Evaluation of $CaCO_3$ Slurry for Alkalinity and pH Control of Second Stage RAS at Spokane County Regional WRF

PNCWA2021
Boise, Idaho

Jacobs

CRC

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Consultants

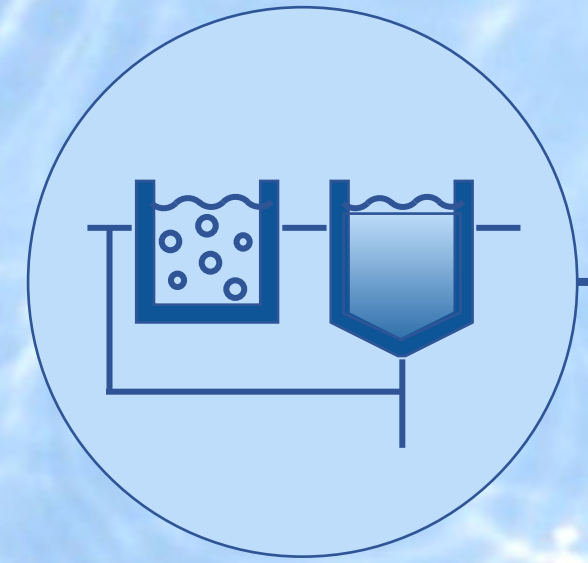
Overview of Presentation

- **Introduction: $CaCO_3$ Slurry (Aquacal 70) in a nutshell**
- Facility Overview
- Operational stability
- Dewaterability of biosolids
- Membrane permeability
- Summary

Aquacal in a nutshell

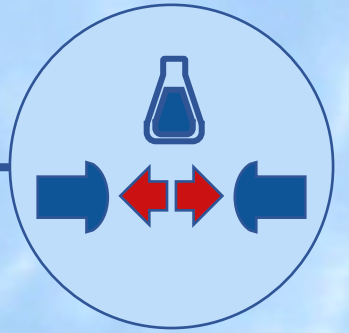
Safe and easy handling

natural raw material

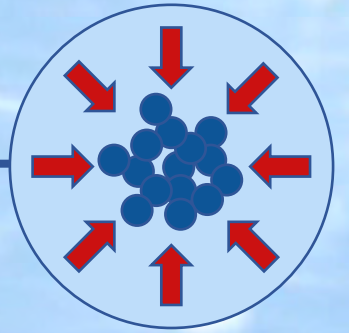


Applied in activated sludge process

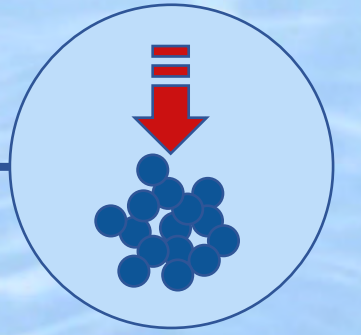
Neutralizes acidity



Stabilizes pH



Improves flocculation



Accelerates sedimentation

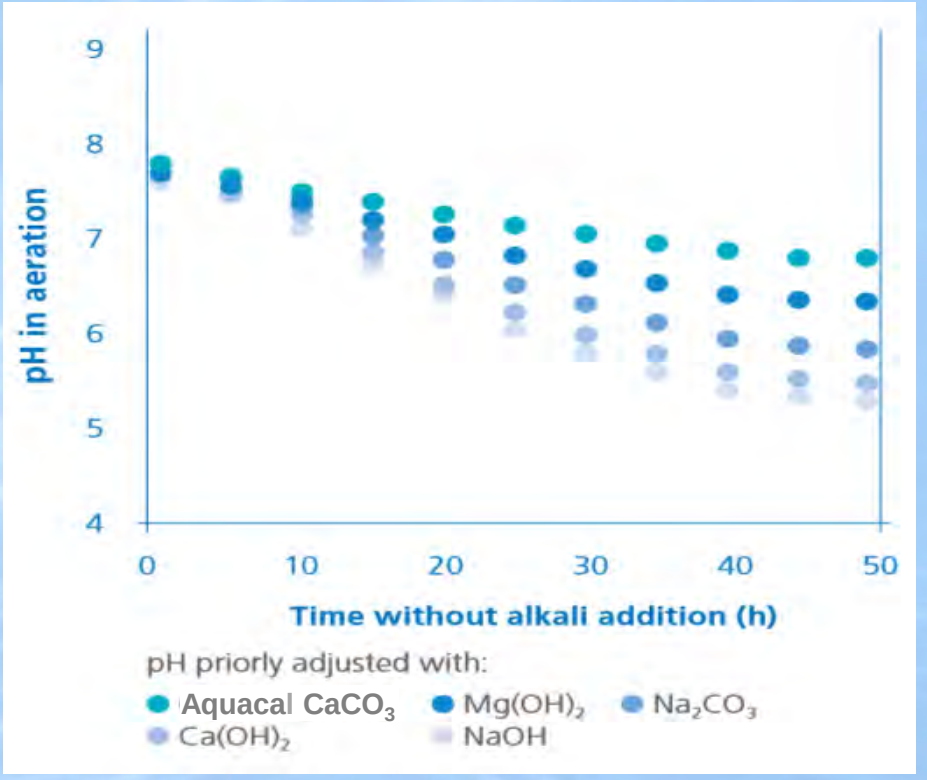
Ease of handling

Aquacal is <u>not corrosive</u> and <u>does not form inorganic scale:</u>

- ➔ clogging of pipes can be ruled out
- ➔ maintenance costs and man-hours are significantly reduced
- ➔ process onstream time is increased

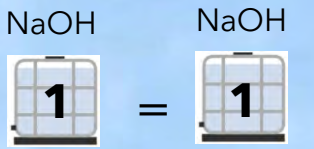
Ease of dosing

<u>Overdosing</u> with Aquacal is <u>not possible</u> and it provides the longest lasting buffering effect of all alkalies on the market.



