time or transport delay off setting the compared properties. The parameters assigned to the pulp segments will be determined by the distributed control system and the final customer prior to start up.

Although the data to be tracked is pre-assigned, to ensure this feature is flexible, tracked parameters can be added or deleted during operation.

Stock Tracking relies on and assumes that various sensors, including consistency, stock flow, and tower levels are accurate.

During the kick-off meeting this aspect was discussed and various ways to overcome any site specific difficulties were developed.

Actual retention time studies of towers where channeling was suspected was recommended.

A total of 20 parameters per tower may be tracked and can generally be selected by the Mill. However, ten common parameters are required by the Advanced Control Package for internal functions, thereby leaving the remaining ten parameters at the selection of the operator.

It should be noted here that often the reserved parameters are in fact the same as many of those normally chosen by the operator.

Stock tracking can be a very beneficial feature for those mills under ISO9000 certification.

GRAPHICS

The ACP graphics rely on windowing techniques to drastically reduce the number of primary graphics require to use the package. Below is a description of each of the primary graphics.

Pulper Advanced Control Summary

The Pulper Advanced Control Summary (ACS) contains all of the information required to operate the recycle plant. The left side of the graphic provides a list of each unit operation, and the current control level setpoint, PV, and engineering unit, including added furnish, water, and chemical totalizers, pulper phase timer values, current phase description, and furnish grade information. The right side of the graphic is used to view pictorial displays of each pulper, dump chest, and blend chest.

Typically each pulper display had the following windows:

List of all available control levels with set points and PV's
Controller status - lists all controllers and whether or not they are available.

Batch Record Overview

The Batch Record display keeps a daily, running account of the individual pulpers displaying added furnish, water, and chemical usage, pulper phase start, stop, and elapsed time values, and furnish grade information.

A report of the previous day's activity for each pulper is printed each morning at the start of the first shift.

Screening Production Rate Change

This display allows the operator to enter a coarse screen production rate target and a ramp time. as well as initiate and suspend rate changes.

Windows are used to show and configure the points that are monitored along with their limits, deadbands, and current alarm status.

Bleaching Advanced Control Summary

The Bleaching Advanced Control Summary (ACS) contains all of the information required to operate the recycle plant. The left side of the graphic provides a list of each unit operation, and the current control level setpoint, PV, and engineering unit. The right side of the graphic is used to view unit specific windows.

Typically each stage will have the following windows:

Overview with pertinent trends.
Limits/Bypasses
List of all available control levels with set points and PV's
Controller status - lists all controllers and whether or not they are available.
Input status - list all inputs used and whether or not they are valid.

Test Entry

This display permits test to be entered and/or allows for the acceptance of test from an MIS system. The last 24 values of data are also accessible for all tests. Test values are checked against limits so as to alert the operator to bad values, or sensor problems.

Bleach Plant Grade Change

This display is used to configure the recipes used by grade change, initiate a grade change, and to view the current location of the grade interface.

A graphical representation of the bleach plant uses a variety of colors to indicate the current grade of each Stock Tracking segment.

Bleach Plant Rate Change

This display allows the operator to enter a Bleach Plant production rate target and a ramp time. as well as initiate and suspend rate changes.

Windows are used to show and configure the points that are monitored along with their limits, deadbands, and current alarm status.

Statistical Process Control

The ACP display package provides on-line statistical analytical tools for use by the operations personnel to achieve and to maintain the process at the statistically optimum level.

These tools include control charts (X, R and s), histograms (of observations and of samples), control limit capabilities index calculations, and MA, EWMA and ARIMA calculations.

REPORTS

In addition to the standard distributed control system journals and logs, a separate, custom ADVANCED CONTROLS SUMMARY RESULTS REPORT was provided for both the Pulper and Bleach Plant operations.

These reports are generated at the end of each operating shift, day and month. They include breakdowns of chemical usage, pulp quantity and quality, process variation and advanced control utilization for the entire period represented by the reports.

CONCLUSIONS

With this Advanced Control Package and a new-found ability to determine and make prompt, timely changes in plant operating conditions the operator can make the best and most informed decisions to assure the optimum quality of the final product, in this case, recycled pulp. Chemical savings in the range of 3-5% or around $2.00 per ton savings representing an annual saving of $167,000. With the implementation of pulper batch scheduling, the mill was able to increase throughput by 6% returning over $540,000 per year. This total of over $707,000 per year led to return on their investment in significantly less than one year.

REFERENCES

.Spangenberg, R.J.; SECONDARY FIBER RECYCLING; TAPPI Press; 1993Ferguson, L.D; 1992 DEINKING SEMINAR, TAPPI Press; 1992

ACKNOWLEDGMENTS

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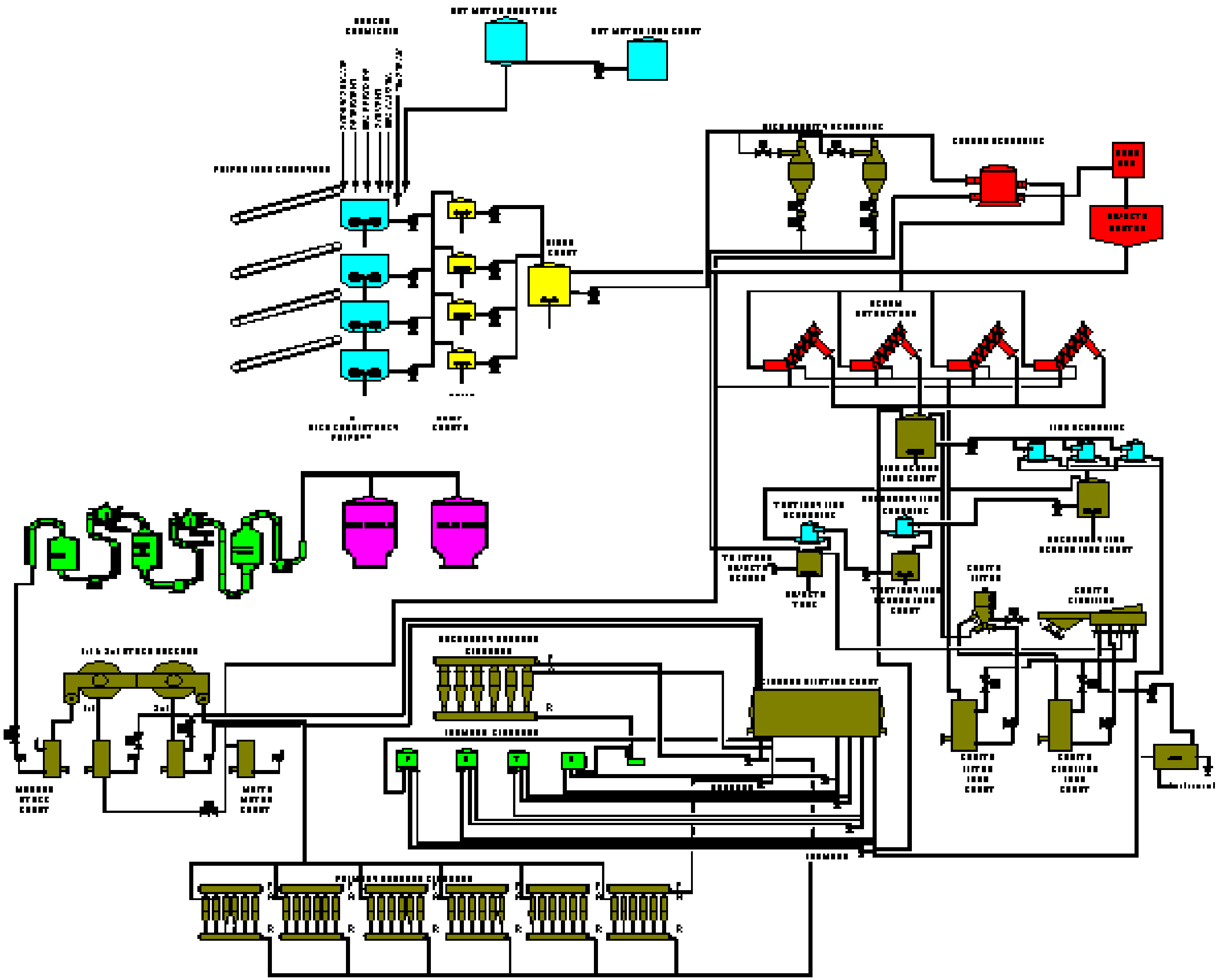
TYPICAL RECYCLE/DEINKING PLANT

