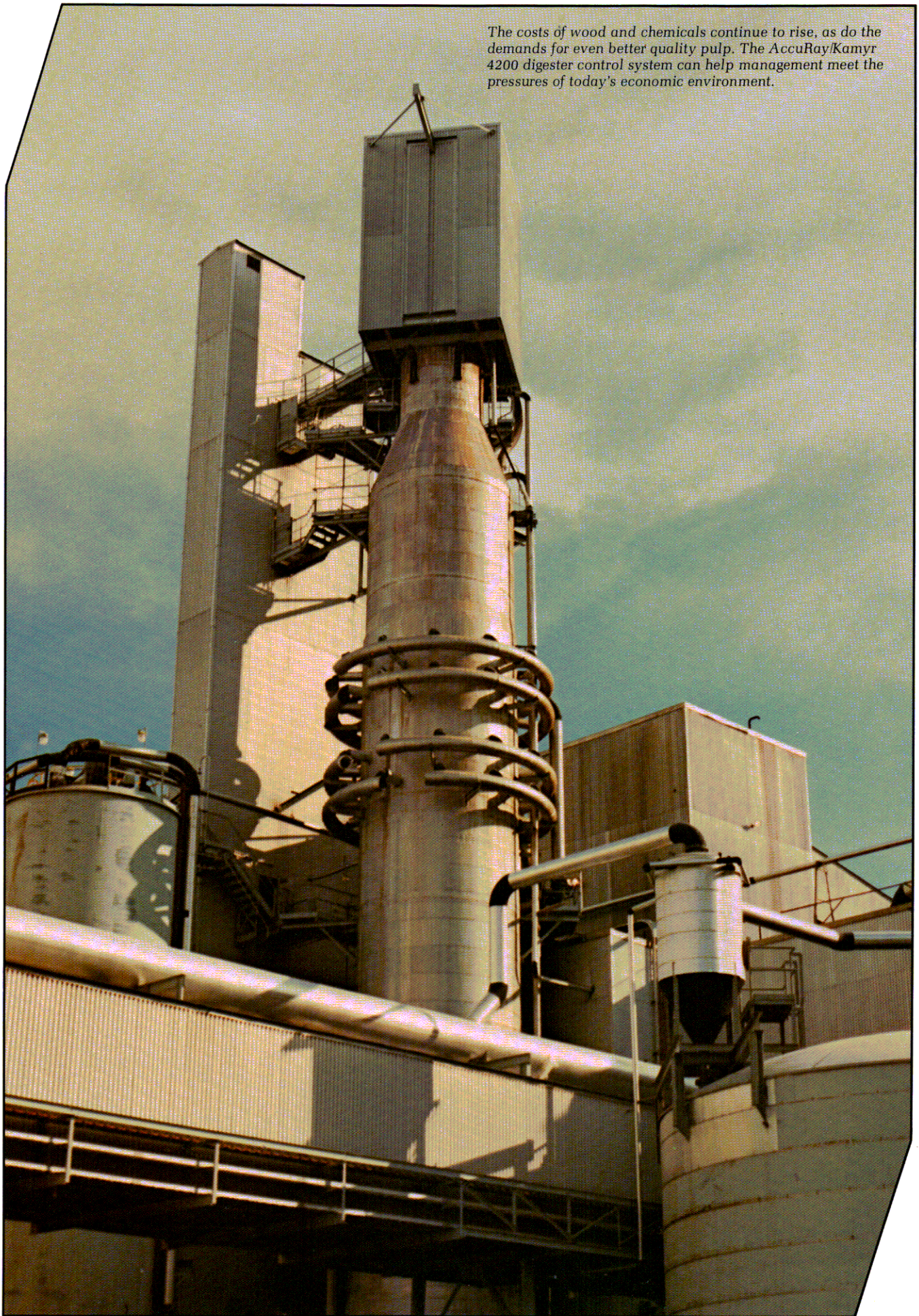


Proven results.

