Reduce Pressure Filter Cycle Times and Stop Buying Presses

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Pressure filter cycle times exceeding 8 hours are directly responsible for growing banks of filter presses at many plating firms. These collections of presses lumber their owners with excessive capital, operating and maintenance costs.

A major plating facility attacked this problem using its experienced operators, managers and an outside contractor to address feed, conditioning and press operating characteristics to achieve 3 hour cycle times. This idled 3 presses previously in use continuously. Often 3 of 8 original units dewater the same volumes of sludge previously occupying the original bank of filters.

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Introduction

Kuntz Electroplating Inc. has eight recessed plate pressure filters split between two groups: a group of five are located at the main Water Treatment Plant (WTP) and three are situated at the Hoist Steel (HS) primary clarifier treatment site. This optimization work addressed shortening the cycle times for pressing mixtures of metal hydroxides (primarily Nickel) and spent powdered activated carbon sludge streams.

Initially a series of baseline operating information was gathered on the current operating conditions. This was followed by bench scale conditioning trials and full scale operating experiments with single and multiple presses.

Solids Inventory – Pressure Filter Technique

Two approaches were taken to determine the quantities of sludge that need to be dewatered weekly. The first inventoried sludge solids in the cake dropped from the presses. The second technique estimated the volumes of sludge from the sludge sources feeding the presses.

Pressure Filter Capacity

Standard manufacturer's values for plate cake volume and filtering area were obtained for each of the plate sizes found in the presses in use and chamber capacities for each press were calculated. They are summarized in Table #1. The total calculated volume was found to be 39.1 m^3 (138.1 ft^3).

Table #1: WTP/HS Calculated Press Capacities

WTP PRESS	Capacity m^3 (ft^3)	HS PRESS	Capacity m^3 (ft^3)
F	.52 (18.3)	Small	.44 (15.4)
Small	.23 (8.0)	Large	.69 (24.5)
J	.55 (19.5)	Old	.40 (14.2)
L	.54 (19.1)	Total HS	1.53 (54.1)
M	.54 (19.1)	**WTP+HS**, m^3 (ft^3)	
Total WTP	2.38 (84.)	3.91 (138.1)	

Pressure Filter Cake Weight Measurement

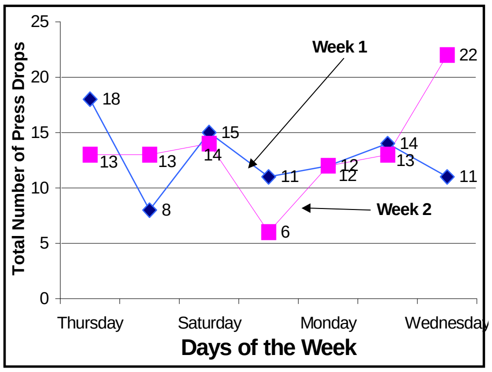
The relative rates that the metal hydroxide and carbon sludges are fed to the presses are random and press cycle times are not fixed. Consequently, the weight of cake from any one press will not remain constant. In order to estimate the amount of solids captured weekly by the presses, over a two-week period:

- Each press load dropped was recorded.
- At the operators' convenience, the net weights of a number of loads were obtained.
- Samples from a number of the weighed loads were taken (a minimum of four samples per press over the study period). The cake was analyzed for Total Solids (%TS), Total Volatile Solids (%TVS) and Specific Gravity (SG).

Working from the above information, the number of presses run per week from each press was totaled along with wet cake weights. The total weight was then estimated for all eight presses. Working with the measured press capacity, weights per unit volume were also calculated. Individual dry solids and volatile solids weights were also calculated where samples had been secured and analyzed.

The following Graph #1 provides a summary of the frequency of total press drops per calendar day over the two weeks of study.

Graph #1: Press Drops per Week: January 14-20, 21-28, 1999



A second method for obtaining the weight of cake dropped, using cake specific gravity and pressure filter volume, was also used. Overall there was very good agreement between these two methods of determining cake weight, with a difference of less than 4%.

Using these two methods of calculation, this pressure filter cake weighing technique provides a weekly dry solids inventory range of 14,775 kg/week (32,506 lb/week) to 15,331 kg/week) (33,729 lb/week).

Another approach was to calculate the dry solids captured across the plant's three wastewater clarifier systems and their carbon pits.

