Improving Evaporator Reliability for Produced Water Re-Use in Northern Alberta SAGD Facilities

In Situ Oil Sands Water Treatment & Re-Use Optimization 2014 Congress

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Personal Introduction – Larry Ginther

• Began Operating in 1984
• Started working in Water Treatment 1988
• First introduced to Evaporators in 2007
• Joined Cavalier Energy in January 2013
• An Operator by trade
• Today’s presentation will be from an OPERATIONS perspective.
• I will use my personal experience as a case study for today’s presentation.
Part of the commissioning team was comprised of ex- Deer Creek operators who had experience operating High pH Evaporators.


Them and the few Pulp Operators I had were my main source of training.

I thought that this was going to be easy! And it was for the first year.

What I didn’t realize was that the Deer Creek Project hadn’t run long enough, or hard enough to really test these units.
So what went wrong?

- We incurred two major scaling episodes.
- First we had two major shutdowns, one in each Evaporator, in January 2009.
- Then numerous events between October 2009 and January 2010
- As quickly as we could clean one unit the next one would crash.
- Scale would build up on the sump walls and then “avalanche” into the recycle pump suction.
- Recycle pump would fill the flood box with scale and flow would STOP.
What’s the worst that could happen?

Recycle Pump Suction

“Avalanche of Scale”

Single hole distribution caps

Note scale inside the tubes!
What’s the worst that could happen?

Flood Box after a major “Scale Avalanche”
• This was costing the company a lot of money in downtime and maintenance.
  • ~6500 hours of Evaporator downtime in one year!!
• Created a task force led by our Steam Chief to solve this problem.
• Enlisted the help of “everyone”.
• Scale analysis showed that the bulk of the scale was calcium silicate.
  • Since the largest part of the design of High pH Evaporators is to keep the silica in suspension the initial assumption was that silica was the problem. That was our early focus.
• Chemtreat recommended doing a transport study to determine what was going in and what was coming out.
Solving the Problem

- We performed the initial Transport Study testing daily for 10 days.
- We used chlorides as the base line to indicate the “cycles” (concentration factor) in the Evaporators.
- While running our Evaporators at 7% concentration the chloride concentration of the effluent was ~25 times higher than the feed. (25 cycles)
- The Calcium concentration indicated a concentration factor <10 times and in some instances barely 3 cycles.
- The Calcium entering the Evaporator was staying in the Evaporator and not being transported out.
- So hardness, particularly Calcium, was our problem!
Why did this suddenly start happening?

Looking at the timeline of the major scaling events:

The first event coincided with the ramp up of the wells after the slow down in late 2008. The wells “loaded up” with calcium while they were slowed down.

The second event coincided with ESP installations. The Workover Engineers had used Calcium Chloride as well kill fluid.

Normal calcium in our PW was ~2 ppm. Digging back through data we found that the calcium had spiked to over 1000ppm.

Chemtreat recommended a program to chelate the calcium hardness using EDTA.

A chemical trial was set up to follow the pending Turnaround, when the Evaporators would be starting clean.
The Transport Study was continued throughout the 60 day test to prove the effectiveness of the chemical.

We began by injecting the EDTA into the Evaporator feed at 150% of the calculated stoichiometric volume.

- Consistently saw 100% transport of the Calcium

Then reduced the rate to 125% of the calculated stoichiometric requirement.

- Transport remained at (or very near) 100%.

Finally, tried injection at the stoichiometric requirement.

- Transport dropped slightly to ~ 90%.

The program was a success - mostly
• It should be noted that although the use of EDTA is very effective at chelating Calcium it is not very effective on Magnesium.
• Calcium is soluble where Magnesium is insoluble.
• When we injected EDTA at 150% of the stoichiometric volume we saw ~40% transport of the Magnesium.
• At 125% the transport got better and climbed to ~60%.
• At 100% the magnesium transport dropped down to ~20%.
• In this instance Magnesium was not a huge component of the Produced Water so we did not spend too much additional energy trying to figure that out.
Another problem

- There was still an issue with oil getting into the Evaporator.
- Excursions in the process increase the oil residual in the feed.
- Higher than expected water return rates exceeded the design flow of one Oil Removal Filter (ORF). *The design was 2 X 100% units in parallel*
- Until changes could be made to operate both ORF’s simultaneously the bypass around these vessels was cracked.
- This contributed to the fouling issues seen in the Evaporators.
Another Problem

Sump after a major oil excursion
Another problem

- The manufacturer’s recommended feedwater specification is 1 ppm of Oil In Water (OIW).
- Once again Chemtreat was able to help. Their R&D department developed an excellent oil dispersant formulated for use in Produced Water Evaporators.
- Injection rates for this dispersant are very low making this a cost effective method of handling this problem.
- We also stopped bypassing the ORF’s and focused on tuning up the De-Oiling System.
- This was very effective and we had no further issues with oil accumulating in the Evaporators.
• It isn’t bitumen getting into the Evaporator it is Dilbit, a mixture of bitumen and diluent.
• The Evaporator happily flashes light ends out of the Dilbit which then carries over with the distillate.
• Watch out for light ends in your Boiler Feedwater Tank. If these get into your boiler there is a high potential for damage!
• Make a mental note to “dip” sample the top of your BFW Tank after an oil excursion into your evaporator.
• The oil will appear to be clean machine oil.
• Adding a skim box to your BFW tank could be cheap insurance.
We continued to perform full water analysis weekly to watch the Transport of hardness through the Evaporators and monitor the inlet calcium concentration.