**AccuRay®/Kamyr™ 4200
Continuous digester control**



The costs of wood and chemicals continue to rise, as do the demands for even better quality pulp. The AccuRay/Kamyr 4200 digester control system can help management meet the pressures of today's economic environment.



Focus: on Results

The AccuRay/Kamyr 4200 Brings a High Return On Investment

AccuRay and Kamyr

The AccuRay®/Kamyr™ 4200 continuous digester control system is designed specifically for full computer control of the Kamyr digester. The result of a long-term cooperative effort between AccuRay and Kamyr, the 4200 control system is available with new Kamyr digester installations, or it can be added to existing Kamyr digesters with a minimum of trouble and no loss of production time. Either way, all AccuRay/Kamyr 4200 systems are fully supported by the combined expertise of both organizations. In addition to computer centers at AccuRay headquarters in Columbus, Ohio, and Kamyr headquarters in Glens Falls, New York, and Karlstad, Sweden, there is a world-wide team of field service specialists for installation, startup, control tuning, service, and maintenance.

In the AccuRay/Kamyr 4200 continuous digester control system, the capabilities of advanced minicomputer technology are combined with over 25 years of AccuRay experience in process measurement and control for the pulp and paper industry. The AccuRay/Kamyr 4200 is a highly reliable, computer-based control system capable of boosting digester performance to its limits. Your digester can produce quality pulp at higher yields with more economical use of chemicals and fewer process upsets with an AccuRay/Kamyr 4200 system.

The AccuRay/Kamyr 4200 relieves the operators of routine, time-consuming chores. It performs frequent and complex calculations to set targets, and it controls the digester to the precise quality and production goals selected by management, while coordinating all of the variables within the digester. It keeps the operators informed of what's happening within the

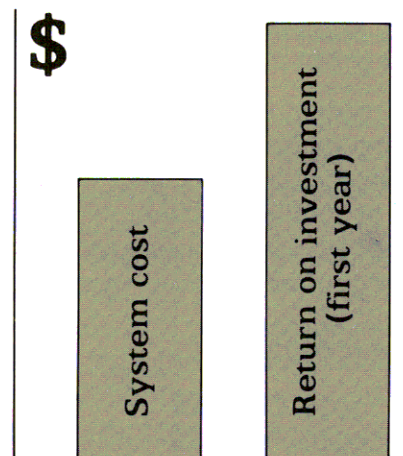
entire process. For management review and analysis, the AccuRay/Kamyr 4200 generates comprehensive reports of critical production data and process variables.

The AccuRay/Kamyr 4200 can mean results like these —

AccuRay®/Kamyr™ 4200 Typical Results

Kappa number variations reduced by 40%.
Yield increases ranging up to 3%.
Chip savings of 5%.
Production increases of up to 5%.
Chemical savings as high as 10%.

While results like these are impressive in themselves, the average return on investment for the AccuRay/Kamyr 4200 is even more impressive. Including installation, the average payback is less than one year.



First year savings are invariably greater than the capital cost of the AccuRay/Kamyr 4200 system.

Payback can be even quicker by using the AccuRay/Kamyr 4200 to multiplex a second digester, a bleach plant, or other pulp mill process. The additional capability requires only another operator station and the appropriate software package.

Focus: on Control

Here's How the AccuRay/Kamyr 4200 Helps You Make Better Pulp For Less

The ideal objective is to control chemical concentration, cooking time, and cooking temperature to achieve maximum yield for every grade of pulp and on any wood species. The AccuRay/Kamyr 4200 can do more to bring your digester closer to that goal than any other system on the market today. The AccuRay/Kamyr 4200 has proven itself on dozens of digesters around the world with results documented by pulp mill managers.

The AccuRay/Kamyr 4200 system uses complementary feedforward and feedback control loops to control input variables, minimize concentration errors, and ensure smooth residence times in the impregnation and cooking zones of the digester. Optimizing control strategies coordinate these basic loops to provide automatic grade change for pulp yield and wood species.

