1. *INTRODUCTION*

The importance of automating a Screw Press sludge dewatering system stems from two (2) major reasons: 1. pulp & paper mill sludges are highly variable in feed characteristics (these variations are rarely predictable); 2. the Screw Press is a high torque device. By implementing certain controls and instrumentation into the Screw Press dewatering process, the sludge variability and associated variations in dewatering performance can be tempered to satisfactory limits allowing predictable performance. This paper will attempt to explain the control and philosophy which will provide a successful, automatic Screw Press dewatering system as based on ANDRITZ experience.

Dewatering System Overview

Referring to the attached ANDRITZ-recommended flow sheet, it is apparent that a certain amount of instrumentation is required to automate the Screw Press system. These items while supplied by others may include flow indicators, controllers, and alarms. The primary objective of these minimum process instruments is to prevent and/or lessen the magnitude of swings in the feed characteristics to the Screw Press Dewatering System. The secondary function is one of information to personnel responsible for the equipment operation and performance. It should be noted that this flow sheet is typical and rather generic. Deviations may occur for different applications and requirements and will be finalized after receipt of a formal purchase order at which time engineering will create the project specific sheet.

III. *Sludge Blend Tank*

A properly sized sludge blend tank is required as this is of the utmost importance to successful automation of the dewatering operation. It's purpose is to "buffer" the dewatering system from changing feed characteristics such as consistency, fiber content, and secondary content. Without the blend tank, the Screw Press could be fed constantly-changing sludge, resulting in corresponding swings in performance and increased requirements for operator attention and housekeeping. Most importantly, an improperly sized or outright non-existent blend tank can result in severe operational problems with the polymer dosage and pre-thickening systems.

Blend tank sizing depends on the expected frequency and magnitude of such changes. Typical sizing requirements are one (1) hour retention time.

As indicated on the flow sheet as a customer option, the blend tank level can be controlled by a feed-forward signal to the Screw Press speed-changing device, usually a VFD. This option can replace the manual actions of an operator who must otherwise adjust the Screw Press speed to meet the increased/decreased throughputs which will result in a change in the blend tank level. In automatic controlled systems, to prevent undesirable swings in Screw Press speed, the signal from the blend tank level-indicating-controller (LIC) should be discrete (step changing) and not analog (continuous).

ANDRITZ generally recommends that the LIC controller be programmed to provide a set speed for a particular set tank level. An example (for a 3600 Screw Press) would be:

Tank Level (%)	Screw Speed (RPM)
High	1.30
Medium	0.95
Low	0.60

Of course, the necessary level element (LE), transmitter (LT) and low (LAL) and high (LAH) alarms should be included.

IV. Polymer System

Successful control and optimization of polymer dosage is the objective of most any sludge dewatering plant manager, but sometimes very difficult to successfully achieve. Difficulty typically arises from not having a properly sized blend tank for the particular dewatering system to adequately buffer the infeed spikes as may typically occur. Successful automated polymer dosage control is inversely related to the variability in sludge characteristics.

Based on ANDRITZ' experience, the best approach for an end user to automate polymer dosage is to, first install a properly sized feed tank, and secondly, to provide the process instrumentation to ratio the polymer flow to the sludge flow. This ratio setting is an operator-input to the flow ratio indicating controller (FRIC) which is predetermined manually. Polymer dilution water should also be flow ratioed (to the polymer flow) to provide the optimum polymer injection concentration for the application. To minimize polymer consumption, ANDRITZ recommends the use of potable fresh water for both polymer make-up and post-dilution. Lack of a fresh water supply will increase the polymer consumption rate and reduce the performance of the dewatering plant.

To aid the operator, a closed loop camera should be utilized to allow viewing the discharge area of the Gravity Table to verify cake formation and that discharge is coming off the pre-thickener.

V. Mixing

Proper mixer type, size, and location are critical, but sometimes overlooked, in minimizing polymer consumption and maximizing dewatering performance. During the design phase of a particular project, ANDRITZ carefully evaluates the application & design parameters to determine optimum mixer settings and placement. However, to account for varying sludge conditions, alternate polymer injection points, usually two (2), should be located upstream of the mixer.

