BrainWave
Control solutions for pulp and paper

The challenge: To control your plant so that it runs at peak efficiency

The solution: Measure. Control. And profit.

In today's economic climate, your facility faces more challenges than ever before. Your plant must run at optimal performance. Product consistency is a must. And utility and chemical costs must be kept to a minimum to maintain profit margins. That's why ANDRITZ AUTOMATION offers a portfolio of advanced control solutions — BrainWave — for pulp and paper operations.

These solutions are revolutionizing control at mills around the world, helping producers large and small remove bottlenecks, reduce energy and chemical consumption, produce higher quality products more consistently, and lower production costs — all of which result in significant savings.

Historically, advanced process control technologies have been deployed only at large scale petrochemical plants where the high cost of implementation and maintenance could be supported.

BrainWave will change the way you think about advanced process control. This patented controller can be implemented quickly. It is robust and stable, and is used by operators continuously. With BrainWave, advanced process control can now be applied in an effective and economical manner in the pulp and paper industry.

Don't see your solution listed? No problem — our control experts not only implement our solutions, but can audit your operation and devise a custom control strategy for you.

"There was no question the performance was much better. We have never seen our dryer operate so smoothly."
Walter Martins, Technical Director
Veracel, Brazil

What is BrainWave?

BrainWave is a patented advanced controller that outperforms traditional Proportional-Integral-Derivative (PID) control. BrainWave outperforms PID systems because of its two main components: an adaptive model and a predictive controller.

BrainWave builds its own live models during normal plant operations, a powerful feature not offered by traditional Model Predictive Control systems.

BrainWave's predictive controller accurately forecasts process responses and accounts for multiple objectives. It adapts to process conditions such as changes in production rate or operating point, keeping your process on target. BrainWave can also accept measured disturbance inputs, like raw ma-

Feature	PID	BrainWave
Controls long dead-time processes	✗	✓
Reacts before being pushed off-target	✗	✓
Handles nonlinear processes	✗	✓
Adjusts to process disturbances	✗	✓
Learns while process is running	✗	✓

terials properties, and takes corrective action before your process is pushed off target (PID, by comparison, must wait for the error to occur, then react).

Because it uses a standard OPC connection, BrainWave easily integrates with an existing control system. In addition, BrainWave's patented Laguerre technology means an average implementation time of just a few weeks,

saving a remarkable amount in operating costs compared to conventional methods. And, best of all, your own staff can support and deploy BrainWave, making it a technology that you can live with—and one you can't afford to live without.

Find out more:

The challenge: To fully stabilize and optimize your processes

The solution: BrainWave advanced control

ANDRITZ AUTOMATION offers a complete suite of BrainWave solutions for industrial operations, with the features described below.

Reduced variability

BrainWave has been proven to reduce variability from 30% to 95%. This allows for more consistent production and products and reduced operating costs.

Guaranteed results

BrainWave projects include a performance guarantee to ensure results are achieved. All costs are known and defined in advance.

Rapid deployment

In most cases, the initial results of BrainWave are obtained in just a few weeks.

Easy connection

BrainWave easily connects to existing control systems and allows migration to new systems. In addition, BrainWave can be used across an enterprise in which a customer may own a variety of DCS components from various suppliers.

Reporting

ANDRITZ AUTOMATION offers full reports on the results of BrainWave, including economic benefits obtained, additional benefits realized, and opportunities for further improvement. ANDRITZ AUTOMATION provides solutions for all areas of a pulp and paper operation where more stable operation is desired.

If you have a specific need that you do not see covered, be sure to contact our sales staff.

Benefits

- Remove bottlenecks
- Reduce energy use
- Produce higher quality product
- Easily integrate with existing control systems
- Usually deployed within a few weeks

Recent successes

- By implementing BrainWave, Mondi Frantschach recorded a reduction in Kappa variability of 30% in the digester at its mill in Austria.
- The Arauco Valdivia mill in Chile experienced a 60% reduction in ClO_2 variation, saving an estimated 400,000 USD annually.
- In Brazil, BrainWave reduced moisture variability of the Veracel pulp dryer by 75%.

Achieve full optimization with Advanced Control Expert

Once you have achieved outstanding success stabilizing your process with BrainWave, you can take your operations to the next level with Advanced Control Expert (ACE).

ACE is an automated "expert operator" that works in conjunction with the BrainWave solution to fully optimize a process. The expert operator in ACE is always at full attention, never distracted, and achieves optimum conditions for your mill.

BrainWave makes sure your process gets to set point and stays there. But how do you know if you have the best set point to run your process? Which set point will help you save the most energy? Will changing the set point improve your product quality? Will it help you save money?

That's where ACE comes in. Once Brain-Wave has stabilized your process, then ACE can be implemented to determine the best set

points, so that the process can operate at maximum efficiency. Unlike the "black box" solutions offered by others, ACE communicates to the operators in their native language, advising them about changing strategies and goals, constraints, and operational issues.

Feature	ANDRITZ	DCS Vendor	Brand X
Advanced regulatory control	Always	Sometimes	No
Learning feedforwards	Always	No	No
Solutions hard-coded in DCS, dependent on programmer skill for success	Never	Yes	Yes
Black box supervisory layer	Never	Yes	Yes
Common structure for all solutions to minimize training time	Always	No	No
Best possible solution/excellent uptime	Yes	No	No

The challenge: To stabilize and improve digester performance

The solution:
BrainWave digester

BrainWave is a proven control system that stabilizes the overall control and improves performance of digesters.

