# IMPACT OF CALCIUM HYDROXIDE ON THE EQUIPMENT AND PROCESS OF OIL SANDS TAILINGS TREATMENT

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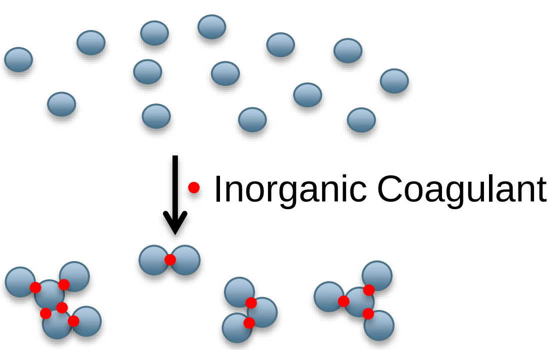
# Agenda

- Coagulation vs Flocculation
- Mixing
- Thickening simulation settling tube
- Particle size
- Pressure filtration
- Filtrate water chemistry
- $Ca(OH)_2$ impact on dewatering equipment

# Coagulation vs Flocculation

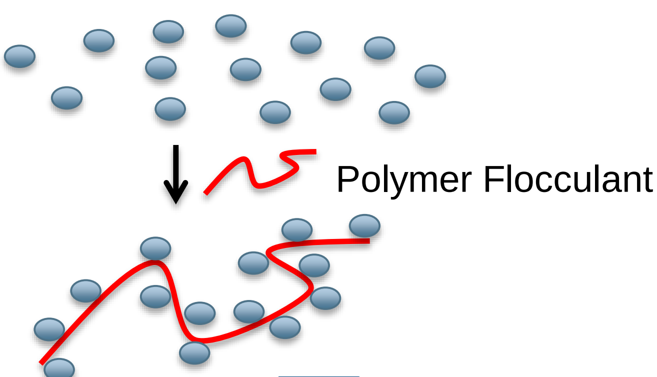
## Coagulation

- Destabilize the electrostatic repulsion of suspended solids by cation exchange and/or chemical reactions
- Coagulants that are multivalent, such as calcium ($Ca^{+2}$), link individual particles together which increases the average particle size.
- High shear mixing can be used to ensure that inorganic coagulants are well dispersed




## Flocculation

- Aggregation of clay particles onto a flocculant surface
- Particles adsorb onto large molecular weight flocculants, such as polymers
- Results in large and fragile flocs held together by weaker intermolecular forces
- Mixing procedure is important



