IT'S PROBABLY NOT THE PUMP'S FAULT:

General Best Practices in Sump & Pump Applications

&

SETTLE DOWN!:

General Design Considerations for Settling Ponds and Tailings Management

Presented by
Craig N. Rautiola, Director of Washing

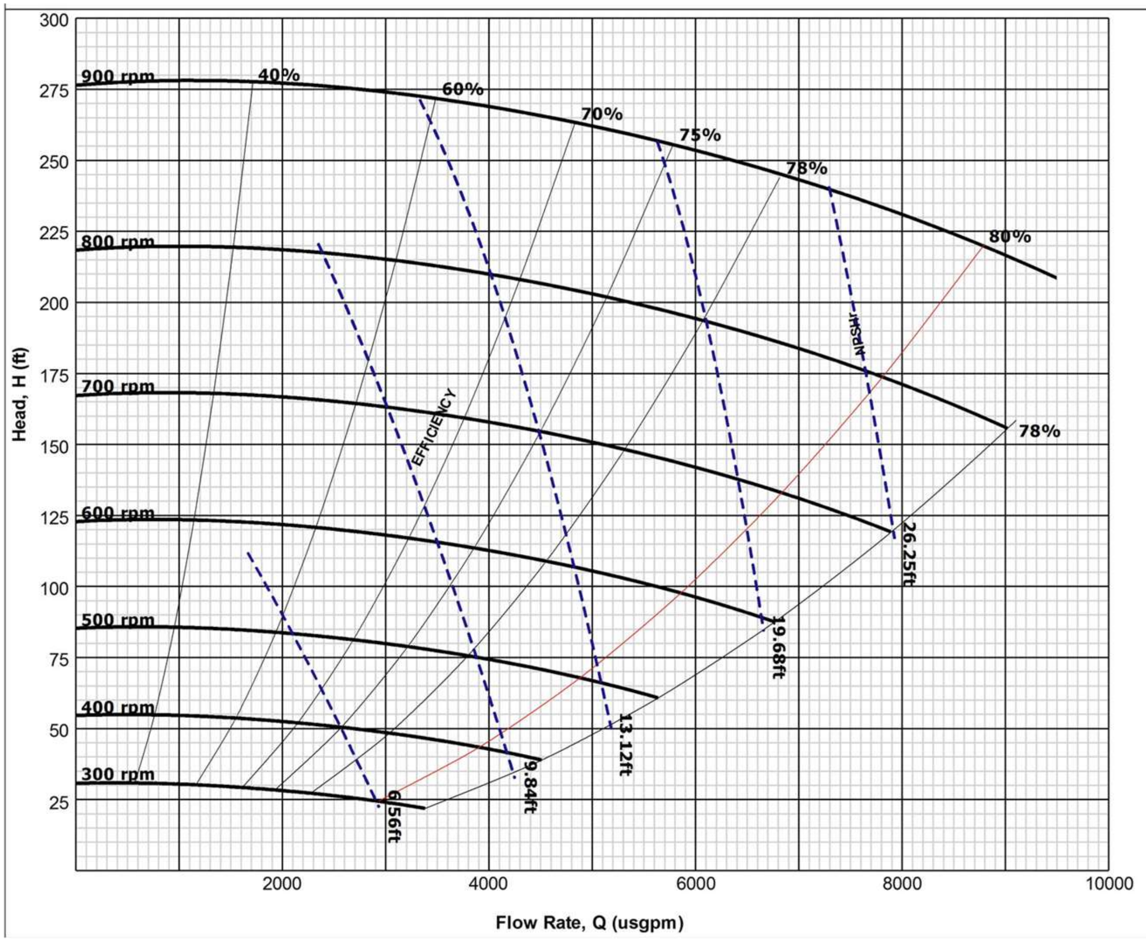






Today's focus: primarily around **Centrifugal Slurry Pumps.**

(but a lot of the principles apply to most other pumps used in Aggregates Wash Plants as well)



Pump	
Discharge	10"
Suction	12"
Impeller	
Vanes	5
Vane ø	30"
Type	Closed
Part No	**Material**
G10147	Metal
FAM10147	Metal
Frame (Rating - HP)	
F	349
FFX	570
FF	570
STX	751
ST	751
G	805
GG	1207
T	1609
Seal	
Gland Sealed Pump	
Liner (Norm Max r/min)	
Polymer	650
Metal	900
Curve	

- X-axis = Flowrate
- *Y-axis = Total Dynamic Head (sum of elevation difference, line losses, discharge pressure)*
- *Different efficiencies and duty points for same pump applied in different TDH/Flow conditions*

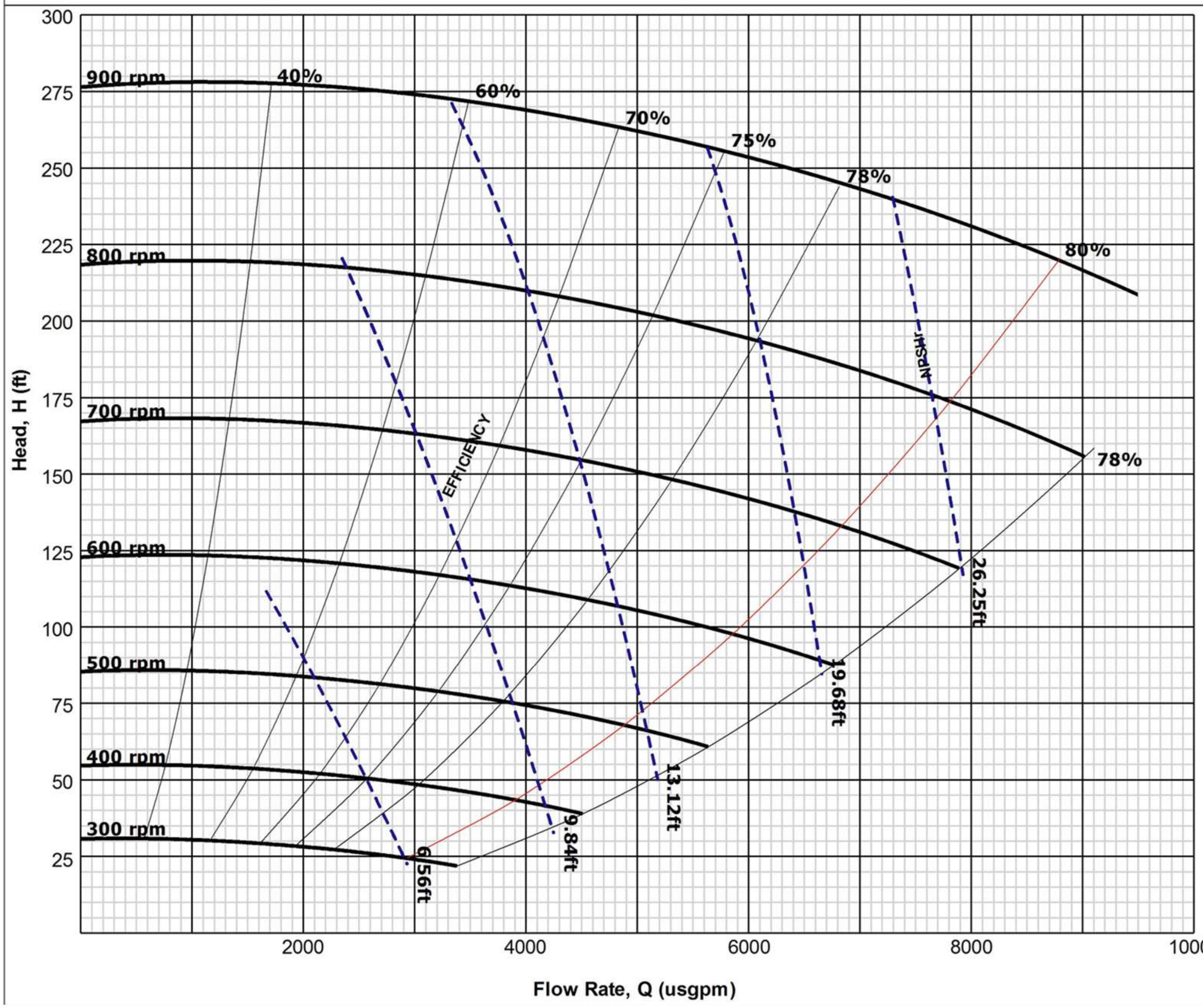
PUMP CURVES

1) All pumps have their own.