Expected alkali consumption

$NaOH + HCl \rightarrow NaCl + H_2O$

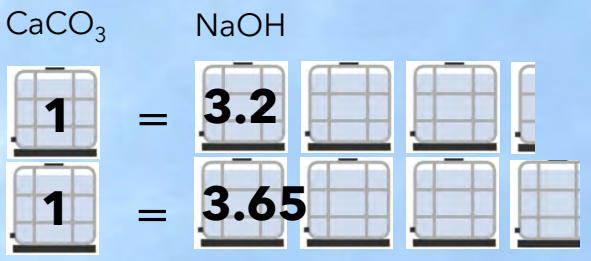


$CaCO_3 + 2\,HCl \rightarrow CaCl_2 + 2H_2O + CO_2$

Volume conversion ratio:

71 %-$CaCO_3$: 25 % NaOH = 1 : 3.2 (Aquacal 70)

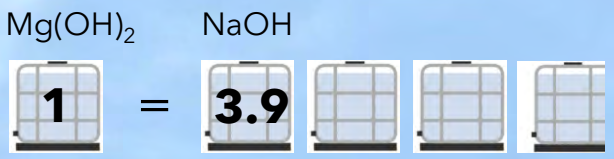
76 %-$CaCO_3$: 25 % NaOH = 1 : 3.65 (Aquacal 150)



$Mg(OH)2 + 2\,HCl \rightarrow MgCl_2 + 2\,H_2O$

Volume conversion ratio:

60%-$Mg(OH)_2$: 25 % NaOH = 1 : 3.9



➔ The most accurate way to compare between excepted alkali dosages is by conversion according to stoichiometric chemistry

Expected alkali consumption

Alkali	Calcium Carbonate		Sodium Hydroxide		Magnesium Hydroxide	Calcium Hydroxide
Common Name	Ground Calcium Carbonate		Caustic Soda		Mag Hydroxide	Slaked Lime, Hydrated Lime
Chemical Formula	$CaCO_3$		NaOH		$Mg(OH)_2$	$Ca(OH)_2$
Alkalinity lb $CaCO_3$	1.00		1.23		1.68	1.32
%Active Alkali in Solution/Slurry	**71**	**76**	25	50	60	34
lb $CaCO_3$ Equiv. / Gallon Solution	**10.7**	**12.5**	3.8	7.6	12.9	4.7
lb OH – Equiv. / Gallon Solution	0.35	0.37	0.215	0.43	0.57	0.45
Buffering pH	**8.5**		>10	>10	9.5	>10
Cost Comparison	**$**		$$$		$$$	$

Key drivers for alkalinity consumption at the SCRWRF

- **Use of ferric chloride**

  $FeCl_3 + 3\ H_2O \rightarrow Fe(OH)_3 + 3\ HCl$
  Each lb. of $FeCl_3$ consumes 0.92 lb. of alkalinity as $CaCO_3$

- **Nitrification reaction**

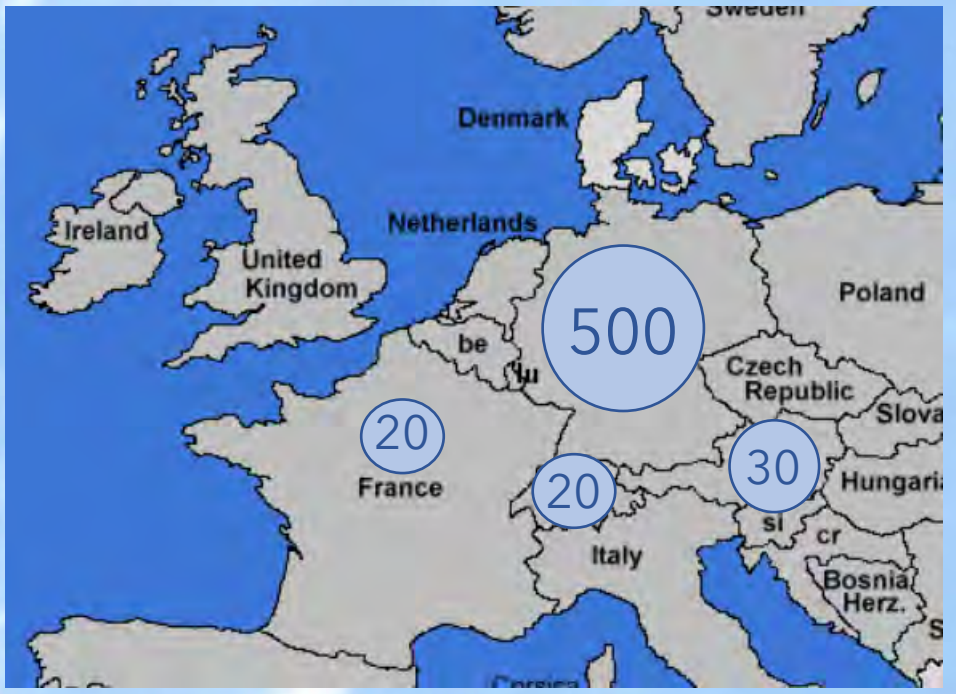
  $NH_4^+ + 2\ O_2 \rightarrow NO_3^- + H_2O + 2\ H^+$
  Each lb. of NH_4-N consumes 7.1 lbs. of alkalinity as $CaCO_3$

➔ Measuring influent alkalinity and using these alkalinity consumption rates can be used to best estimate what alkali demand should be

Market success

These product features have led to a rapid market growth of $CaCO_3$ in Europe for alkalinity and pH control in wastewater treatment plants:

- ➔ First trials with $CaCO_3$ for pH/alkalinity adjustment in wastewater treatment in Germany date back to 2005.
- ➔ Now, with more than 500 customers, $CaCO_3$ is a fully established product for wastewater treatment in the German speaking countries.
- ➔ First initiatives for further market development are currently underway in many countries in Europe and beyond.