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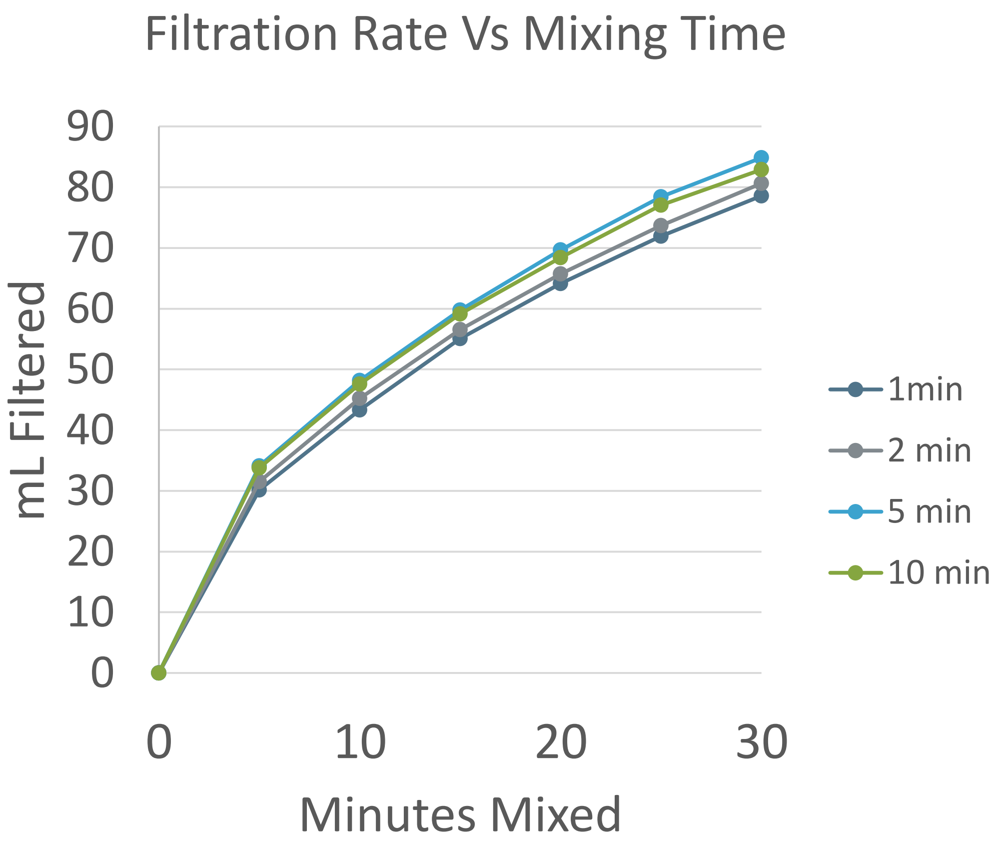
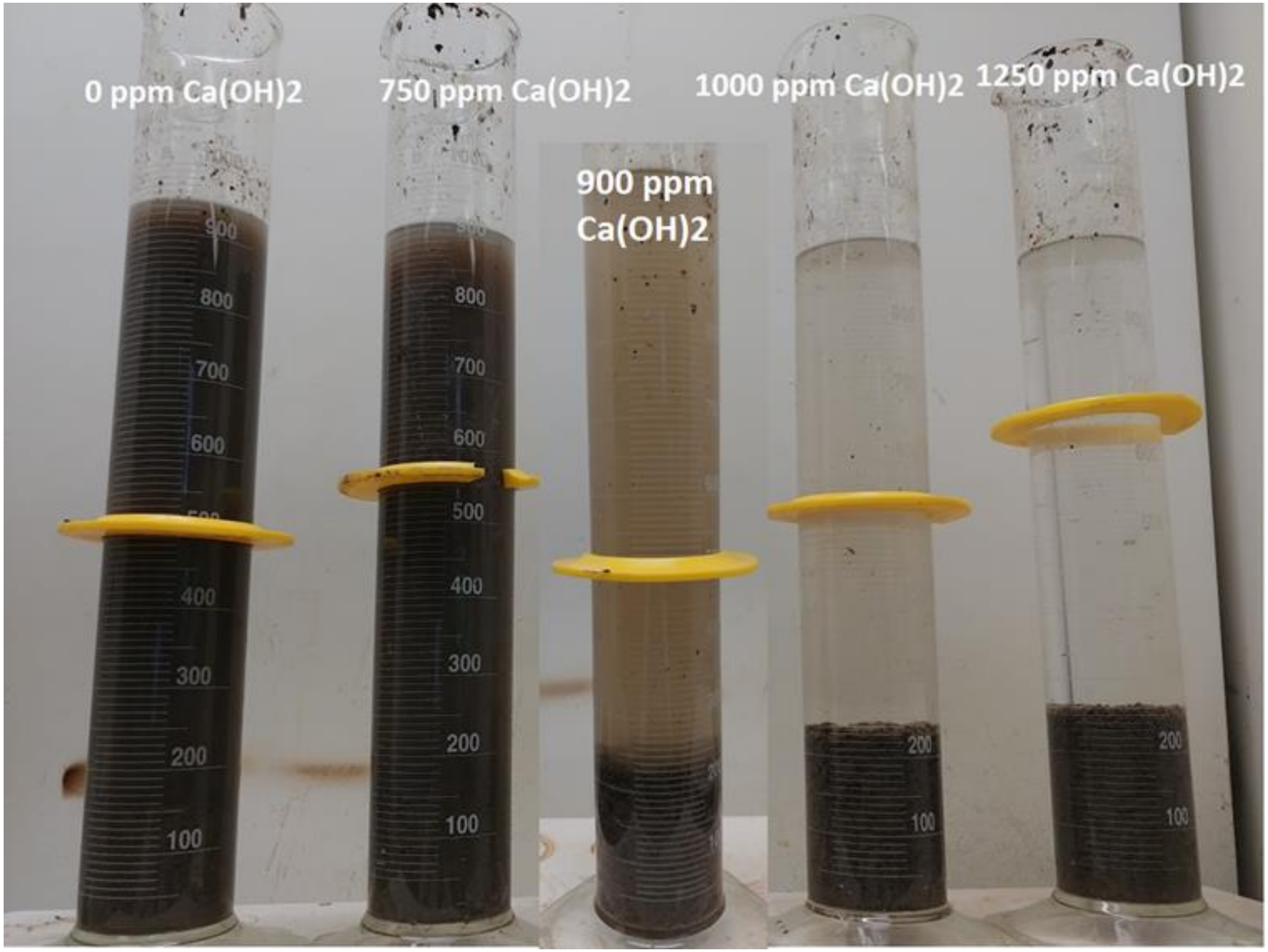
# Coagulation Simplifies Mixing