BrainWave digester uses patented model-based, predictive, adaptive technology to provide precise control of the chip bin, IV, and the digester level. This, combined with Kappa, EA, and white liquor temperature, provides a consistent cook and uniform residence time throughout the cooking plant, which is proven to reduce Kappa variation by 50% to 85%. This precise Kappa control can reduce bleach plant costs and is certain to improve the quality of the pulp.

The first fundamental step in the application of the BrainWave patented controller is to precisely hold the critical digester variables on target. BrainWave allows the digesters to operate at the most efficient operating point and reject disturbances, while considering the effects of all measured and controlled variables.

BrainWave permits consistent automatic control, without burdening the operators with the variation of conventional controls. BrainWave keeps the critical loops of the process closed and running in automatic. Stabilizing the level in the chip bin, IV, and digester, using a special patented BrainWave algorithm just for this type of response, ensures a uniform cook time for all chips. The white liquor temperature is stabilized and the BrainWave H-factor control will adjust that target. The EA and white liquor to wood ratio controls are then adjusted to further reduce the variation in Kappa and other performance metrics.

Benefits

- Increase digester pulp yield
- Reduce off-spec pulp yield
- Improve operation of washing
- Lower bleaching chemical costs
- Achieve faster start-up after grade and/or production changes
- Achieve smoother operation

Digester control schematic (for simplicity, the chip bin, IV, if present, and digester level controls are also included, but not shown in this diagram) ▼
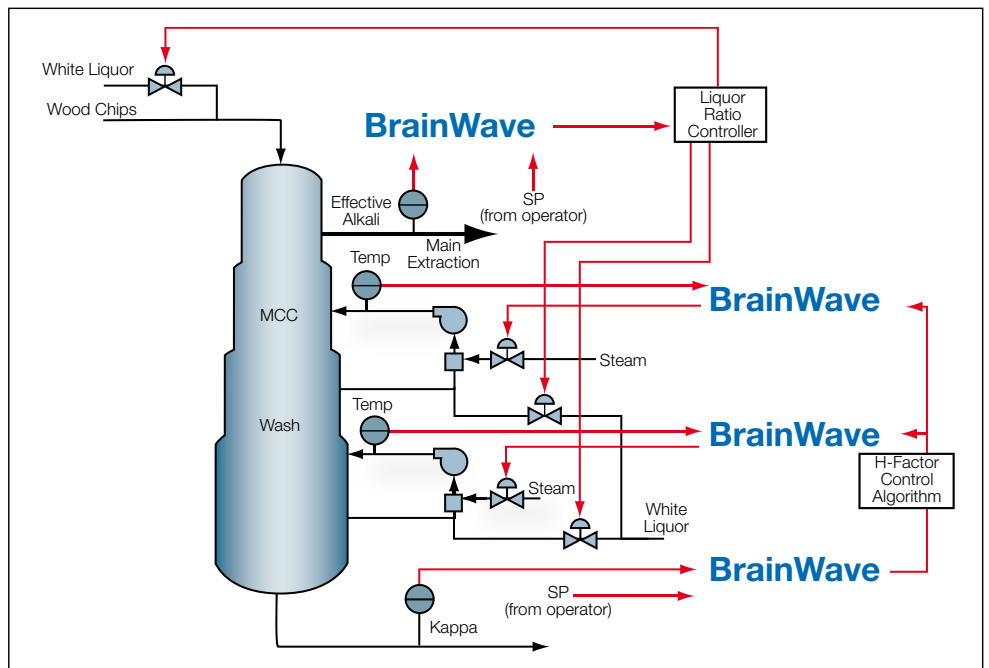
Success story

Customer: Mondi Frantschach GmbH

Control objective:

- Reduce Kappa variability
- Stabilize operations
- Keep digester control in automatic
- Control system: ABB MOD 300/Advant

Mondi Frantschach has realized dramatic improvements by implementing BrainWave to reduce variation of Kappa from the continuous digester at its mill in southern Austria.

The mill produces a very high grade of brown stock packaging materials upon which its customers frequently print. Before Brain-Wave, the mill received many complaints about the paper's appearance and its performance at the printing plants. In addition, the paper sometimes experienced problems running through the paper machine. Mondi Frantschach knew that it could address these issues by improving Kappa control.