Solids Inventory – Primary Clarifier\Carbon Pit Technique

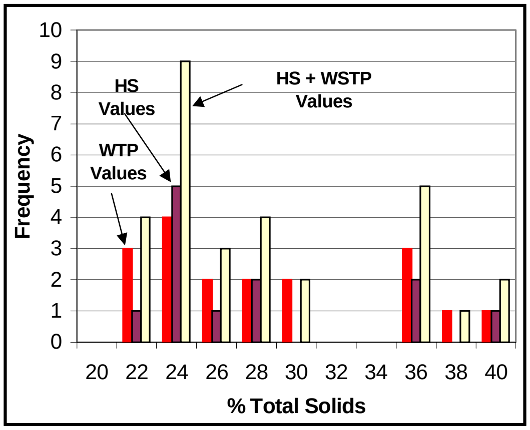
Sludge solids are captured in the WTP, HS and Hoist Aluminum (HA) clarifier systems. Solids for the WTP and HS systems were calculated from their primary underflow volumes and Total Solids (TS) concentrations while the HA solids were calculated from its associated thickening tank volumes and their TS concentrations.

Carbon pit discharge volumes were not measured directly. Operator anecdotal information provided the experienced insight to the frequency that each was currently emptied, weekly. From these frequencies, the volumes per pit (determined earlier), and samples of carbon pit sludge, solids loadings from these three sources were calculated.

In summary, this approach provided an alternative weekly quantity of dry solids of 17,874 kg (39,322 lb) to compare with the solids inventory provided through measuring cake discharged from the filter presses. The average of the three values is 15,992.5 kg (35,184 lb) dry solids per week. Also calculated through determining weekly dry solids loadings were the following process parameters. These provide useful guides in evaluating on-going filter press operation.

- The overall average sludge wet cake weight was 1,157.8 kg/m^3 (72.2 lb/ft^3).
- The overall average sludge wet cake Specific Gravity (SG) was 1.2 .
- Total Solids (%TS) values for wet cake showed two distinct regions of values. The first centers around the 22% to 24% TS range and is the larger grouping while the second is closer to the 34% to 36 %TS range. These values are illustrated in Graph #2.

Graph #2: Press Cake % Total Solids: Frequency Distribution



An overall summary of the results of cake sampling is found in Table #2.

Table #2: WTP & HS Press Cake %TS, %TVS and Specific Gravity Summary Values

WTP and HS Cake Analyses for %Total Solids, Total Volatile Solids and Specific Gravity									
	Total Solids - %			Total Volatile Solids			Specific Gravity		
	WTP	HS	WTP+HS	WTP	HS	WTP+HS	WTP	HS	WTP+HS
Count	18	12	30	18	12	30	18	12	30
Average	28.1	27.4	27.8	27.5	20.7	24.8	1.20	1.20	1.20
Minimum	21	22	21	23	16	16	1.12	1.15	1.12
Q1	23.3	23.0	23.0	26.3	17.8	22.3	1.16	1.18	1.16
Median	26.5	25.0	25.5	27.5	18.5	26.5	1.21	1.19	1.20
Q3	33.8	29.0	33.8	29.0	23.5	28.8	1.24	1.22	1.24
Maximum	39	40	40	32	28	32	1.29	1.25	1.29
Mode	21	23	23	29	18	29	1.16	1.18	1.16

Filter Press Operating Cycle Times

Prior to the January 1999 study, during the 1998 Christmas "break", the filter cloths on all 8 press were removed and replaced with new cloths. These new cloths were all rated at .42 m^3 /minute (15 Standard Cubic Feet per Minute (SCFM)). Further, the press filter plates were removed and acid washed to remove modest solids build-up in their channeling. Consequently, the characteristics of the dewatered cake reflect **baseline operating conditions** for the manner in which Kuntz Electroplating has run their systems.

A key measurement in assessing filter press performance is cycle time (CT). For two periods, February 10 to 14, 1999 and March 2 to 17, 1999, press cycle times were recorded for both the WTP and the HS system presses. The results are summarized by groups of presses as presses are either run alone or, most often, in groups. In Table # 3 , the average hours of pressing time are recorded by operating group for the WTP presses; Table #4 provides this information for the HS presses. The February and March data are combined in these tables.