2) Once installed in an <u>*accurate*</u> *duty environment, it’s typically the ‘before or after’ the pump that is the issue.*

Put a Pressure Gauge shortly after Pump Discharge

- Critical for troubleshooting
- PSI reading x 2.31 = TDH in feet (ft.)
- Easy to retrofit
  - Pipe saddle on HDPE, threaded nipple, ball valve, gauge
  - Weld a threaded nipple on steel, ball valve, gauge
  - Glycerine-filled gauge ideal



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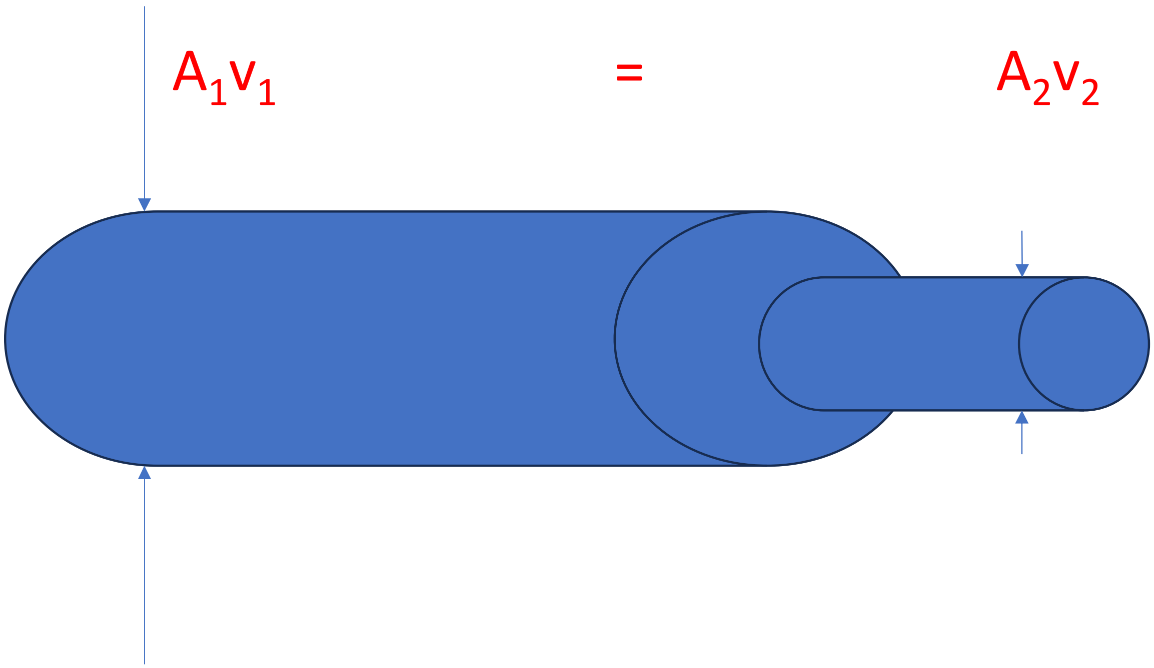
Line diameter and *proper* velocity is critical

- **Don’t simply match pipe size to pump flange size!**
- -3/16” sand slurry needs more line velocity (10-12 ft/s is sufficient) than…
- -100# tailings (screw washer weir overflow?) (7-8 ft/s can be sufficient)
- Water line velocity doesn’t need to be high at all along the way to wash plant
  - Speeds up when you reach the manifold and reduce the diameter
  - Spray pressure is high flow through small area (high velocity where it’s needed)

Quick Fluid Dynamics Lesson

Good ole' Bernoulli's Equation…

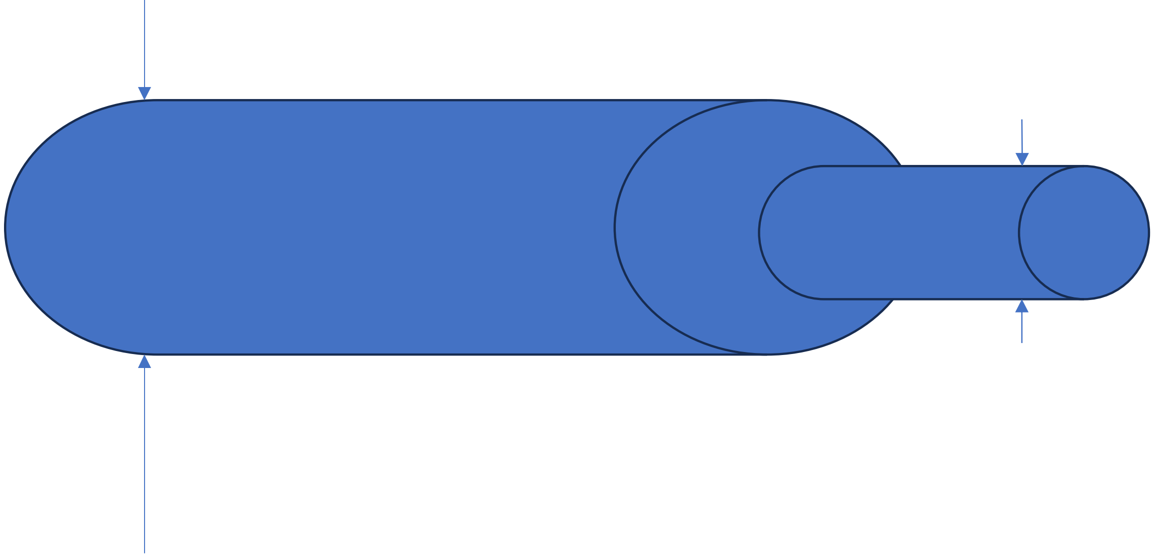
$$A_1v_1 = A_2v_2$$



The same flowrate through bigger pipe moves slower than same flowrate through smaller pipe.

Why is this important?

$$A_1 v_1 = A_2 v_2$$



Same flow, same elevation, same pipe length

		(SECTION 2)						(SECTION 4)						(SECTION 5)			
		Static and Pressure Heads						Discharge Side Pipe Loss Calculations						Power Requirements			
Flow Rate GPM	Slurry S.G.	Operating Elev., ft	Discharge Elev., ft	Static Lift, ft	Discharge Press, psi	Pipe Material	Pipe Size Nominal	Velocity ft/sec	Pipe Length, ft	Friction Loss, ft	Fittings Loss, ft	Total Loss, ft	TDH ft	Drive SF	Brake HP	Brake KW	Motor HP
2000	1.00	0.00	10.00	10.00	0.00	SDR17	8.0	14.26	1000.0	67.90	14.3	82.2	94.2	1.100	69.8	52.0	**100**

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In this first example: 8” DR17 for 1000ft

- Brake HP = 70 HP
- Line velocity = 14.3 ft/s

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2000	1.00	0.00	10.00	10.00	0.00	SDR17	10.0	9.18	1000.0	22.77	5.9	28.7	40.7	1.100	30.2	22.5	40