- Amount of mixing required is minimal
- As long as sufficient homogenization is achieved further mixing is unnecessary
- The capability of a coagulant to withstand high shear makes rigorous mixing not only possible but preferential



# Thickener Clarity is Dependent on Dosage



# Settling Velocity Increases when Pretreated

- **When paired with polymer, settling velocity is improved**
  - Dosage of $Ca(OH)_2$ is variable and is dependent mostly on carbonate concentration among other factors
  - Clarity of the water interface is determined by $Ca(OH)_2$ addition

| Lime Dose (ppm) | Time to settle to 700 mL (s) | Mud Line at 30 min (mL) |
|---|---|---|
| **0** | Not Observed* | 155 |
| **750** | 8 | 190 |
| **900** | 5 | 245 |
| **1000** | 3 | 245 |
| **1250** | 4 | 275 |

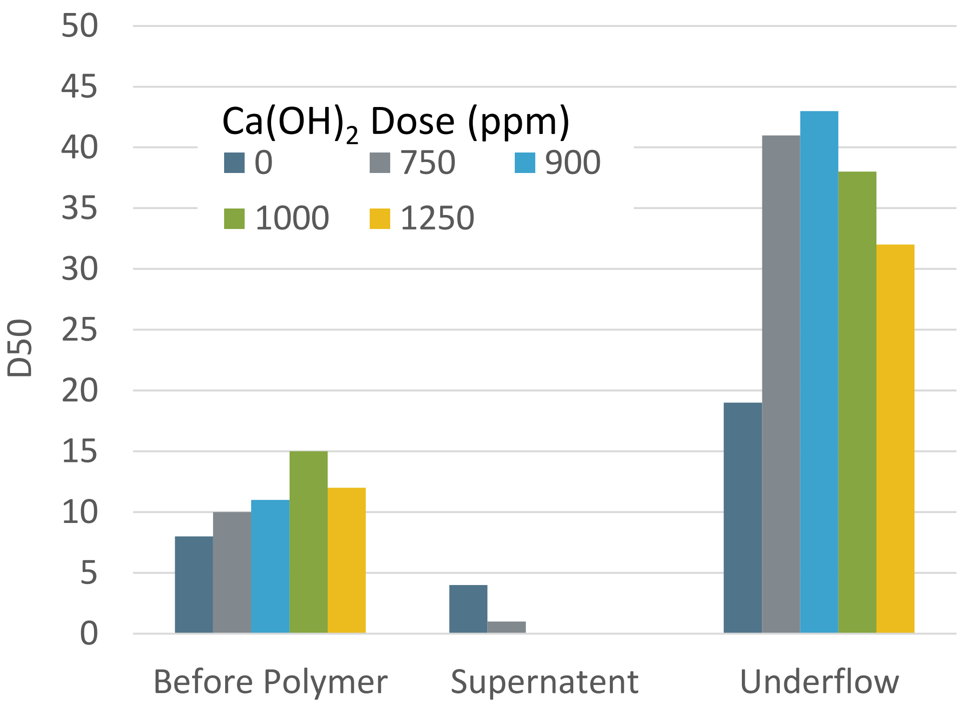
*A clear mud line was not noticed until the flocculated particles had settled well below 700 mL

