Sludge dewatering and incineration at Westvaco, North Charleston, S.C.

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The advent of new mechanical sludge dewatering equipment provides the paper industry with a new approach to sludge dewatering and represents a practical and profitable solution to one of the most challenging environmental issues facing the industry today: solid waste management.

Sludge from Westvaco's 24-million gal/day capacity wastewater treatment plant presented Westvaco and its neighbors with a growing environmental challenge during the 1980s. The 2200-ton/day unbleached kraft mill is supported by a two-stage wastewater treatment process with primary treatment for settleable solids removal and an activated sludge secondary system for BOD removal. Prior to 1989, 2400 o.d. (ovendry) tons of waste sludge were landfilled each month. Landfill costs and regulations were increasing as available landfill space diminished. At the same time, the public was becoming increasingly sensitive to truckloads of wet sludge transported daily from Westvaco's mill to its company-owned landfill in Berkeley County 22 miles away.

Coil spring filter, V-press, and centrifuge approaches to sludge dewatering had proven ineffective in producing a dewatered sludge with moisture content low enough to allow incineration in mill power boilers. While incineration of sludge is possible (if mixed with waste wood) at levels of approximately 32% solids and practical at levels of 40-45% solids, dewatering attempts prior to 1989 produced combined sludge of 28% solids, at best. The processed sludge from the wastewater treatment primary clarifier, at roughly 28-36% solids, and from the secondary clarifiers, at 10% solids, were combined to form a moderately dewatered solid waste material suitable only for landfilling. The primary sludge could have been combined with bark and used as fuel; however, the secondary sludge could not be landfilled at 10% solids and needed to be stabilized with the primary sludge.

During the 1980s, Westvaco Kraft Division engineers were committed to the establishment of a system capable of dewatering sludge to moisture levels practical for power boiler incineration. Extensive research was conducted to determine which dewatering system available on the market would meet the needs of the North Charleston mill. Mill trial runs of an FKC screw press produced combined primary and secondary dewatered cake solids of up to 55%. With these positive results, a decision was made to utilize the FKC presses.

A single FKC sludge press unit was purchased and installed in 1987. Only one unit was purchased because Westvaco wanted to be sure the press could satisfy the mill's dewatering needs over an extended period of time. Also, burnability studies of the dewatered sludge in the bark boilers needed to be conducted to ensure the dewatered primary and secondary sludge could be burned effectively.

After approximately six months of experimentation with the FKC press, favorable results led to the go ahead for a complete dewatering facility utilizing five screw-press units. Division engineers proceeded to design and implement a comprehensive mechanical sludge dewatering and processing system. By January 1989, the new system was fully operational, allowing 100% of the North Charleston mill's waste sludge to be dewatered and utilized as a new fuel source for mill energy production.

Authorized expenditures for purchase of the five FKC screw-press units, plus design and installation costs for the Charleston mill's dewatering system, totalled US$4.6 million. Increased costs of polymer now needed in the sludge processing system are insignificant in comparison to the savings in bark fuel and solid-waste treatment cost. During the project's first year of operation, a substantial return on investment was realized.

Waste treatment system overview

The wastewater treatment and sludge dewatering systems are outlined in **Fig. 1**. Mill waste is collected in two main process sewer systems and is pumped into the primary clarifier. The overflow from the primary clarifier is pumped through a cooling tower and into an aeration basin. The wastewater leaving the aeration basin proceeds into one of two secondary clarifiers. Overflow from the secondary clarifiers is then sent to the Cooper River. Secondary sludge is recycled back into the aeration basin to provide biomass for BOD reduction.

Primary sludge removed from the bottom of the primary clarifier and excess secondary sludge wasted from the

