

Screw presses in waste dewatering

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Reverse position of presses results in lower reject rates, improved wastewater.

Screw presses installed at the Jefferson Smurfit boxboard mill in Wabash, IN, have significantly decreased the load on the wastewater treatment facility and facilitated the capture and disposal of fines in the primary clarifier sludge. The benefits were achieved by reversing the position in which screw presses are normally used. In the typical installation, the screw press goes at the end of the cycle, receiving the sludge from clarifiers, the DAF systems, or both. At Jefferson Smurfit the presses were instead placed to receive reject material flows ahead of the clarifiers (Fig. 1).

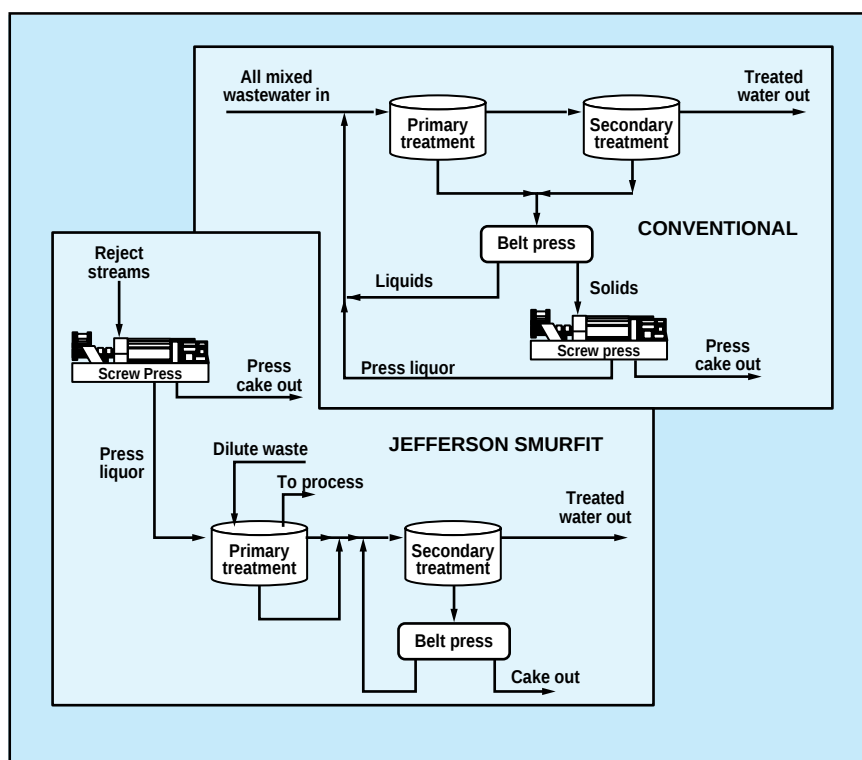
Higher-than-anticipated reject rates from the mill's cleaning systems had increased the load on the existing wastewater treatment facilities. Conditions reached a level where, during upsets, unacceptable discharges could occur. Resolution of this problem was necessary to ensure continued compliance with the mill's NPDES permit. Screw presses offered key advantages. They operate continuously through wide swings in flow rate and solids concentration, they operate unattended, and they require minimal maintenance.

Background

Established as a recycling mill in 1892, this plant now specializes in producing high-quality boxboard, including breakfast cereal boxes. The nominal mill capacity is 365 tons/day. Basic machinery includes six Hydrapulpers and two paper machines: a 96-in., 10-cylinder (4500 ft/min) multi-ply and a 120-in., eight-unit (500 ft/min Ultraformer. Both machine coated and uncoated combination boxboard are produced.

There are a great many point sources of wastewater including pulper detashing screens, pressure screen rejects, unclaimed cooling water, and tank overflows. The rejects are pumped directly to a screen press. They include forward cleaner

1. Diagram of conventional method of installing a screw press compared with the reverse method used at Jefferson Smurfit, Wabash, IN



rejects as well as fine and coarse screen rejects. Large trash from the Hydrapulpers is removed continuously by a continuous scavenger system. This bulky material is moved by conveyor to a dump hopper.

