OPERATION OF THE BELT FILTER PRESSES AT THE ROCKSPRING DEVELOPMENT PREPARATION PLANT

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ABSTRACT

Alpha Natural Resources commissioned eight three-meter filter belt presses in July of 2010 at the Rockspring Development Preparation Plant. Their installation improved water management and extended the life of the tailings impoundment area from 18 months to 4½ years. The integrated control systems are used to control operations and feed flocculants into the presses with on-the-fly adjustments to maintain optimal press operations. Operational data and control systems for waste and flocculent feeds are described.

INTRODUCTION

The Rockspring Development Preparation Plant has a throughput of 1800 tons of coal per hour and, in the process, produces approximately 180 dry tons of fine tailings material each hour as 30% solids slurry. This slurry had previously been pumped to the tailings impoundment area, but in 2008, the impoundment area was reaching capacity. To extend the life of the impoundment area, a dewatering solution was required. After an extensive study of dewatering solutions, filter belt presses were found to provide the most practical and economical solution.[3] Eight presses were installed (six running at once) along with an effective system of slurry feed, water management and chemical feed equipment and controls. As a result, the tailings slurry solids are now 55% to 60% solids and can be mixed with capping material prior to the tailings impoundment.

THE TAILINGS SLURRY AND FLOWSHEET

Figure 1 outlines the flowsheet for the flotation tailings through thickening, pressing and distribution to the impoundment. The tailings slurry from the flotation circuit is approximately 5% to 10% solids. Utilizing a two-component polymer program from Ashland the slurry is thickened to 30% at the thickener. The polymer program includes Zalta™ MF-1530 dry anionic flocculent and Zalta™ MC-529B dry cationic coagulant. The slurry contains fairly high clay content and approximately 80% of the solids are smaller than 40 microns in size, which creates problems when trying to increase solids content.

The clarified water from the thickener is sent to a 30,000 gallon surge tank for redistribution throughout the preparation plant. Clarified water flow is estimated at approximately 396,000 gallons per hour. Before the presses became operational, an additional 72,000 gallons of fresh