In this second example: 10” DR17 for 1000ft

- Brake HP = 30 HP
- Line velocity = 9.18 ft/s

Line diameter and *proper* velocity is critical

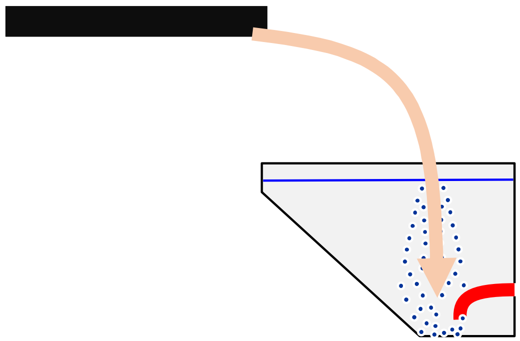
- **Velocity has a square effect on energy/power demand**
  - **$^1/_2mv^2$ = kinetic energy (…remember, it is total *DYNAMIC* head)**
  - More HP is costly and wasteful
  - Larger pump bearings, larger MCC, larger cable, etc.
    - Bigger pipe from the start pays off

Sump Design is Critical

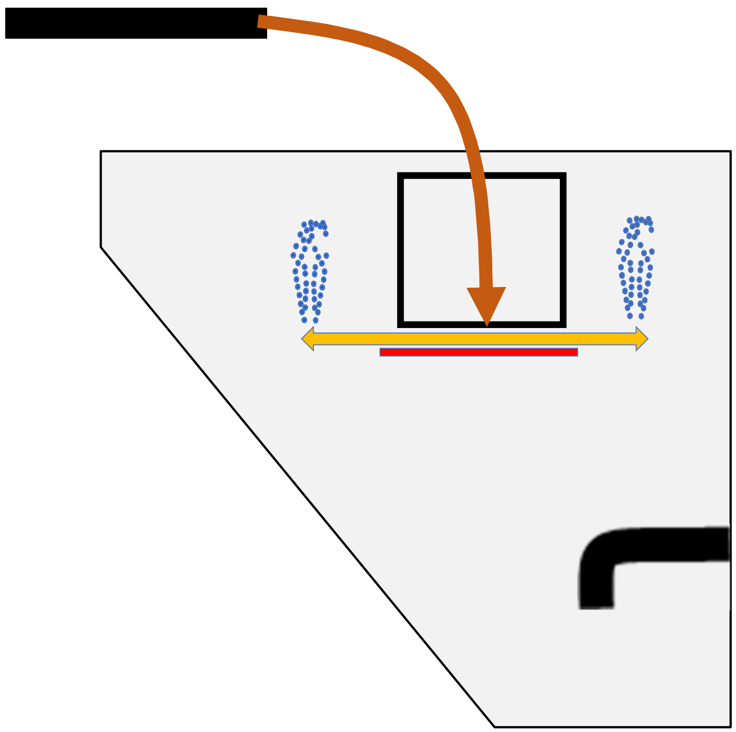
- **MOST** sand plant slurry pump issues are related to poor sump design

Air gets into pump suction

Too small of sump, and/or sump with no feedwell



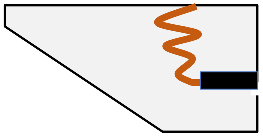
Feedwell disperses flow across and not directly down



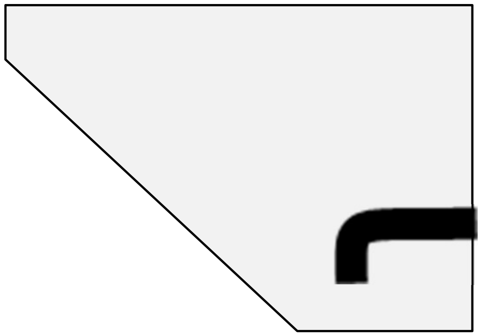
Air bubbles remain near top of surface

Air drawn in via vortex

Too little of slurry volume above the suction line



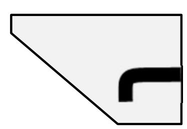
Elbow downward on Suction line



Size the sump for proper residence time

Too little of residence time means the air can’t escape.

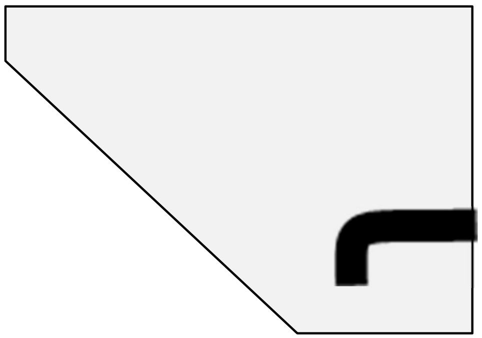
*NOTE: the air gets in the sump from incoming flow “pushing” the air that is between the sump and the end of the incoming pipe.



Residence time 1.0-1.25 minutes

i.e. 2,000 USgpm pump =

2,000-2,500 gallon sump

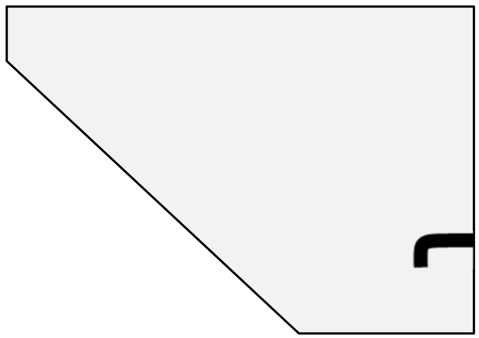


Build up blocks suction line

- Sand settles in corners
- Sand gets steeper toward suction
- Build up near wall gets too steep and sloughs off and buries the suction line

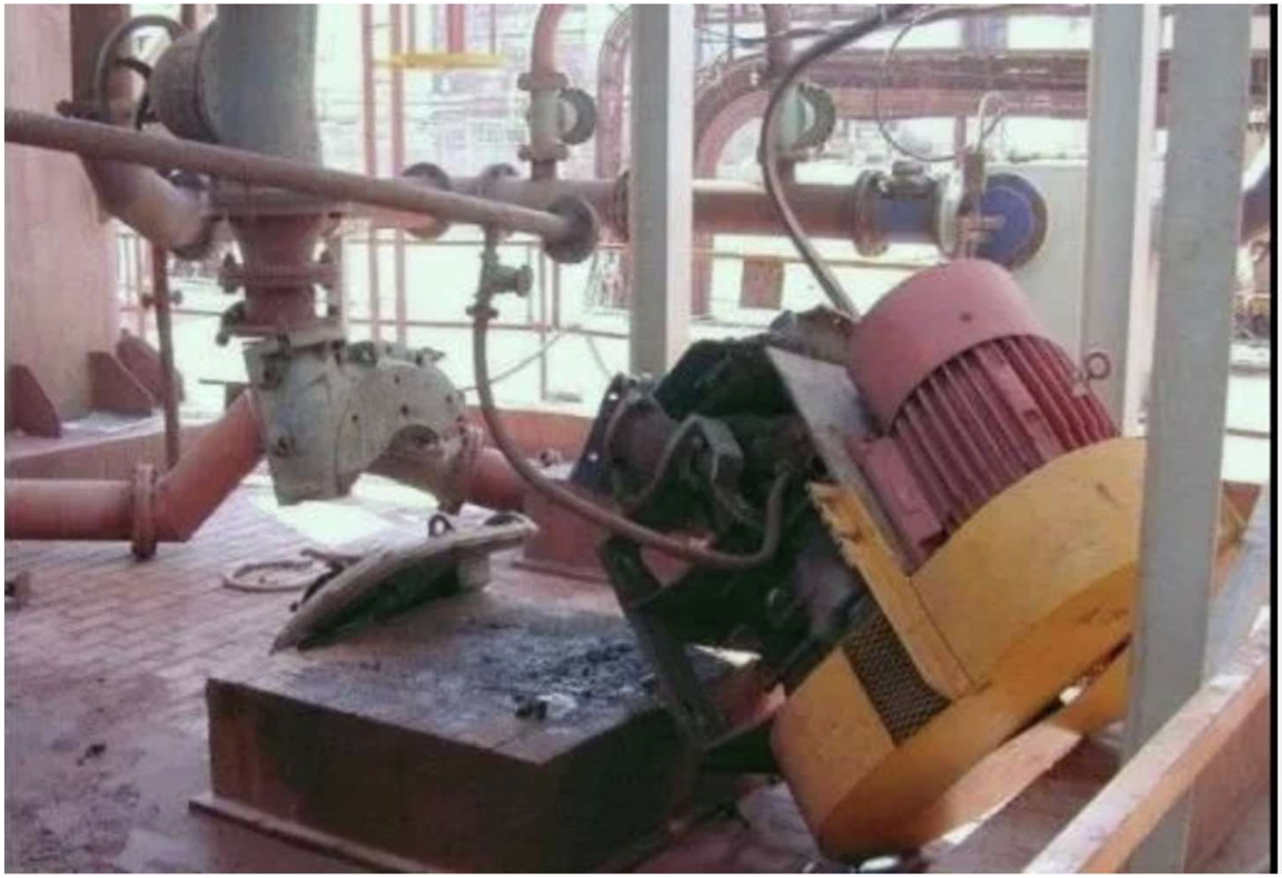
Design sump with sloped side opposite the suction line