VI. Pre-thickening - Gravity Table

The pre-thickener, or Gravity Table, provides volume reduction and relatively constant feed consistency to the Screw Press. Automatic speed control is generally not required as there is typically no reliable parameter to base the speed upon. Usually the pre-thickener speed is set and maintained constant to handle the maximum sludge flow expected for a particular operating period. The speed, especially for Gravity Tables, should not be set faster than required to maximize belt life.

VII. Screw Press Hopper and Choke Control

To maximize average cake dryness, especially important for any sludge burning projects, the Screw Press hopper should be kept at a constant level at all times. To maintain the set hopper level, a level-indicating-controller (LIC) is to be used to provide an automatic adjustment of the sludge flow via a flow control valve (FV) or a variable speed sludge feed pump (VFD). A change in the hopper level can result from a change in the sludge feed consistency, flow rate, pH swing or several other characteristics, which will cause a change in pre-thickener performance. The level control element is usually a pressure (static head) measuring device which is calibrated in feet or % hopper level.

The Screw Press choke control loop is used to achieve maximum average dryness, maintain this dryness and protect the press and drive components from excessive torque. Depending on the desired dryness, the operator inputs a Screw Press load (choke) set point. This set point is in % FLA (full load amps) of the Screw Press motor. During operation the choke (within a range) will maintain this set point via an I/P transducer,

i.e., as the screw press motor current increases above this operator set point, the choke pressure will decrease so that the current will drop back to the set amperage.

If the sludge feed characteristics changes causing the % FLA to exceed the choke set point, the high torque set point (TAH) fully retracts the choke and sounds an alarm to alert the operator.

If the screw press motor load continues to increase up to the preset TAHH setpoint, the screw press motor (and entire sludge system) alarms & shuts down. This is mandatory to prevent damage to the Screw Press and/or associated drive components. The actual values used for choke setpoint, high alarm, and high high alarm vary depending on sludge type and performance requirements.

WARNING:
The screw press drive control system must be a torque controlled system as defined per ANDRITZ documentation supplied in the engineering review package.

The high & high-high alarm setpoints must never be set above ANDRITZ recommendations otherwise damage to the drive and machinery may result invalidating any vendor guarantees and product warrantees.

NOTE:
ANDRITZ Scope of Supply is solely defined per confirming ANDRITZ Purchase Proposal & resulting purchase order from buyer.

VIII. ITEMS NOT IN THE ANDRITZ SCOPE OF SUPPLY;

Specifically the ANDRITZ scope of supply does NOT include the following items as are necessary for installation & operation to the performance levels specified;

- civil engineering, design & supply of structural steel & concrete as needed for support of the ANDRITZ supplied equipment,
- polymer, flocculation systems, piping, tanks, mixers, controls etc.,
- slurry pumps, piping, valves, nor controls nor indication of flows,
- washwater boost pumps, piping, controls, nor indication of flows,
- air supply compressors, piping, FRLs, air line, piping nor controls,
- structural steel or supports for Gravity Table, or any associated walkways, handrails, stairs, ladders, etc., as will be required to service and operate the Gravity Table,
- MCC, motor starters, VFDs, high voltage bus, field wiring, diagrams, etc.,
- piping, hoses, clamps, fittings, stands, etc. to shower pipes of ANDRITZ machines,
- drain hoses, pipes, clamps, fittings, etc. from ANDRITZ machines,
- instrumentation, flow, level nor pressure measurement devices for slurry, polymer water or air supply lines to the sludge dewatering equipment, or panels,
- SAMA diagrams, instrument lists, specifications nor selection criteria for instruments nor sensors,
- PLC hardware devices, I/O racks, chassis, power supply for same, nor engineering for same,
- Block logic nor loop diagrams, PLC programming, nor engineering for same,
- Valves, piping, fittings, elbows, hangers, straps, clamps, hoses, etc.,
- LIC, FIC, SIC, PID nor any process related type measuring instruments,
- field installation, tools, labor nor materials or tools to do same,
- field wiring, conduit, labor, etc. nor materials or tools to do same,
- maintenance tools, jigs, fixtures, etc. as required to service machine,
- Lubricants, applicators, oilers, filters, etc. nor equip. to service machine,
- hoists, cranes, portable jib cranes, etc. as may be needed for maintenance and access to the service areas of the machine.

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