Table #3: WTP Cycle Times by Press Grouping, February/March 1999

Press Group	F+L	J+L	J+M	F+S+M	J+L+M	F+J+L+M	F+S+J+L+M
Capacity – m^3 (ft^3)	1.06 (37.4)	1.09 (38.6)	1.09 (38.64)	1.29 (45.41)	1.63 (57.72)	2.15 (76.04)	2.38 (84.01)
# of CT	1	4	6	1	14	11	4
Average CT – hrs.	8.25	8.2	6.5	3.6	6.8	7.1	6.8
Overall Average CT Hours			6.9				

Table #4: HS Cycle Times by Press Grouping, February/March 1999

Press Group	S+B	S+B+O
Capacity – m^3 (ft^3)	1.13 (39.91)	1.53 (54.13)
# of CT	14	3
Average CT – hrs.	14.4	11.0
Overall CT – Hrs.		13.8

From each of these tables it is clear that cycle time does not necessarily increase with increasing press capacity. Anecdotal information from the WTP operators indicate that the much longer cycle times found in the HS system are more likely a reflection of two operational characteristics. First of all, the feed sludge is almost always clarifier sludge – nickel sludge – with no carbon added. Nickel alone tends to require a longer cycle than a press feed with carbon added. Secondly, there is often insufficient sludge to feed the HS presses continuously. This leaves periods with the presses closed and the cake inadequately formed and the feed pump idle until sufficient sludge builds up for the pump to restart. Among the cycle times for the WTP presses there are a number under 3 hours in length. Operator site information suggests these are runs that are wholly or predominantly carbon fed sludge with little or no nickel sludge. Press cycle times were also summarized for each press group. Overall, the WTP press cycle time was 6.9 hours; for the HS presses, 13.8 hours.

The two sets of WTP press groupings with the most observations, J/L/M and F/J/L/M, 14 and 11 runs respectively, were reviewed in five number summaries as well. These are found in Table #5. Regardless of the fact that the F/J/L/M grouping has 31.7% more press chamber capacity, the cycle time values for their averages and the five number summaries are remarkably similar to the J/L/M values, excepting the single value for maximum run time. **This further illustrates that increasing chamber capacity does not necessarily require a corresponding increased cycle time.**

Table #5: WTP Cycle Times in Hours for Press Groupings J/L/M, & F/J/L/M

Press Group	J/L/M	F/J/L/M
Capacity – m^3 (ft^3)	1.63 (57.72)	2.15 (76.04)
# of CT	14	11
Average CT – hrs.	6.8	7.1
Minimum	2	2.5
Q1	5	4.2
Median	6.3	6.8
Q3	7.8	7.8
Maximum	13	18.4

The following section summarizes the filter press trials, using polymer, to reduce the cycle times currently found at Kuntz Electroplating Inc. The excellent cake quality found to date at Kuntz was used as a measure of the quality sought while seeking much lowered press cycle times.

Filter Press Cycle Time Optimization Trials

Introduction

Sludge removal from Kuntz Electroplating's primary clarifiers is characterized by frequent withdrawals. In addressing improving the cycle times for the pressure filters, the addition of polymer to primary sludges on a batch basis ahead of dewatering was introduced. Three polymers were "jar tested" prior to dewatering trials. Sludge from the WTP and HA systems are both run across the WTP presses from a common feed tank. Typically, the carbon component is also run as part of a mixture with the metal hydroxide sludges across this series of presses as well. The HS sludge is run across the HS presses.

Jar Testing Polymers on WTP and HS Sludge Samples

Kuntz Electroplating currently uses an anionic polymer[*] ("A") for aiding in settling suspended solids across its primary clarifiers. This product, along with two additional polymers[**] ("B","C")suggested by the firm's polymer supplier, were run on sludge samples taken from the WTP and HS pressure filter feed tanks and from the HA system's thickening tank. The basic approach reflected the following steps:

Settling Rate for an Untreated Sample:

In order to provide a measure of improvement in solids/liquid separation by conditioning the sample with polymer, an initial test with no conditioning was carried out:

- Three to four gallons of feed sludge were collected in a five-gallon pail.
- Well-mixed, 1 liter of sample was transferred to a 1liter graduated beaker.
- When the transfer was complete, the time was noted and served as "t"=0.
- Periodically the solids/supernatant interface level was recorded along with the corresponding time.
- Interval and overall settling rates were calculated as ml of settling/minute of settling.