- Sand angle of repose ~38^{o}, so a 45^{o} wall is typically good
  - Note: this cuts into residence time volume

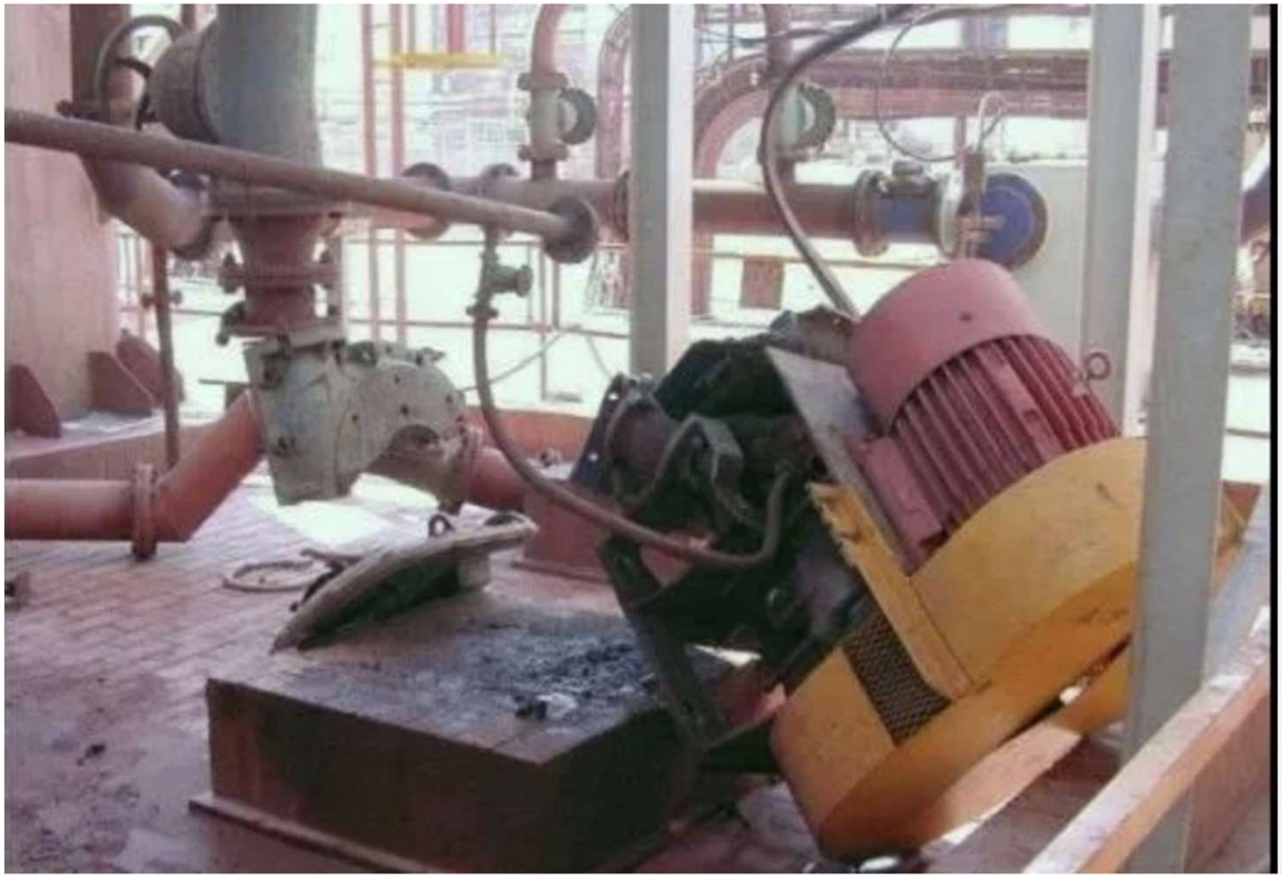


Too high %-solids in slurry, or excessive sloughing can lead to:

- Pump liner and impeller damage
- Variable flow and poor performance
- Plugged pipelines (discharge or suction)
- EXPLOSION (if both suction and discharge plugged)