The flexibility of the AccuRay/Kamyr 4200 system allows it to control one or two continuous digesters with any combination of the following:

- Single or dual chip feeding systems.
- Standard hydraulic or steam/liquor phase cooking.
- Single or dual extraction.
- One- or two-temperature cooking.
- Internal and/or external washing.

Here's how it works.

Cooking Time Control

Blow Consistency Control Adjusts outlet device speed (primary control actuator) and bottom dilution flow (secondary control actuator, used when primary is outranged) to maintain consistency of blow flow. Based on density measurement of blow flow.

Production Rate Control Regulates volume of blow flow to maintain constant flow of dry stock from the digester.

Stabilizes digester operation and helps maintain constant digester level.

Compensates for operator changes and coordinates with all control loops for yield, species, and rate changes. Adjusts blow flow, outlet device speed, and bottom dilution flow.

Digester Level Control Controls flow of chips to the digester to maintain desired level. Based on measurement of chip level in top of digester. Coordinates with production rate control.

Wash Liquor Upflow (Extraction)

Control Stabilizes the location of the bottom of the cooking zone by adjusting the total extraction flow to maintain constant dilution factor.

Cooking Temperature Control

Lower Heater Control Controls lower heater temperature to maintain concentration-compensated H-factor. Uses adaptive H-factor model. Based on production rate, residual alkali concentration, upper heater temperature, and pulp yield target.

Cooking Concentration Control

Alkali/Wood Ratio Control Controls flow of white liquor to achieve the desired alkali/wood ratio target. Based on results of white liquor strength test entered by operator and computer calculation of flow of dry wood to digester. Control target modified by feedback corrections from residual alkali control to conserve chemicals.

Residual Alkali Control Adds a small trim flow of white liquor to the heater circulation to maintain constant chemical concentration going to cooking zone. Based on conductivity measurement in upper

heater. Feeds forward to adjust lower heater to compensate for changes in chemical concentration.

Chip Meter Calibration Checks chip meter calibration periodically to verify accuracy of volume of chips to digester. Based on chip bin volume, weightometer measurement, and chip meter speed. Should be coupled with chip moisture measurement for highest accuracy.

Cooking Liquor Downflow Control

Controls flow of black liquor to the top of the digester to maintain constant cooking liquor downflow. Based on chip moisture, alkali/wood ratio, white liquor concentration, and production rate. Controlled to minimum target for least steam consumption.

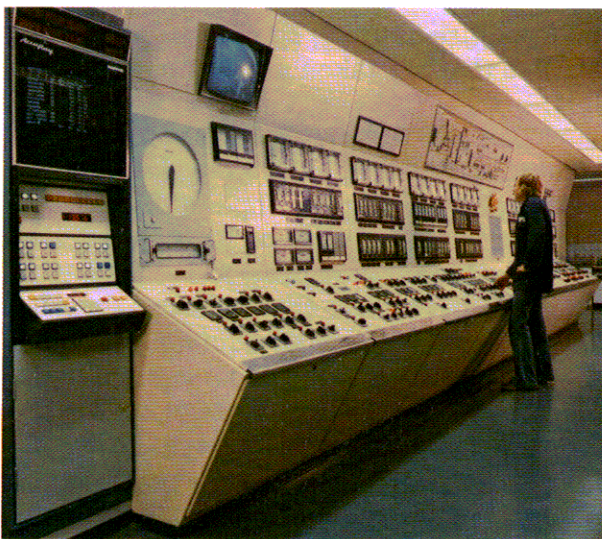
Optimizing Controls

Pulp Yield Control Controls lower heater temperature based on Kappa number indication from blow line. Uses dynamic H-factor model and adaptive control to accommodate time lag between lower screens and blow line. Compensates for production rate changes and comes on control with bumpless change of temperature targets. Coordinates with feedforward portion of residual alkali control.