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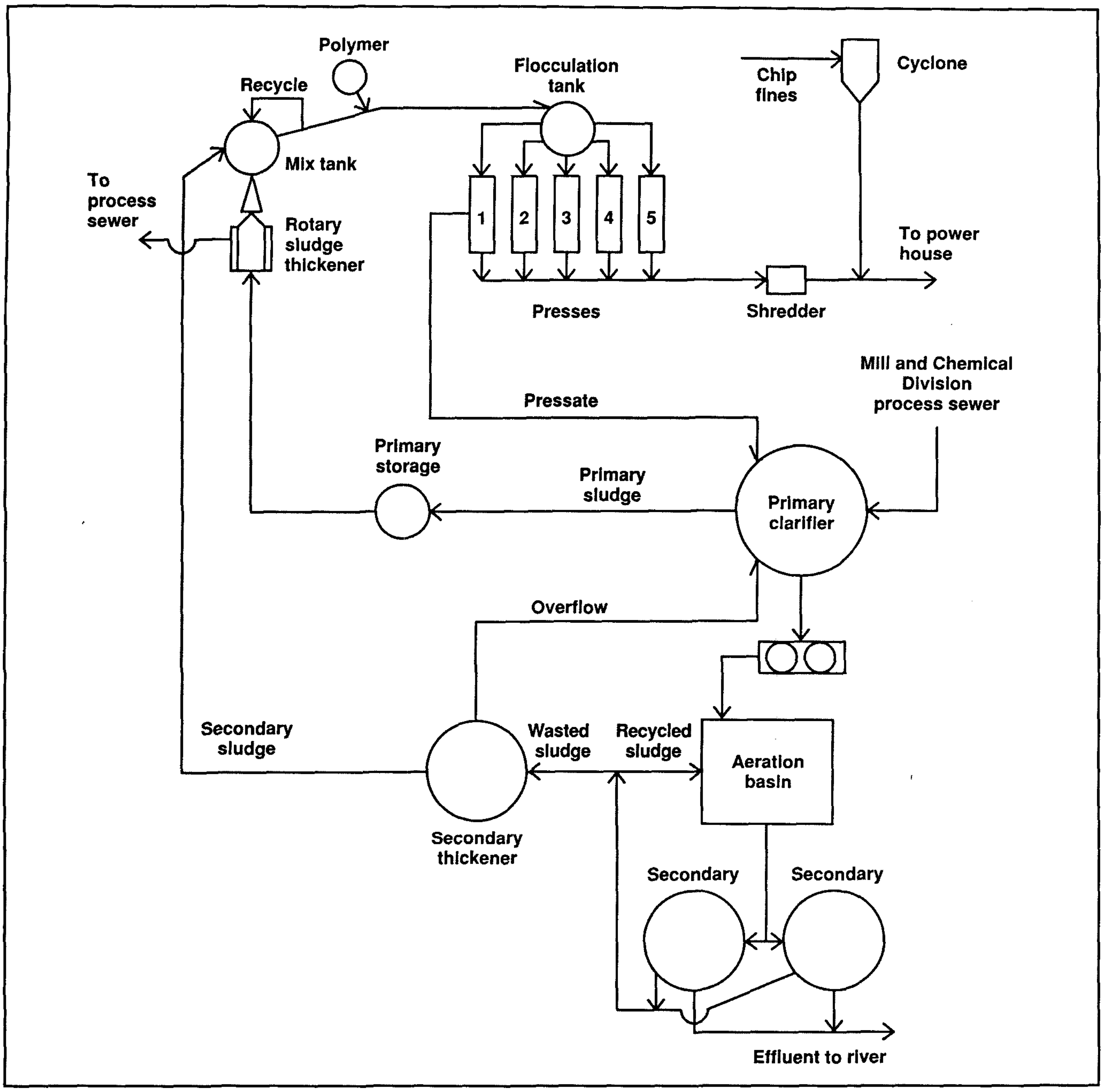
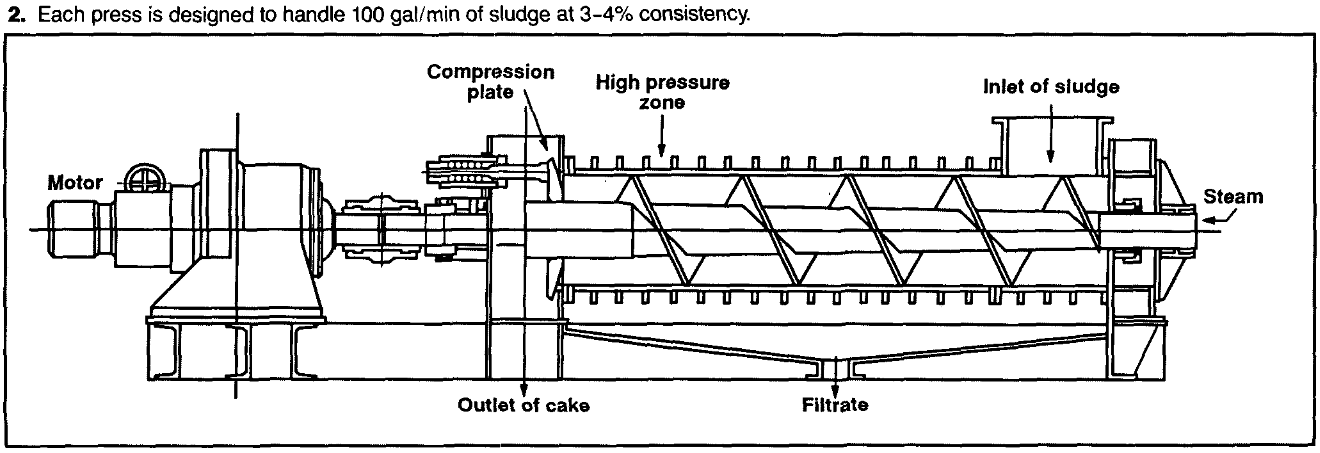
1. Wastewater treatment and sludge dewatering systems