Number of wastewater treatment plants using $CaCO_3$ in European wastewater plants

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Facility Overview

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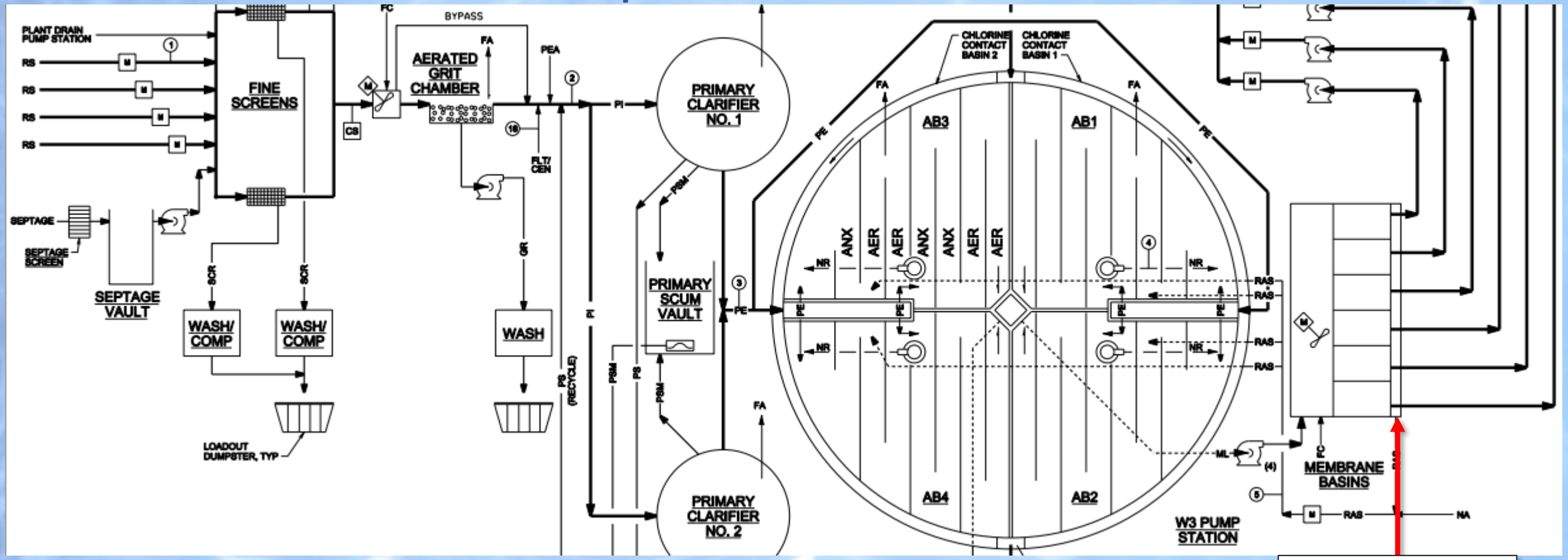
Facility Overview

50	0.25	7-9
ug/L Total Phosphorus	Mg/L Ammonia	S.U. Effluent pH

Demonstration Trial of Aquacal 70 at SCRWRF



Purpose of the trial

- ☑ Completely substitute NaOH by Aquacal 70 for pH/alkalinity adjustment in the activated sludge process
- ☑ Observe extended performance, robustness / flexibility to operational extremes etc.
- ☑ Rule out any unexpected interactions with the existing system
- ☑ Determine the consumption ratio vs. NaOH