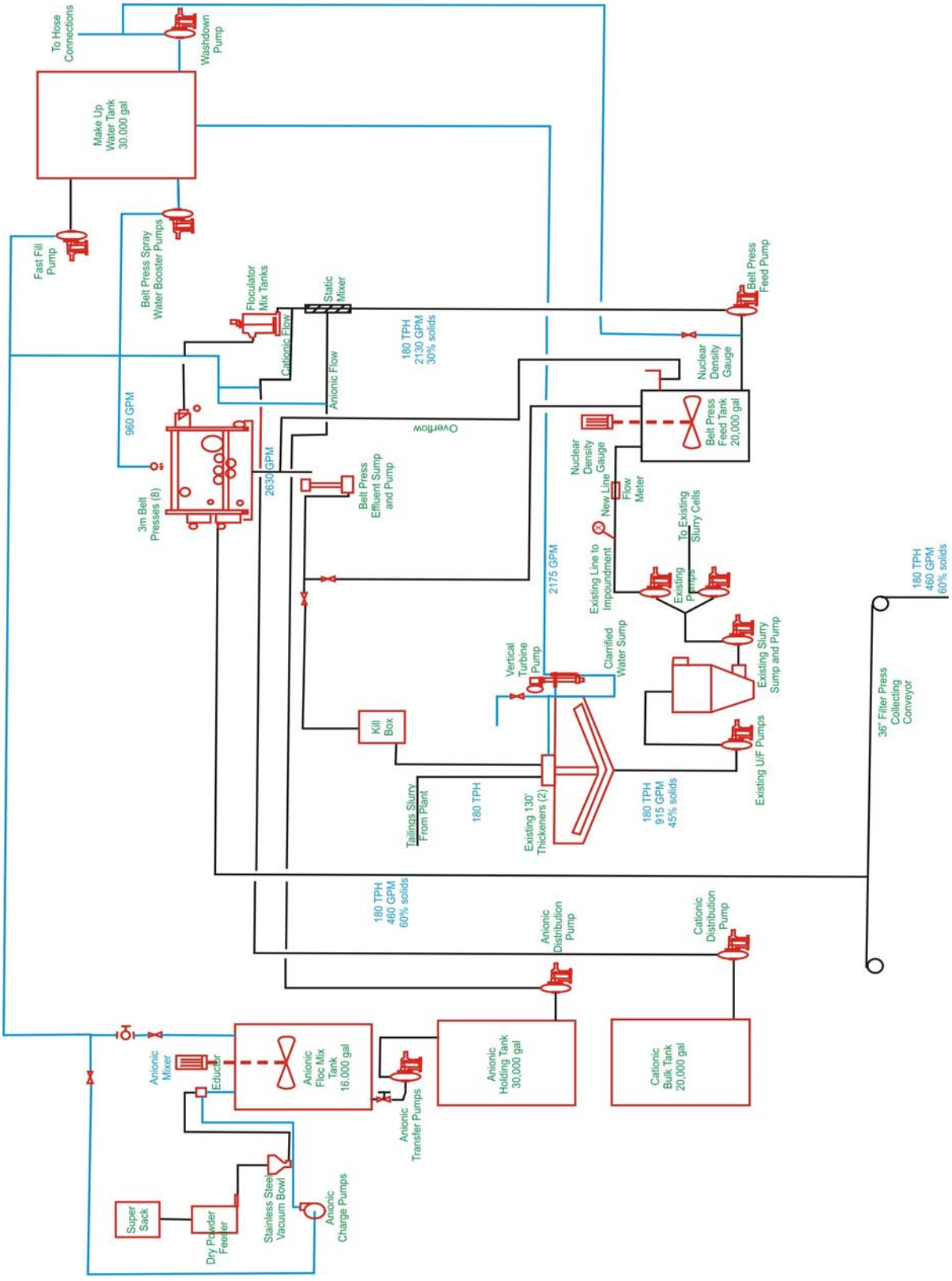

Figure 1: Flowsheet of the Rockspring Development Preparation Plant Dewatering System

water was added to the clarified water to fulfill the water needs of the preparation plant every hour. The resulting underflow from the thickener containing 100,800 gallons of water and 180 dry tons of solids per hour is pumped up a hill for half a mile to the press building.

Again, utilizing the Ashland polymer program of Zalta™ MF-1530 dry anionic flocculent and Zalta™ MC-524 liquid cationic coagulant at the belt presses, the slurry reaches 55-60% solids. This process removes approximately 72,000 gallons per hour of water which is sent back to the thickener and replaces the 72,000 gallons per hour of fresh water that had previously been required. Although the fresh water pumps are still attached to the system, they have not operated since the presses have become fully operations. The recycled water from the 30,000 gallon surge tank is used for chemical mixing of the dry Ashland flocculants, water sprays for the presses and hose connections in the preparation plant.

At the belt presses, the pressed solids drop onto a conveyor belt where they are transported for mixing with capping material for the impoundment.