Primary wastewater treatment is performed in an Infilco clarifier. The secondary treatment plant is an activated sludge system. It is physically located on an adjoining property. Originally it was operated by the City of Wabash, treating both mill and municipal wastewater. It consists of three rectangular aeration basins, two rectangular digesters, and three final settling tanks. The water is discharged into the Wabash River in accordance with an NPDES permit. Polymer is added to sludge that is pumped from the digesters. This sludge is then dewatered on a belt press. The belt press requires an operator

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on each shift, and it is generally regarded as a high-maintenance machine.

To minimize the tonnage or cubic feet going to landfill, 40% or higher solids is desirable in the press cake. The belt press used at the secondary treatment plant can achieve only 30% (approximately). Although screw press material, due to its characteristics, can be spread with solids up to 50%, the belt press cake material cannot be spread at consistencies above 30% solids. This is due to the operation of the feeders on the trucks that are used to landspread the press cake.

There are various practical and theoretical means of disposing of sludge from the belt press. One of the most economical is land application: farmers accept the material without charge because of its benefits to the soil, and the farm acreage in the immediate area of the plant currently supports these operations. Placing the press cake in a landfill was very economical in the past. However with the decline in landfill sites in the immediate area and regulations that applied to landfill operations, this disposal option has lost favor. Additional potential future disposal means are under review. The sale to other business operations is especially attractive. Potential buyers include paper recyclers capable of using the fiber that is rejected at Wabash because of stringent product specifications. Also, it is recognized that material that is dewatered to approximately 50% moisture might be used as a boiler fuel by blending with coal. A final option under review involves coal mine reclamation activities.

Press application

Most wastewater streams from the mill are combined ahead of wastewater treatment. The combined flow is pumped across a bank of inclined screens to remove long fiber prior to entering the primary treatment. The long fiber is returned to the mill for reprocessing. Reject streams from forward cleaners and pressure screens do not pass over the sidehills; instead, they are fed directly into a pair of screw presses. Filtrate water from the screw presses flows to the primary clarifier. Excess clarified water then overflows to the secondary treatment plant.

Each screw press can generate 7–50 a.d.tons/day of press cake at up to 50% moisture. It is important to note that the wastewater treatment facility does not have to handle this tonnage of solids. By capturing the solids with a screw press, a significant reduction of load on the wastewater treatment plant is achieved (Fig.2).

Capture of clarifier sludge in a screw press is difficult. There is a tendency for the fines (clay or ash) to blind the screens of the press, which results in drastically reduced press throughput capacity. The operation results in screw press filtrate water with 500–1000 ppm solids. This range of solids is within an acceptable range for treatment and capture in the secondary treatment plant.

2. Screw press installation at the mill has facilitated sludge removal.



Selection of a screw press

Six presses by four different manufacturers were tested on-site with varying results. In the end, a design manufactured by Vincent Corp. was selected. The design is a modified version of their standard citrus press, a machine used in converting orange peel into cattle feed. The modifications were required because, while wet fiber dewateres much more readily than citrus peel, it is much less compressible once the free water is removed.

During the trial operation, efforts were made to develop a set of specifications for the screw presses. This effort began with a focus on normal technical details such as g/m capacity, horsepower requirements, press cake moisture, and screw diameter. This proved unsatisfactory because of the very wide range of flow rates and solids concentrations that were encountered. The varying nature of the inbound flow (easy-to-press fiber as compared with difficult-to-press sludge) made the specifications difficult to write.

In the end, the unique purchase specifications were as follows:

- The primary performance criteria for satisfactory operation of each press are: (1) it must not plug or jam and (2) it must not pass large quantities of unpressed liquid into the flow of press cake.
- The press must operate like a pump: reliably, unattended, and with very infrequent maintenance.