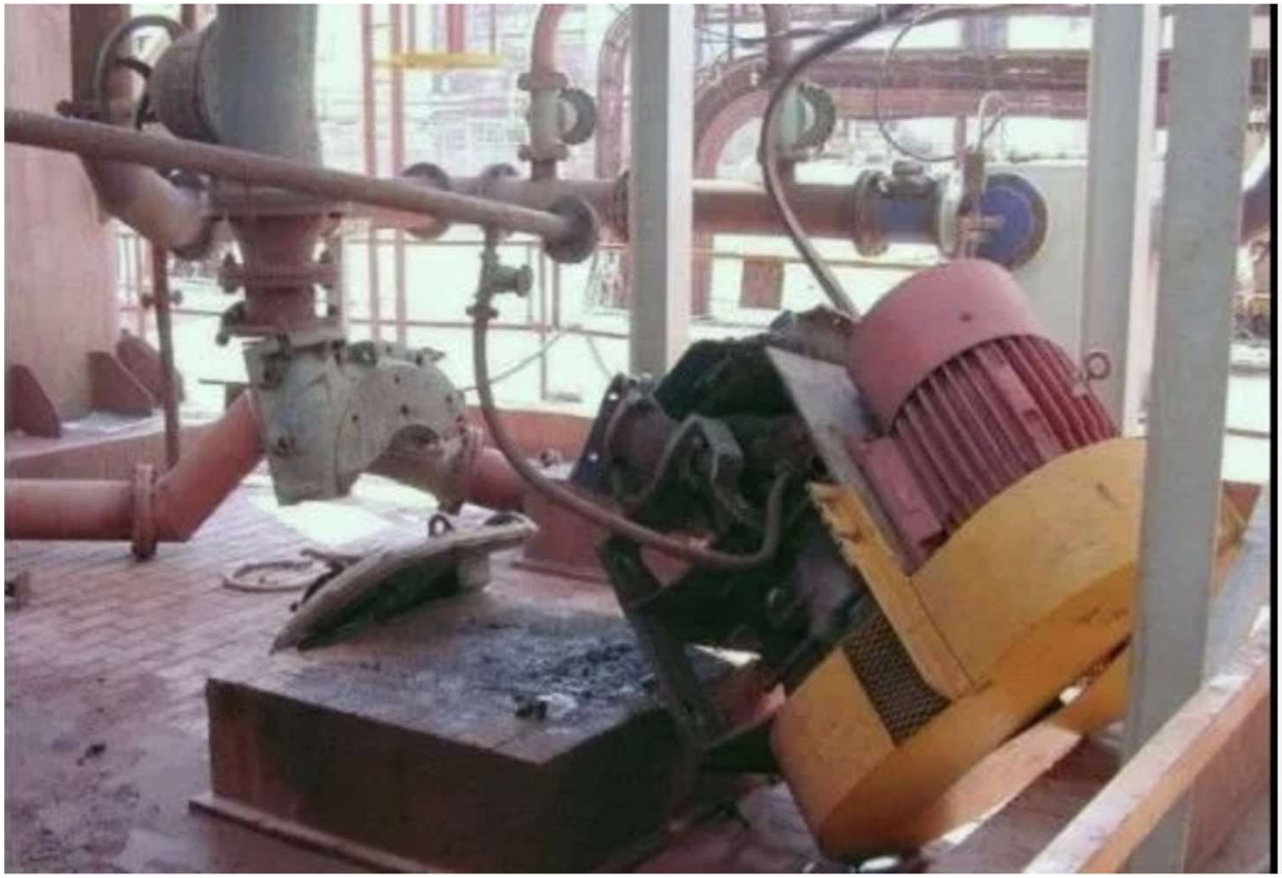


Steam-bomb.



Steam-bomb.

Impeller rotating, nothing moving in or out.



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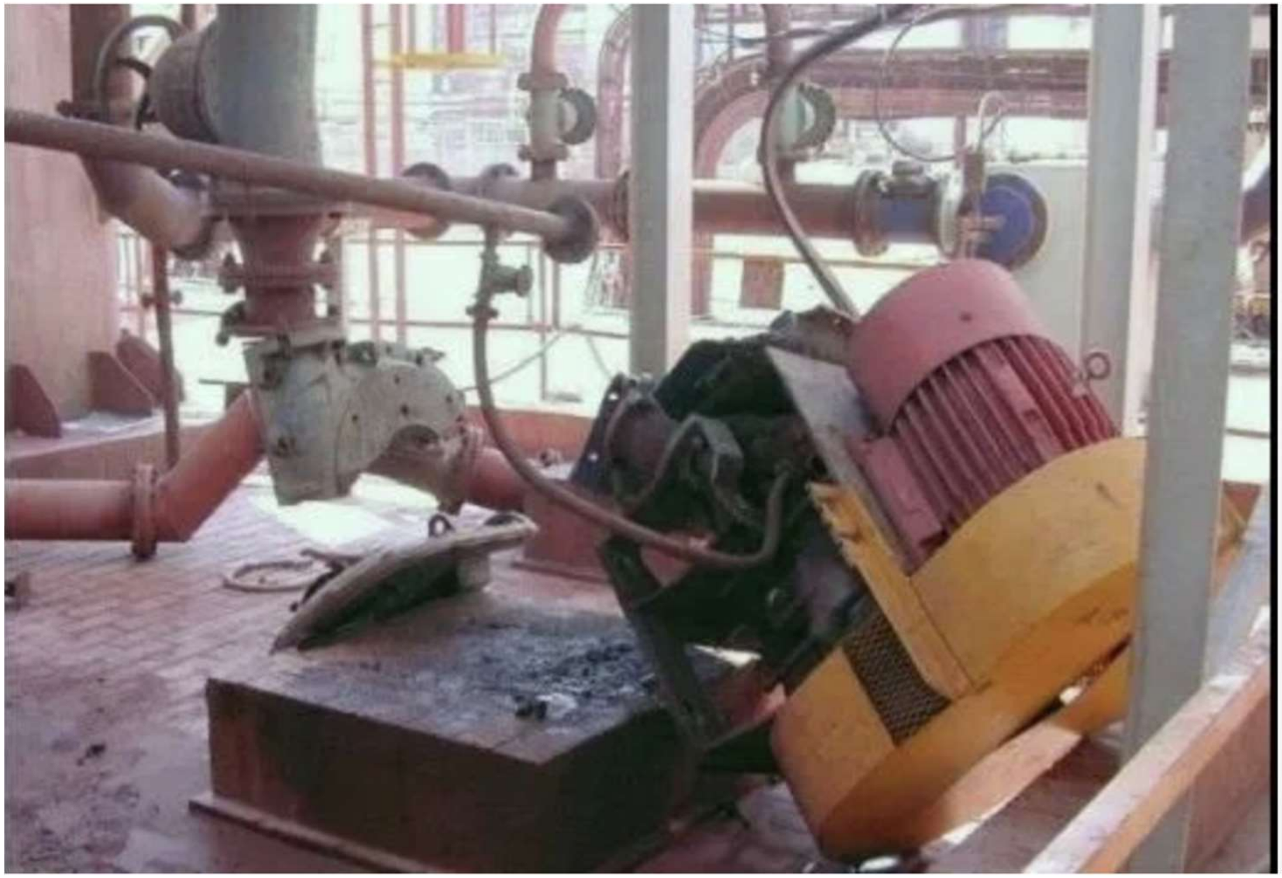
Motion = energy

Energy = heat



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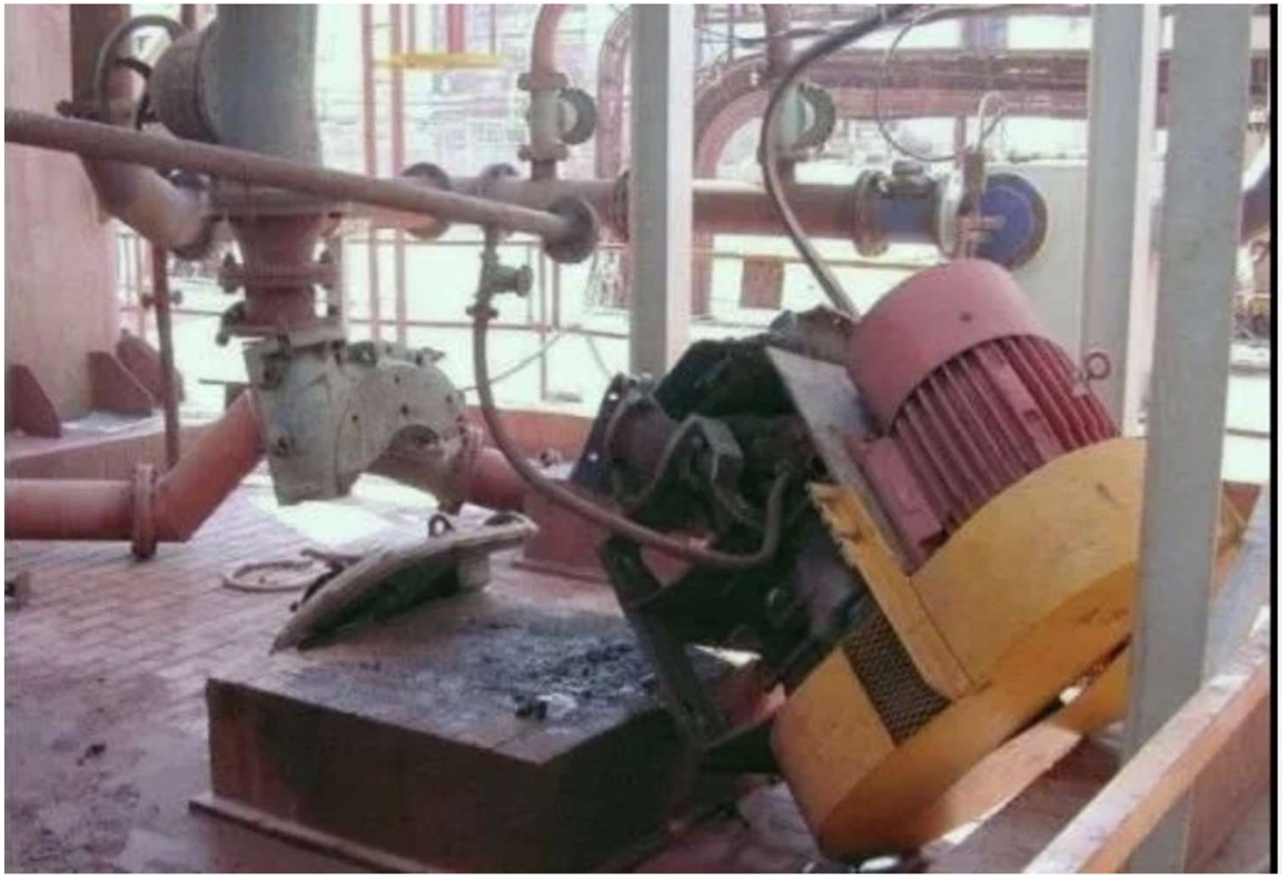
Heat + water = steam