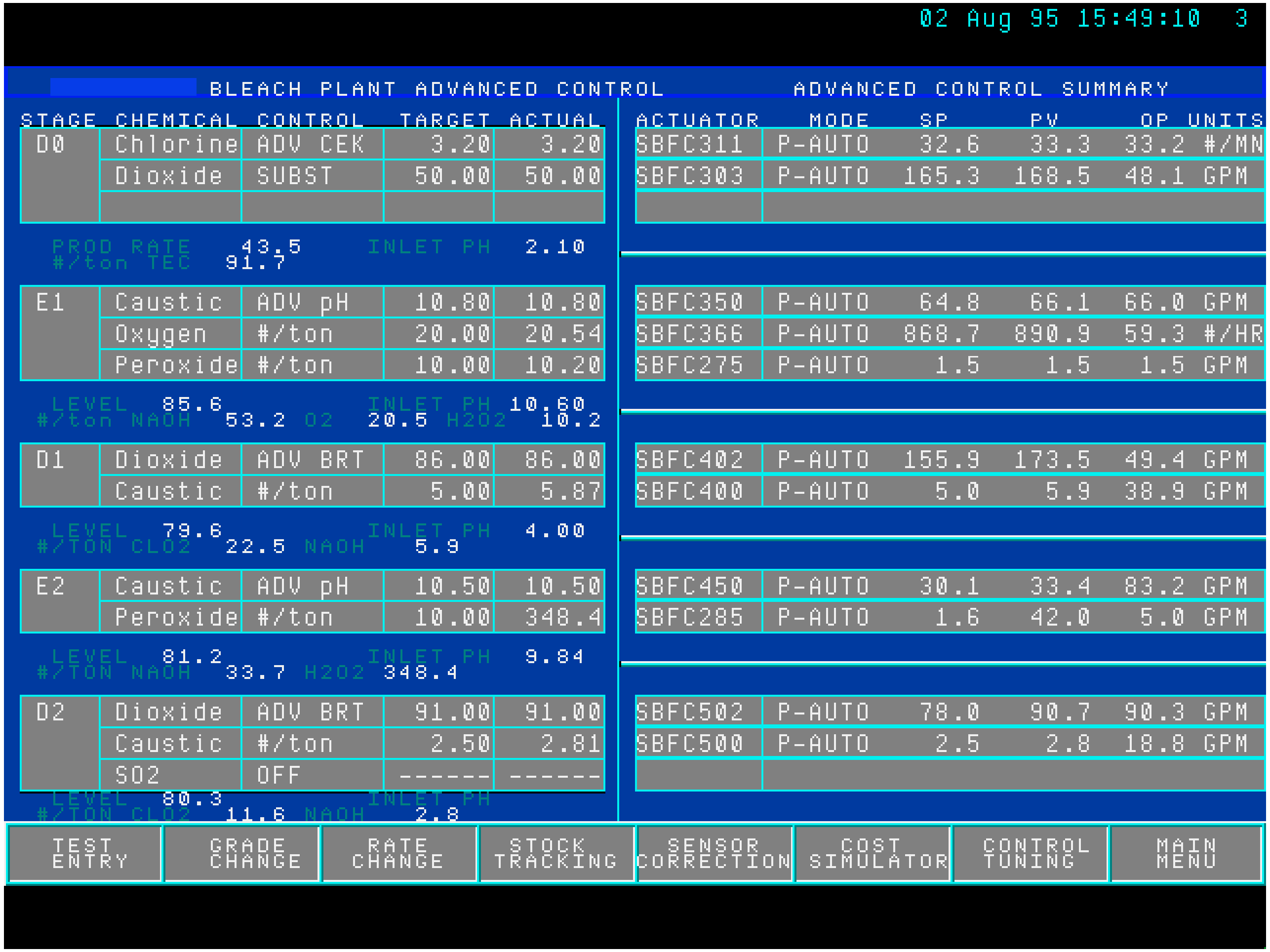


- Pulpers
- Dump Chests
- Blend Chest
- Hi-Density Cleaners
- Coarse Screens
- Extractors
- Screens
- Forward Cleaners
- Fine Screens
- Filtering & Clarification
- Reverse Cleaners
- Thickeners
- Bleach Plant
- Hi-Density Storage

Main menu


03 Aug 95 15:19:43 3
BLEACH PLANT ADVANCED CONTROL
MAIN MENU
ADVANCED CONTROL SUMMARY
PRODUCTION RATE CALCS
TEST ENTRY
COST SIMULATOR
STOCK TRACKING
CONTROL TUNING
GRADE CHANGE
SENSOR CORRECTION
RATE CHANGE
SPC