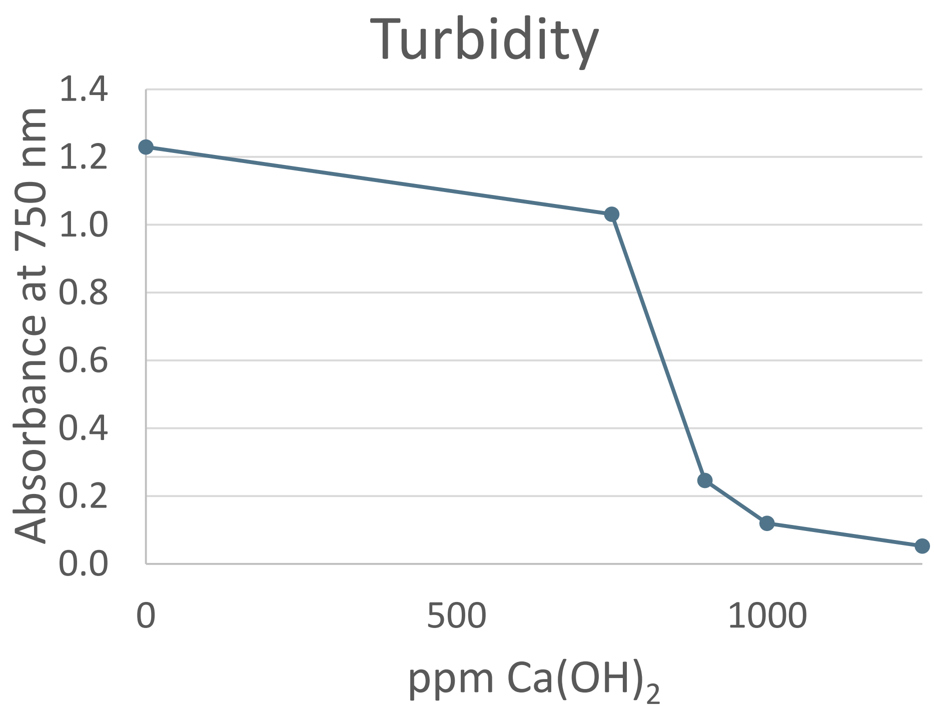
# Water Chemistry Improves

| ppm of $Ca(OH)_2$ | Ca mg/L | Na mg/L | K mg/L | S mg/L | Mg mg/L | Al mg/L | Cl mg/L | (H)CO3 mg/L | pH |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 31 | 263 | 7 | 28 | 12 | 1 | 90 | 529 | 9.09 |
| **750** | 11 | 232 | 4 | 29 | 1 | 1 | 90 | 71 | 11.35 |
| **900** | 16 | 261 | 8 | 26 | 1 | 2 | 89 | 23 | 11.60 |
| **1000** | 31 | 246 | 7 | 29 | 1 | 0 | 90 | 18 | 11.70 |
| **1250** | 93 | 279 | 8 | 37 | 1 | 1 | 90 | 17 | 11.80 |