Typically, settling rates of unconditioned sludge were on the order of 2.0 mL/minute. As an initial measure of successfully conditioning the sludge – achieving good solids/liquid separation without over conditioning – settling rates of 20 to 40 times the untreated rate were sought. Conditioning tests using a six station jar testing unit were undertaken as follows:

- A 0.05% weight/weight (w/w) stock solution of each polymer was prepared fresh for each day's tests.
- Each of six 1 liter beakers was filled with a well-mixed sample of the source sludge, from the five gallon pail.
- Working one beaker at a time, each beaker of sludge was mixed at high speed, conditioned with a measured mount of polymer stock solution, mixed for an additional 30 seconds and then mixing was stopped and the mixing paddle removed from the beaker.
- When the mixing was stopped and the paddle removed, the time was noted and served as "t"=0 for measuring the settling rate.
- Periodically the solids/supernatant interface level was recorded along with the corresponding time. These were typically much faster rates than those found for unconditioned sludge, necessitating more frequent, earlier recordings.
- Sludge characteristics and supernatant quality were also noted.
- Interval and overall settling rates were calculated as ml of settling/minute of settling.

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[*] 1C34, Nalco, Canada, Burlington, Ontario
[**] 8C35,8184, Nalco, Canada

- Conditioned rates were compared to unconditioned values and rates among the three polymers were compared for similar dosage rates in order to best determine the most cost-effective agent.

The results from one of these jar tests is shown below:

1. Sludge sample from the WTP Clarifier. %TS = 4.8%

2. Untreated Settling Rate – 2.0 mL/min

3. Successful Settling Rates/Polymer Dosage Rates (kg dry polymer/Metric Tonne Dry Solids (kg/MTDS) (lb/ton)

   "A", : 90 – 90 mL/min, .79 kg/MTDS (1.58 lb/ton)– Test #1
   "B", 220 - 120 mL/min, .31 kg/MTDS (.62 lb/ton)– Test #2
   "C", : 100 - 100 mL/min, .96 kg/MTDS (1.92 lb/ton) – Test #3

The range of dosage rates – often under 1kg/MTDS (under 2 lb polymer per ton dry solids)- was typical of these tests, while providing very good liquid/solids separation.

"F" Press, Pressure Filter Trials on WTP Sludge

The "F" press in the WTP press grouping was selected for cycle time (CT) reduction trials using polymer conditioning. A pressure gauge was installed on the sludge feed line just ahead of the press.

The objective of the trials was to obtain an acceptably high total solids filter cake in a shortened cycle time.

High quality sludge cake with %TS values ranging from 24% to 28% was obtained regularly through the "historical" dewatering approach used by Kuntz Electroplating Inc. Two key parameters were addressed in seeking a similar result but with a shorter cycle time: 1. Conditioning the feed sludge and 2. Dewatering at a higher feed sludge pressure.

Testing Procedure

Key to undertaking this testing work was strong support from Kuntz Electroplating managers for their operators to be directly involved in the process. For each test, an operator worked with the selected contractor across all of the steps identified below. For example, the operator selected the dosage rate to be used on the full-scale test based on his work from the jar-testing phase.

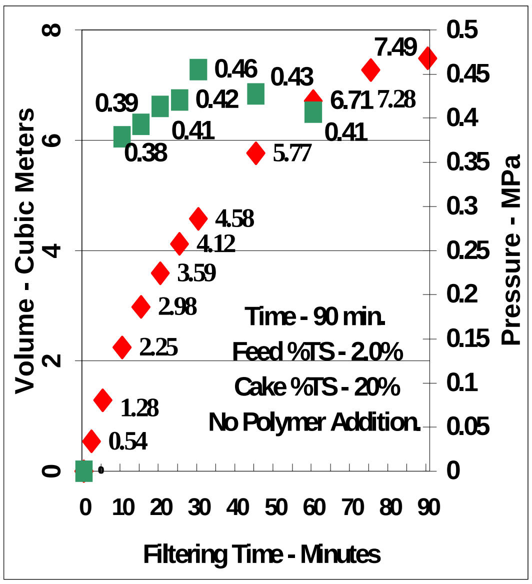
The testing procedure followed these steps:

- Typical WTP sludge was pumped into the WTP cleaner-neutralization pit; its volume was determined and the contents sampled.
- The sludge sample was subjected to jar testing using .5% v/v of polymer "A" to determine a dosage (ml of .5% "A" v/v per liter of sludge) for treating the pit contents.
- An appropriate amount of .5% v/v polymer "A" was made up to treat the pit contents and allowed to age a minimum of 20 to 60 minutes prior to use.
- The polymer "A" solution was added rapidly to the pit and mixed for 2 minutes.
- The conditioned sludge was pumped from the feed pit to the "F" press.
- Pumping time was recorded from the beginning to the end of the press cycle.
- Filtrate discharge rates were recorded at regular intervals by filling a barrel of known volume over a measured time.
- At 15 minute intervals, the pit mixer was turned on for exactly 30 seconds.
- The run was judged finished when the filtrate rate had dropped significantly.
- The press was opened and the cake dropped.
- Feed, filtrate and cake samples were taken and analyzed for total solids. Filtrate samples were taken at t = 30 minutes and were inevitably clear and free of obvious suspended solids.