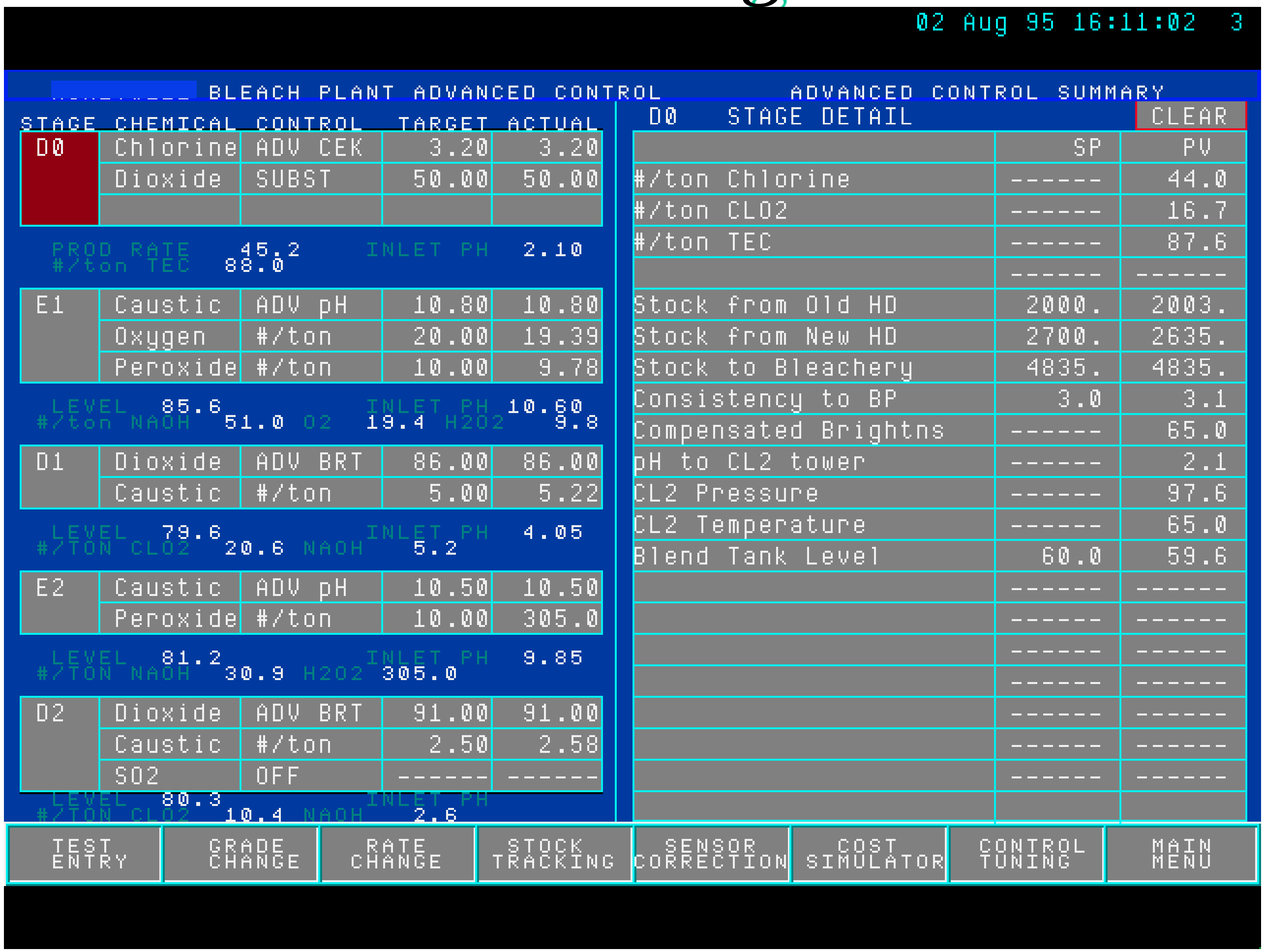
Advanced Control Summary



- On a Stage-by-stage basis
- Chemical Dosages
- Advanced Control Modes

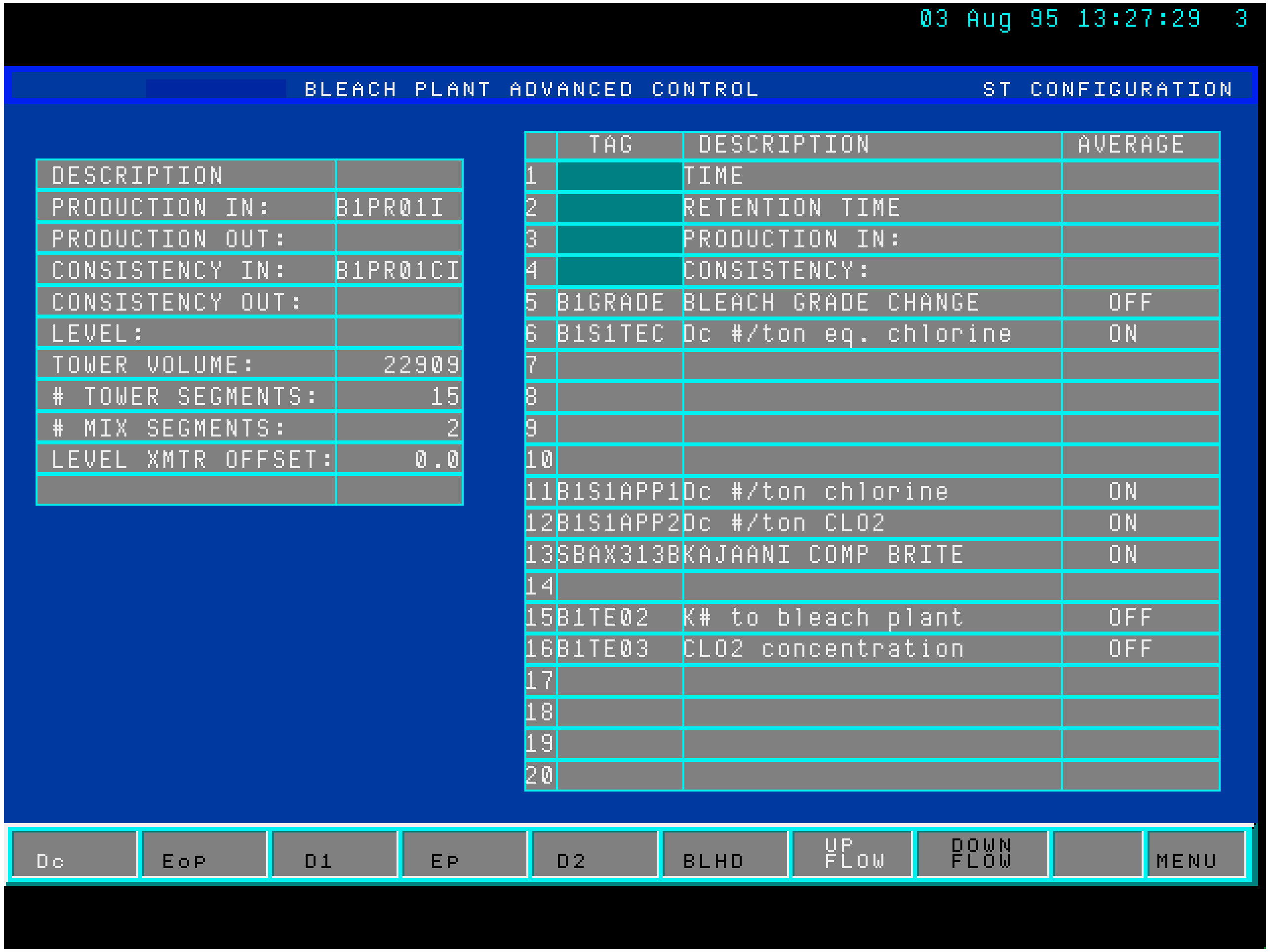
Advanced Control Summary

Stage Detail



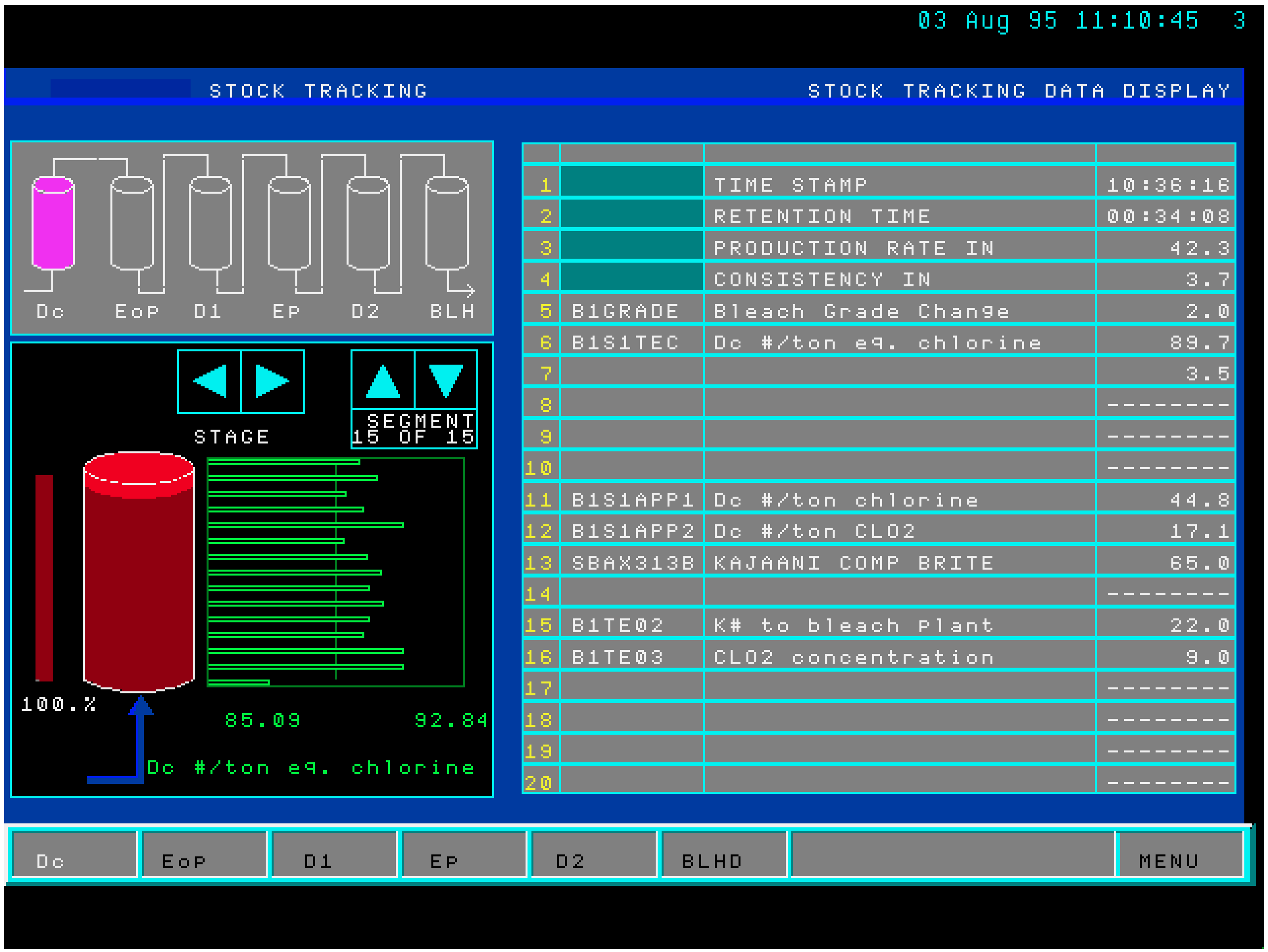
- Stock Tracking
- Quality Parameters

Parameter Configuration



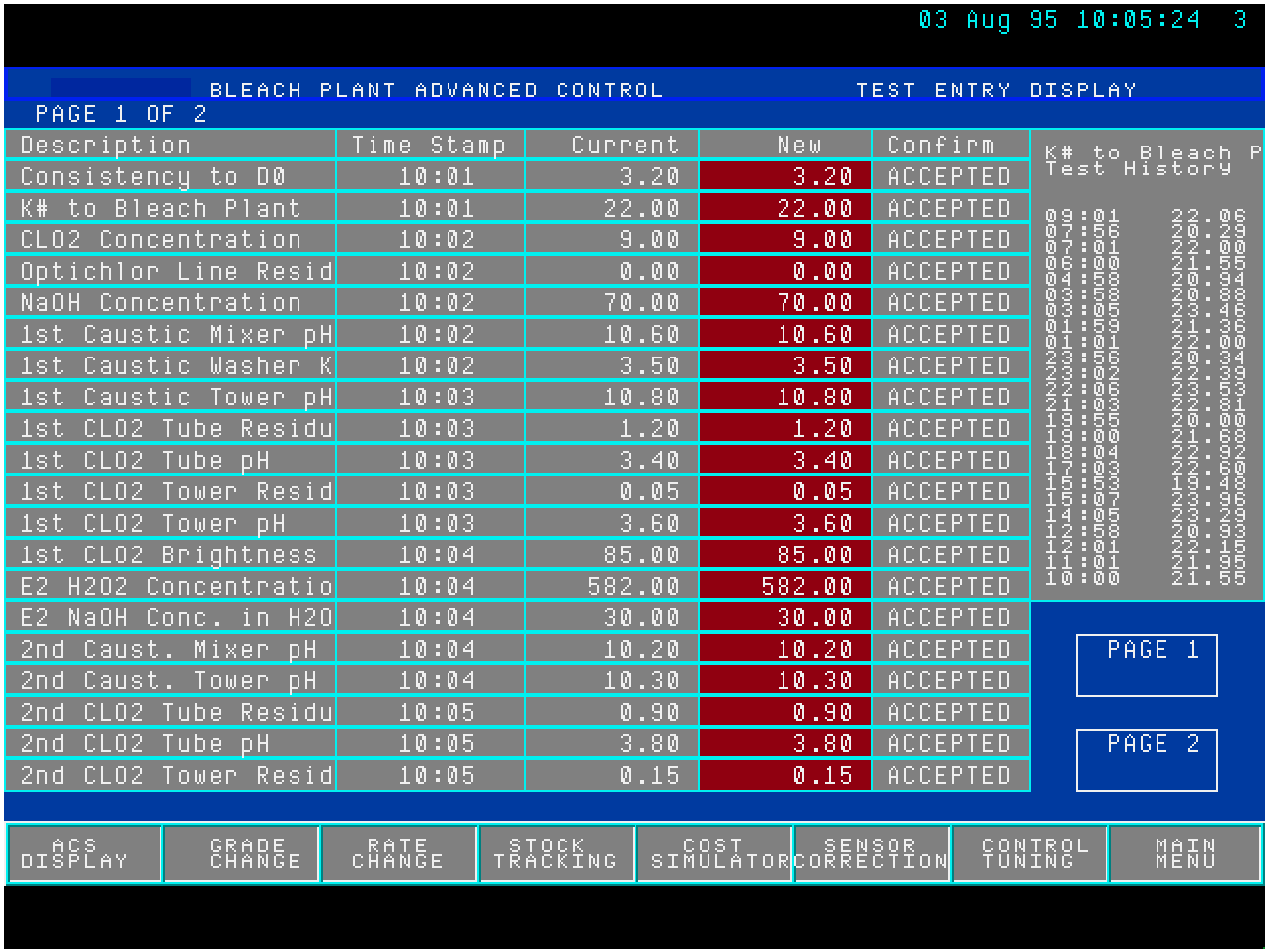
Stock Tracking Main Menu

Stock Tracking Tower Display



- Segment Qualities
- Parameter Entry
- Stage Selection

Test Entry



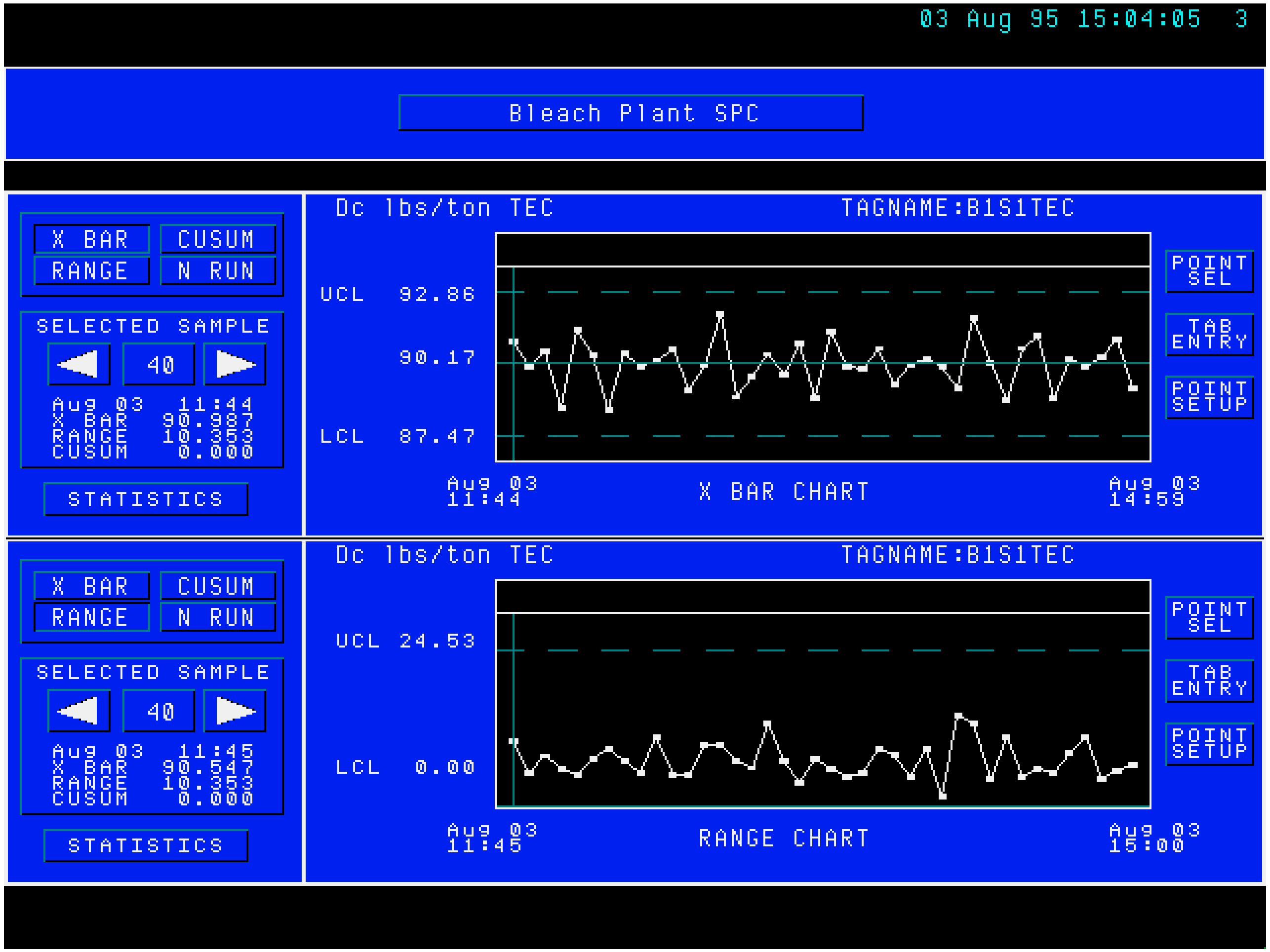
Description	Time Stamp	Current	New	Confirm
Consistency to D0	10:01	3.20	3.20	ACCEPTED
K# to Bleach Plant	10:01	22.00	22.00	ACCEPTED
CLO2 Concentration	10:02	9.00	9.00	ACCEPTED
Optichlor Line Resid	10:02	0.00	0.00	ACCEPTED
NaOH Concentration	10:02	70.00	70.00	ACCEPTED
1st Caustic Mixer pH	10:02	10.60	10.60	ACCEPTED
1st Caustic Washer K	10:02	3.50	3.50	ACCEPTED