# Particle Size Determines Turbidity

- **Larger particles derived from coagulation with $Ca(OH)_2$ provide less turbid supernatant.**
  - Low turbidity coming off the thickener would reduce demand of clarification processes



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# Pressure Filtration Rates Improve

- **Pressure filtration of $Ca(OH)_2$ treated tailings**
  - Dosage of $Ca(OH)_2$ is dependent on a number of variables but is consistently between 3000 and 4000 ppm based on the wet weight of tailings.
  - $Ca(OH)_2$ shows a significant upgrade in filtration rate over flocculant alone.
  - Faster filtration requires fewer pressure filters
  - Cake solids consistently greater than 70%

| Feed Mixture | Filtration Rate ($kg/m^2/hr$) |
|---|---|
| **Flocculant only** | 1.727 |
| **4000 ppm calcium hydroxide** | 3.811 |
| **Flocculant and 4000 ppm calcium hydroxide** | 4.094 |



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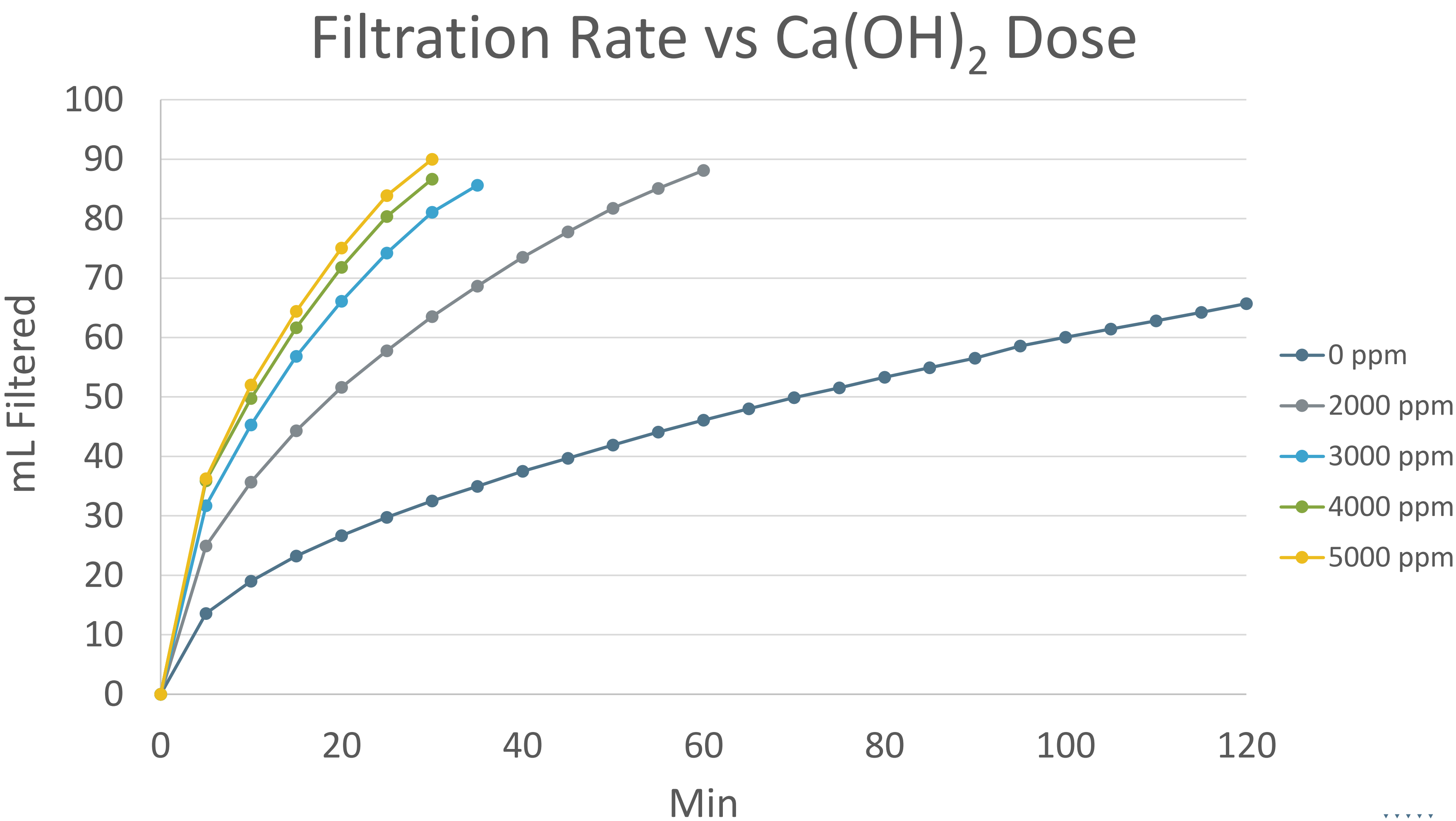
# $Ca(OH)_2$ Dose is Important