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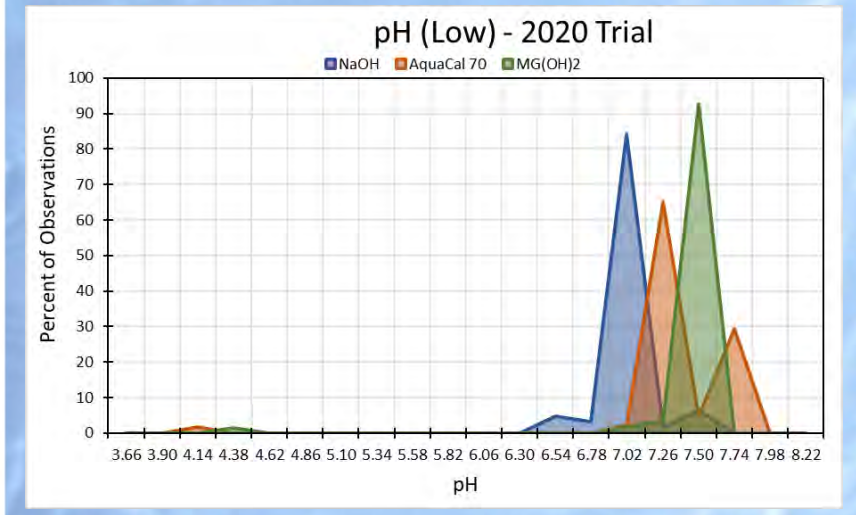
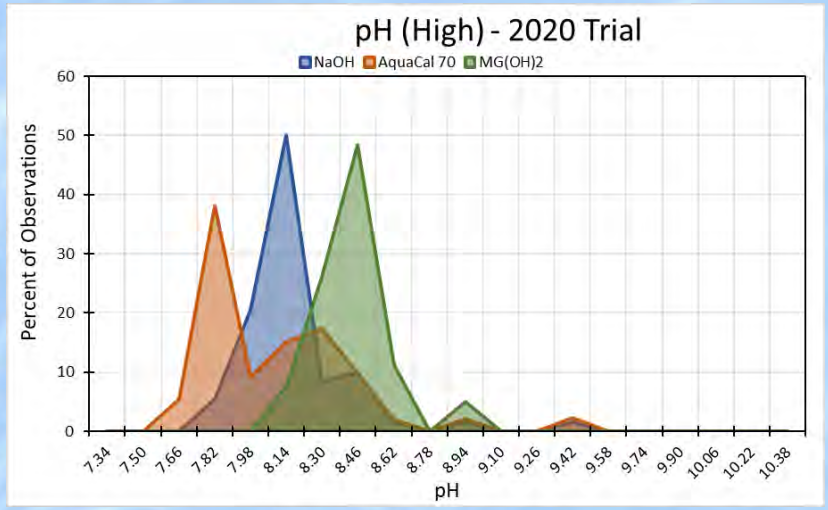
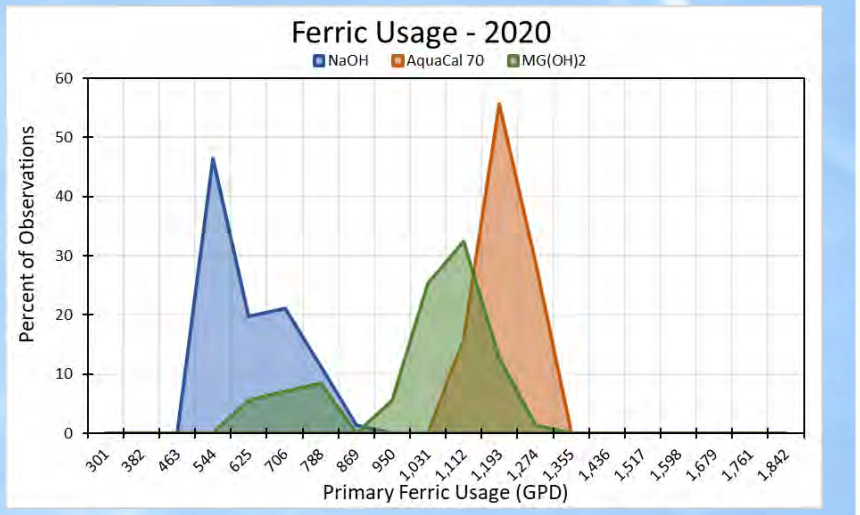
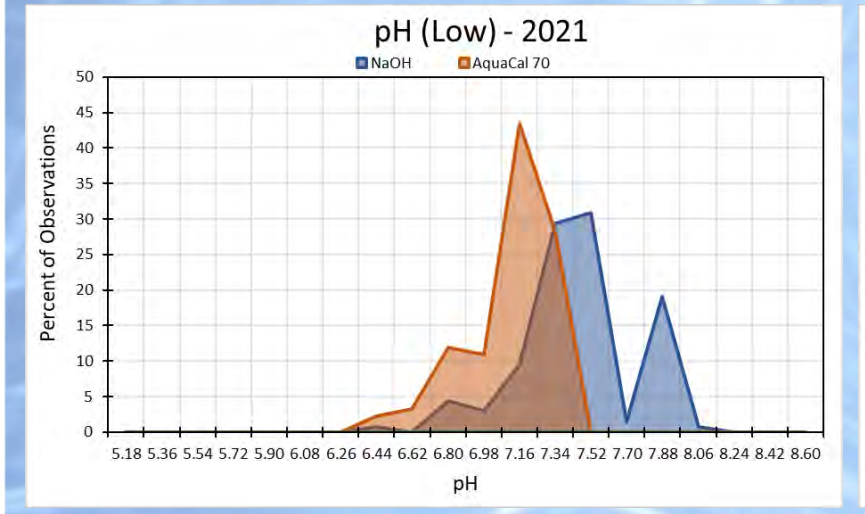
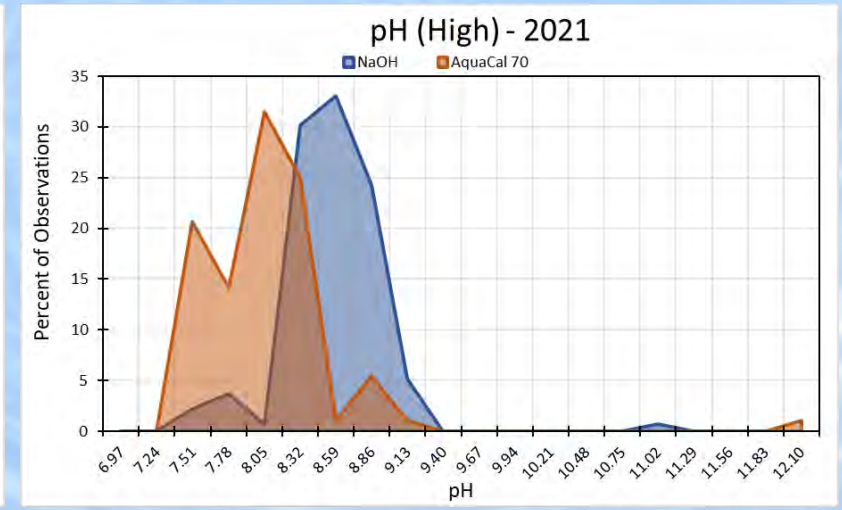
Variability of influent parameters