Production Rate Change Coordinates all process controls to change rate of production without affecting pulp yield. Uses dynamic H-factor model. Production rate held constant until chips entering the cooking zone reach the end of the cooking zone, then rate is changed. During that time, chemical concentration and lower heater temperature are adjusted to anticipate rate change. Chip feed, concentration, and temperature set to final

targets for new rate when production rate is changed.

For an emergency rate change, all controls are set immediately to new targets. Pulp yield is disturbed, but returns to target when steady-state conditions are reached.



The AccuRay/Kamyr 4200 is designed to work with standard supervisory setpoint controls.

Yield/Species Change Computer tracks the chip interface (old yield/new yield or old species/new species) through the digester. The computer —

- (1) sets new alkali/wood ratio when interface reaches top of digester,
- (2) adjusts lower heater temperature when interface reaches cooking zone,
- (3) sets new dilution factor target when interface reaches extraction screens,
- (4) sets new blow flow consistency target as interface passes through blow line,
- (5) signals when to divert the new pulp grade to appropriate high density storage chests.

It uses density, yield, and reaction rate constants for each grade.

Focus: on Measurement

AccuRay/Kamyr 4200 Control Begins with Accurate, Reliable Measurement

One of the primary benefits of the cooperative association between AccuRay and Kamyr has been in the area of process and product measurement. Joint developments over the years mean that control by the AccuRay/Kamyr 4200 system is based on virtually continuous measurement rather than on the results of tests that could require hours to complete and on samples that are taken as seldom as once a shift.

The LI-10 and the K-1000 sensors for monitoring digester level were developed by Kamyr. AccuRay developed the electronics package for the LI-10 and the software programs needed to accept the signals from these sensors and process usable signal levels for automatic control. The LI-10 and the K-1000 sensors are unique to AccuRay/Kamyr 4200 control.

The AccuRay/Kamyr 4200 also offers a proprietary sensor package for blow line consistency; it's unavailable on any other control system. This package provides the ability to precisely measure and control the dry stock leaving the digester. It also contributes to the stabilization of level control and provides a reliable input for Kappa number prediction and yield calculations by the computer.

All of the sensors recommended for use with the AccuRay/Kamyr 4200 have been thoroughly tested on operating digesters and the results documented using the computer capability inherent in the 4200 system.

Here are the basic measurements — in addition to those from standard temperature sensors — used by the AccuRay/Kamyr 4200.

Chip Moisture The 4200 system will accept input for chip moisture values from a continuous moisture sensor, operator-entered values from laboratory tests, or standard values from the grade code file. Repeatable, on-line chip moisture measurement is superior, resulting in as much as a 31% reduction in Kappa test variations.



Continuous measurement of chip weight and moisture contribute to significant reductions in Kappa test variations.

Chip Weight A chip weightometer, either a strain gauge or a radioisotope gauge, is essential. Weight and chip bin volume are used to calculate an apparent chip density which will change to reflect differences in chip moisture, chip density, chip size, species, age, etc. This, in turn, is used to adjust the chip meter calibration (Kg/revolution) to control the flow of dry wood to the digester.

Digester Level The Kamyr digester may use any or all of three chip level sensors — top separator amps, the LI-10 sensor, and the K-1000 sensor. The LI-10 torque tube can indicate false levels. Therefore, it is often supplemented with three K-1000 sensors mounted through the sides of the digester and below the LI-10. A rising chip level deflects paddles on the sequentially mounted K-1000 sensors, and strain-gauge bridges send independent signals to the computer.



The K-1000 has no moving parts and can be serviced while the digester is under pressure.

Chemical Strength An electrical conductivity measurement device senses alkali concentrations in the upper heater circulation line and controls residual alkali at that point. Provides continuous on-line measurement of concentration unaffected by black liquor or salts, requires little maintenance, and does not need re-standardization as do wet chemical analyzers.