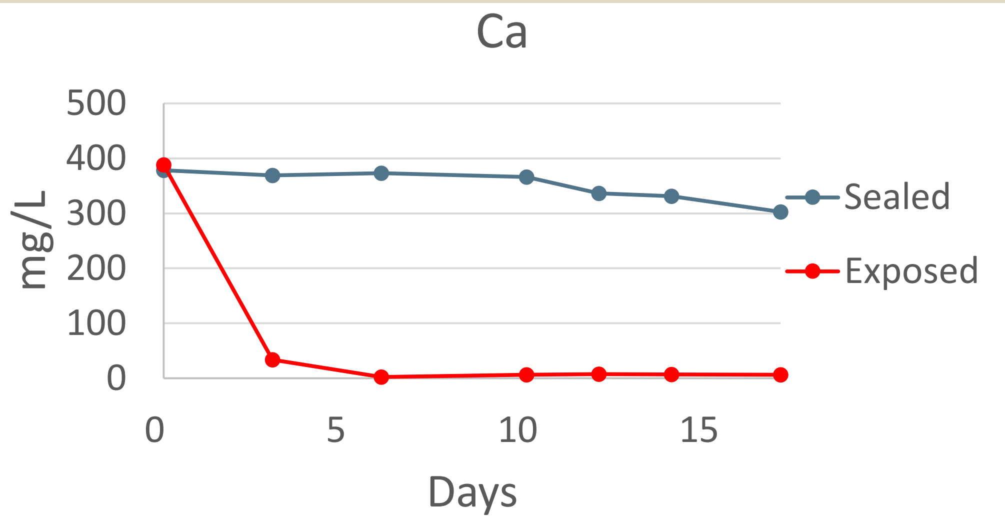
# Filter Cake Properties are Improved

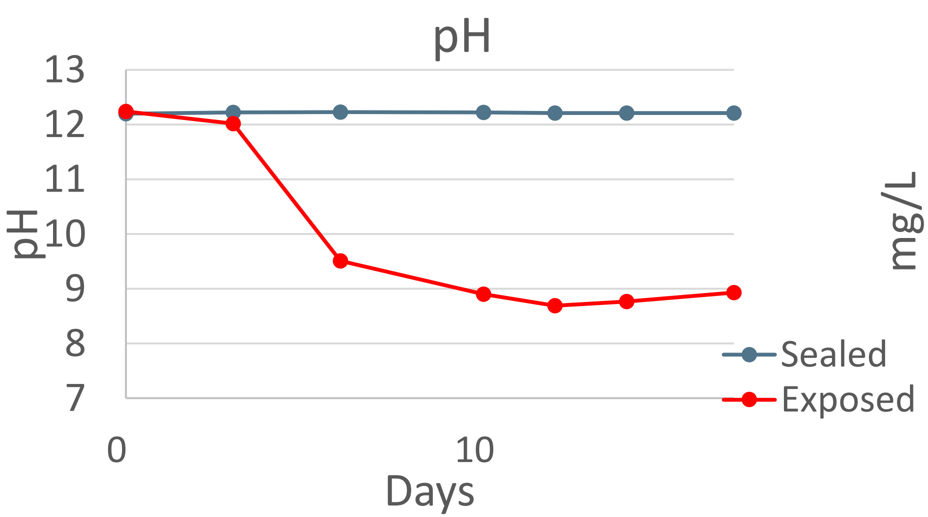
| | Final Cake Solids (wt%) | Dry Cake Density ($lb/ft^3$) |
|---|---|---|
| Unthickened with 4000 ppm $Ca(OH)_2$ | 71.2 | 75.7 |
| Thickened with $Ca(OH)_2$ | 72.6 | 77.8 |
| Thickened with Floc | 65.8 | 65.9 |
| Thickened with Both | 74.3 | 81.7 |