2. Each press is designed to handle 100 gal/min of sludge at 3-4% consistency.



secondary clarifier recycle is pumped to the dewatering area. Here, the respective sludges are thickened, mixed, and fed to the screw presses. The dewatered sludge cake is then shredded, mixed with chip fines, and conveyed to the bark bin as fuel for the boilers. Pressate is pumped back to the primary clarifier launder for processing.

New dewatering operation

Primary sludge transfer to sludge mix tank

Primary sludge is pumped from the bottom of the primary clarifier to a 106,680-gal storage vessel via a 10-in. line and two 75-hp centrifugal pumps. Primary sludge is fed by gravity to a FKC parallel, double-drum, rotary screen thickener. The thickener increases primary sludge consistency from 2% to 4%. The thickened sludge flows out of the rotary thickener and directly into the sludge mix tank. Waste effluent from the rotary thickener is discharged by gravity to the mill process sewer. Primary sludge can bypass the double-drum thickener and be directly fed to the mix tank if the thickener is taken out of service.

A coagulant is added to the primary sludge, leaving the clarifier to control pitch deposits in the 10-in. transfer line. Also, polymer is added to the primary sludge before it enters the double-drum thickener to keep the screens free of pitch.

Flow of the primary sludge out of the storage tank is controlled by the level of the mix tank. Flow to the storage tank is controlled by the storage tank level and by the amount of sludge available in the primary clarifier.

Secondary sludge transfer to sludge mix tank

Excess secondary sludge is pumped from the bottom of the secondary clarifiers to the secondary sludge thickener tank via an 8-in. line and two 40-hp centrifugal pumps. The sludge thickener tank is similar in design to a clarifier and increases sludge consistency from roughly 1% to 2%. Secondary sludge is pumped from the bottom of the thickener using one of two 75-hp centrifugal pumps. Overflow from the thickener tank launder flows by gravity back to the primary launder for treatment. Flow of the sludge out of the secondary sludge thickener tank is manually controlled and is dictated by the waste flow of sludge out of the secondary clarifiers.

Sludge mix tank

Primary and secondary sludge are combined in a 13,817-gal stainless steel mix tank. Mixing is accomplished with a 15-hp agitator and by recirculation. A 60-hp pump with recirculation valve supplies blended sludge to an elevated flocculation tank. Mix tank recirculation is controlled by the level of the flocculation tank. A polymer solution, to aid in sludge flocculation and dewatering, is added to the mixed sludge as it is pumped to the flocculation tank.

Polymer addition

Polymer must be added to the combined sludge to aid in flocculation and dewatering. The polymer is purchased in 2400-lb reusable tote bins, which are utilized in an automatic mixing system. Batch solutions of the dry polymer and raw water are mixed at approximately 0.5 wt% polymer to water. The batches are mixed in a 2500-gal FRP tank with a retention time of about 1 h. Upon mixing, the wet polymer solution is dumped into a 3000-gal holding tank until it is ready for use. Polymer addition to the flocculation tank is automatically adjusted relative to the secondary sludge flow rate to the mixing tank.

Flocculation tank

The stainless steel flocculation tank is installed on an elevated galvanized platform at the headbox end of the screw-press platform. The 3635-gal tank is sized for 5-7 min and is kept well mixed with a 5-hp variable-speed agitator. The flocculation tank overflows via 8-in. stainless steel lines to each of the five presses. Flow to each press is regulated by individual control valves. Control valves are automatically adjusted by screw-press headbox levels. The velocity in the gravity feed lines is maintained at approximately 0.5 ft/s to prevent the breakup of floc.

Screw presses

Combined sludge from the flocculation tank is fed to each of the five FKC SHX screw presses (0.9-m diam., 8-m length). Each press, pictured in **Fig. 2**, is designed to handle 100 gal/min of sludge at 3-4% consistency. The presses are mounted on an open, elevated, concrete platform 15 ft above grade. Each screw press is driven by a 15-hp motor. Press speed, usually between 0.3 and 0.6 rpm, is controlled by a variable-speed drive. Press speed is adjustable and is set according to the torque on the primary clarifier rake arm.