1st Caustic Tower pH	10:03	10.80	10.80	ACCEPTED
1st CLO2 Tube Residu	10:03	1.20	1.20	ACCEPTED
1st CLO2 Tube pH	10:03	3.40	3.40	ACCEPTED
1st CLO2 Tower Resid	10:03	0.05	0.05	ACCEPTED
1st CLO2 Tower pH	10:03	3.60	3.60	ACCEPTED
1st CLO2 Brightness	10:04	85.00	85.00	ACCEPTED
E2 H2O2 Concentratio	10:04	582.00	582.00	ACCEPTED
E2 NaOH Conc. in H2O	10:04	30.00	30.00	ACCEPTED
2nd Caust. Mixer pH	10:04	10.20	10.20	ACCEPTED
2nd Caust. Tower pH	10:04	10.30	10.30	ACCEPTED
2nd CLO2 Tube Residu	10:05	0.90	0.90	ACCEPTED
2nd CLO2 Tube pH	10:05	3.80	3.80	ACCEPTED
2nd CLO2 Tower Resid	10:05	0.15	0.15	ACCEPTED

K# to Bleach P
Test History

09:01	22.06
07:56	20.29
07:01	22.00
06:00	21.55
04:58	20.94
03:58	20.88
03:05	23.46
01:59	21.36
01:01	22.00
23:56	20.34
23:02	22.39
22:06	23.53
21:03	22.81
19:55	20.00
19:00	21.68
18:04	22.92
17:03	22.60
15:53	19.48
15:07	23.96
14:05	23.29
12:58	20.93
12:01	22.15
11:01	21.95
10:00	21.55