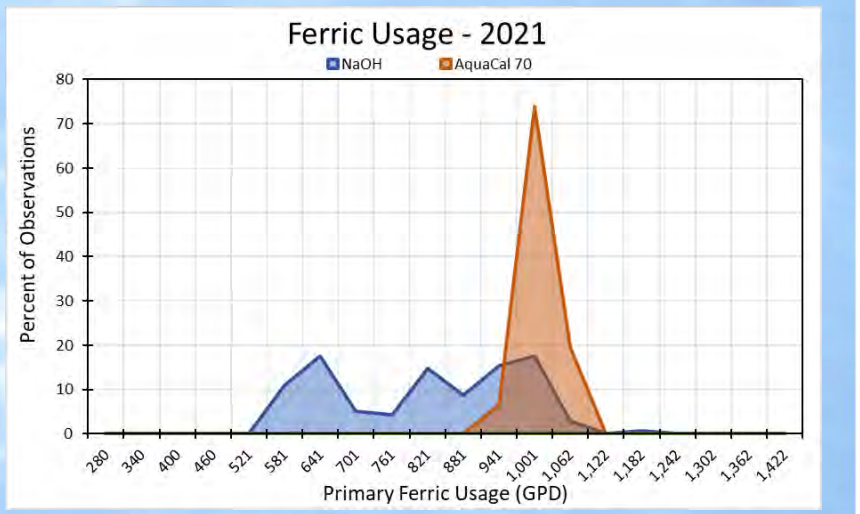






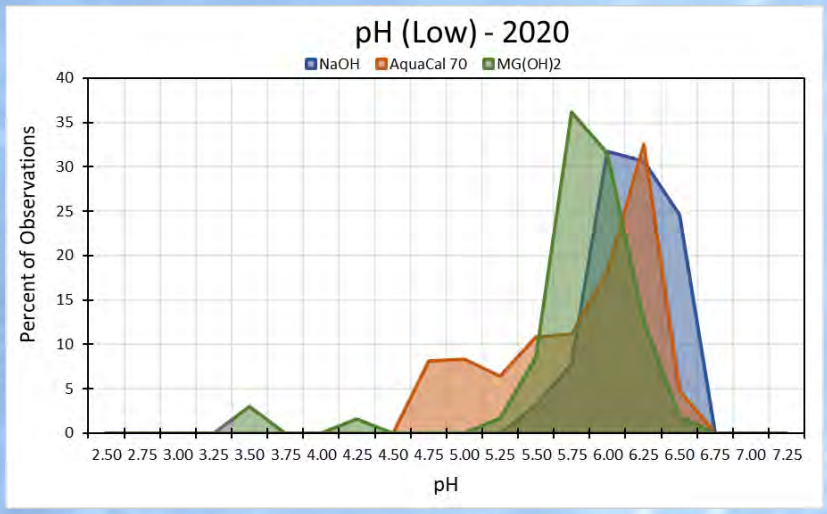


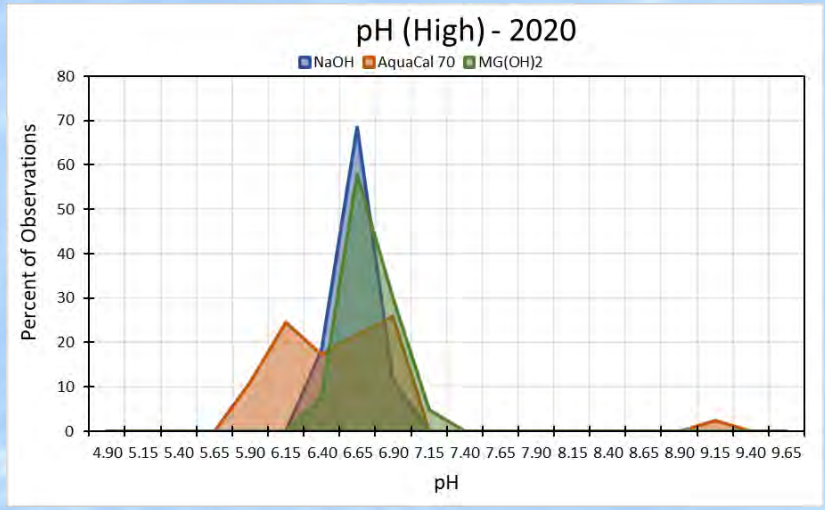


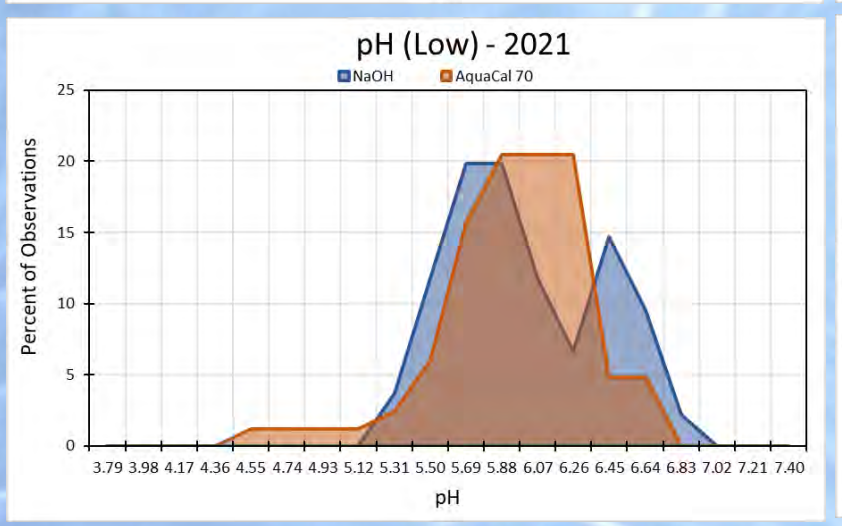


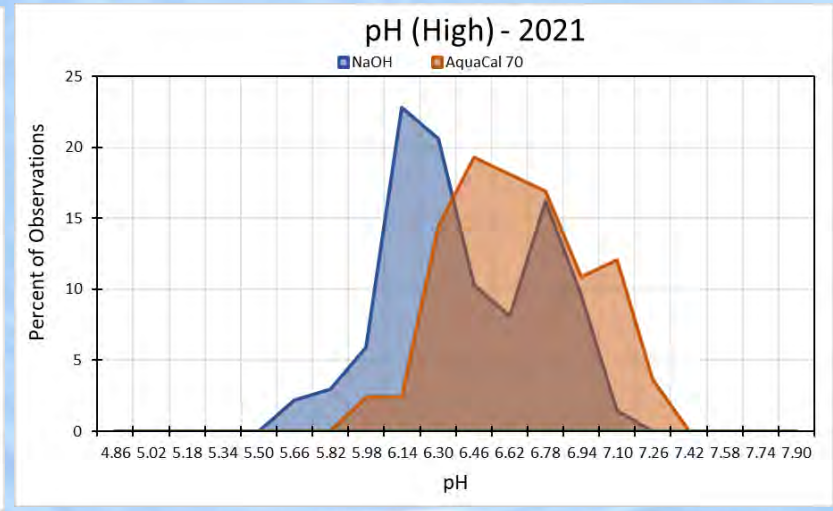
➔ The composition of wastewater is subject to natural fluctuations which often makes a comparison between different periods difficult. However, due to lower incoming pH and higher total usage of Ferric, alkalinity demand was higher during $CaCO_3$ usage