Sludge enters the press from its headbox. The sludge, dewatered by gravity and compression, exits at the opposite end of the press. Initial gravity dewatering gives way to pressure dewatering as the sludge travels through the press. Compression is applied to the exiting sludge cake by a spring-loaded plate which restricts flow out of the press. Radial pressure is also applied to the sludge. This pressure is generated by the screw shaft as the diameter of the shaft, which is a conical tube, increases towards the high-pressure end of the press. The sludge drops out of the press only when the exiting cake, forced by the rotating screw, has built up enough pressure to overcome the force applied by the plate. The dewatered sludge discharges through the operating platform from each of the five presses onto a 24-in. × 70-ft belt conveyor. The sludge cake falls from the collection conveyor onto a 24-in. × 139-ft transfer conveyor which carries the sludge to be shredded and blended with chip fines.

The pressate from the sludge is collected in a catch basin below each press. The catch basins drain to a common header. Combined pressate is then pumped to the primary launder for treatment or is discharged into the process sewer.

Sludge press drive motor current is monitored to prevent motor and gear reducer overload. As the sludge cake moisture drops, the cake becomes harder to push through the press, and the torque from the motor increases. Steam at a maximum of 25 pounds per square inch (psi) is injected into the press's hollow conical shaft to decrease torque while maintaining sludge flow. Individual steam flow rates are automatically set according to drive motor load. Also, the steam plays a role in the dewatering of the sludge.

Much of the water contained in the secondary sludge lies within the microorganisms present in the biological waste. Removing the intracellular water requires high thermal or mechanical energy to break down the cell walls. This high energy requirement has been a limiting factor in secondary sludge dewatering in the past. However, the combination of heat and pressure applied by the screw press provides enough energy to crush and dewater the biological waste.

Sludge shredding and chip fine addition

Sludge falls from the transfer conveyor into an elevated Shredding Systems, Inc. Model 600-E shredder. The sludge cake, in lumps as big as softballs, is shredded into pieces of 5/8 in. or less and is discharged into a pneumatic conveyor feed screw. The sludge cake falls to grade in the event of a shredder malfunction. The conveyor feed screw also accepts chip fines pneumatically conveyed from the woodyard chip screening operation. Chip fines drop into the screw feeder after passing through a cyclone. The shredded sludge and chip fines fall to grade if the pneumatic conveyor system malfunctions.

The feed screw discharges sludge and chip fines into a rotary air lock and onto a pneumatic conveyor line driven by a 100-hp blower. Sludge and fines are conveyed to the top of the bark bin where they pass through a cyclone and drop onto the bark. The bark/sludge/fines mixture is then used as fuel in the No. 4 and No. 5 power boilers.

Control system

The waste treatment and dewatering operation is controlled by a Foxboro Intelligent Automation system. The system employs full-color graphics to display alarms, operational status of all motors, flow rates, pH, temperatures, tank levels, screw press speed, motor amps, and any other system variable needed for exceptional levels of control. The entire waste treatment and dewatering operation can be run from one monitor. However, some pumps, motors, and valves require manual adjustment for safety purposes.

Manpower

The entire waste treatment operation is run by one licensed operator, with the aid of an operator assistant on the day shift. Little training of the operators was needed because they were all involved in the testing of the original screw press at the mill. Training had to be completed on the use of the Foxboro control system.

Dewatering system evaluation

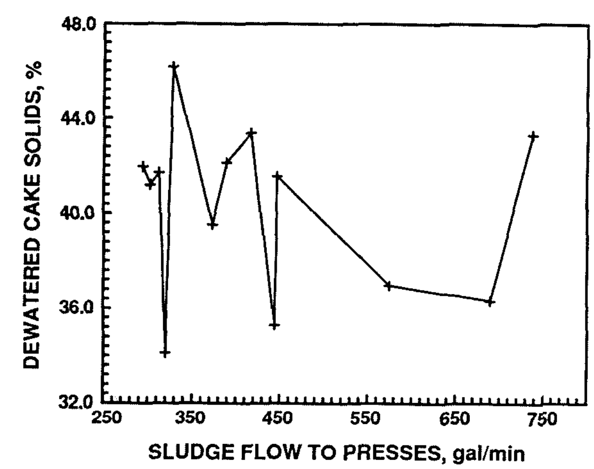
Since system startup in December 1988, the dewatering operation has been running smoothly. Operator training during testing had a large impact on the successful startup of the project. The new presses have needed little maintenance since startup, requiring only routine lubrication and cleaning. The screw presses and rotary screen thickener are hosed off every two days.