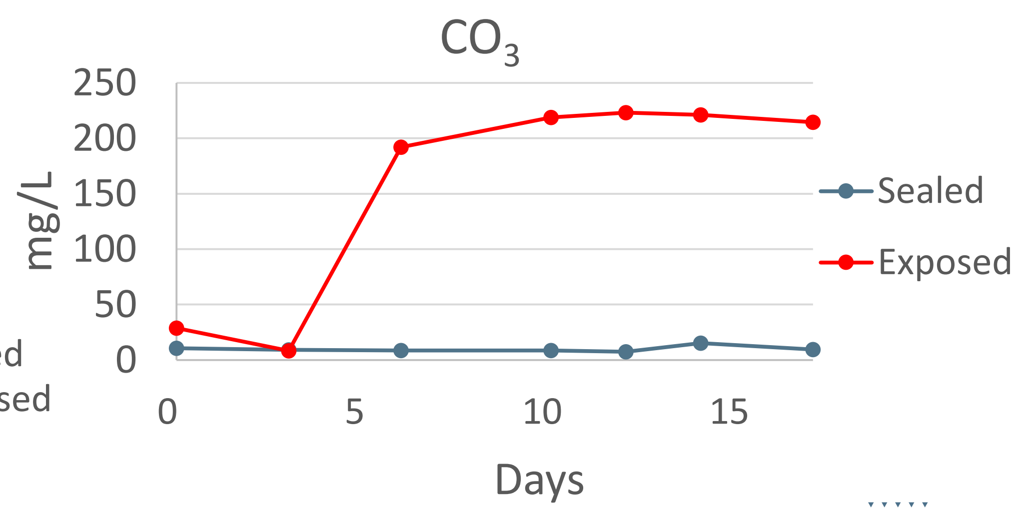
- **Pressure filtration after thickening shows that $Ca(OH)_2$ can have a dramatic influence on filtration equipment performance**
- **Cycle time, cake solids, and density all improves when $Ca(OH)_2$ coagulated tailings are flocculated and thickened before filtration**
- **Thickening and filtration equipment benefit from $Ca(OH)_2$ coagulation**

# Filtrate Quickly Equilibrates

- **Water equilibrates to desirable conditions in a short time**
  - Dissolved $Ca^{2+}$ precipitates when exposed to the $CO_2$ in the air
  - pH neutralizes when exposed to the atmosphere



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# Conclusions

- Ease of mixing $Ca(OH)_2$ removes the necessity of expensive mixing equipment and costly processes for mixing.
- $Ca(OH)_2$ when used as a coagulant in pretreatment to flocculation in settling tube tests radically improved release water clarity and settling.
- Adding $Ca(OH)_2$ to a pressure filtration operation can double filtration rate when compared to polymer alone reducing the amount of required pressure filters.
- The water extracted provides a basic environment without adding more sodium which can be quickly prepared to return to the extraction process.

# Questions?