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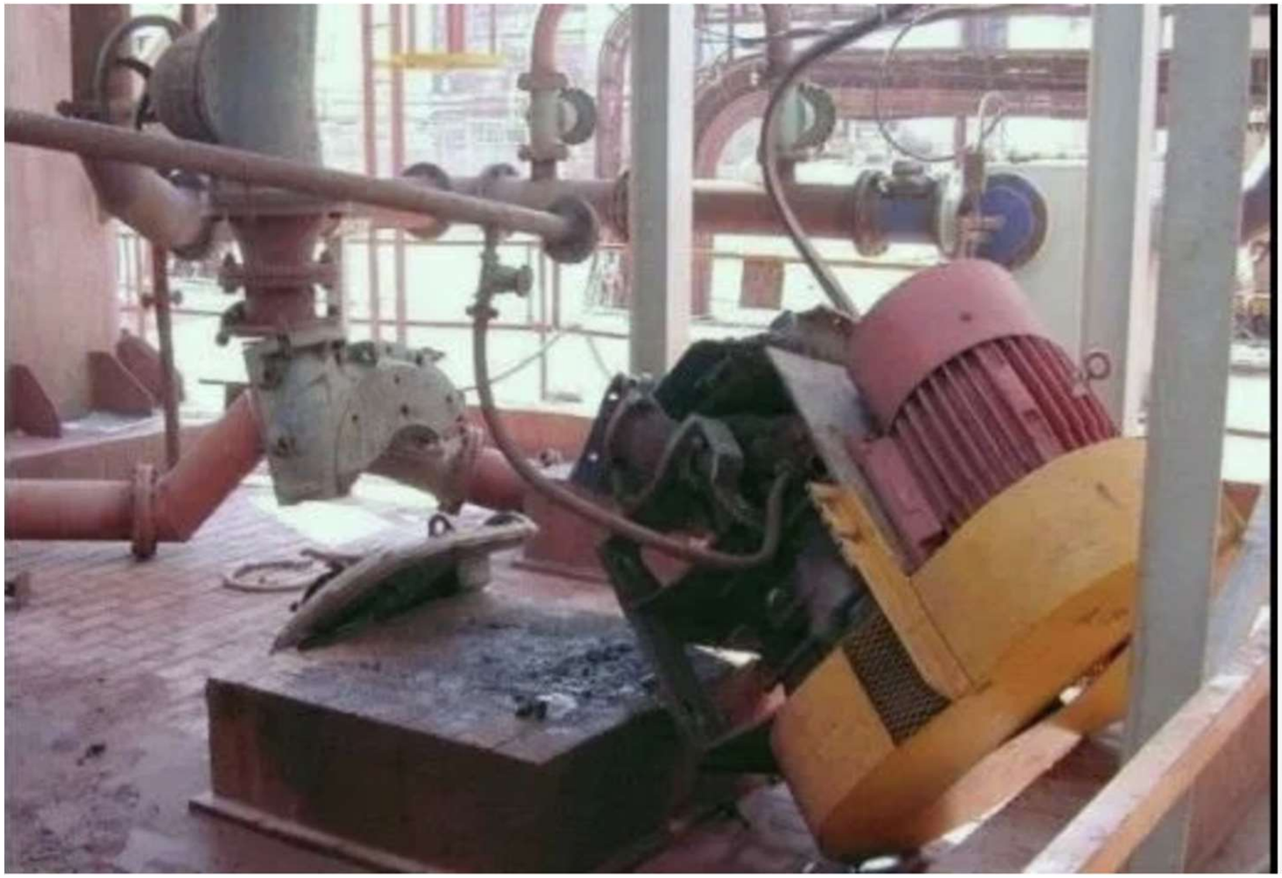
No exhaust (plugged discharge and suction)



Steam-bomb.

Impeller rotating, nothing moving in or out.

Motion = energy

Energy = heat

Heat + water = steam

No exhaust (plugged discharge and suction)

= Bad day.

GENERAL DESIGN CONSIDERATIONS FOR SETTLING PONDS and SYSTEMS RELATED TO IMPROVING POND MANAGEMENT

Multi-stage Pond

- In operations with ample area
- Vast majority water recycled
- Multi-stage
  - Water drawn from final stage
  - Slurry tailings enters exact opposite corner

Future Reserves Covered?

- Several acres of surface area covered
- Location typically near plant for minimizing piping
- Closer for lower TDH on water pumps
- Possible loss of mineable material

How much surface area?

- Ideal at 1.5-2 acres per 1,000 USgpm
- Deep as a long reach excavator can reach down from one edge at middle
- Velocity and retention time
- Minimize cadence of scooping
    - Costly aspect of pond management

Losses of water?

- ~75-80% of process water recycled in traditional settling pond sites
  - Losses to product surface and plant spillage
  - Losses to evaporation and pond floor/wall seepage
- Liners in operations that have sandy terrain
- Clays/silts naturally cap in others