Only one mechanical problem was encountered in the new dewatering operation. A thrust bearing, which holds the press shaft in place, had to be replaced on the No. 1 press. The No. 1 press was used in the initial development of the dewatering system. Bearing failure was attributed to excessive loading on the bearing during testing, at a

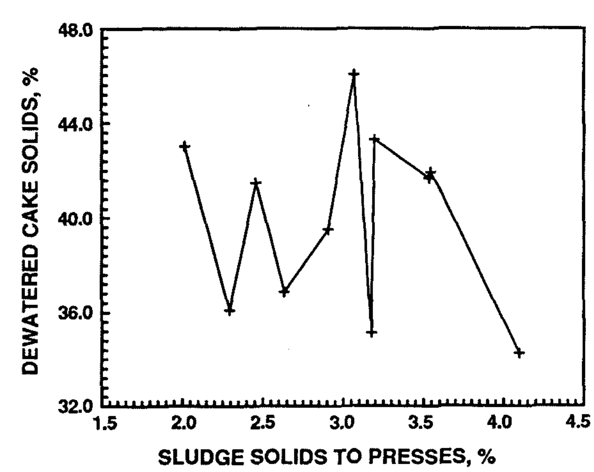
I. Average consistencies and flow rates

Primary solids, %	3.12
Primary flow, gal/min	435
Rotary thicknener pressate, gal/min	105
Secondary solids, %	1.64
Secondary flow, gal/min	170
Combined sludge solids, %	3.04
Combined sludge flow, gal/min	430
Dewatered cake solids, %	40.1
Dewatered cake production, o.d. tons/day	71.4
Pressate flow, gal/min	420

3. Dewatered sludge solids vs. sludge flow to presses



4. Dewatered sludge solids vs. feed solids



time when we had little operational experience on the screw press.

Equipment deficiencies have been encountered with the sludge shredder and the flow control valves to the sludge press headboxes. Initially, the sludge shredder could not process a high throughput of sludge. Unshredded sludge was entering and plugging the pneumatic conveyor. Spacing between shredder blades was increased from 3/8 in. to 5/8 in. to solve this problem. Also, the shredder blades supplied by the manufacturer had to be replaced with higher-alloy steel because of wear rate.

The flow control valves have clogged at feed consistencies above 3.5%. To combat this, dilution water to the primary sludge was increased until the plugging stopped. This was not the optimal solution because more water was being added to the sludge. The original pinch valves have been replaced with V-notch ball valves, and dilution water has been minimized. With the installation of the new control valves, feed consistencies can be increased to the design level of 4%. This has helped to elevate the dewatered sludge cake solids from an average of 40% towards the design target of 45% solids.

Hydrogen sulfide gas was detected around the rotary sludge thickener, sludge mix tank, and the screw presses shortly after startup.

Potassium permanganate was added to the primary sludge to eliminate the hydrogen sulfide. However, the addition of permanganate proved to be a costly solution and was replaced by ferric sulfate addition. Approximately 800 gal/day of ferric sulfate are now used to control hydrogen sulfide release. Because of the presence of hydrogen sulfide, personal hydrogen sulfide meters are required when working in the sludge press area.

Other operational problems with the screw presses, which we have not encountered, should be considered. Abrasive sludge could wear down screw flights at excessive rates, causing long maintenance outages to refurbish the flights. Operating the presses at high speed (above 0.7 rpm) will have the same effect. There is also the potential problem of tearing a press screen.

Dewatered sludge cake production averaged 70 o.d. tons/day at an average solids of 40% during the period between June 21 and Aug. 9, 1989. These data are based on 13 material balances performed during this time period. Cake production rates varied between 57.5 and 90.1 o.d. tons/day. Solids content ranged between 34% and 46%. Average primary, secondary, combined, and product consistencies and flow rates are listed in **Table I.**

During the evaluation period, flow of combination sludge to the presses ranged from 298 to 735 gal/min (59.6 gal/min/press vs. 147 gal/min/press) with no adverse effect on the dryness of the sludge cake. **Figure 3** plots sludge cake solids vs. combined sludge flow rate, and **Fig. 4** plots sludge cake solids content vs. combined sludge solids content. The two graphs reveal that the presses work equally well across a wide range of inlet solids and flow rates. Sludge production rates between October 1989 and March 1990 averaged 87 o.d. tons/day at 42% solids.

Operations has noted that as sludge throughput increases, product solids out of the presses decreases. Product solids can be increased by slowing the presses down and reducing the steam. But when this is done, load on the press drive increases, causing the steam to increase.