Operational Stability – Mixed Liquor



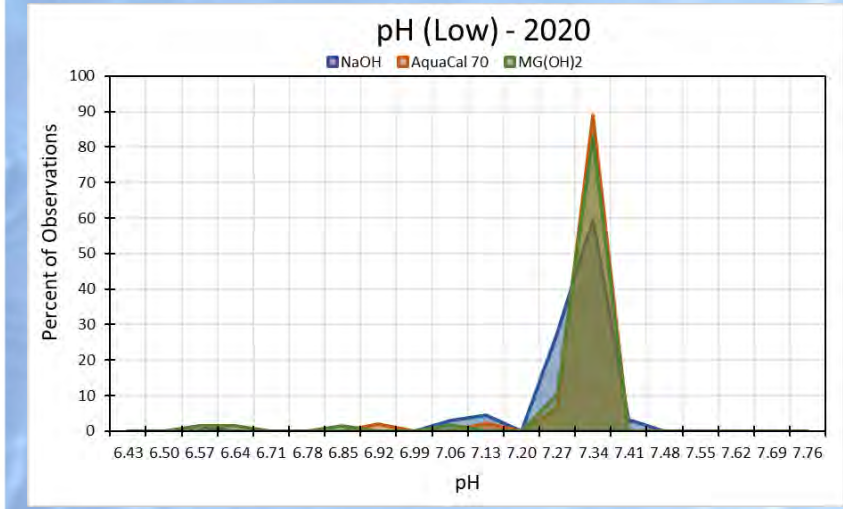


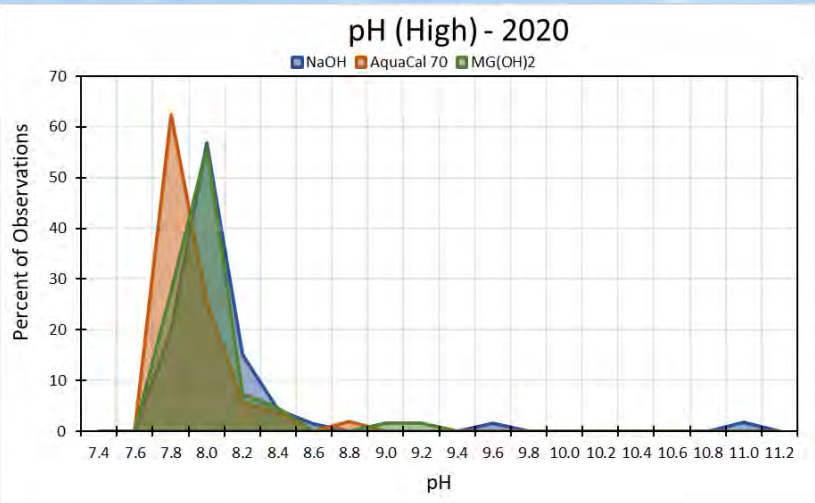


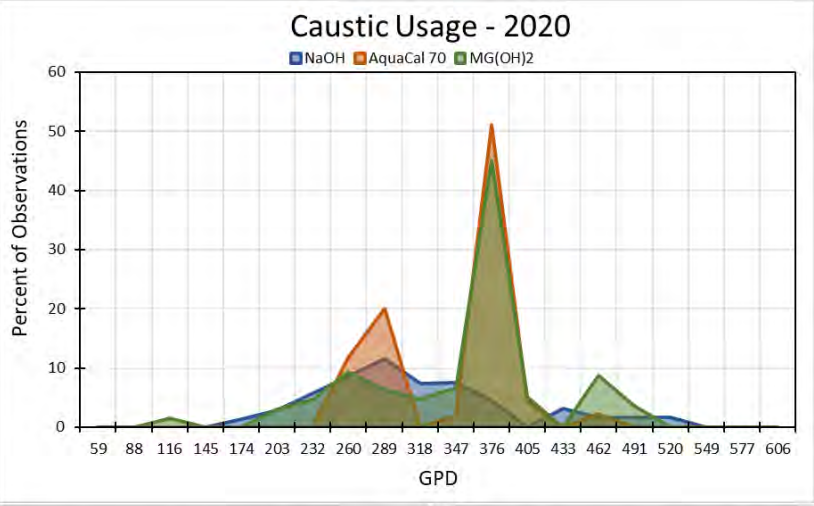


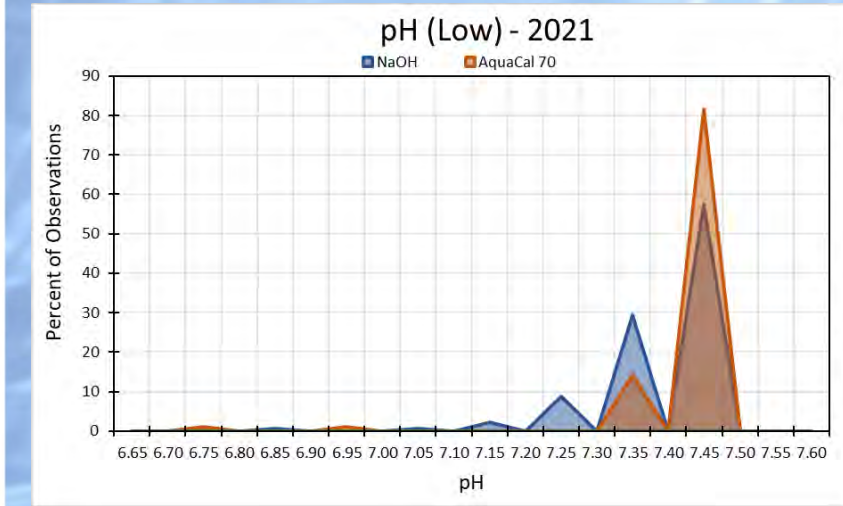
➔ In 2021 the 25% NaOH was not able to maintain a suitable high pH for Nitrification – Aquacal 70 was brought via an unagitated bulk baker tank and pH normalized to within the optimal range