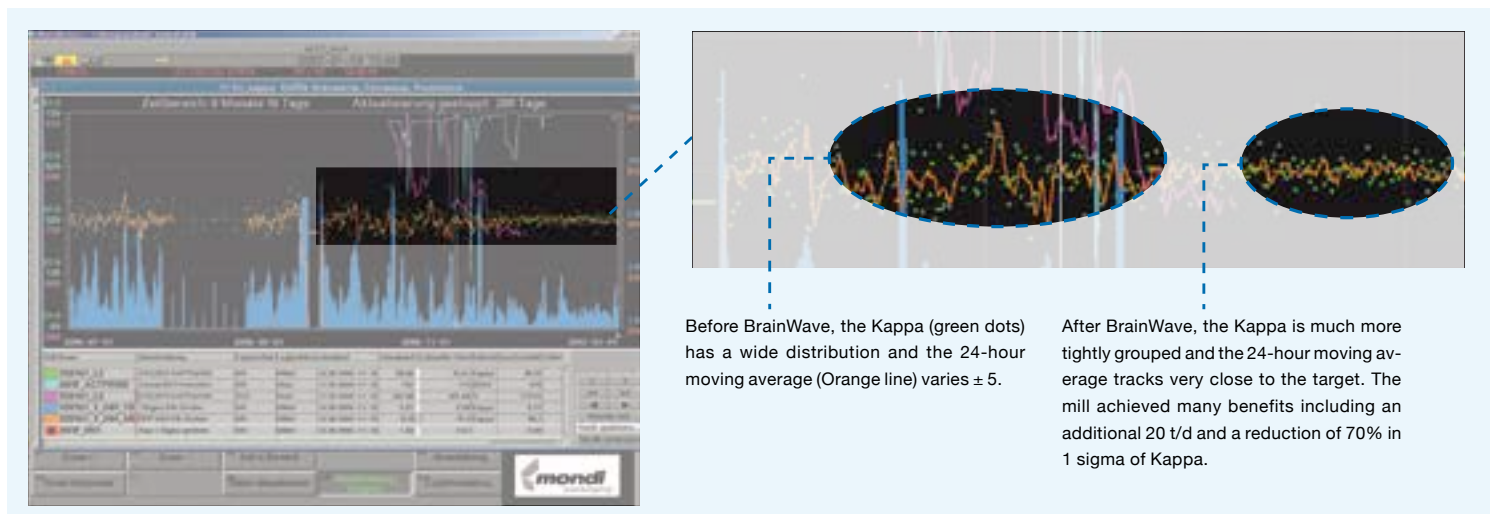Since installing BrainWave, Mondi Frantschach has realized significant results, in-

cluding better paper appearance, increased production (by about 20 t/d) and improved refining and energy consumption.

Dr. Johann Zwainz, Pulp Mill Superintendent, remarked, "Within just a few days of turning on BrainWave on our Digester we saw the

Kappa variability reduced remarkably and our pulp quality improved. Our operators now rely on BrainWave for excellent automatic operation and responsive control."

Digester Kappa control before and after BrainWave ▼

Before BrainWave, the Kappa (green dots) has a wide distribution and the 24-hour moving average (Orange line) varies ± 5.

After BrainWave, the Kappa is much more tightly grouped and the 24-hour moving average tracks very close to the target. The mill achieved many benefits including an additional 20 t/d and a reduction of 70% in 1 sigma of Kappa.

The challenge: To accurately control and stabilize bleach operations

The solution:
BrainWave bleaching

BrainWave is a proven control system that improves process variables such as brightness and pH in bleach plants.

BrainWave bleaching uses patented model-based, predictive, adaptive technology to provide accurate control of brightness and pH through each stage of a bleach plant. It automatically manages changes in grade, production and pulp quality, greatly reducing the chance of error or excessive chemical use.

BrainWave uses a percentage applied ratio scheme for chemical addition. The percentage applied scheme includes stock flow and stock consistency measurements to ensure that the correct amount of chemical is added to achieve the desired pH and product brightness as stock flow and consistency changes occur. Stock consistency can be determined from an online measurement or can be estimated by the plant based on

mass balance. The actual pH or stock brightness is used to adjust the percentage applied factors to correct for changes in pulp properties and reaction efficiency.

When the product brightness variability is reduced at each stage, the target brightness can be lowered to remove any over-bleaching being done previously to ensure that minimum brightness targets are met. Optimal brightness targets can then be determined

by making small shifts in the target brightness at each stage to determine the overall bleach profile that will minimize the total bleach used in the plant. As shown in the figure, the optimal brightness gain for each stage must be determined to avoid saturation and waste of bleach chemicals. This optimization is only possible due to the ability to accurately maintain the target brightness at each stage with BrainWave.

Benefits

- Reduce variability by 50% to 80%
- Reduce chemical usage, thus increase profit
- Achieve precise pH and brightness control
- Maintain control (automatically) even during grade and production rate changes
- Achieve smoother operation

Bleaching control with BrainWave – EoP stage ▼
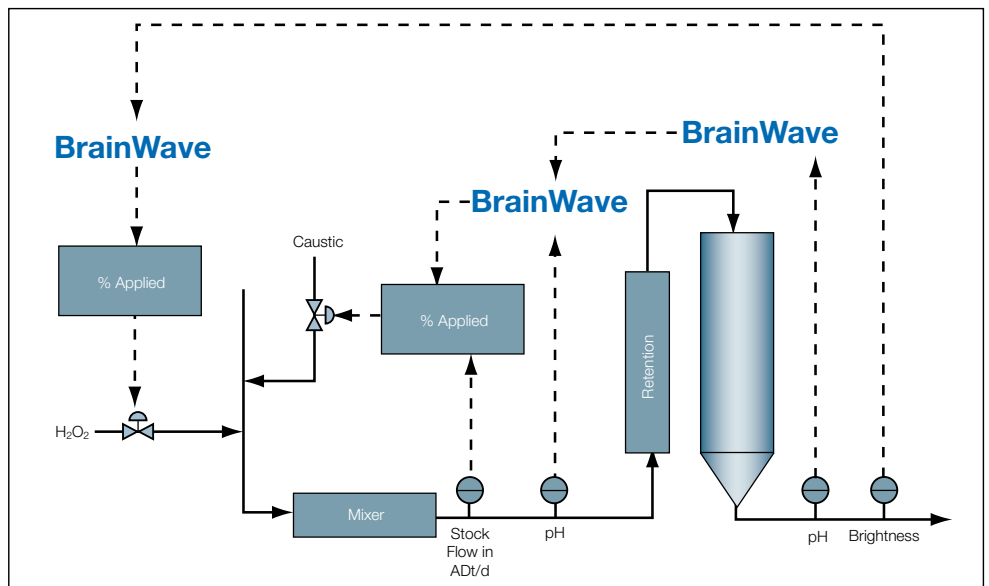
Success story