Approximately 10 lb of dry polymer are being used per o.d. ton of sludge. Percol 763 is currently being used as the main flocculent. It seems to be the only polymer that effectively flocculates the sludge on a continual basis; however, due to the mill-specific nature of waste sludge, other polymers may work better at other mill locations. New polymers are continually being tested. Ten percent of polymer usage is set aside for trials. The Percol 763 polymer is only effective at a sludge pH between 6 and 9. Black liquor spills and other disturbances to the mill sewer system causing dramatic pH swings have temporarily rendered the polymer ineffective. Without the polymer, the sludge will not flocculate and becomes difficult to dewater. Black liquor spills have resulted in dewatered sludge solids as low as 32%.

Roughly 12,500 kW•h/day of electricity and 2700 lb/h of steam are used by the dewatering system each month. Utility and polymer costs are more than offset by the savings in landfill costs.

The use of dewatered sludge as fuel for the mill's bark boilers has been successful. Feed to the bark boilers has averaged about 20 wt% sludge with no adverse effect on the operation of the power boilers. After six months of full system operation, a study of sludge burning effects in the power boilers was conducted.

Evaluation of sludge burnability

General boiler operations

Dewatered sludge from the presses is sent to the shredder and reduced to 5/8 in. in diameter or less. The shredder sludge is combined with the woodyard chip fines (sawdust) and usually is pneumatically conveyed up to the bark bin. There the mixture is fed to the powerhouse by means of conveyors. The bark bins can be bypassed by dropping the sludge and fines mixture onto screws that feed a bypass conveyor which feeds the main conveyor directly to the powerhouse.

In the powerhouse, there are two boilers capable of burning bark and sludge fuels: No. 4 and No. 5. The No. 5 power boiler is a 275,000-lb/h boiler that can be supplemented with No. 6 fuel oil. The No. 4 power boiler is an 80,000-lb/h boiler with no supplementary fuel. Both boilers produce 600 psig steam. Number 4 was chosen to be the test boiler due to its lower capacity and because the controls are adjacent to the boiler. Should problems be encountered during the tests, the boiler could be shut down without drastically cutting back on 600-psig steam available to the mill.

The No. 4 power boiler is a Babcock and Wilcox boiler installed in 1945. It is designed to produce 600-psig steam at a maximum designed rate of 80,000 lb/h. It is a Stirling, stoker fired boiler with Detroit Stoker Rotofeeders. The boiler bank is vertical, the economizer is horizontal, and the air heater is single-pass.

The combustion characteristics of dewatered sludge do not differ much from that of bark. The bulk of the sludge is made of pulp fibers. **Table II** is a comparison of the elemental analysis of dewatered sludge and bark. The major differences between the two are the moisture and heating value. The dewatered sludge moisture is usually about 58% but has been as low as 45%. This can be attributed to many variables such as the content of primary sludge and press speed.

The heating value of dewatered sludge is also very inconsistent. The average heating values of primary and secondary sludge are 7900 and 10,100 Btu/lb, respectively, on a dry basis. On average, dewatered sludge contains about 25% secondary sludge. Although it would be more advantageous to use a higher level of secondary sludge from a combustion standpoint, operating difficulties could be encountered. There is a far greater amount of primary sludge formed than secondary at the waste treatment plant. Therefore, if the ratio of secondary to primary sludge were raised, problems would arise with materials balance throughout the system. Also, mixed sludge tends to dewater better with more primary sludge. If less dewatering occurs, logically the sludge moisture out of the presses rises. As with any fuel fed to a boiler, the higher the moisture, the higher the heat loss to moisture, and the lower the thermal efficiency. The heating value-sludge moisture-thermal efficiency relationship is a balance that must be maintained when burning dewatered sludge.

II. Elemental analysis of bark and sludge (dry basis)

Element	*Dewatered sludge*	*Bark*
Carbon, %	48.0	48.0
Hydrogen, %	5.7	6.0
Nitrogen, %	1.2	0.3
Sulfur, %	0.8	0.1
Oxygen, %	36.3	42.1
Ash, %	8.0	3.5
Moisture, %	60.0	46.0
Heating value, Btu/lb	8500	8700

Normal sludge combustion

The No. 4 power boiler normally produces about 50,000 lb/h of 600-psig steam. Approximately 350-400 wet tons/day of bark are required to operate the boiler at these conditions. During periods of burning all bark, the thermal efficiency averages about 62% by heat loss method. The major losses are due to dry gas heat loss, moisture in the fuel, and hydrogen content of the fuel. The ash is normally dewatered in a lagoon and landfilled.