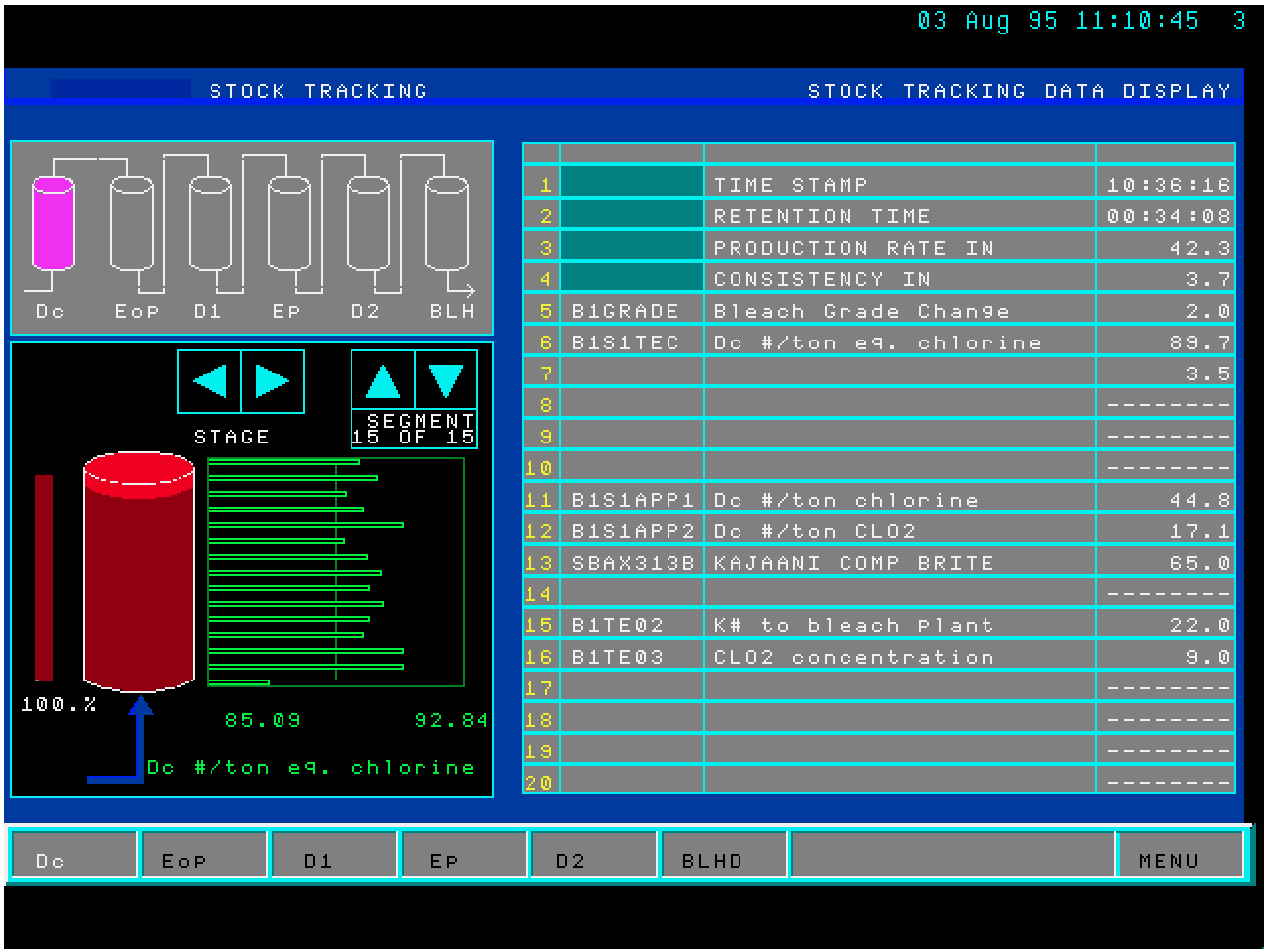
- Descriptions
- Alarm Limits
- History
- Time Stamping

Statistical Process Control



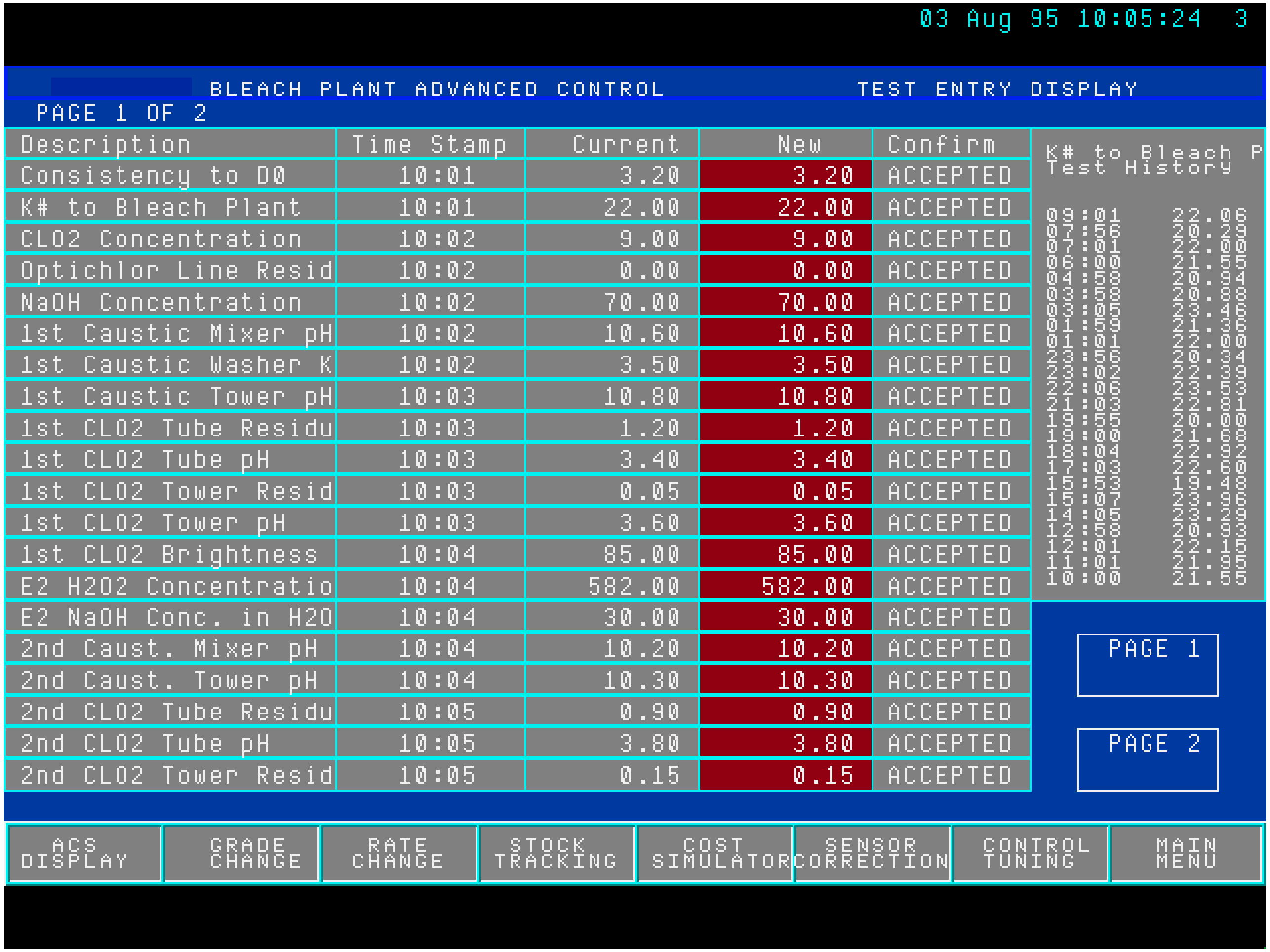
- LCL & UCL
- X Bar
- Point Selection
- Point Setup

Stock Tracking Tower Display



- Segment Qualities
- Parameter Entry
- Stage Selection

Test Entry



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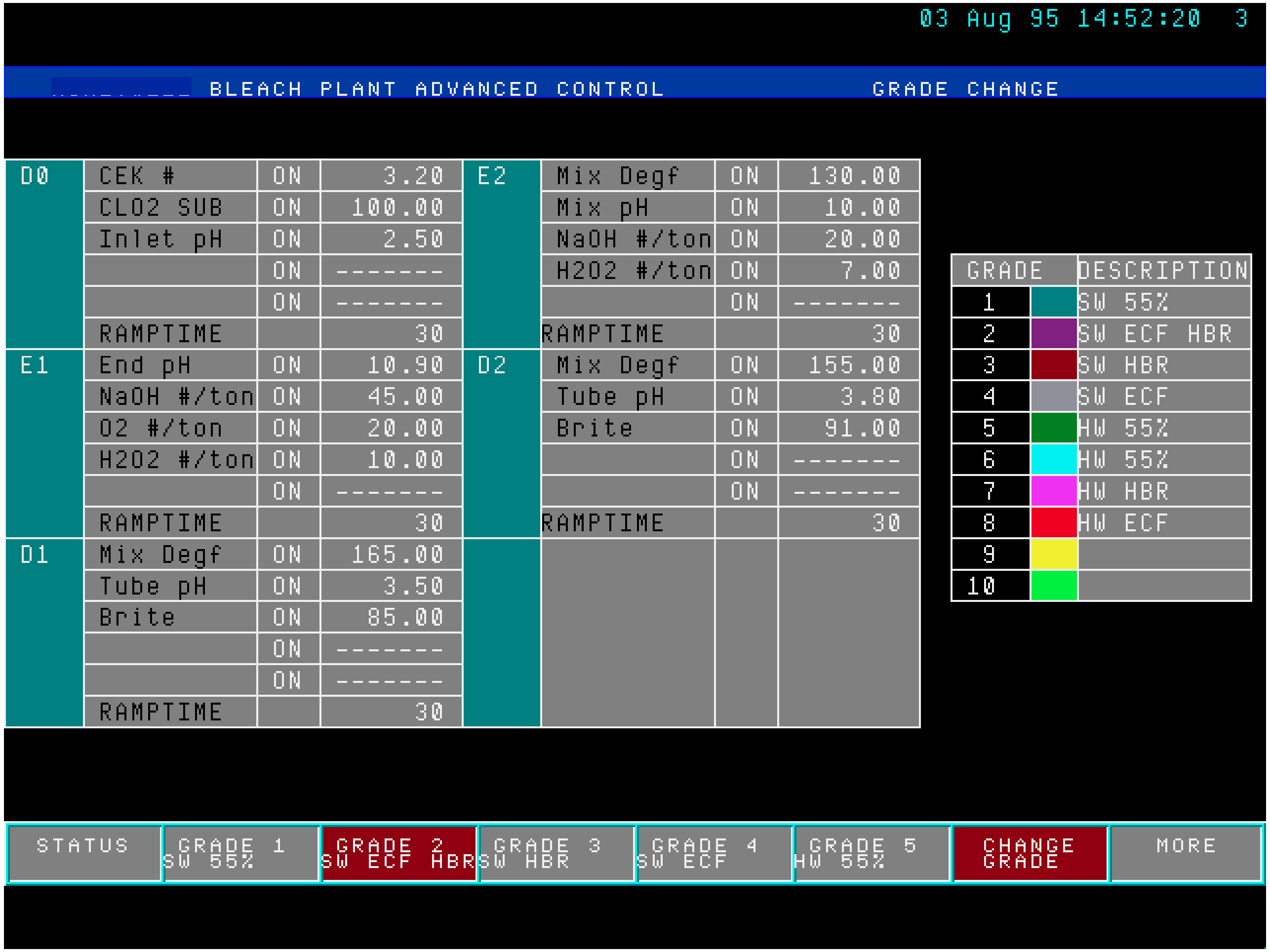
1st CLO2 Tube Residu	10:03	1.20	1.20	ACCEPTED
1st CLO2 Tube pH	10:03	3.40	3.40	ACCEPTED
1st CLO2 Tower Resid	10:03	0.05	0.05	ACCEPTED
1st CLO2 Tower pH	10:03	3.60	3.60	ACCEPTED
1st CLO2 Brightness	10:04	85.00	85.00	ACCEPTED
E2 H2O2 Concentratio	10:04	582.00	582.00	ACCEPTED
E2 NaOH Conc. in H2O	10:04	30.00	30.00	ACCEPTED
2nd Caust. Mixer pH	10:04	10.20	10.20	ACCEPTED
2nd Caust. Tower pH	10:04	10.30	10.30	ACCEPTED
2nd CLO2 Tube Residu	10:05	0.90	0.90	ACCEPTED
2nd CLO2 Tube pH	10:05	3.80	3.80	ACCEPTED
2nd CLO2 Tower Resid	10:05	0.15	0.15	ACCEPTED