Customer: Celulose Arauco y Constitución

Control objective:

- Operate the E stage at lowest possible pH to minimize caustic consumption
- Keep pH at optimal settings in D1 and D2 stages to minimize ClO_2 consumption
- Optimize D1 brightness to keep product at specification without over-bleaching, while reducing ClO_2 consumption
- Control system: Emerson DeltaV

The implementation of BrainWave at Celulosa Arauco y Constitución's Valdivia pulp mill in Chile has been an unconditional success. BrainWave was installed on four key control loops: EoP, D1 and D2 stage outlet pH, and D2 stage outlet brightness. As a result, the mill was able to achieve better control of final pH, E, D1, and D2, with a 60% to 70% reduction in variability. Better control of D1 brightness was also achieved, with a 60% to 70% reduction in variability.

While reduction in variability allows for better and more consistent product quality, the BrainWave control loops also caused a significant reduction in ClO_2 use.
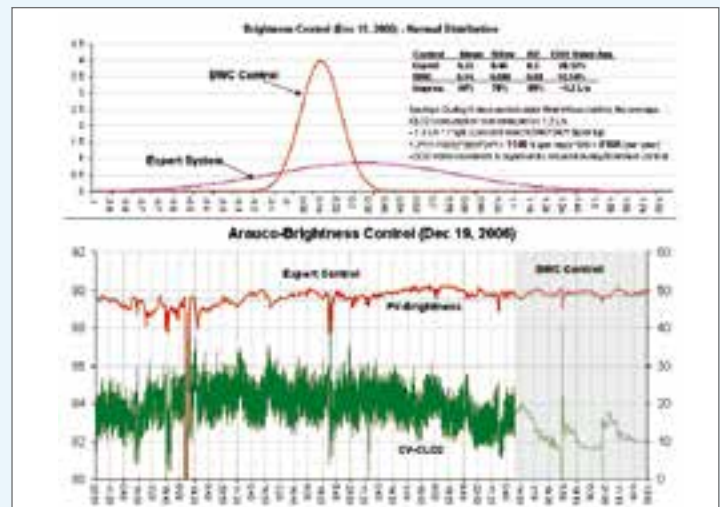
The estimated annual savings for the brightness loop alone are 400,000 USD. Additional benefits included reduced ClO_2 valve movement, smoother plant operation, a 30% faster start-up after shutdowns, and a smoother control transition when the mill switched from pine to eucalyptus.

BrainWave versus original control at the Valdivia pulp mill ▼
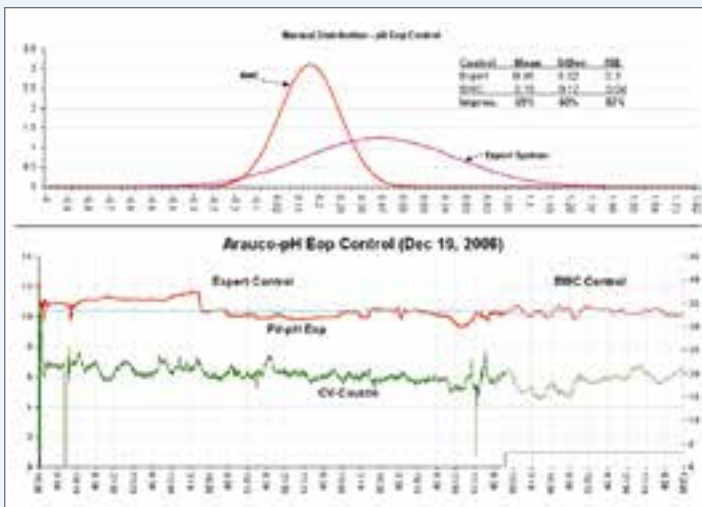
EoP pH control

D1 brightness control

The challenge: To stabilize pulp dryer operations

The solution:
BrainWave pulp dryer

BrainWave is a proven control system that stabilizes the operation of pulp dryers, resulting in improved moisture control of the final product and reduced energy consumption.

BrainWave pulp dryer applies patented model-based, predictive, adaptive, control technology to regulate moisture in the pulp drying process and pulp gramature (mass of pulp per square meter). BrainWave achieves tight, stable control over moisture content and gramature by precisely adjusting the stock flow and steam supply.