Blow Line Consistency Proprietary sensor package allows precise measurement of dry stock leaving the digester. A gamma gauge measures total density in the blow line. A refractometer measures the refractive index of the liquid, which correlates with black liquor density. The computer, correcting for temperature variations, then calculates the dry stock. Accurate to about 0.05% of actual consistency.

Focus: on AccuRay

Here's Why the AccuRay/Kamyr 4200 Belongs on Your Digester

The AccuRay/Kamyr 4200 is primarily an operational tool. It relieves operators of the routine tasks of monitoring process variables and adjusting them to steady-state conditions. This leaves the operators free to make operating decisions and run the digester to achieve the goals established by management. To help the operators even further, the AccuRay/Kamyr 4200 provides organized process and product information and the capability for advanced control strategies that are possible only with computer technology.

Just as important, the AccuRay/Kamyr 4200 is also a management tool. It provides the means to explore and define the limits of the digester without jeopardizing the quantity or the quality of production. The AccuRay/Kamyr 4200 helps identify and quantify the individual factors which limit production and quality. Those factors can then be thoroughly analyzed to determine the economic feasibility of design or operational changes.

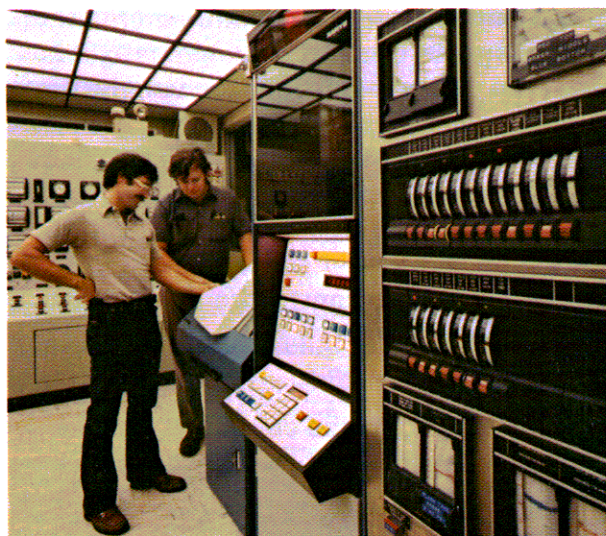
The AccuRay/Kamyr 4200 Communicates with Your Operators

The control console of the AccuRay/Kamyr 4200 is designed to let the operators know in mill language what is going on in the digester and throughout the pulping process.

The conversational video also makes it easy for the operators to respond, to enter instructions or ask for further information to help in diagnosing a situation.

All information the operators regularly need is presented instantly on the video screen. Color is used to help organize the data and alert the operators to process conditions that require immediate attention.

In addition to process reports, trend reports, and change reports, the operators may call up any of the following standard



The control console is the focal point of the AccuRay/Kamyr 4200 system. It presents all product and process information and receives all instructions and interrogations.

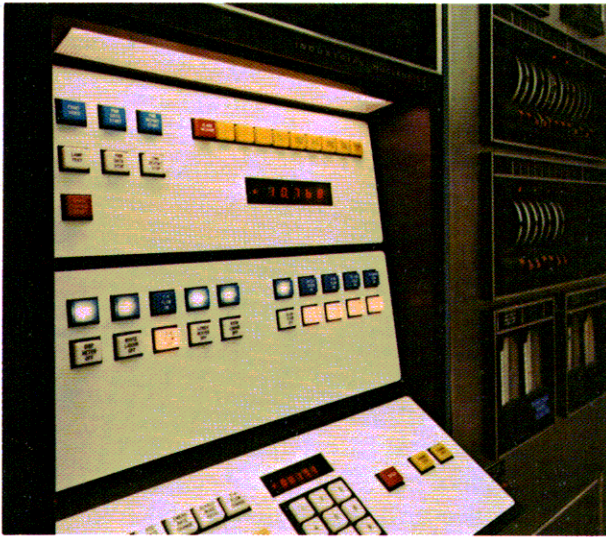
reports at will: alarm message report, control status report, grade code reference report, channel list report, and histograms of any of 6 process variables.