THE BELT PRESS OPERATIONS

How the Presses Work

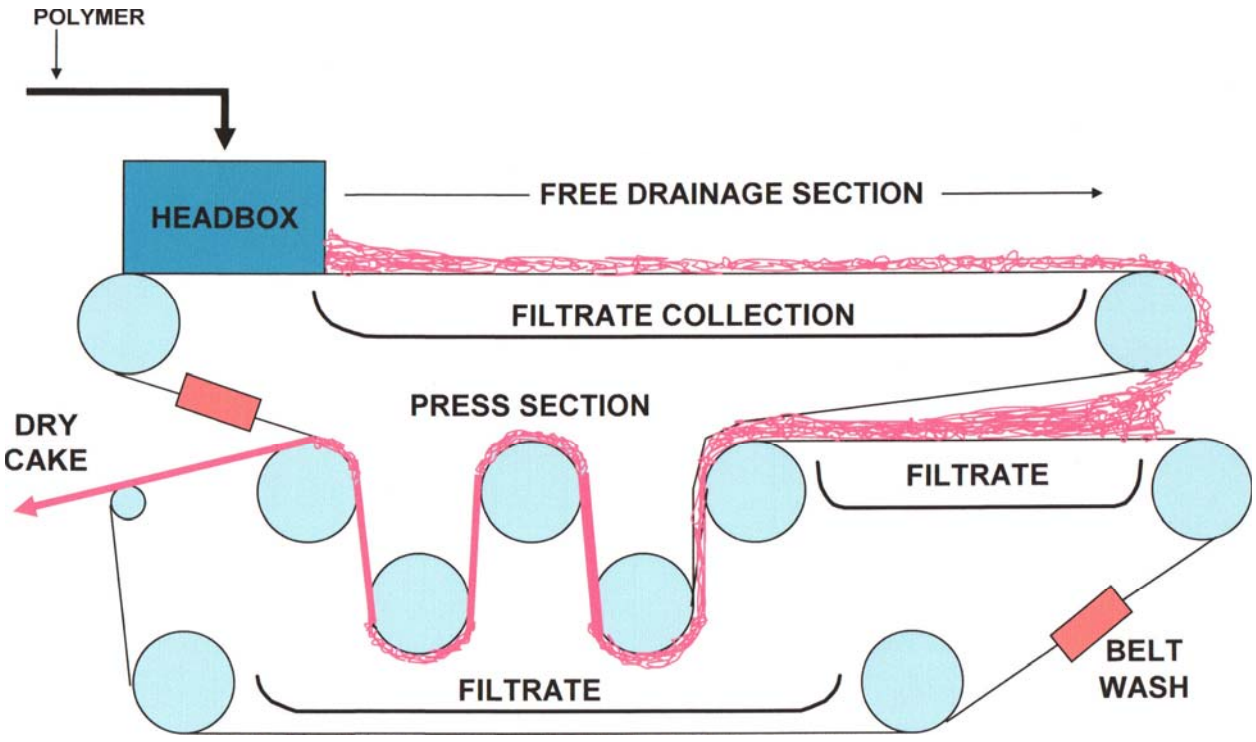

Figure 2: Illustration of Filter Belt Press Operations [2]

As shown in Figure 2, the belt presses operate with two belts that compress solids between them through a series of rollers. Flocculants are applied to the slurry as it enters a head box. The slurry then is spread onto the top moving belt through a rake allowing free water to drain away. The

solids proceed to drop onto the bottom belt as the top belt covers them. Through the roller system, the belts increase the pressure applied to the solids, squeezing water out to drain away from the belt press. The pressures can be adjusted to obtain the optimal percent solids level (for Rockspring tailings, the maximum was found to be 70%, with the target range between 55% and 60%). At the end of the roller system, the belts separate. The top belt goes through a belt wash and returns to the head box to be reloaded with slurry. The bottom belt also goes through a belt wash prior to more solids being deposited onto it.

The belts are made of strong water permeable material. The Rockspring presses are manufactured by Phoenix Process Equipment Company of Louisville Kentucky. They have 117 inch wide belts and are capable of processing 30 dry tons of coal tailings per hour. Six presses run continuously with two additional presses available to maintain production while other presses are down for maintenance.

The Press Plant

The presses are arranged in two rows, four presses per row sitting side by side. Tailings slurry is fed from the outside while the press discharges tailings onto a conveyor belt running between the presses and sent out of the building. Figure 3 is a picture of the alignment of two presses.

Water Management

All water removed from the tailings slurry is collected in a large floor sump under the presses. The water flows out through pipes directly onto a sloped concrete floor angled towards the sump pump. The arrangement allows for 360 degree access to the presses for maintenance. The sump pump handles approximately 72,000 gallons per hour, sending it back to a kill box prior to the thickener from which the tailings underflow feeds the presses. Here, the water is recycled back into the plant system for press rinsing, flocculent preparation and hose fitting in the plant. Figure 4 is a view of the sump area under the presses.

Figure 3: Belt Presses in the Press Building

Figure 4: Water Flow under the Presses

Process Control

All flows are controlled and monitored automatically by a logic control system. Presses can be taken down and brought on-line easily and quickly. Continuous monitoring of flow rates and

densities are recorded in real time by means of a nuclear density flowmeter that makes adjustments to pumps to maintain 30 dry tons an hour of tailings solids on every press.

Process control extends to the flocculent system where automation is used for the mixing of the dry anionic floc (Zalta™ MF-1530) into solution for application to the presses. Apart from raising the supersac above the mixing tank, everything else is automatic. Figure 5 shows the panel screen for the anionic flocculant mixing system. Figure 6 shows the system for adding the dry flocculant to the mixing system.