An initial test provided a "baseline" run across the "F" press, with no polymer addition and with shop air pressure available at approximately .55 MPa (80 lb/in.^{2}).

Graph #3, **Flow Volume versus Cycle Time** illustrates this baseline example. Anticipating that cycle times would be reduced significantly with conditioning and/or increased feed pressure, the baseline press was run for 90 minutes only (as opposed to 7 hours) in order to provide a more direct comparison of operating values and cake results.

Graph #3: Flow Volume/Feed Pressure versus Cycle Time, Trial Press



Pressure Tests #'s 5, 6, 7, 11C, 12B: WTP Nickel/Carbon Feed Sludge, Shop Pressure (Low, 80 psi), Conditioned.

Five trials, 5, 6, 7, 11C and 12B, were performed on conditioned WTP nickel/carbon feed sludges, using shop air. These were operationally identical to Test #4, excepting the addition of polymer "A" as a conditioning agent and a unique sludge feed was used for each run. The results are summarized in Table #6.

From Table #6, runs #4 and #5 provide the closest comparison for feed solids concentrations. The Total Filterable Solids (TFS) were calculated as the difference between their Total Solids (TS) values and their filtrate's TS values. Subsequent runs typically had higher feed TFS; their polymer conditioning rates did not necessarily increase with increasing feed solids levels. Regardless, these typical feed sludges were consistently providing good quality cake in cycle times as low as 45 minutes and no longer than 90 minutes. (Gallon equivalents are in US gallons.)

Table #6 Sludge Feed Characteristics Press Trials, 4, 5, 6, 7, 11C, 12B

Trial #	Feed %TS	Filtrate %TS	TFS %	Volume m^3 (gal)	Run Time Minutes	Final Pressure MPa (lb/in.^{2})	Cake %TS	Polymer kg/MTDS (lb/ton)
4	2	0.7	1.3	7.49 (1978.6)	90	.41 (59)	20	0 (0)
5	2.2	0.66	1.54	6.74 (1782.0)	90	.47 (68)	25	0.54 (1.08)
7	3.9	1.6	2.3	6.17 (1630.2)	75	.43 (62)	29	0.48 (0.96)
6	4.1	1.4	2.7	6.31 (1667.8)	75	.43 (63)	29	0.81 (1.62)
12B	3.64	0.69	2.95	4.62 (1221.5)	45	.46 (66)	32.7	0.47 (0.94)
11C	5.75	2.13	3.62	5.02 (1325.3)	60	.43 (63)	34.5	0.56 (1.12)

Table #7 summarizes the volume of sludge pressed at 45 minutes into the press cycle by run along with filterable and feed total solids values. Significantly, although press run #4 has processed the largest cumulative volume by 45 minutes, each of the remaining runs have pressed on the same order of flow. This is in spite of the fact that the latter runs' filterable total solids values are 18.5%, 76.9%, 107.7%, 126.9% and 178.5% higher than found in press #4 for runs 5,7,6,12B and 11C respectively. The polymer facilitates liquid solids separation, enabling comparable flow rates for increasingly concentrated feed sludge concentrations.

Tables #6 and #7 provide a good indication that a typical WTP clarifier sludge mixture of nickel/carbon sludges can be dewatered to pressed cake with acceptably high Total Solids concentrations using a minimal amount of polymer addition in significantly shortened cycle times of 45 to 90 minutes.

Now consider other comparisons from among the remaining trials runs.

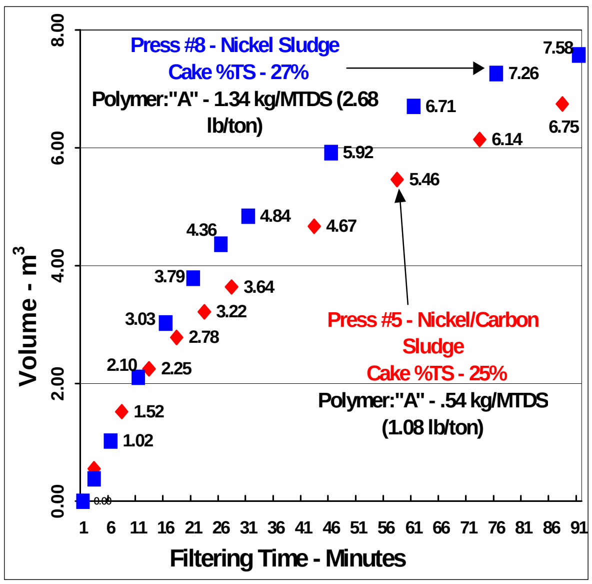
Table #7 Sludge Feed Volume for T=45 Minutes, Press Trials, 4, 5, 6, 7, 11C, 12B