Normally the sludge presses are in operation, and the daily production is about 87 o.d. tons per day. The sludge is shredded, mixed with chip fines, and blown up to the bark bin. The fuel sent to the boiler is usually about 25% sludge by weight. Operating at these conditions, the thermal efficiency varies from 58% to 64%, averaging about 62%. There are usually no major difficulties operating the boiler at this sludge level. The operators state that there are no differences between burning all bark and burning low-concentration sludge and bark mixtures.

Sludge burnability and thermal efficiency

To examine the effect of burning sludge on the boiler's thermal efficiency, the fuel weight percent of sludge was varied from 0% to 98%. The highest attainable sludge content was 98 wt% due to residual chip fines in the equipment. Operation parameters were monitored, and samples were taken to calculate the thermal efficiency at various sludge levels.

At 0 wt% sludge, the thermal efficiency averaged 62%. This is the original boiler design condition, so there were no major operating problems.

Figure 5 is the plot of the actual thermal efficiencies and averages vs. fuel sludge weight percent. From 1-25 wt% sludge content, the thermal efficiency varies a maximum of 6%, from 58% to 64%, averaging slightly less than 62% (the same as the average thermal efficiency at 0% sludge). In general, the thermal efficiency is not adversely affected by burning fuel with sludge content of 1-25 wt%.

Fuels in the 25-50 wt% range burn in much the same manner as lower-sludge-content fuel. Overall, the thermal efficiency varied only slightly from the 62% range (Fig. 5). Again, there were no major operating difficulties at these levels.

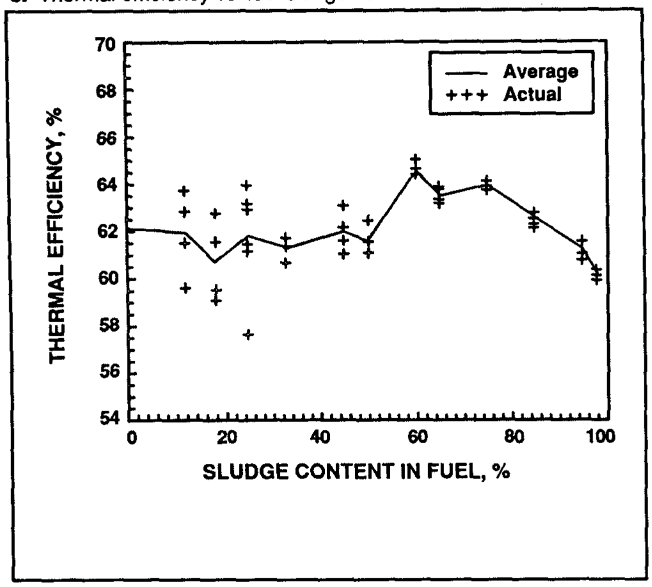
Fuels in the 50-80 wt% sludge range yielded an average thermal efficiency of 63.5%. This was higher than expected and was the result of low sludge moisture, roughly 51%, during this phase of testing. At 60 wt% sludge, the thermal efficiency was slightly above 64%. If the sludge moisture was at the normal 60%, the thermal efficiency would average about 61% for the 60-wt% sludge test. **Figure 6** is similar to Fig. 5, except a bottom line from 50 to 98 wt% indicates the thermal efficiency if the sludge moisture was at the normal 60%. As Fig. 6 indicates, the higher the weight percent of sludge in the fuel, the lower the thermal efficiency. This downward trend was expected due to the higher moisture of the fuel being fed to the boiler.

The effect of burning very-high-sludge-content fuel, above 80% sludge, on thermal efficiency was the same as the 50-80 wt% test. As Figs. 5 and 6 indicate, the thermal efficiency decreased with increasing sludge weight percent. During this trial, the sludge moisture was lower than normal at 52% for the 98-wt% fuel test. Referring to Fig. 6, the thermal efficiency averaged about 61% at 98 wt% sludge. If the sludge was at the normal moisture content of 60%, the average thermal efficiency would have been about 56%. Again we see the same scenario: the higher the sludge content of the fuel, the lower the thermal efficiency.