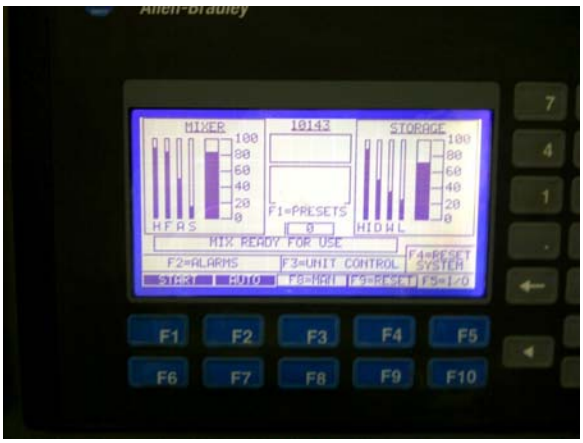

Figure 5: Control Panel - Anionic Flocculant **Figure 6: Supersac Loading System**

The Flocculant and Coagulant

The nature of the Rockspring tailings requires a two stage flocculation process to manage the clays. Supplied by Ashland Water Technologies, the first polymer added is a very high molecular weight, anionic flocculant (Zalta™ MF-1530) which adsorbs onto the surface of the particles thereby making them net negatively charged. This flocculant is the same product used in the thickener before the press plant. The transportation of the tailings slurry ½ mile up the hill causes the polymer chains to break, requiring an additional dose to refloc the tailings. The second polymer is a low-medium molecular weight, cationic coagulant (Zalta™ MC-524) which interacts with both the clay particles and anionic flocculant to cancel the net negative charge. The resultant tailings are now neutral and prone to push water away from the solids.

Certain clay particles have both anionic faces and cationic edges. The primary anionic flocculant not only neutralizes those cationic edges, but it also provides anionic loops of polymer that extend far from the surface of the particles to make the attachment of the secondary polymeric coagulant more efficient. The second cationic polymer interacts with the anionic loops and tails of the first polymer. This process tightens the flocculated tailings and squeezes excess water from between the clay particles. The result is a much faster release of water in the free drainage section of the press and better compressibility of the sludge cake in the press section. This combination of polymers acts to increase the solids throughput of the press while, at the same time, increasing the final cake solids (alternately lowering the cake moisture).

The Flocculant System

The flocculant distribution system was designed and constructed by Ashland Water Technologies. The anionic flocculant requires dissolution in water. Using four dry powder feeders, the flocculant is mixed with water to a 0.25% concentration in a 16,000 gallon mixing tank. This process is fully automated, adding the right amount of water for four supersacs to make a consistent concentration. From the mixing tank, the anionic flocculant is pumped to a 30,000 gallon holding tank for distribution to the static mixer at each belt press.

The cationic coagulant is in the form of a liquid polymer, ready to be added directly just before the floculator tank for each belt press. Stored in a 20,000 gallon tank, it uses the same type of pumping systems as the anionic flocculant.

The distribution system is set up at the source with eight individual pumps for each product. Each pump sends its product to one press, allowing for press by press control as needed during the operation. The pumps are controlled by a box located at the headbox of each press. This control box has a dial for each product that can be used to raise or lower flocculant or coagulant dose as required. Figure 7 shows the designed pump system and Figure 8 the control box up by the headbox.

Figure 7: Eight Pumps for Coagulant

Figure 8: Flocculant Manual Control Box

Total flowrate of the diluted anionic flocculant is about 30 gpm while the cationic coagulant flowrate is about 27 gpm. At present, there is no automated way of determining when floc dose changes are required except visually by an operator. From their position by the headbox, they can look into the headbox to visually see how the solids are flocculating and also out on the top belt for visual inspection. Figure 9 shows the solids on the top belt as they should look when the flocculant and coagulant are added correctly.

Figure 9:Tailings Solids on the Top Belt of the Press

Data Collection

Flocculant and coagulant dosages were also optimized during commissioning. Figure 10 is a graph of the press performance during the first six months of 2011. The pound per ton dosage varied as conditions in the presses and slurry characteristics varied. Cake moistures averaged in the low 40% range (high 50% solids), which is sufficient for the capping operations. Excess capacity is built into the system such that, when needed, press conditions can be modified to lower the target moisture levels.

Dosage of the anionic flocculant and the cationic coagulant are controlled through DC pumps. There is no direct automation on the polymer feed system besides specific gravity for control of slurry gravity with water. The anionic flocculant is injected into water and diluted before entering the 2- inch static mixer. After dilution, the cationic flocculant is injected into the bottom of the flocculator. To allow proper conditioning time between the two flocculant additions, the static mixer is positioned eight to ten feet before the flocculator.