The AccuRay/Kamyr 4200 also features a series of alarm and "attention needed" indicators. These flashing red signals are located just above the video screen and signal the operator to enter essential data or verify current operating conditions.

Any video report may be copied for future reference or analysis. At the push of a button, the data on the screen is duplicated on the high-speed printer/plotter.

The data entry panel on the AccuRay/Kamyr 4200 control console allows quick and easy response. It combines the simplicity of dedicated pushbuttons for routinely entered variables with the flexibility and scope of channel numbers and a keyboard for requesting and entering additional information and data. Improper entries are limit checked

and automatically rejected, and the operators are notified.



All automatic controls are activated by simple on/off buttons.

The AccuRay/Kamyr 4200 Reports to Management

A unique feature of the AccuRay/Kamyr 4200 is the optional remote data terminal. Using it, management may call up any of the available video reports independently of the reports appearing on the video screen at the control console.

The AccuRay/Kamyr 4200 automatically provides a printed summary of key production and process information. The computer generates these reports on the high-speed printer/plotter on a timely basis for production and technical management to closely monitor process and crew information, materials usage, and production quality.

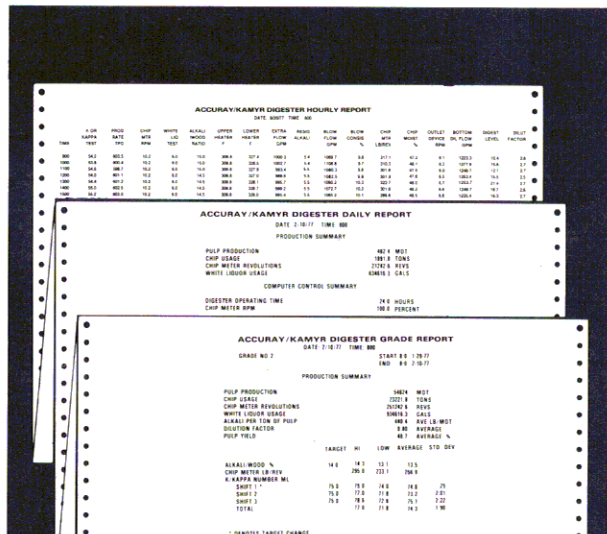
Hourly Report An hour-by-hour report of the instantaneous values for 15 process variables. Similar to operating log sheet normally kept by operators.

Daily Report Shows production, chip usage, chip meter revolutions, and white

liquor usage for previous 24 hours. Also shows percent of time digester was under the control of the various control loops.

Grade Report Printed at the end of each day and at the end of each grade. Shows Kappa target and test values, plus a production summary.

In addition to basic reports, the AccuRay/Kamyr 4200 also offers the Process Monitor Routine (PMR), an extremely powerful tool for process performance analysis and trouble-shooting. The PMR automatically collects and records data on up to 15 variables normally used by the system or which can be instrumented into the system. Data may be collected on a set sampling interval (multiples of 5 seconds), or collection may be triggered by a specific event. The results of the PMR are documented by the printer/plotter in numerical and graphical formats. Up to 6 PMR setups may be stored for repeat use at a later time.



Through a comprehensive series of video and hard-copy reports, the AccuRay/Kamyr 4200 keeps production and management personnel fully informed of digester performance.

AccuRay/Kamyr 4200 Reliability — 99% Uptime

Even in the hostile environment of the pulp mill, the AccuRay/Kamyr 4200 will deliver an uptime of better than 99%.

The hardware of the AccuRay/Kamyr 4200 is designed with a minimum of interconnects, and most communications between components of the system take place over printed circuits. All electronics are solid-state, grouped in convenient plug-in circuit boards. And the system features self-diagnostics which allow mill personnel to check quickly and easily for the location of any trouble spots. In fact, most routine service and maintenance may be handled by mill personnel following a formal training course conducted by AccuRay.