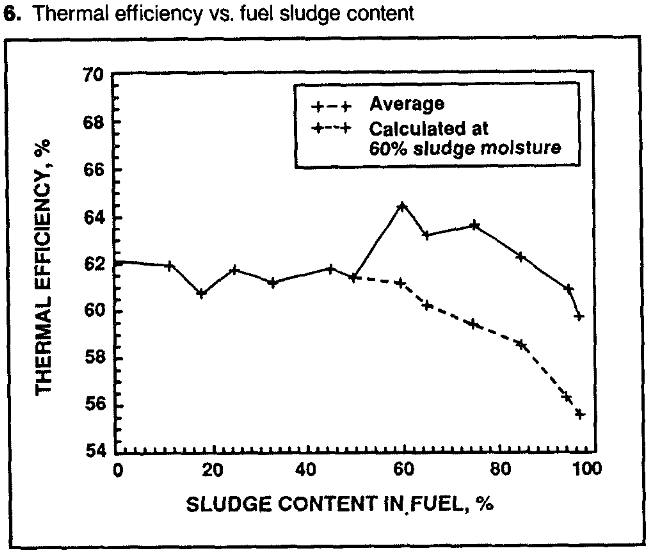
Operating problems

When the sludge content of the fuel fed to the boiler was high, 50-98 wt%, operating problems were encountered. The problem that caused the most concern was the stack gas opacity. Normally the opacity is between 20% and 25%, whether burning low-sludge-content fuel or all bark. When the tests burning 50-98 wt% sludge fuel were conducted, the opacity was difficult to control. Constant monitoring and adjustments had to be made to keep the opacity down. For example, the opacity averaged about 375 during the trial using 98 wt% sludge fuel. The operator had to

5. Thermal efficiency vs. fuel sludge content



6. Thermal efficiency vs. fuel sludge content



constantly adjust the induced draft (ID) and forced draft (FD) fan speeds to maintain opacity control.

The control of the opacity leads to another problem when burning high-sludge-content fuel. By slowing the ID fan down to lower the opacity, the boiler can become pressurized. The area around the boiler tends to fill with smoke. To alleviate this, the FD fan was slowed. Sludge in general burns slightly slower than bark. This fact, and the slowing of the FD fan, caused slower burning of the sludge. This led to piling on the grates, which caused uneven burning, and the bark feed rate had to be slowed. This cycle continued for the duration of the test.

The effect of this cycle was to slowly decrease boiler temperature. After operating like this for a few hours, the cycle of adjustments slowed down, and the boiler was still able to produce steam. But, if this mode of operation was extended over several days, the boiler would have to be supplemented with an alternate fuel source to maintain the temperature and steam production. Since steam production is the most important measure of the boiler operation, combustion of high-sludge-content fuel will lower steam production. A boiler that has an alternate fuel source, such as Charleston's No. 5 power boiler, could operate with high-sludge-content fuel.

Another drawback to burning high-sludge-content fuel is the ash recirculation system. The operators state that the ash produced when burning sludge tends to stick to equipment in the recirculation system. The pipes must be disconnected and the ash removed by air lances or by beating the ash loose. Although this did not occur during the trials conducted for this report, it has been seen previously.

Burning high-sludge-content fuel, 50–100% by weight, requires more monitoring and control on the part of the operators. Because of this, burning high levels of sludge should not occur unless absolutely necessary. If this is necessary, the boiler should be supplemented with a secondary fuel which would require less operator supervision.

Conclusion

The new dewatering system has been operating well since January 1989. Product solids have averaged 42% at a production rate of 87 o.d. tons/day. The use of dewatered sludge as a fuel in the bark boilers has had little or no negative effect on their performance. The presses have proven to be a sound investment, yielding considerable savings in landfill costs.

Dewatered waste treatment sludge is normally burned in the Charleston mill power boilers without any major operating difficulties. By keeping the fuel sludge content at 20–25% by weight, there are no adverse effects on thermal efficiency. In general, the low-sludge-content fuel burns very much like bark. Higher-sludge-content fuels can be burned in a power boiler, but the thermal efficiency is lowered due to the increased moisture of the fuel. By lowering the moisture content of the fuel, the thermal efficiency will elevate, allowing combustion of higher-sludge-content fuel without adverse effects on operation. Also, other operating difficulties such as opacity, combustion rate, and ash recirculation must be overcome to operate the boiler using higher-sludge-content fuel. Should a mill's sludge quantity be large enough to support a boiler solely on sludge, an alternate fuel source may need to be used for ease of operation and boiler stability.

The advent of new mechanical sludge dewatering equipment provides the paper industry with a new approach to sludge dewatering and represents a practical and profitable solution to one of the most challenging environmental issues facing the industry today: solid waste management. Landfilling of waste treatment sludge at the Charleston mill is now a thing of the past. Furthermore, immediate and long-range demand for landfill space, at a premium in an area characterized by sensitive wetland regions, has been dramatically reduced. □

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