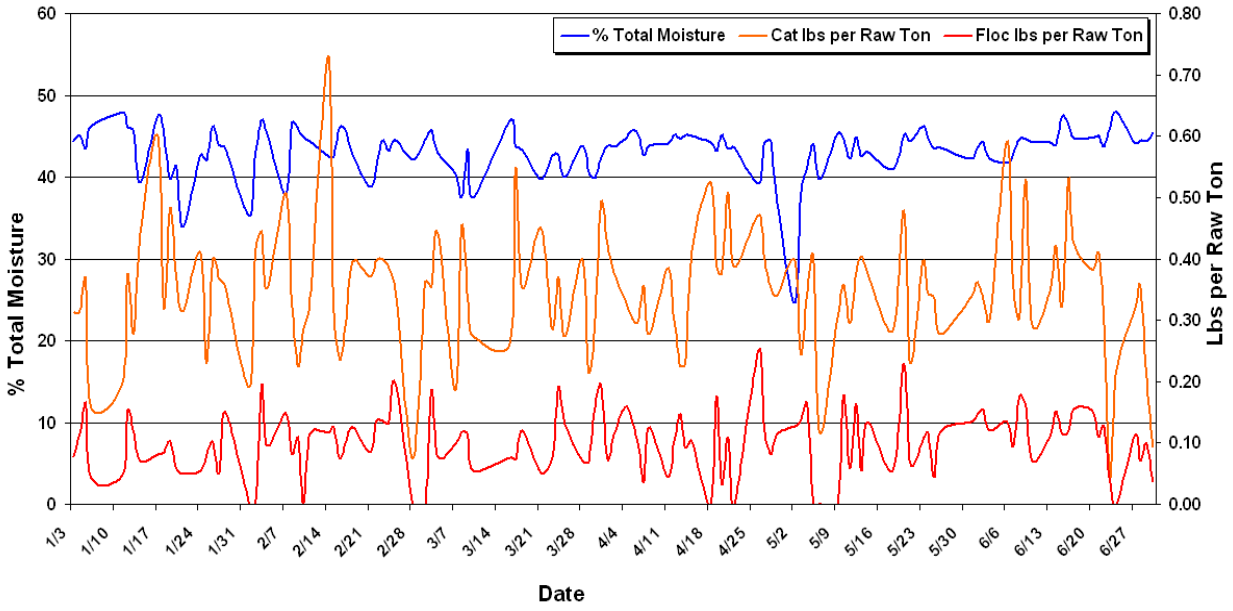

Figure 10:Cake moisture and chemical usage data

PLANT COMMISSIONING

In late July 2010, the new Rockspring dewatering plant underwent commissioning. Slurry flow was slowly turned over to the presses to allow each press to be fully commissioned one at a time.

During the commissioning period, maximum dewatering was determined for the belt presses and produced cakes with percent solids in the 70% range, confirming pilot test investigations. The overall commissioning went smoothly with each of the six presses converting approximately 30 tons of dry solids as 30% solids slurry into 60% solids per hour. The automated systems worked well, keeping start-up time to a minimum.

CONCLUSION

The installation of filter belt presses at Rockspring extended the life of the current impoundment area by approximately four and a half years by making the tailings slurry usable as part of capping material and by reducing the volume per day pumped to the impoundment areas.

With the full commissioning of the filter presses, Rockspring has been operating trouble free with normal maintenance for about a year and a half. The flocculant systems have proven low labor intensive, safe to operate, easy to control and economical by optimizing flocculant dose.

ACKNOWLEDGMENTS

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REFERENCES

1. Tao, D., Parekh, B.K., Honaker, R. 2008. Development and Pilot Scale Demonstration of Deep Cone Paste Thickening Process for Phosphate Clay Disposal. *Final Report to Florida Institute of Phosphate Research*. FIPR Publication No. 02-162-229. Lexington, KY: University of Kentucky.
2. Jellesma, A. 1978. Belt Filter. *US Patent No. 4212745*.
3. Murphy, C., Bennett, C., Olinger, G., Cousins, B., 2012, Alternatives to Coal Mine Tailings Impoundment - Evaluation of Three Dewatering Methods at Rockspring Coal Mine. *Proceedings of the 2012 SME Conference*, Seattle, Washington.