The architecture of the AccuRay/Kamyr 4200, especially the architecture of the computer, is also designed for reliability and long life. The advanced minicomputer, the heart of the system, features Error Detection and Correction (EDAC). This allows the computer to detect minor internal data

transfer errors and automatically compensate for those errors. EDAC also logs every error so the source can be located and fixed during regularly scheduled servicing. Proven over many years on large data processing computer installations, EDAC eliminates over 90% of computer failures attributable to memory malfunctions. EDAC is essential for long-term reliability.

Installation schedules for the AccuRay/Kamyr 4200 are arrived at jointly with mill management. Under normal circumstances, critical hookups are performed during scheduled downtime to avoid production interruptions. All interconnects between the AccuRay/Kamyr 4200 system and the digester occur in a single junction box. This approach clearly indicates responsibility during installation and simplifies maintenance and service over the life of the system.

AccuRay installation and application engineers are on-site for installation, system checkout, and training of all operator and supervisory personnel.

Focus: on Action

Proven Results Applied to Your Digester

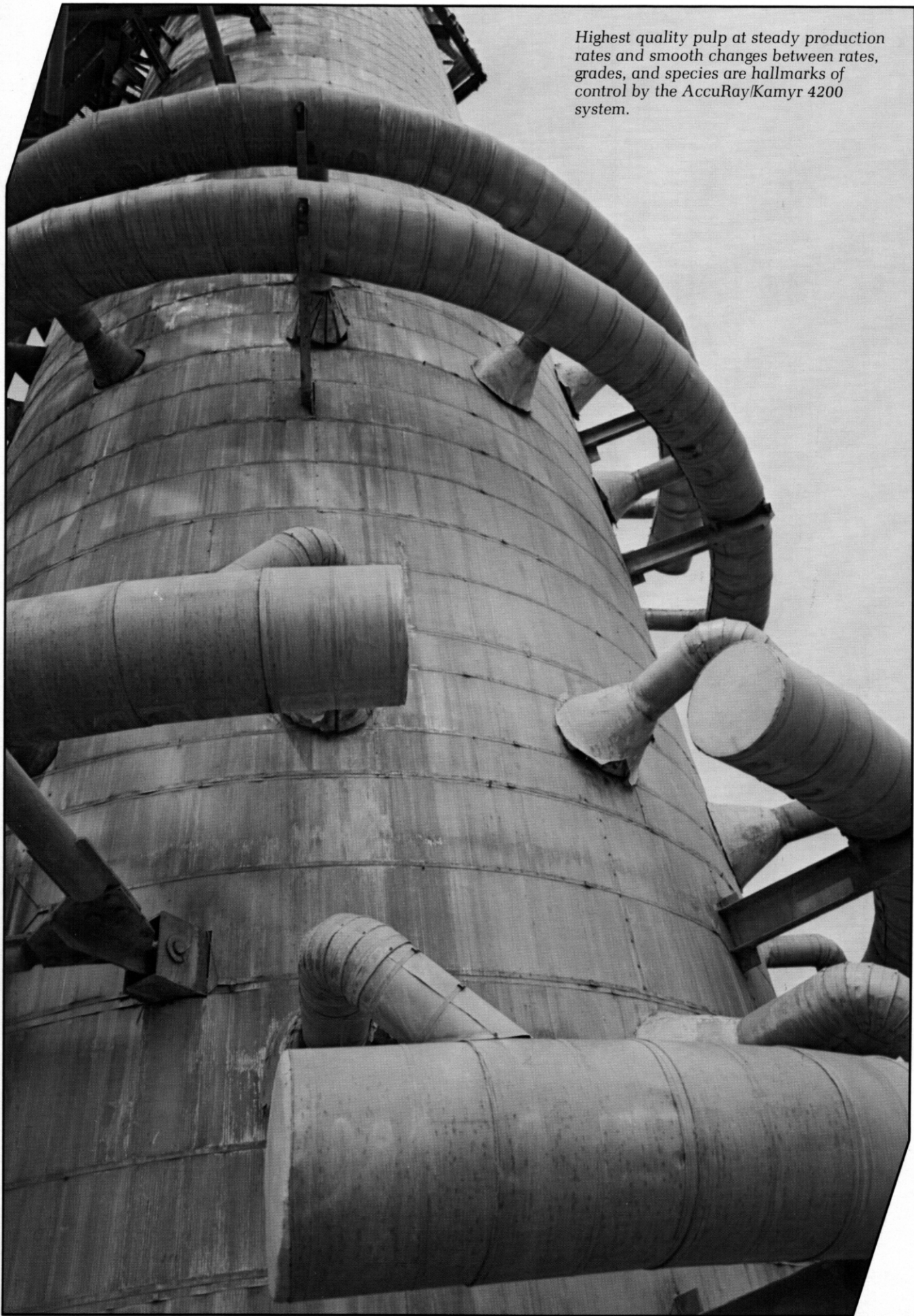
An AccuRay/Kamyr 4200 continuous digester control system can achieve substantial results on your digester — just as it is doing on dozens of other digesters around the world. The system will help you produce quality pulp at higher yields with more economical use of chemicals and fewer process upsets.