BrainWave is ideally suited to control the drying process due to its ability to account for the long transport delay times as the product moves through the dryer to the moisture measurement sensor. As well, key process variables such as sheet speed, broke flow, and consistency may be used as feedforward signals. BrainWave provides for excel-

lent coordination between the feedforward and feedback control; as a result, the controller compensates for changes in these variables, preventing disturbance to pulp quality and guaranteeing consistent pulp moisture and gramature.

The BrainWave pulp dryer solution is typically installed within a few weeks and the benefits are immediately obvious. Because BrainWave achieves low variability moisture control, there are much fewer process upsets, less
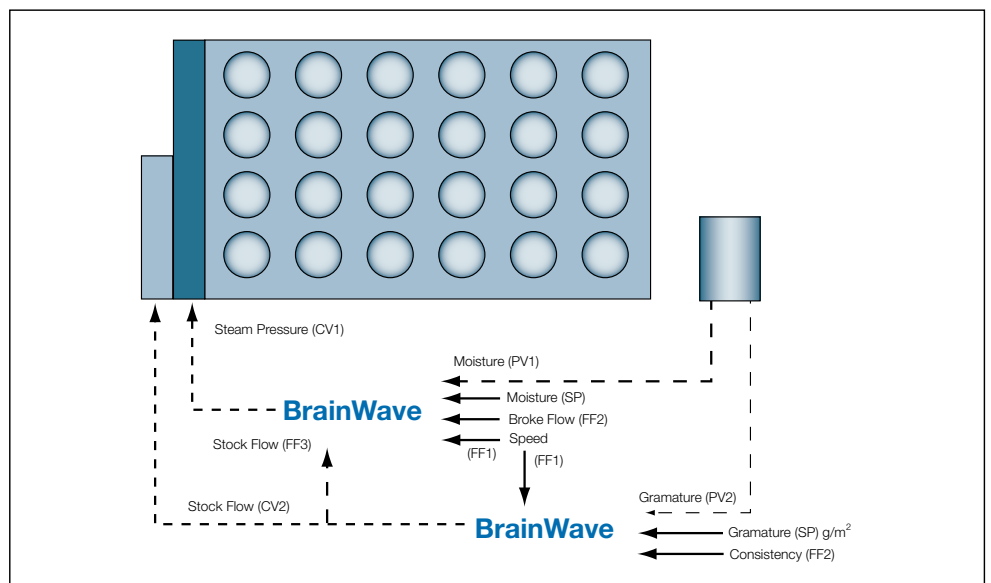
pulp sent to recycle, and higher production. In addition, since moisture variability is less, the average pulp moisture can be kept closer to maximum, leading to increased production and energy savings.

BrainWave control is smoother and more precise than operator or conventional automatic control. Start-up times will be reduced and there will be fewer disturbances to the boiler.

Benefits

- Decrease moisture variability
- Increase production and yield
- Decrease energy consumption
- Achieve smoother operation
- Provide a more consistent product
- Reduce quality variations

Pulp dryer control schematic ▼

Steam Pressure (CV1)

Moisture (PV1)

BrainWave
Moisture (SP)
Broke Flow (FF2)
Stock Flow (FF3)
Speed
(FF1)
(FF1)

Stock Flow (CV2)

Gramature (PV2)

BrainWave
Gramature (SP) g/m^2
Consistency (FF2)

Success story

Customer: Veracel Celulose S.A.

Control objective:

- Reduce moisture variability
- Stabilize operations
- Control system: Foxboro IA

The largest pulp dryer in the world can be found at Veracel, a state-of-the-art pulp plant, located in Eunapolis, Brazil. Veracel Celulose implemented the BrainWave advanced controller to improve efficiency of their 3,000 t/d eucalyptus pulp dryer.

BrainWave was deployed within two weeks and the results were seen immediately.

Full automatic operation was achieved, decreasing operator workload and helping the dryers stabilize faster after start-up and during production rate changes. With Brain-

Wave, moisture variability was reduced by 75% to 85%. "The pulp dryer immediately stabilized and BrainWave was accurately controlling moisture and basis weight," said Walter Martins, Technical Director of Veracel. "There was no question the performance

was much better. We have never seen our dryer operate so smoothly."

Rubine Gouveia, Advanced Control Project Leader for Veracel, added, "I have been part of other advanced control projects, but never ones that provided such great results so fast. I am amazed; I expected this to take months."