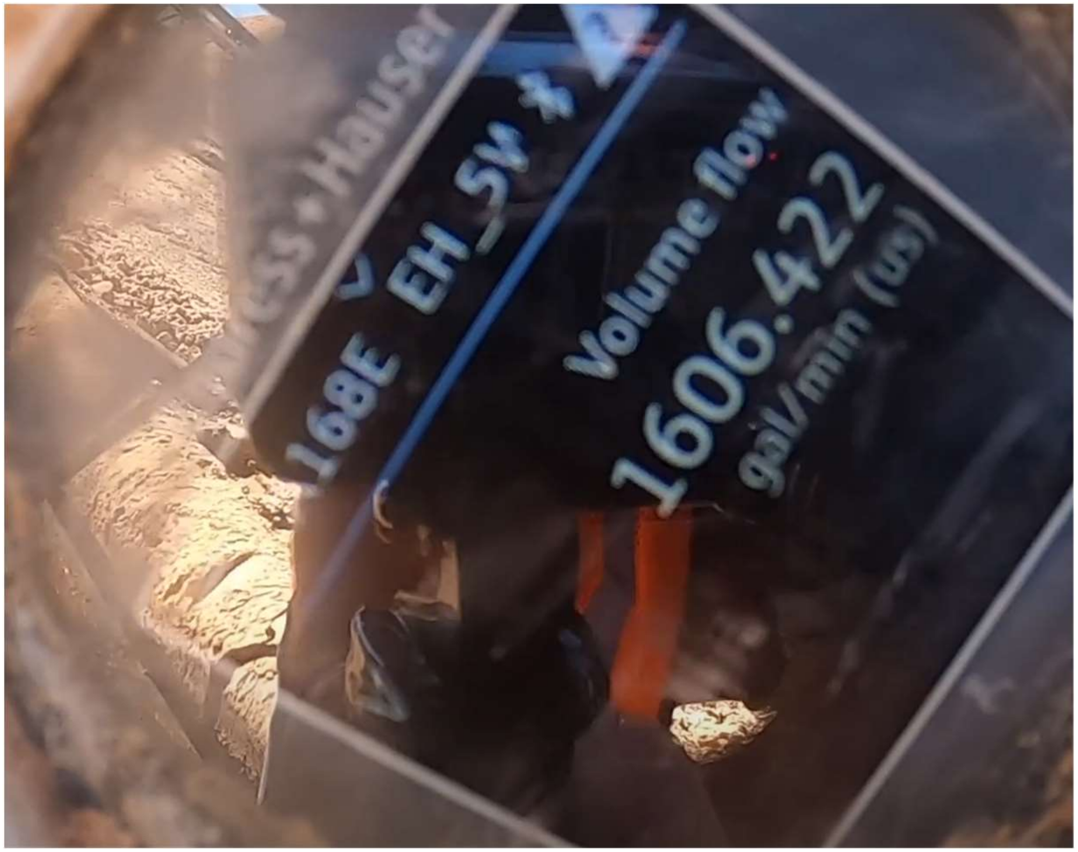
Process Water Requirements

- Depending on Sand Plant Equipment
- Rough estimates in most operations of 8-10 USgpm per stph of **sand to be washed**
- Plan for 25% makeup water ability
  - i.e. 160 stph of sand x 10 USgpm

  = 1,600 USgpm

  25% of 1,600 USgpm = 400 Usgpm

  - Sourced from well? Permitted river/creek?
  - Top up when not operating plant?



Water Pump Locations

- Furthest corner opposite of pond feed pipe
- Deep corner for minimizing strainer plugging
- Considerations on placement for minimizing TDH on pump
- Ideal to use larger diameter delivery pipe than manifold inlet flange

Tailings entry to ponds

- Gravity ideal
  - Large diameter pipe to keep velocity lower
  - However, need to keep velocity enough to prevent settling of potential sand in tailings
- Far opposite corner away from water pump location

Tailings entry to ponds

- Velocity to slow as quick as possible
- Aimed into pond away from direction of next weir
- Build up of coarsest particles in this area

Tailings entry to ponds

- Scooped the most due to immediate area of settling
- Loses effectiveness every day as volume fills up
- Gallons per minute = flowrate
- Ft^3/min = flowrate
- Surface area = ft^2
- Flowrate / surface area = ft/min
  - =VELOCITY

Primary Pond Larger

- Slow down high velocity exiting tails pipe
- Spread flow across width
- Sequential Ponds can be smaller
- Primary pond larger for ample area to slow progression of slurry
    - Wider than sequential ponds

Settling progression

- Largest and heaviest particles in first
- Smaller and smaller particles settle in further pond stages
- Ideal that final pond have no settling occurring
    - Process Water Storage

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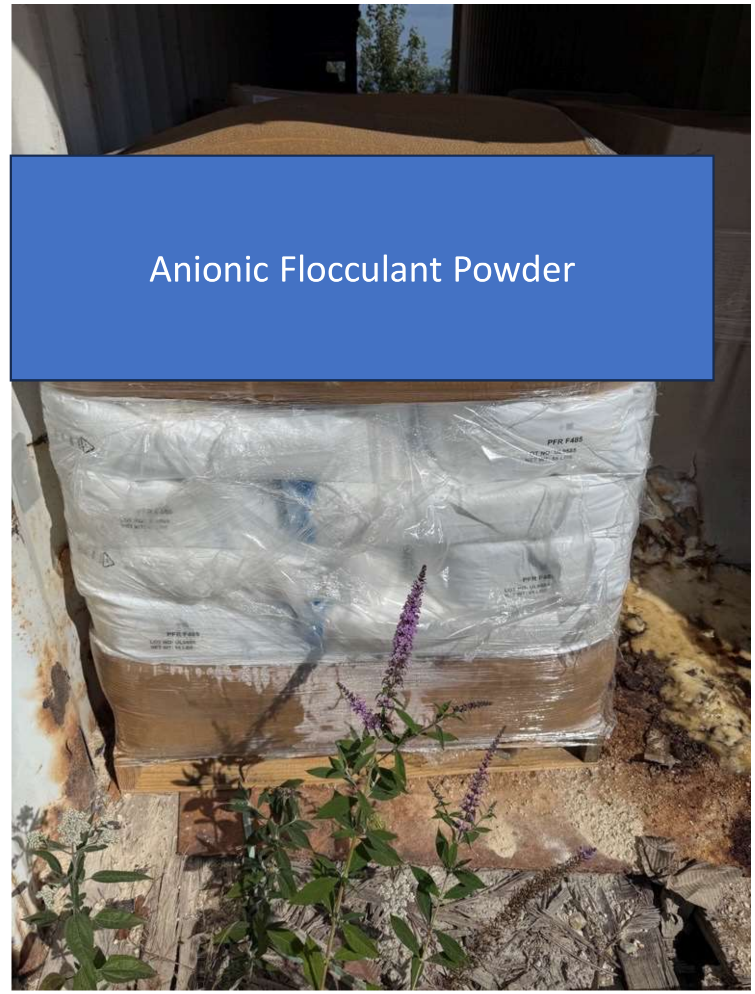
Separation Dams

- Wide enough for Tracking Excavator
- Width of Sequential Ponds such that Excavator can reach center line of pond at full boom reach
- Excavator can scoop half from one edge and half from other edge/ next dike

Interconnecting Ponds

- Wide weirs
- Smaller area means increased velocity
- Flowrate = ft^3/min
  - Area of weir = ft^2
  - Ft^3 per minute / ft^2 = ft/min
  - =VELOCITY
  - Smaller ft^2 on weir means HIGHER ft/min i.e. higher velocity
- Effectiveness of area right after weir disrupted due to increased velocity in this zone
- Direction and location critical
- Opposite ends of each respective pond



Anionic Flocculant Powder


NALCO


LiquiFloc 122
IBC PICKUP
North East Container
www.necontainer.com

Flocculant for Ponds

- Promote more immediate settling
- Improve Water clarity
- Anionic powder with Floc Dosing Units to make the flocculant emulsion on site
- Cationic floc totes for water clarity and further water release/thicker sludge
- Pre-made anionic emulsions for convenience
    - Mostly water in the totes….expensive water for convenience of not needing to make the powder into pumpable 'slime'

Recover some of the solids before Pond – Ultra Fines Recovery (UFR)

- Collect tailings in sump and pump to manifold of small diameter cyclones
- High Frequency Dewatering Screen to dewater recovered wet solids
- Nominally 325#-400# cut point
- Still have super-ultra fines report to pond and these are the very light particles that take more time to settle
  - Flocculant system after UFR to promote quicker settling
- Sometimes a sellable recovered product
- Mostly ease of pond maintenance and reduced pond scoop cadence