K# to Bleach P
Test History

09:01	22.06
07:56	20.29
07:01	22.00
06:00	21.55
04:58	20.94
03:58	20.88
03:05	23.46
01:59	21.36
01:01	22.00
23:56	20.34
23:02	22.39
22:06	23.53
21:03	22.81
19:55	20.00
19:00	21.68
18:04	22.92
17:03	22.60
15:53	19.48
15:07	23.96
14:05	23.29
12:58	20.93
12:01	22.15
11:01	21.95
10:00	21.55

- Descriptions
- Alarm Limits
- History
- Time Stamping

Grade Change



BATCH RECORD

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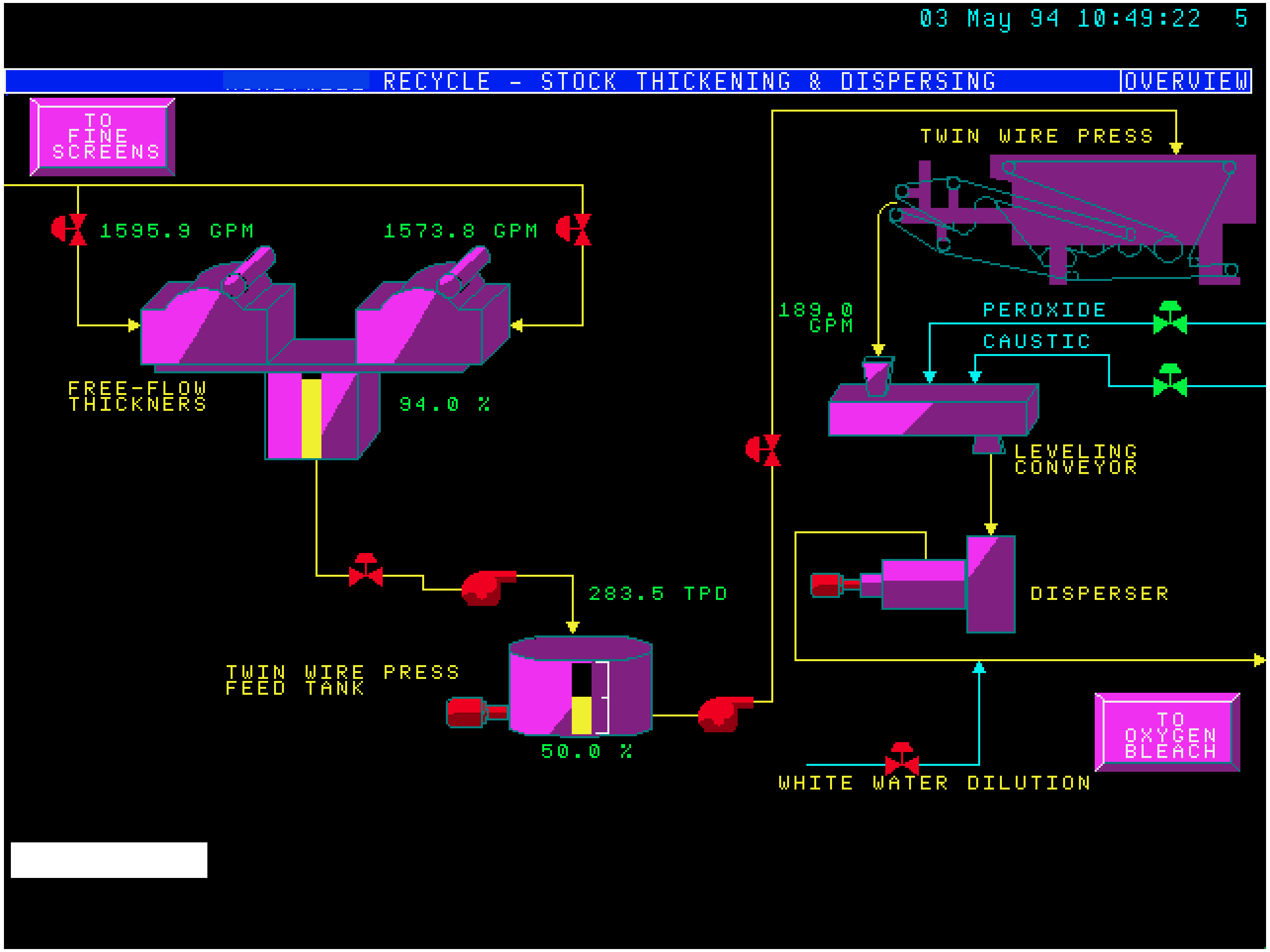
RECYCLE ADVANCED CONTROL PULPER 12 BATCH RECORD

Batch No	TOTAL Weight	Pad Time Start	Charge Complete	Fill Start	Time Finish	Cook Time Start	Dump Time Start	TOTAL Time	Dump Chest
02269601	35,000	01:51	01:57	02:12	02:13	02:14	03:02	00:47	E1
02269602	35,000	02:38	02:43	02:48	02:49	02:50	02:38	00:54	E2
02269603	35,000	03:42	03:47	04:02	04:03	04:04	04:52	00:48	E3
02269604	35,000	04:30	04:35	04:50	04:51	04:52	05:40	01:02	E4
02269605	35,000	05:32	05:37	05:52	05:53	05:54	06:42	01:16	E1
02269606	35,000	06:48	06:53	07:08	07:09	07:10	07:58	00:56	E2
02269607	35,000	07:44	07:49	08:04	08:06	08:07	08:55	01:05	E3
02269608	35,000	08:49	08:54	09:09	09:10	09:11	09:59	00:53	E4
02269609	35,000	09:42	09:47	10:02	10:03	10:04	10:52	00:49	E1
02269610	35,000	10:53	10:58	11:13	11:14	11:15	12:03	00:47	E2
02269611	35,000	11:40	11:45	12:00	12:01	12:02	12:50	00:52	E3
02269612	35,000	12:32	12:37	12:52	12:53	12:54	13:46	00:54	E4
02269613	35,000	13:26	13:31	13:46	13:47	13:48	14:36	00:49	E1
02269614	35,000	14:15	14:20	14:35	14:36	14:37	15:25	00:46	E3
02269615	35,000	15:01	15:06	15:21	15:22	15:23	16:12	00:51	E1
02269616	35,000	15:52	15:57	16:12	16:13	16:14	17:02	00:44	E2
02269617	35,000	16:36	16:41	16:56	16:57	16:58	17:46	00:52	E4
02269618	35,000	17:28	17:33	17:48	17:49	17:50	18:38	01:10	E1
02269619	35,000	18:38	18:43	18:48	18:49	18:50	19:38	01:06	E3
02269620	35,000	19:44	19:49	20:04	20:05	20:06	20:54	00:59	E2
02269621	35,000	20:43	20:48	21:03	21:04	21:05	21:52	01: 11	E4
02269622	35,000	21:54	21:59	22:14	22:15	22:16	23:04	00: 52	E3
02269623	35,000	22:46	22:51	23:06	23:07	23:08	23:56	00: 46	E1
02269624	35,000	23:32	23:37	23:52	23:53	23:54	01:42	01: 48	E2