We focused on getting the feedwater into the Evaporators as clean as possible.

- Working with our Baker Chemical reps and the Operating Team we achieved <5 ppm OIW 98% of the time.
- <3 ppm OIW over 85% of the time
- This led to over two years of Evaporator operation without an unplanned shutdown!!!
- To some people this is where the story would end.
  - Sorry! You can never look away! Things change too fast.
- Here are some recommendations…
Internal Inspections

• Make it a practice to perform internal inspections whenever possible.
• Obviously this needs to be timed with facility water levels and requirements.
• This can be somewhat tricky since the Evaporators are very hot and there is always the risk of steam burns if proper procedures are not followed.
• If you think you’re have a problem don’t wash away the evidence!!!
  • Take the time and care to open the evaporator without a cooling cycle.
Internal Inspections
We continued to take samples weekly and tracking the transport results of the contaminant transport.

We monitored the Evaporators closely, continuously.
  • Engineers look at U-Value
  • Operators look at Condenser pressure

Of course distillate production is also a good leading indicator.

When production starts to deteriorate perform a chemical wash.
  • Done properly this can be done in under 12 hours.
  • This can be very effective at removing oil and Calcium Silicate.
• What about the Magnesium?
• Try “shedding”
  • After a chemical wash, open the vessel to let it cool and dry for a while (4-8 hours)
  • Witness the snowing in the vessel
  • Refill with distillate and start up.
• Test the sump after an hour of circulation.
  • Note the presence of Magnesium now in your sump.
  • Blowdown at maximum rate for at least 24 hours.
Who Makes the Evaporators Reliable?
Who is the cornerstone of the Facility?

EVAPORATOR RELIABILITY

- OPERATIONS SUPERINTENDENT
- WATER CHEMICAL SERVICE COMPANY
- PRODUCTION ENGINEER
- OIL TREATING CHEMICAL SERVICE COMPANY
- OPERATORS
- PROCESS ENGINEER
• Operators have their fingers on the “pulse” of the facility. Give them an opportunity to use their knowledge or to learn.
• Supervisors need to review the key points of the operation with their operators daily.
  • The more focus the supervisor puts on an issue the more focus everyone puts on it.
• You need to make a point of focusing on water quality every day.
• If your water plant goes off spec and you can’t make steam you won’t be making any oil.
We’ve shown that changes at the well head / formation can cause issues in the Evaporator.
We’ve shown that trouble in the De-Oiling train can cause Evaporator issues.
Every unit operator needs to know what is going on in the other units.

- IF Process has an upset the De-Oiling Plant needs to know so they can compensate.
- IF the De-Oiling Plant has an upset the Evaporator Operators need to know!!

Communication between the plant and the field is vital. Starting or shutting down wells can:

- Change flow rates
- Change inlet BS&W
- Even change the make-up of the Produced Water
• Operators should be given the responsibility to make changes to stay ahead of what is coming, and be held accountable for those changes.
• To be most effective have the unit operators report the key numbers for their unit to you.
• They will soon key into the things the supervisor is interested in and they will make those things their own priority.
Communicate

- 1440 m³ Bitumen
- 4700 m³ Water
- 4450 tonnes/day
- 7% Sump
- 12.8 kPa Condenser Pressure
- 3 ppm OIW
- 5 ppm OIW
- 12 ppm OIW
- 9.8% BS&W
- 25 ppm OIW
- 0.4% BS&W
• New projects should build on the lessons of others
• The sooner you find an experienced operator to work with the design team the better.
• Be realistic in your SOR estimation
• Design your De-Oiling system to handle greater than expected flow.
• Never under estimate the importance of having a complete De-Oiling system. Cutting equipment from your De-Oiling system is not the answer to saving project cost.
• Know what is in your formation! Know what will be in the water you are going to have to treat. Design your plant to treat the worst case.
• Additions in CAPEX will quickly be paid back on OPEX.
  • CONSIDER LIFE CYCLE COST!
• The learning curve for PW Evaporator has been steep but we (manufacturers, process engineers, chemical reps, operators) are getting it figured out.

• Evaporators are great machines that can be operated to a very high degree of reliability if you view each unit in your facility as cogs in machine.

• All we need to do is:
  • Be diligent,
  • Be focused,

• COMMUNICATE!
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