The presses that were purchased have added many benefits to the process. For example, it was found that the use of wedgewire screens, as opposed to perforated metal, not only increased physical strength but also reduced the concentration of suspended particles in the press filtrate. Wedgewire appeared to be more self-cleaning than perforated metal.

Accommodating the absolute peak flow under conditions of maximum blinding would have required an excessively large screw press. Rather than purchasing such a large machine, provisions were made to allow the incoming flow to overflow the inlet hopper during the unusual peaks. This overflow is

directed back into the treatment system. It is estimated that this overflow provision is used less than 5% of the time.

A pneumatically adjustable cone at the press discharge allows the press to operate satisfactorily over a wide range of flow rates and solids concentrations. If the inbound solids are low, the cone pinches off the discharge to prevent liquid from purging into the press cake discharge. The design of this cone mechanism negated the need for a variable speed drive on the screw press, which represented a significant capital savings.

The presses also feature an interrupted screw flight design, as opposed to a continuous screw. Because the screw is discontinuous, fixed resistor teeth can be mounted to the press frame, protruding into the flow of material inside the screen. This design reduces co-rotation, the condition where material rotates with the screw and nothing either enters or leaves the press. The stirring action by the teeth allows for a shorter machine that requires less horsepower to operate.

To assist in unblinding the filter screen, presses were acquired that have a wiper-brush mounted on the screw auger. This clears blinding material from the screen surface. The feature assists operation during periods of high sludge content.

Maintenance requirements also guided the press selection process. Presses were purchased with all contact parts made of T-304 stainless steel, which will minimize maintenance requirements over many years. Similarly, presses in a horizontal

configuration were selected because of the ease of disassembly in the event of screw, screen, drive, or cone maintenance. Finally, the presses selected make use of standard OEM gear boxes, bearings, seals, etc., which further reduces maintenance expense over the long run.

Results

The principal result of the installation of the screw presses has been to relieve solids loading on the wastewater treatment facilities. A recent expansion of the mill cleaning system had resulted in serious overloading of reject material going to the wastewater plant. With the addition of the screw presses, this condition has been resolved.

One side benefit of removing such large quantities of solids ahead of the treatment plant has been a reduction in the amount of sludge to be belt pressed. The sludge from this source has been reduced from 1000 to 600 a.d. tons/month.

Results of the wastewater plant from before and after installation of the screw press have been measured and compared. The analysis shows that suspended solids were reduced from an average of 75 mg/L (or ppm) to 25 mg/L. 

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Troubleshooting guide

During an extended period of trials at Jefferson Smurfit, numerous problems were encountered. These included:

- Overload and trip-out. This was apt to occur when pressing too tight. Typically, it was a consequence of feeding thick stock to the press during upset conditions. Solutions included providing for dilution water at times of high amperage draw and oversizing the press.
- Purge of liquid in the press cake. Some presses had difficulty when insufficient fiber was present to form a press cake. Pre-thickening can relieve this problem. The design of the press discharge cone is very important.
- Screen blinding. The screens of most presses tend to blind on clarifier sludge. It appears that platelets of clay in the sludge bridge the openings in the screen and prevent the flow of liquid through the openings. This problem is even more pronounced if biological (secondary treatment) sludge is present. At times the addition of fiber waste will act as a press aid and wipe the screen clear. Also, pre-thickening with a belt press can help. Alternatively, the use of a low-rpm continuous screw press will address this problem.

- Excessive solids in press filtrate. With certain screen configurations, the ppm of suspended solids in the press filtrate were found to be 10 times greater than the acceptable range. The use of wedgewire screens resulted in the best performance.
- Interrupted operations. Some presses required operator attention before satisfactory operation was achieved on a restart. This occurred under conditions such as a period of no incoming flow followed by resumption of mill operations. Dilute flows during flushing and wash-down can also require operator attention to the screw press. The machines at the Wabash boxboard mill were selected to be able to handle these swings without adjustment.
- Screw wear. Excessive abrasive wear was noted on press components such as the screw flights and discharge cone. This is addressed with the addition of hardfacing in the wear areas.

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