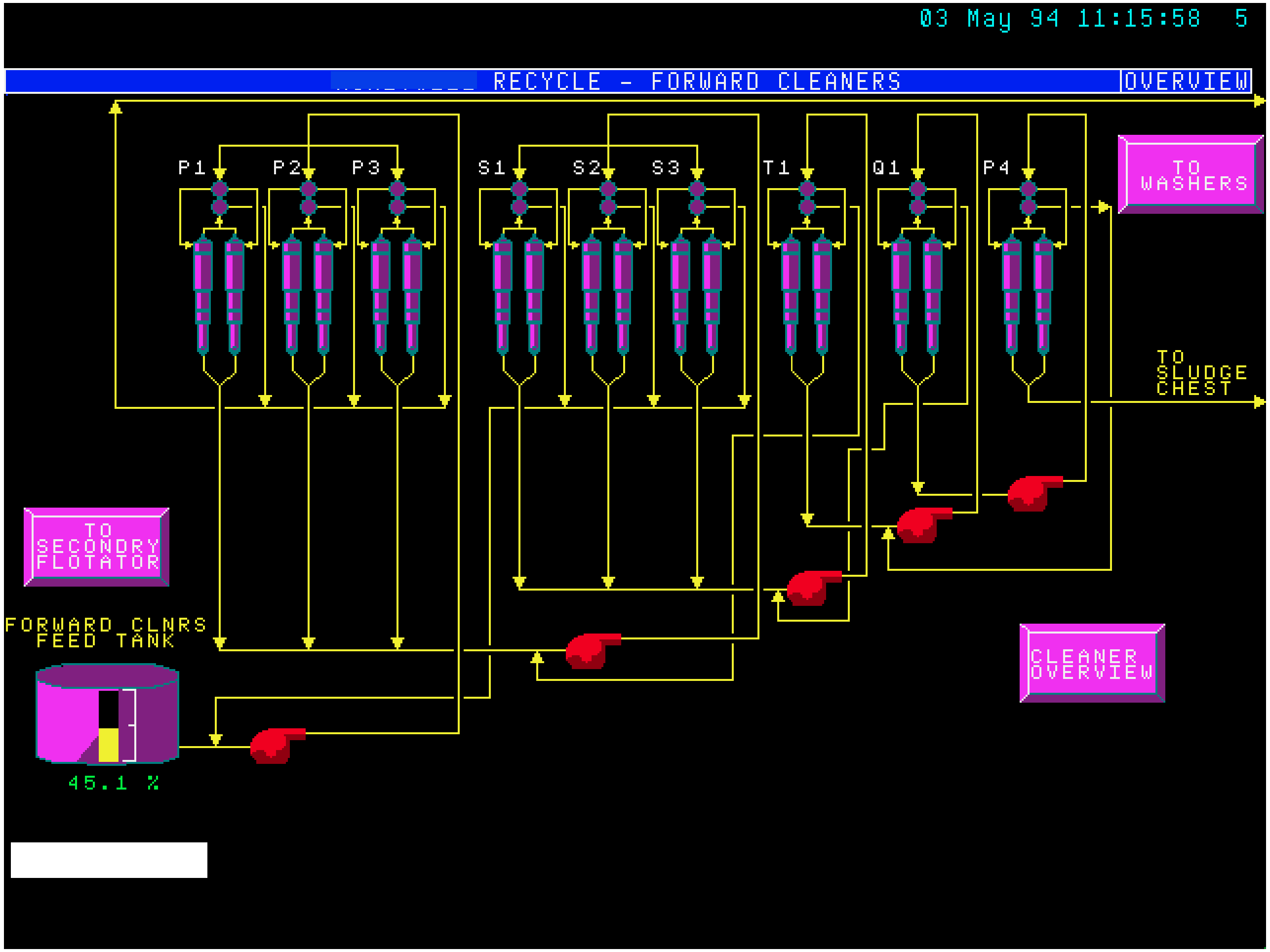
TEST ENTRY	BATCH RECIPE	RATE CHANGE	PULPERS	H-D SCREENS	FINE SCREENS	FWD&REV CLEANING	SENSOR CORRECT	CONTROL TUNING	MAIN MENU