Trial #	Feed %TS	Filtrate %TS	TFS %	Volume m^3 (gal)	Run Time Minutes
4	2	0.7	1.3	5.77 (1523.8)	45
5	2.2	0.66	1.54	4.67 (1233.4)	45
7	3.9	1.6	2.3	5.26 (1389.2)	45
6	4.1	1.4	2.7	5.56 (1469.4)	45
12B	3.64	0.69	2.95	4.62 (1221.5)	45
11C	5.75	2.13	3.62	4.62 (1221.7)	45

Polymer Across Dissimilar Sludges: Trials #5 and 8

Trial press #5 ran with a typical WTP nickel/carbon sludge feed mixture. Press #8 had a straight nickel sludge feed, without carbon added. With similar feed total solids values they also shared similar filterable total solids values (1.54% and 1.4%, respectively). Both were conditioned with polymer 1C34, .54 and 1.34 kg/MTDS (1.08 and 2.68 lbs./ton respectively) for trials 5 and 8 respectively. 90 minute cycle times produced cake total solids of 25% for run #5 and 27% for run #8. Similar results across dissimilar sludges may be at least partly the consequence of the conditioning agent rendering the two feeds similar in nature by being more amenable to separating their solids from their liquid phase. These runs are illustrated in Graph #4.

Graph #4: Polymer Across Dissimilar Sludges: Trials #5 & 8.



High Pressure/Low Pressure Trials: Single Conditioned Sludge Feed: Trials #11A and 11C, 12A and 12B.

Typically, shop air pressure to the air double-diaphragm pump which feeds the filter presses is available at approximately 5.7 kgr./cm^2 (80 psi). After losses through the delivery piping to the presses occurs, pressure at the feed end of the presses ranges from 4.2 kgr./cm^2 (59 psi) to 4.8 kgr./cm^2 (68 psi.). Kuntz Electroplating installed temporarily a compressor in the WTP to provide a feed of 7.1 kgr./cm^2 (100 psi) to the pumps, translating to approximately 6.0 kgr./cm^2 (85 psi) at the feed end of the presses. Presses of this type are typically designed for a minimum feed pressure of 7.1 kgr./cm^2 (100 psi) at the feed end of the press.
Two series of tests, 11 A and C and 12 A and B were undertaken to look for differences between a low pressure feed and a higher pressure feed. These tests were conducted along the same principles listed above for a typical run. However, the first run in each series (11A and 12A) was run at the higher pressure and the second runs (11C and 12B) were run at the usual shop pressure. The same conditioned feed sludge was used for both 11A and 11C. Similarly, 12A and 12B shared the same conditioned feed sludge (though, independently from 11A and 11C).

Table #8 summarizes the basic operating characteristics of each of these runs, including press trial #10, run alone at high pressure. All were run on “typical” nickel/carbon feed sludge from the WTP and conditioned with Polymer “A”.

Table #8 Sludge Feed Characteristics Press Trials, 10, 11A&C, 12A&B

Trial #	TFS %	Volume m3 (gal)	Run Time Minutes	Final Pressure. MPa (lb/in.^{2})	Cake %TS	Polymer kg/MTDS (lb/ton)
10	2	7.19 (1900.5)	75	.62 (90)	27.3	0.88 (1.76)
11A	3.57	6.13 (1619.2)	60	.60 (87)	34.5	0.56 (1.12)
11C	3.62	5.02 (1325.3)	60	.43 (63)	34.5	0.56 (1.12)
12A	2.9	5.49 (1449.3)	45	.58 (84)	33.6	0.47 (.94)
12B	2.95	4.62 (1221.5)	45	.46 (66)	32.7	0.47 (.94)

Feed sludge for both the 11 and 12 series of runs was characterized by relatively high filterable total solids, aiding in the production of high cake total solids values. Regardless, these presses provided the best cake %TS results of any run for this work and in the shortest cycle times of 60 and 45 minutes.