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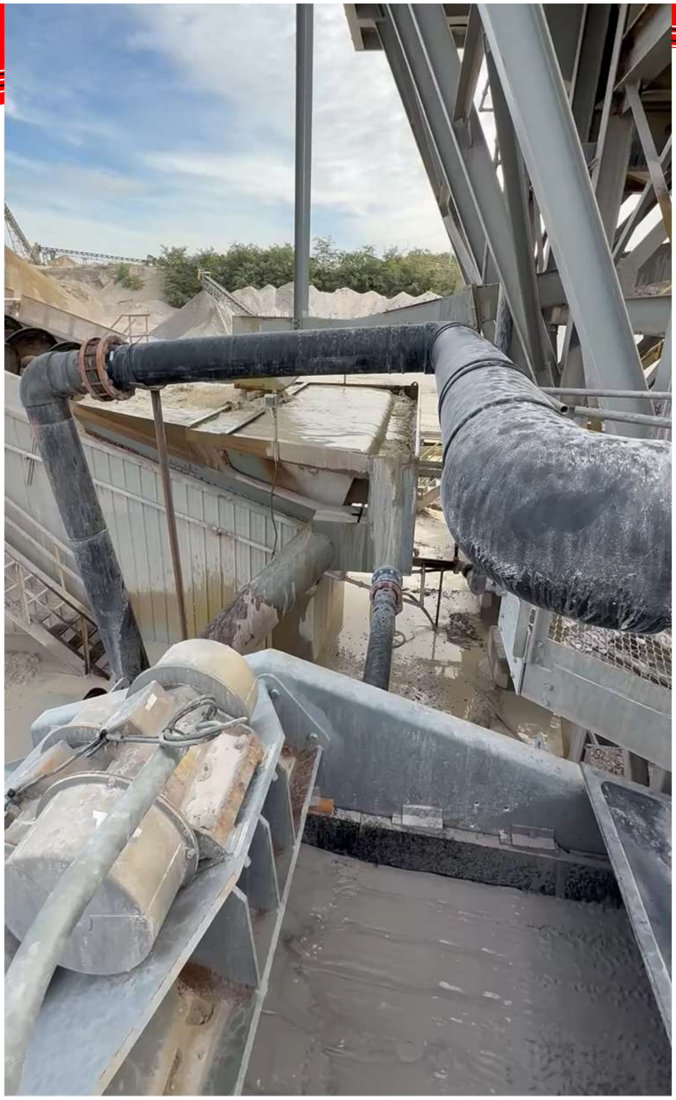
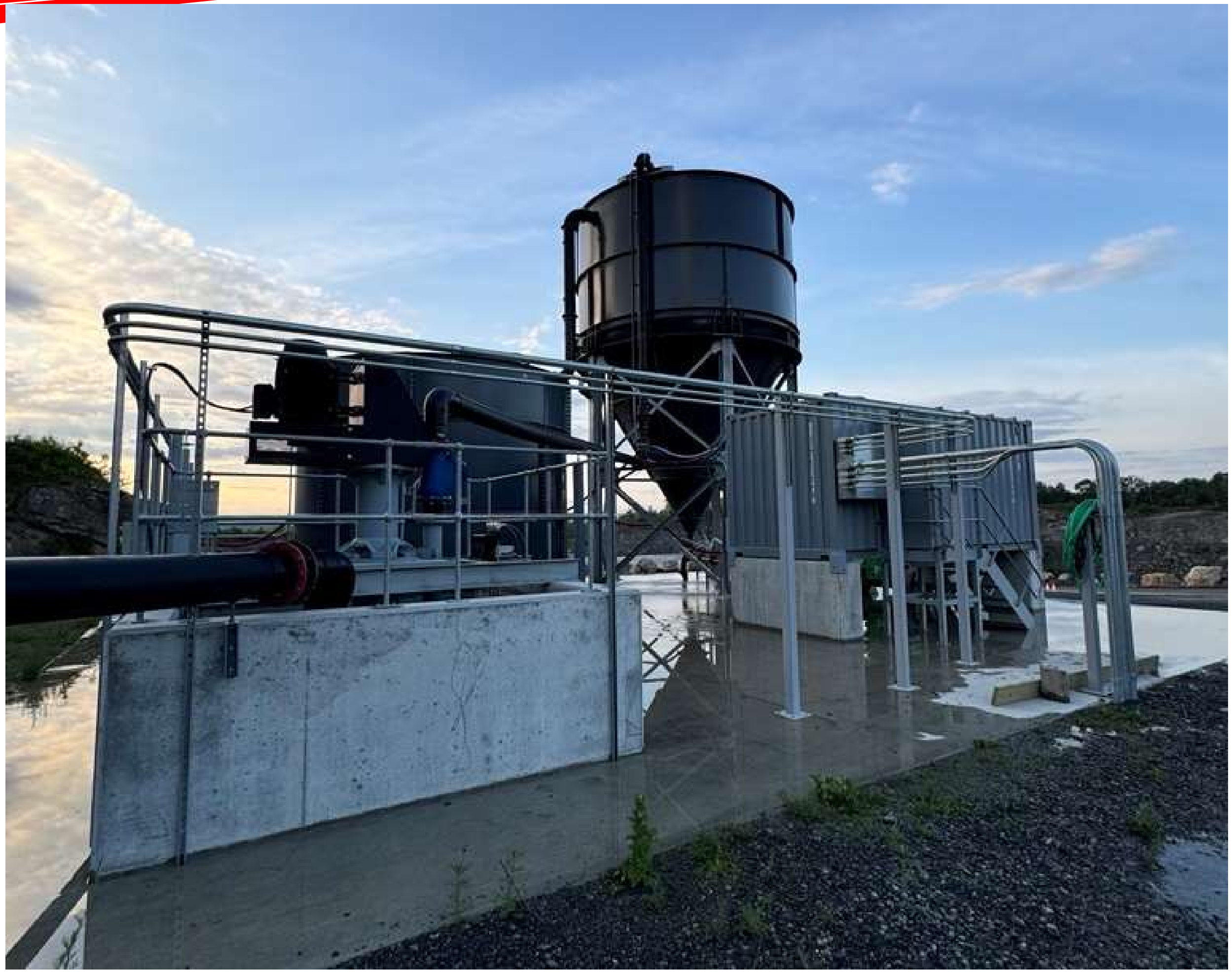


Thicken Sludge and Recycle Water with Thickener/Clarifier System

- Collect tailings in sump and pump to thickener/clarifier
  - Gravity flow in some cases
- Flocculant pumped in and mixed to promote fast settling in the tank
- ‘melted milkshake’ consistency sludge produced and exits underflow
- Clarified process water recycled over weirs and into process water storage tank
- Still need location to store ‘melted milkshake’ sludge
  - Old settling ponds converted to sludge storage cells
- IMMEDIATELY recycled water
- 80-85% water recycled



Eliminate Settling Ponds Entirely with Thickener and Press System (Belt Presses or Recessed Plate Filter Presses)

- After thickener, sludge reports to a press for filtering out free water between particles of clay/silt/sand.
- Produces a drip free cake or dewatered pressed product that can be easily managed with conveyor or front end loader
- Eliminates sludge storage ponds entirely
- Higher Flocculant costs when using belt press
  - Anionic powder consumed for thickener and press
  - PLUS cationic totes required for belt cleaning and water release on Belt Press
- No batch tanks (continuous process)
- 90-95% of water recycled

EASTROCK Solutions

OLD DOMINION

Eliminate Settling Ponds Entirely with Thickener and Filter Press

- After thickener, thickened sludge reports to a batch tank that has pump which feeds Recessed Plate Filter Press in cycles
- Operates in 20min to 1hr cycles typically
- Eliminates sludge storage ponds entirely
- Less Flocculant costs when using filter press versus belt press
- 95%+ water recycled in operations with these systems

Silt/Clays pressed into Cakes with Filter Press

- Often elevated above concrete bay so front end loader can scoop and haul away
- Not often a sold product but very manageable for mine reclamation
- Current research being performed with cement and concrete companies on use of these cakes

Eliminate Settling Ponds Entirely with Thickener and Press System (Belt Presses or Recessed Plate Filter Presses)

- Settling Ponds require less of an operator attention.
- Adding a press does add operational labor
- Additional equipment is additional parts costs and attention

Eliminate Settling Ponds Entirely with Thickener and Press System (Belt Presses or Recessed Plate Filter Presses)

- Belt Presses and Recessed Plate Filter Presses often require a building for best preventative maintenance
- Storage of flocculant
- Presses allow wash plants to exist in much smaller footprint operations and in cities (i.e. no room for settling ponds)

THANK YOU