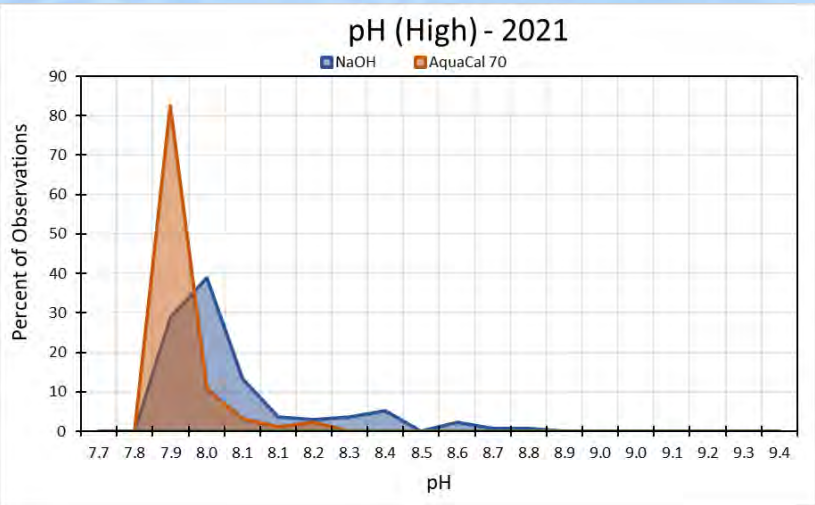
Operational Stability – Effluent

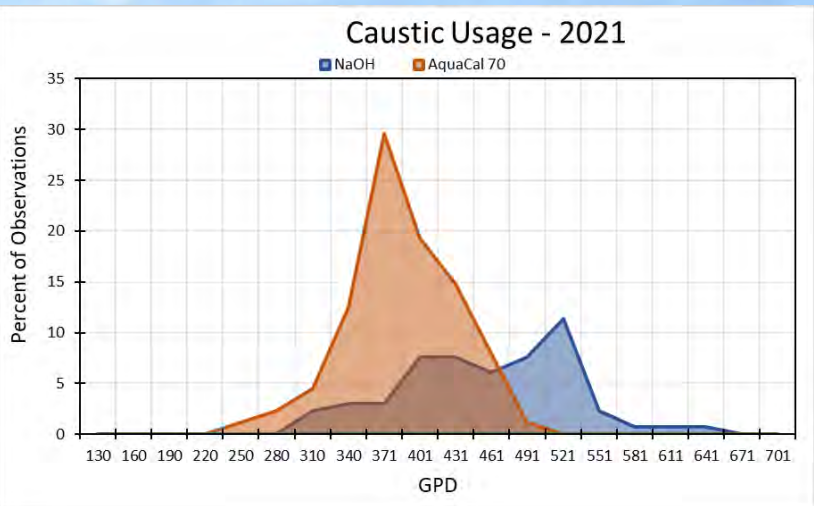












➔During both the trial period and transition back to Aquacal in 2021 – both pH and effluent caustic usage stabilized while the plant operator reported a very stable process operation

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- **Dewaterability of biosolids**
- Membrane permeability
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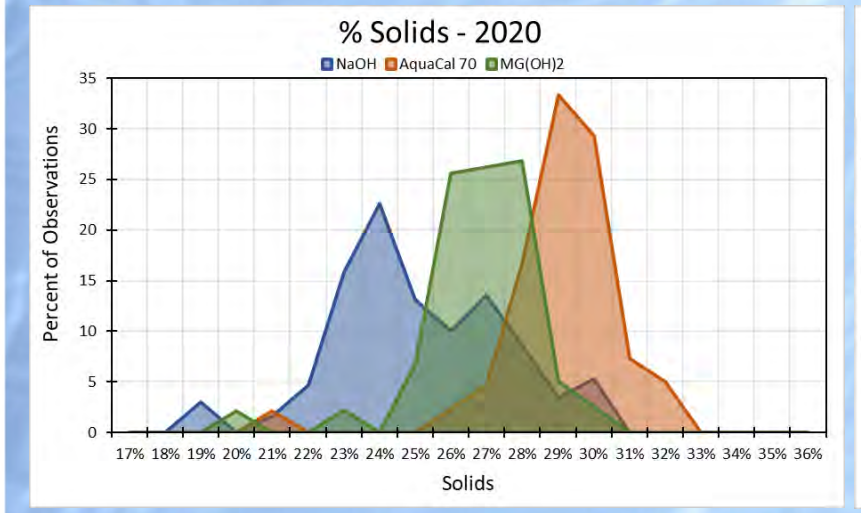
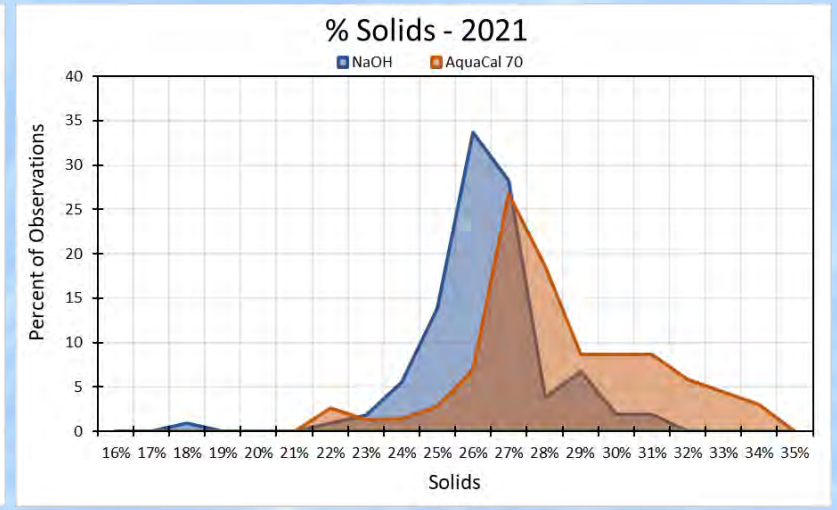
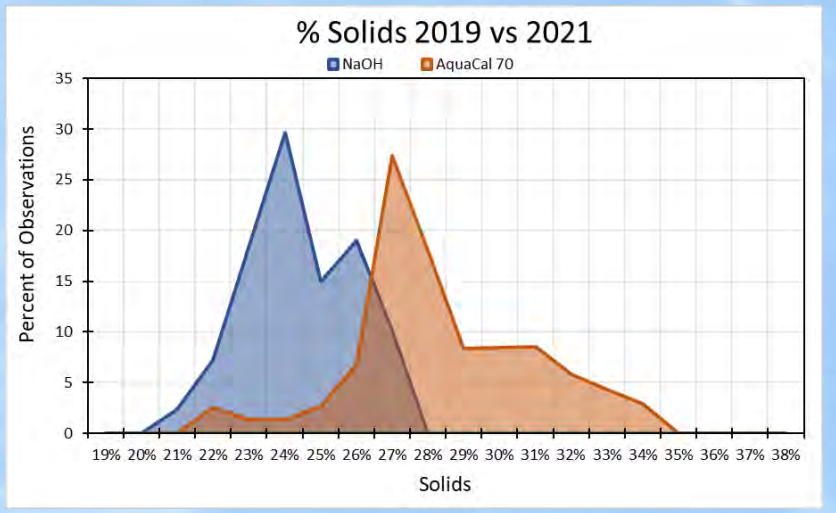
Dewatering