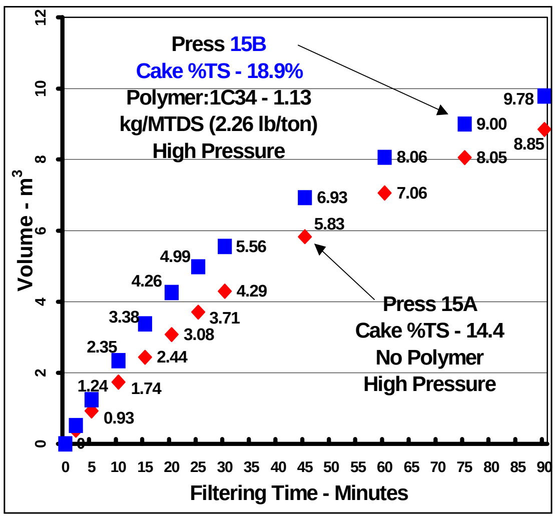
High Pressure Trials: Single Sludge Feed, Conditioned/Unconditioned:Trials 15A/B

In Table #5, conditioned versus unconditioned feeds of similar sludges at shop pressures were compared. Trials 15A and 15B were performed on the same sludge feed, at high pressure, with 15A unconditioned and 15B conditioned with polymer “A’. Table #9 and Graph #5 summarize these trials’ operating characteristics. The common feed sludge for 15A and 15B was very thin with a filterable total solids value of approximately .64 %TS, making high quality sludge cake production problematic at best, for short cycle times. Regardless, with only 90 minute cycle times, the differences between the two runs were remarkable. 15B, the conditioned run, provided a cake total solids value of 18.9% compared to the unconditioned 15A cake total solids value of 14.4%. Graph #5 demonstrates how the initial 30 minutes of a run benefit from higher throughput and solids removal with the conditioning than without.

Table #9 Sludge Feed Characteristics Press Trials, 15A&B

Trial #	TFS %	Volume	Run Time	Final Pressure	Cake	Polymer
		m^3 (gal)	Minutes	MPa (lb/in.^{2})	%TS	kg/MTDS (lb/ton)
15A	0.64	8.85 (2338.1)	90	.50 (73)	14.4	0
15B	0.63	9.78 (2584.5)	90	.52 (76)	18.9	1.13 (2.26)
% Increase		10.5				

Graph #5: Conditioned/Unconditioned Feed Sludge (High Pressure), Flow Volume vs. Time: Trials 15A & 15B



"Multiple Presses", Pressure Filter Trials on WTP Sludge

Recall, from Table #3, that average cycle times for "2-press" runs ranged from 8.25 hours to 6.5 hours over a total of 11 runs, where "F & L", "J & L" and "J & M" presses were run together, with no conditioning and at current shop (low) pressures.

Utilizing the conditioning experience for single press runs addressed above, 2, "2-press" press runs were initiated. In each case, the "F" press was one of the presses used and it was monitored directly. The second press was selected based on availability according to on-site operators. Each run used typical nickel/carbon feed sludge and high pressure for their respective runs.

The basic approach to single press runs was followed for multiple press runs, with the following changes:

- The sludge level in the cleaner-neutralization feed pit was measured prior to and after the run and used to calculate a total volume pressed between the two presses. The difference between the volume calculated for the "F" press and this total volume was estimated to be the volume run across the second press.
- Filtrate was sampled from only the "F" press; its characteristics were viewed as representative for the full filtrate stream.
- Sludge cake was sampled from both presses and analyzed separately.
- High pressure feed was used for both sets of "2-press" runs.

"2-Press" Run 12C: Presses "F" and "L"

Press runs 12A and 12B were run as single press runs with the "F" press at high and low feed pressures respectively. The conditioned feed source was then used for "topping up" additional presses prior to being made available for running 12C. In doing so, it was felt the feed sludge solids concentration was altered (reduced) necessitating the feed sludge be sampled again. It was, at the end of 12C.

Run 12C provided 1.06 M^3 (37.4 ft^3) of press capacity between "F" at .52 M^3

(18.32 ft^3) and "L" at .54 M^3 (19.08 ft^3). This is a 104.1% increase in capacity over the "F" press runs.

Table #10 summarizes the three runs 12A, 12B and 12C. Each run was only 45 minutes.

Table #10: Single Press Runs 12A & 12B, "F" Press versus Multiple Press Run 12C, "F" and "L" Presses.