BrainWave (BWC) versus original control (QCS) at the Veracel dryer (March 2007) ▼
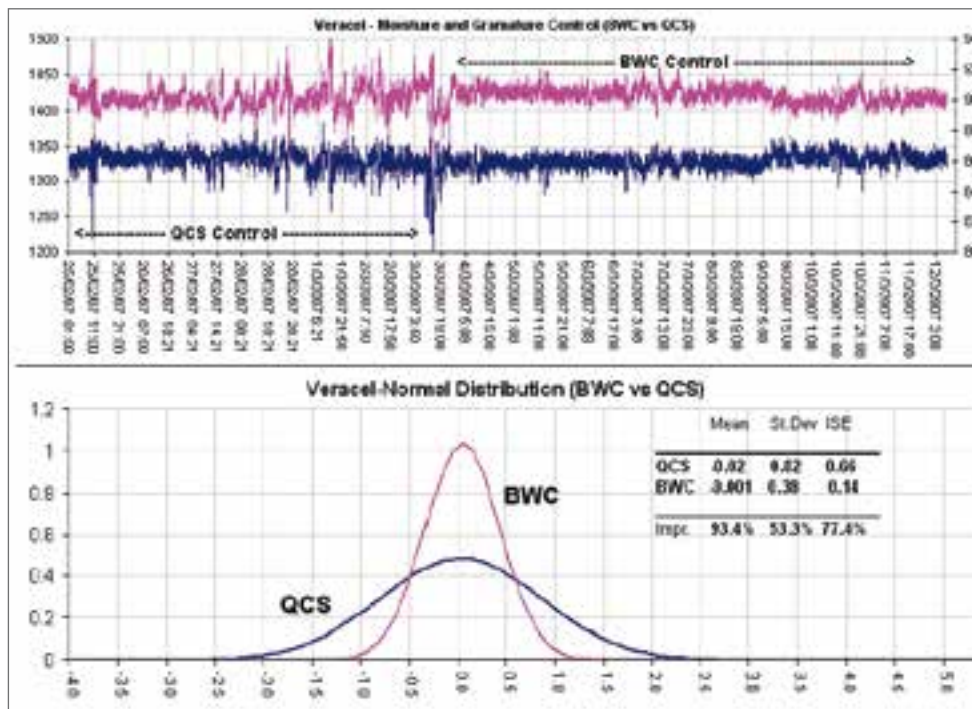
The challenge: To improve process performance in recaust systems

The solution:
BrainWave recaust

BrainWave is a proven control system that improves performance in recaust systems, particularly in the control of slaker causticity, slaker temperature, and final white liquor effective alkali (EA).

BrainWave recaust uses patented model-based, predictive, adaptive technology to improve process performance in recaust systems. Excessive costs and suboptimal results typically plague this area of the mill. Many of the loops in a typical chemical plant run in manual or cycle around the target due to long time delays and changing loop responses.

BrainWave recaust eliminates "over-liming" and reduces the energy load on the evaporators and recovery boiler. It reduces plant bottlenecks and results in increased capacity and greater profits.

BrainWave's optimization strategy uses conductivity measurements at the discharge of

the first causticizer to adjust the ratio of lime addition to green liquor flow in the slaker. Maintaining white liquor conductivity is critical at this stage of the process, because it is here that 80% to 95% of the causticizing reaction can be completed. Final causticity at the discharge into the receiver tank is measured with conductivity. This measurement is then used to adjust the set point of the conductivity controller at the first causticizer.

Feedforward signals are the flow and conductivity of the green liquor at the inlet of the slak-

er. The temperature in the slaker is managed by adjusting the set point of the green liquor temperature controller. BrainWave controllers are used in a cascade control configuration to ensure that the slaker temperature is maximized for optimal reaction efficiency. Laboratory samples of final white liquor TTA are used to determine the set point for the final white liquor conductivity controller. If online TTA measurements are available, these can be used in place of the conductivity sensors.

Benefits

- Close all loops and run them automatically

- Reduce lime use through higher causticizing efficiency

- Reduce "dead load" and energy use

- Reduce variability of white liquor by 30% to 50%

- Increase pulp production

- Achieve smoother operation

Slaker and recaust schematic ▼
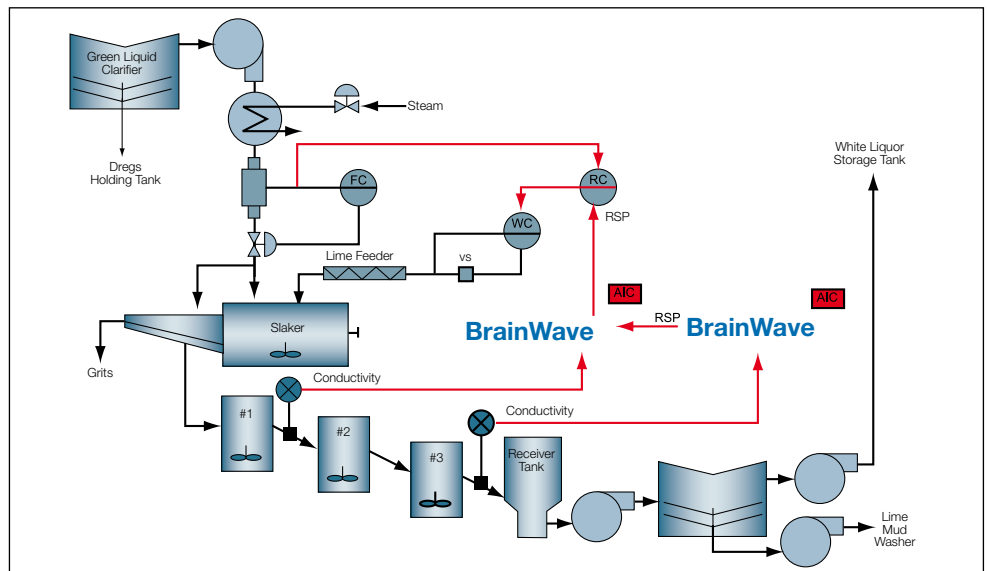
Success story

Customer: Alabama River Industries

Control objective:

- Reduce dead load/excess energy usage
- Improve causticizing efficiency
- Control system: Foxboro IA

Alabama River Industries has two large 1,100 t/d pulp mills in southern Alabama. After great results on the lime kiln, the mill decided to implement BrainWave on the re-causticizing plant.