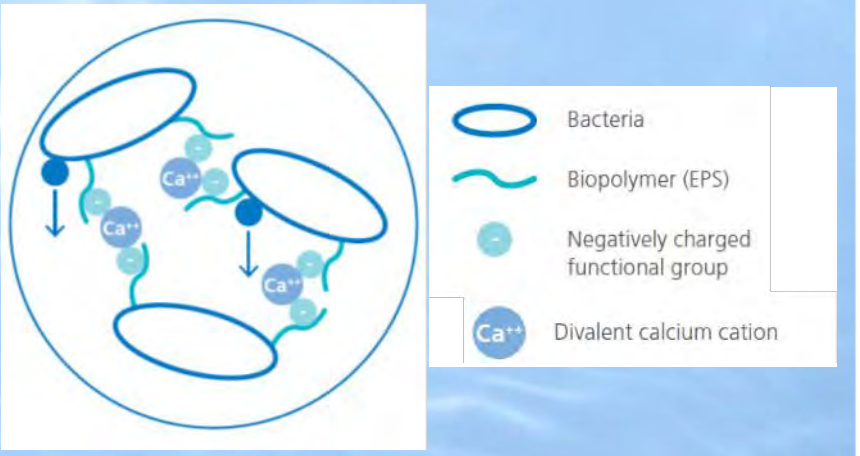


➔Sludge dewaterability greatly improved

➔The increase from 23.3% to 28% in 2020 would result in a decrease of 1500 tons of dewatered sludge per year

➔2021 shows the same comparative increase in solids production through the centrifuges

➔When comparing the same timeframe 2019 vs 2021 we see the same dewatering improvement in the sludge production



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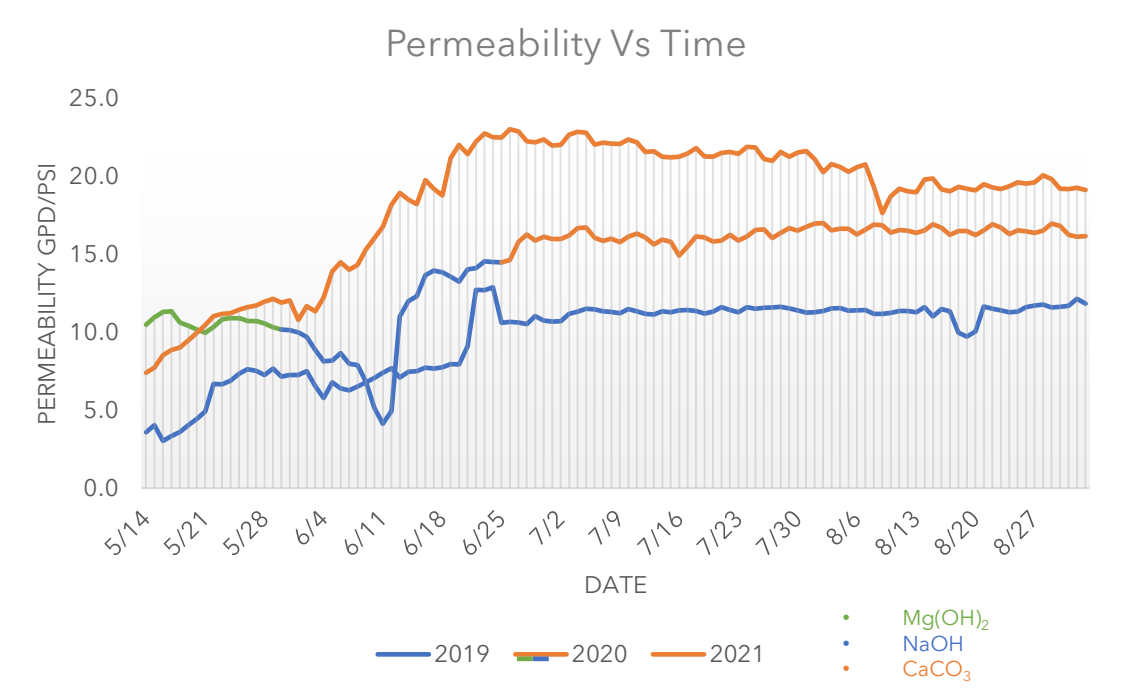
Membrane permeability



- In each year peak permeability coincided during the trial period of Aquacal 70
- Calcium is known to bind dissolved microbial substances which may reduce organic fouling
- Ferric chloride usage as well as seasonally warmer wastewater is known to lead to higher permeability
- A review of permeability comparing operating data from 2019 – 2020 - 2021 is shown below:

2019			2020			2021
Jan 1 - Mar 10	Mar 11 - May 30	June 25 - Sep 26	Jan 1 - Mar 10	Mar 11 - May 30	June 25 - Sep 26	June 25 - Sep 1
25% NaOH for Mixed Liquor Alkalinity			NaOH in ML	Mg(OH)2 in ML	CaCO3 in ML	CaCO3 in ML
Average Outdoor Temperature in Spokane						
35	49.5	70.5	34	49	66.5	73.1
Ave. / StdDev Total $FeCl_3$ (GPD) to SCRWRF						
869 / 62.3	1096 / 20.9	941.6 / 106.0	590 / 40.5	972 / 117.8	1163 / 33.5	987 / 23.8
Avg. / StdDev Membrane Permeability (gpd/psi)						
4.1 / 1.1	**10.3 / 1.8**	**11.8 / 0.2**	**6.3 / 2.5**	**9.1 / 1.4**	**16.3 / 0.6**	**20.8 / 1.3**
	Baseline for $Mg(OH)_2$	Baseline for $CaCO_3$	Improved by 54%	$Mg(OH)_2$ Trial Period	$CaCO_3$ Trial Period	CaCO3 Commercial

Summary

- Use of Aquacal 70 resulted in a stable operation without observing any unexpected contrary effects.
- Caustic soda in the activated sludge process was completely substituted.
- Sludge dewatering significantly improved during the trial, and the reapplication of Aquacal 70 in 2021, greatly reducing the amount of dewatered sludge. However, seasonal patterns and an increased ferric chloride consumption are likely to have an effect as well.
- Permeability peaked during the Aquacal trial period and when compared to the corresponding timeframe in 2019 showing no detrimental effect to membrane operations

Thank you!

Questions?

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