Find out for yourself. Write AccuRay at 650 Ackerman Road, Columbus, Ohio 43202. Or write Kamyr at Ridge Center, Glens Falls, New York 12801.

AccuRay is a registered trademark of Industrial Nucleonics.

Kamyr is a trademark of Kamyr, Inc.

Highest quality pulp at steady production rates and smooth changes between rates, grades, and species are hallmarks of control by the AccuRay/Kamyr 4200 system.



AccuRay 4200 System Offers Savings To Papermakers

The AccuRay 4200 Digester Control system is one of the best things to happen to the papermaking industry since the AccuRay 1180 system.

The new AccuRay 4200 system, introduced to papermakers in 1972, provides automatic control of an important process which produces the main ingredient in paper manufacture — wood pulp.

Consider for a moment that most paper is made from trees, disregarding the small amount made from cotton and other fibers less abundant in nature. How, then, does a papermaker get from a tree to a sheet of delicate paper? The answer is by chemical processing, turning wood into a liquid pulp that is the main ingredient of paper. It is this chemical process that gives the AccuRay 4200 system the opportunity to perform.

But first the papermaker must grind up trees into shoe-size chips which act as the raw material for the chemical processing. With an ample supply of this raw material, the conversion of wood into pulp begins and the AccuRay 4200 system goes to work in two main ways. The system controls the chemical processing as the wood chips become pulp and saves the papermaker a bundle of money in the cost of his raw materials.

The AccuRay 4200 system is the star of the conversion



Digester — AccuRay's 4200 system provides the automatic control necessary to conserve raw materials in the production of wood pulp for the paper industry. The result is an increase in the yield of salable or usable pulp for IN's customers.

because it controls the entire process called digesting. The process is similar in principle to animal digesting in that wood chips are reduced by chemical processes into a liquid pulp useable by the paper machine to make paper sheets and other products.

There are two kinds of digesting techniques in papermaking, but the AccuRay 4200 system controls the one method used by the vast majority of mills. With this technique a typical digester (which may stand over 300 feet tall) can produce 1,000 tons of wood pulp a day.

When the digester is controlled by the AccuRay 4200 system it can produce up to 50 percent more pulp using

the same amount of raw material. A savings of raw materials on this scale must get a standing ovation from today's papermakers.

The brains of the AccuRay 4200 system is a mini computer programmed by an Industrial Nucleonics system programmer. Also in the system are circuit designs mainly in the form of solid-state printed circuit boards. This mating of computer and circuit designs provides the control signals necessary to achieve great efficiency from the digester.

The AccuRay 4200 system thus takes its place in the long list of Industrial Nucleonics equipment designed for the paper industry.