The mill operators at Alabama River now have confidence with BrainWave and are pleased with its ability to hold targets tightly and reject disturbances.

The BrainWave loops are always the first ones turned on by the operators after a shutdown or outage. This robust and responsive control has allowed the mill to eliminate over-liming, which reduces the dead load and has resulted in improved causticizing efficiency. There is a direct link between causticiz-

ing efficiency (CE) and financial benefit. In a non-low solids digester at a typical 1,100 t/d mill, a 3% improvement in CE is worth approximately 302,000 USD. For a low solids digester at a typical 1,100 t/d mill, a 3% improvement in CE is worth 585,000 USD. The

CE improvements are pure energy. The benefits are seen in recovery boiler, evaporators, and digester and, if production in these areas is limited, then there may be an increase as a result of improving CE.

Slaker temperature: manual control versus BrainWave control ▼
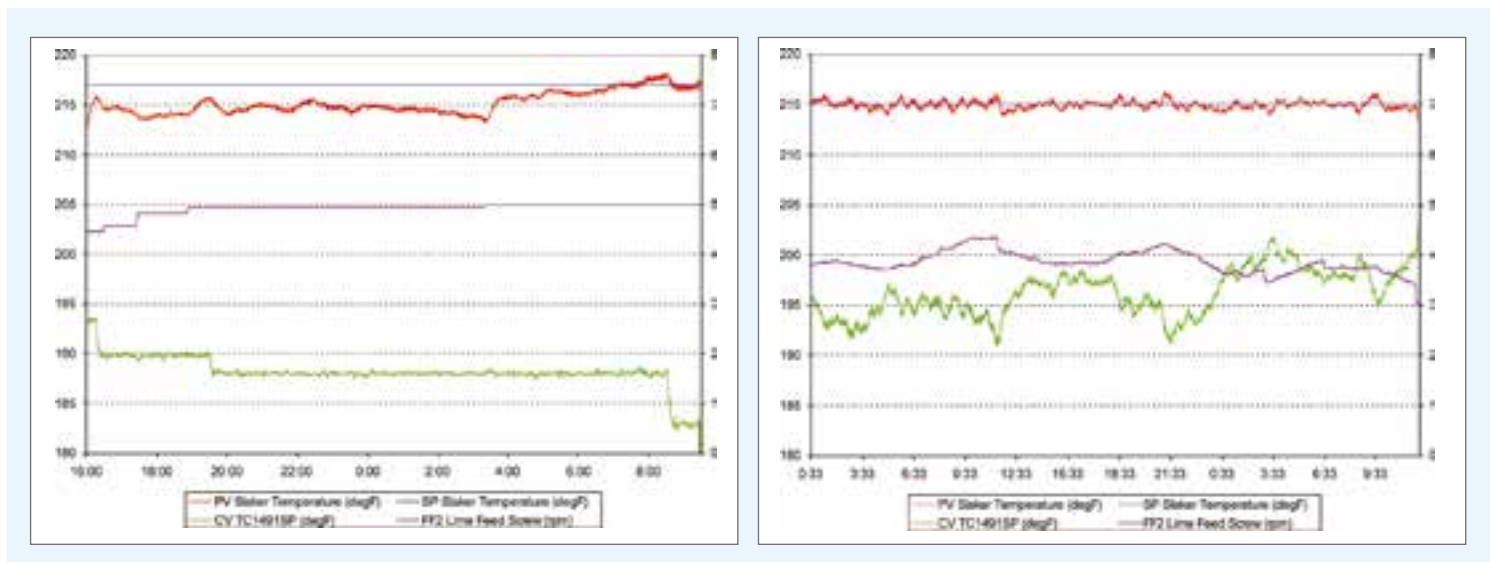
The challenge: To improve and control lime kiln operation

The solution: BrainWave lime kiln

BrainWave is a proven control system that improves product quality, reduces fuel consumption, maximizes yield, and increases the effective production rates of rotary kilns.

BrainWave lime kiln uses patented model-based, predictive, adaptive technology to stabilize operations and hold the front and back end temperature targets tightly while accounting for production rate changes and NCG load disturbances. Excess oxygen is also controlled to maintain fuel efficiency.

BrainWave keeps the critical loops closed and running in a continuous automatic mode. Stabilizing the feed end and firing end temperatures and oxygen, using a special patented BrainWave multivariable algorithm, ensures a stable and precise temperature profile and allows the operator to set the desired targets and have them held tightly.
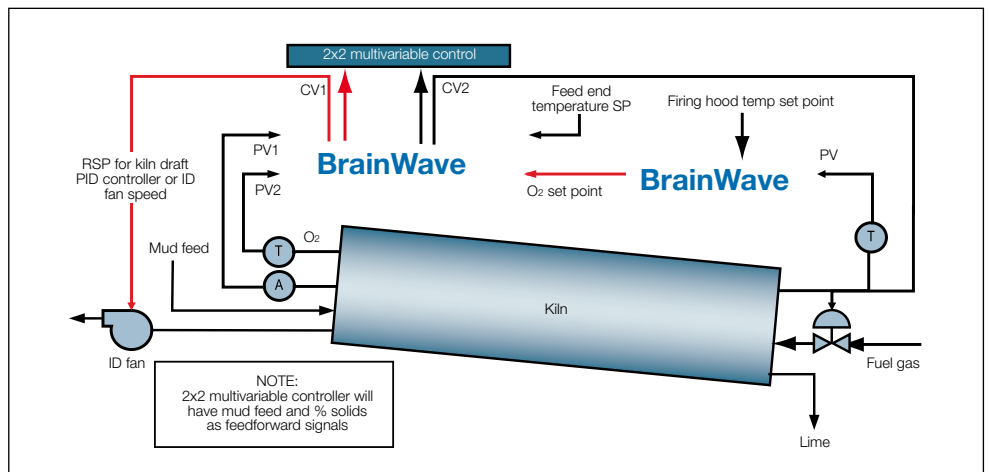
With the kiln running in automatic, the controls automatically reject disturbances from changing mud flow, NCG, and mud solids. BrainWave adapts and learns the changing impacts caused by those disturbances, giving the operator quality data—and a chance to manage inventories.