Trial #	TFS %	Volume "F"	Run Time	Final Pressure "F"	Cake, %TS		Polymer
		m^3 (gal)	Minutes	MPa (lb/in.^{2})	"F"	"L"	kg/MTDS (lb/ton)
12A	2.9	5.49 (1449.3)	45	.58 (84) High Pressure	33.6	NA	0.47 (.94)
12B	2.95	4.62 (1221.5)	45	.46 (66) Low Pressure	32.7	NA	0.47 (.94)
12C	1.74	6.74 (1781.1)	45	.47 (68) High Pressure	27.3	31.3	0.47 (.94)

12C provided comparable cake to 12A and 12B in the same dewatering cycle time of 45 minutes, while filling 104.1% more press capacity than for either 12A or 12B. This is also a significant reduction in dewatering time compared to the historical 8.25 to 6.5 hours noted above for "2-press" runs. Further, the cake solids produced were close to or better than the average WTP historical cake total solids value of 28.1% noted earlier. Also note that the feed pressure at 45 minutes for the 12C run was 4.83 kgr./cm^2 (68 psi), very close to the low pressure run 12B's final pressure, even though 12C was run at the higher pressure. A slightly longer running time for 12C would most likely have generated a higher final feed pressure and drier cake.

Run #14 provided 1.06 M^3 (37.4 ft^3) of press capacity between "F" at .52 M^3 (18.3 ft^3) and "M" at .54 M^3 (19.1 ft^3). This is a 104.4% increase in capacity over the "F" press runs. The results of this press are summarized in Table #11. The results for run #10, a single "F" press run, are also included in Table #11. Both runs #10 and #14 have similar carbon/nickel feed sludge characteristics and both were run with the higher pressure option. It is useful to view the "F" press performance characteristics under the two operating conditions – one, #10, by itself and the second, #14, in conjunction with another press, to compare their performances.

Table #11: Multiple Press Run 14, "F" and "M" Presses, Single Press Run 10

Trial #	TFS%	Volume	Run Time	Final Pressure	Cake, %TS		Polymer
		m^3 (gal)	Minutes	MPa (lb/in.^{2})	"F"	"M"	kg/MTDS (lb/ton)
14	2.26	7.45 (1969.4)	75	.54 (78)	32.6	31.8	0.47 (.94)
10	2	7.19 (1900.5)	75	.62 (90)	27.3	NA	0.88 (1.76)

Once again, a multiple press run has provided cake %TS values better than the noted historical values and has done so in 1.25 hours, significantly less than the 6.5 to 8.25 values recorded earlier for typical 2-press runs at the WTP. All indications from these first two sets of multiple press runs is that high quality cake solids can be achieved over significantly lower cycle times. Indeed cycle times may be able to be reduced by anywhere from 80% to 90%.

Summary of Press Trials Using Polymer Conditioned Feed Sludge

Single Press "F" Press Trials

- A press trial using typical unconditioned feed was run for a 90 minute cycle, producing a 20% TS cake. A similar feed, but conditioned with Polymer "A' at .54 kg/MTDS (1.08 lbs./ton), produced a 25% TS cake in a 90 minute cycle.
- A group of five trials, using a variety of nickel/carbon sludge feeds, and low (shop) feed pressure, showed the following:
    - Cake total solids values where conditioned feed was used ranged from 25% to 34.5% for cycle times ranging from 45 minutes to 90 minutes.
    - Two distinctly different sludges – one straight nickel and one a mixture of carbon and nickel, with similar feed concentrations – tend to press with similar results when each is treated with polymer. Trial #5, with a nickel/carbon mix produced a 25% cake while trial #8, with a straight nickel sludge feed, produced a 27% TS cake.
- A common sludge feed source was dewatered unconditioned for one trial and then conditioned for an immediate second, subsequent trial, providing the following results:
    - The unconditioned trial provide a cake %TS value of 14.4%, over 90 minutes.
    - The conditioned feed processed 10.5% more sludge and produced an 18.9% total solids cake, also over 90 minutes.
    - (Note. These two trials were run on a very thin feed sludge of .64% TFS)

- Cycle times for "2-press" runs can be reduced by 80% to 90% from historical levels, using conditioned feed on a batch operation.
- The performance of the "F' press over a run for volume processed when operated on its own is very similar to its performance when it is operated with another press.
- Cake quality total solids values from multiple press operations approached or surpassed historical cake quality total solids values.
- Polymer addition rates used in the multiple press runs were in the same low range used for the single press runs.

Traditional cycle times of 8 hours and more can be reduced successfully to less than a third of their historic values – to 1 to 3 hours – through the judicious use of polymer conditioning and adequate feed pressure rates. In accomplishing this, pressure filters are used more efficiently, freeing up press capacity to meet increasing demands from production, without the addition of new presses.