Stock Thickening & Dispersing



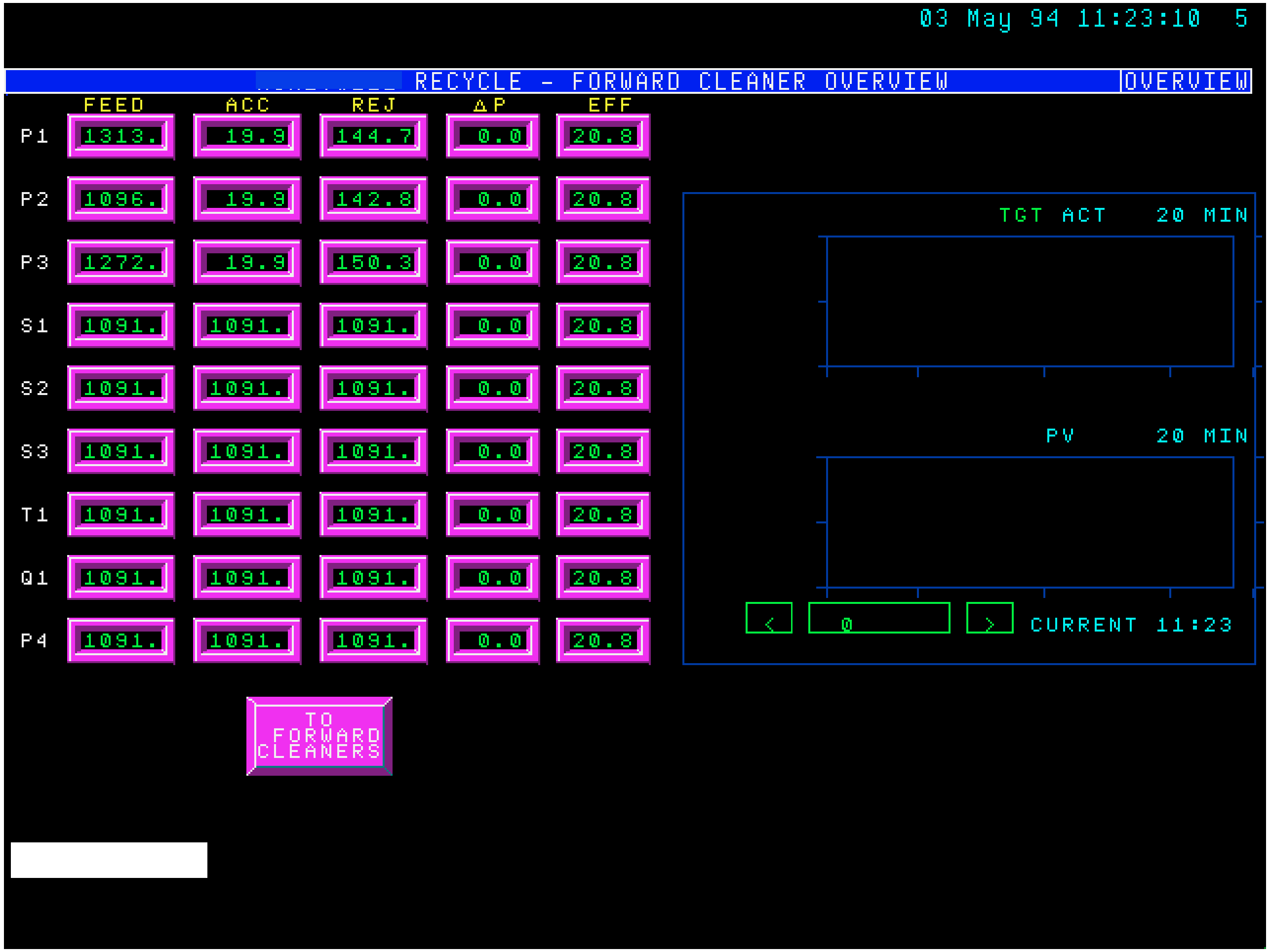
- Thickeners
- Press
- Disperser

Forward Cleaners



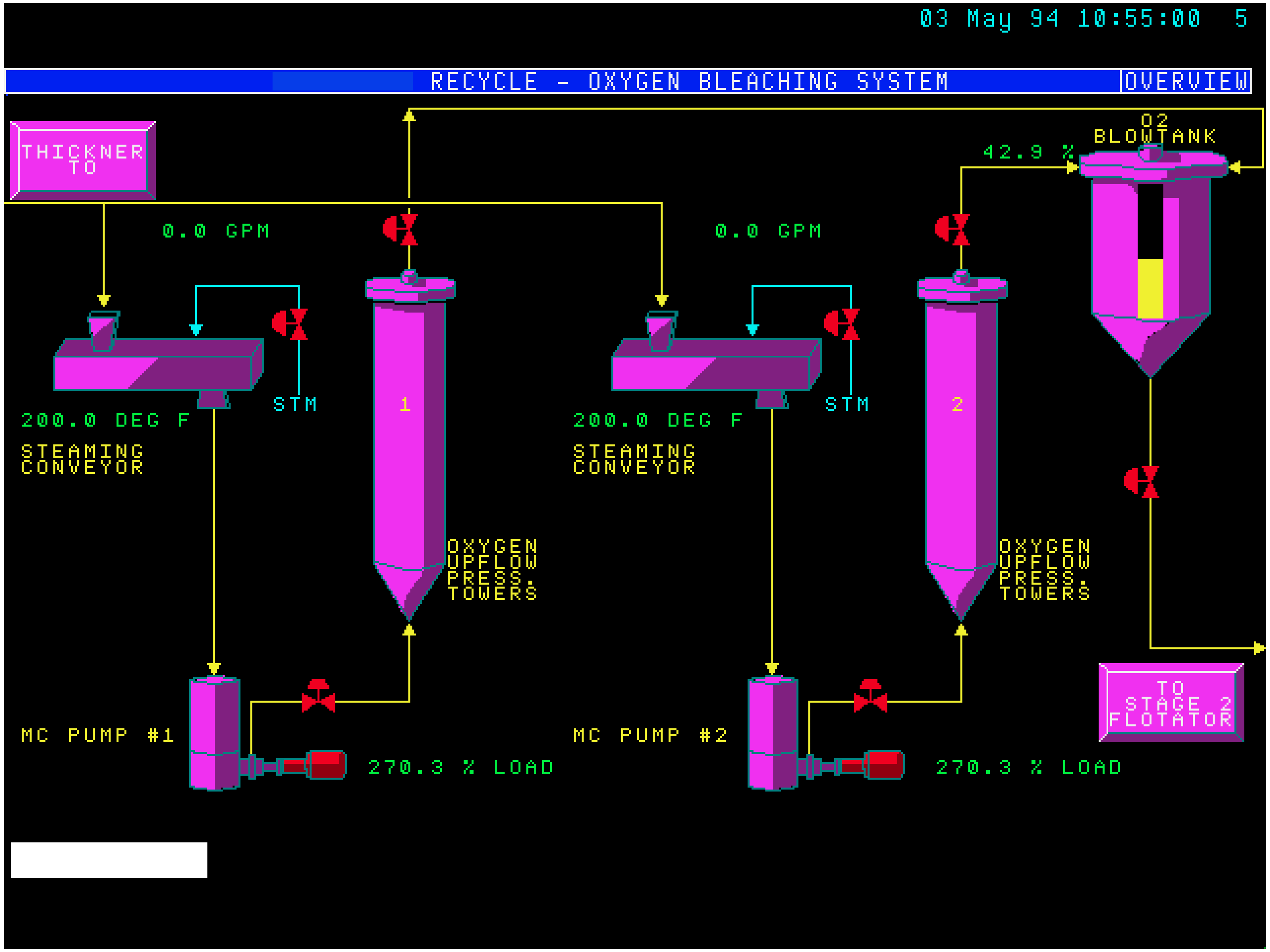
- Primary
- Secondary
- Tertiary
- Quarternary
- Feed Pumps

Forward Cleaner Overview



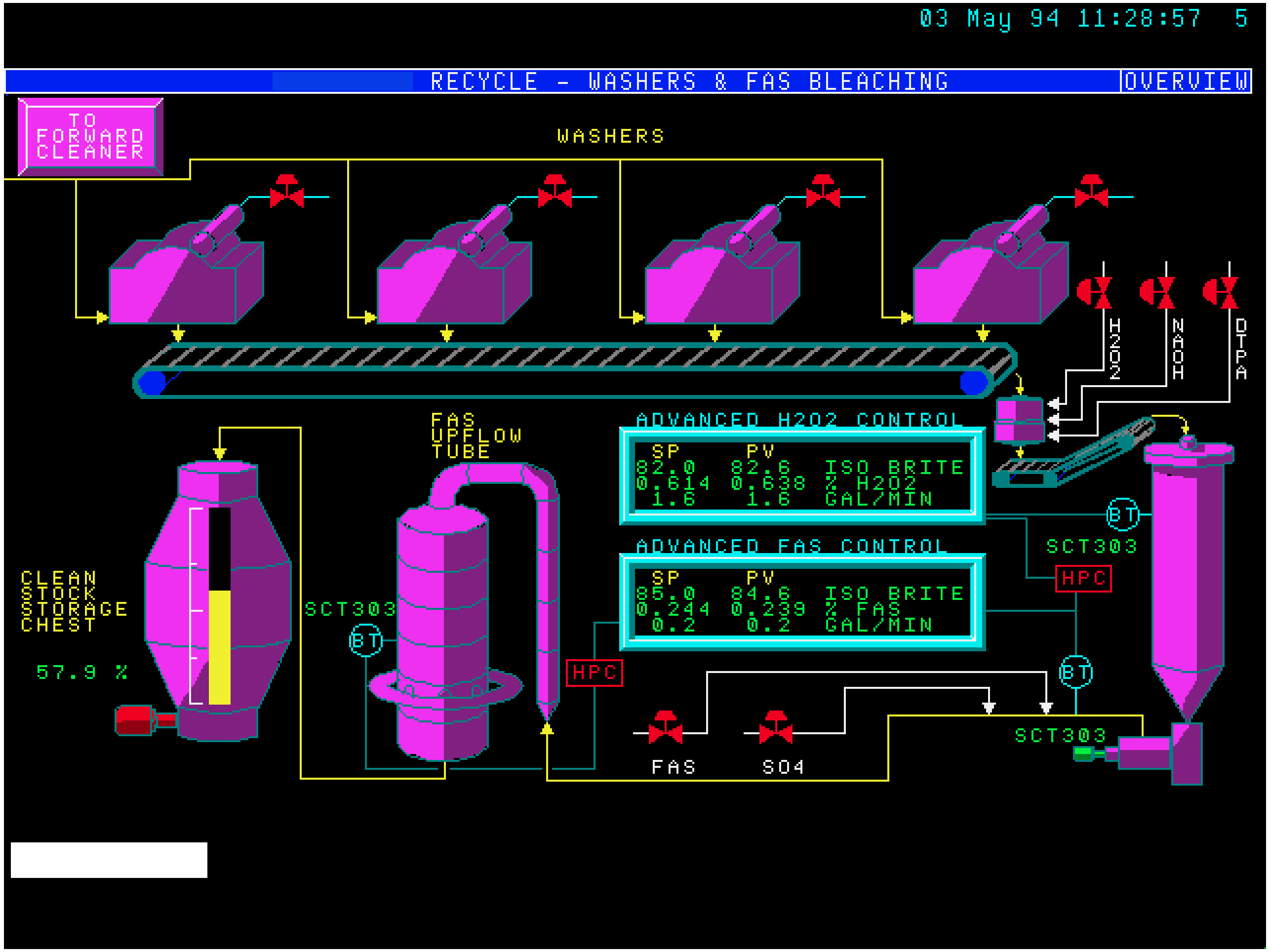
- Primary
- Secondary
- Tertiary
- Quarternary
- Feed/Accept/ Reject Rates
- ΔP
- Efficiencies
- Real-Time Trends

Oxygen Bleaching System



- O2 Towers
- Mc Pumps
- Blow Tank

Washers & FAS Bleaching



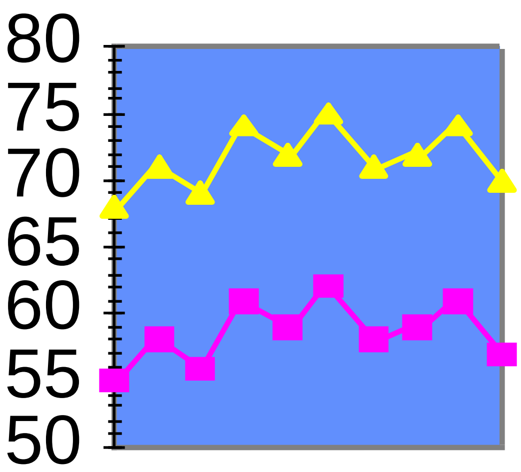
- Washers
- Stock Chest
- Advanced Peroxide Control
- Advanced FAS Control
- Downflow Tower

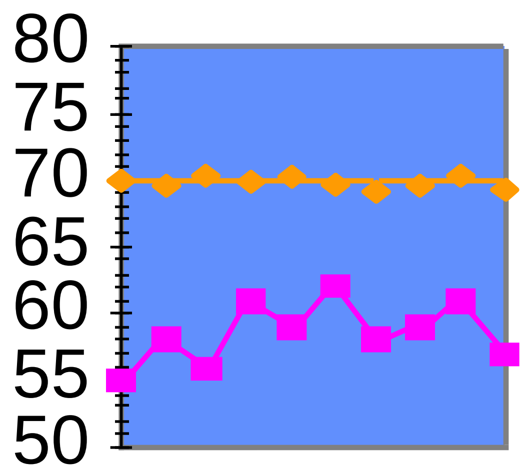
Brightness

■ Before

▲ Ratio Control

◆ Sensor-based Control





Typical Recycle/Deinking System