Benefits

- Increase energy efficiency
- Increase production
- Achieve better lime quality
- Increase plant availability by achieving faster start-up after grade or production changes
- Lower maintenance costs
- Achieve smoother operation with more consistent control

Lime kiln control schematic ▼

Lime kiln control schematic showing 2x2 multivariable control with BrainWave, CV1, CV2, PV1, PV2, RSP for kiln draft PID controller or ID fan speed, Mud feed, O_2, ID fan, Kiln, Feed end temperature SP, Firing hood temp set point, O_2 set point, PV, Fuel gas, Lime.

NOTE:
2x2 multivariable controller will have mud feed and % solids as feedforward signals

Success story

Customer: Various

Control objective:

- Reduce temperature variability
- Stabilize operations
- Keep lime kiln control in automatic
- Reduce ring formation
- Control system: various

BrainWave lime kiln has been installed on many plants throughout North America, South America, and Europe. It has proven to consistently reduce temperature and oxygen variability by substantial amounts.

This has resulted in automatic control that is available over 98.5% of the time. The tight control of temperature allows the operator to adjust the calcining profile to produce the highest quality lime at the lowest possible cost.

BrainWave lime kiln is proven to reduce energy consumption by 5% to 15% from conventional controls while completely automating the temperatures and oxygen control. The automated control greatly reduces operator workload.

Lime kiln temperature control before and after BrainWave: O$_2$ feed end temperature wave control ▼
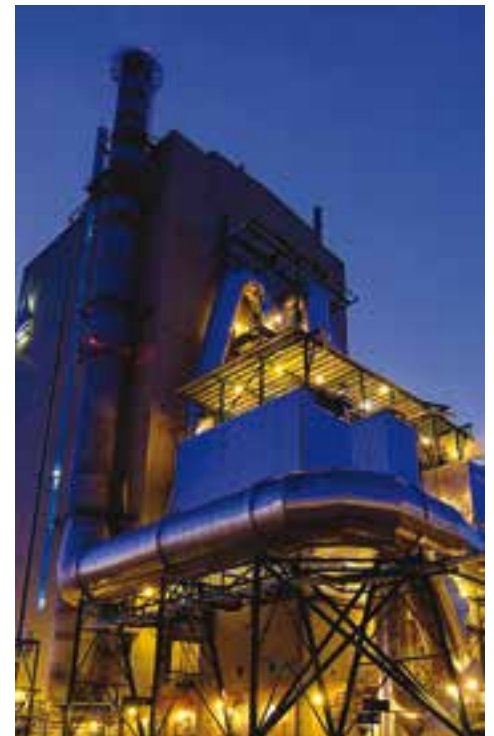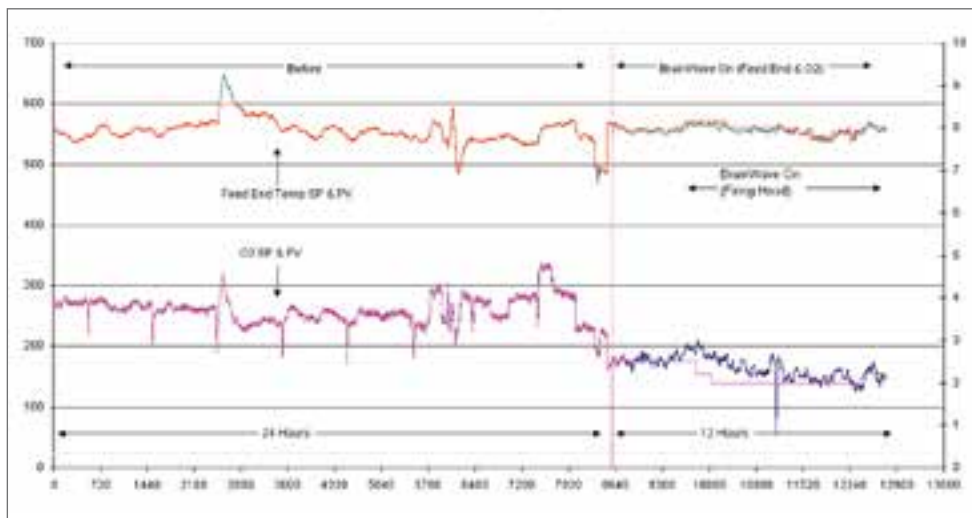
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Release your full potential

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