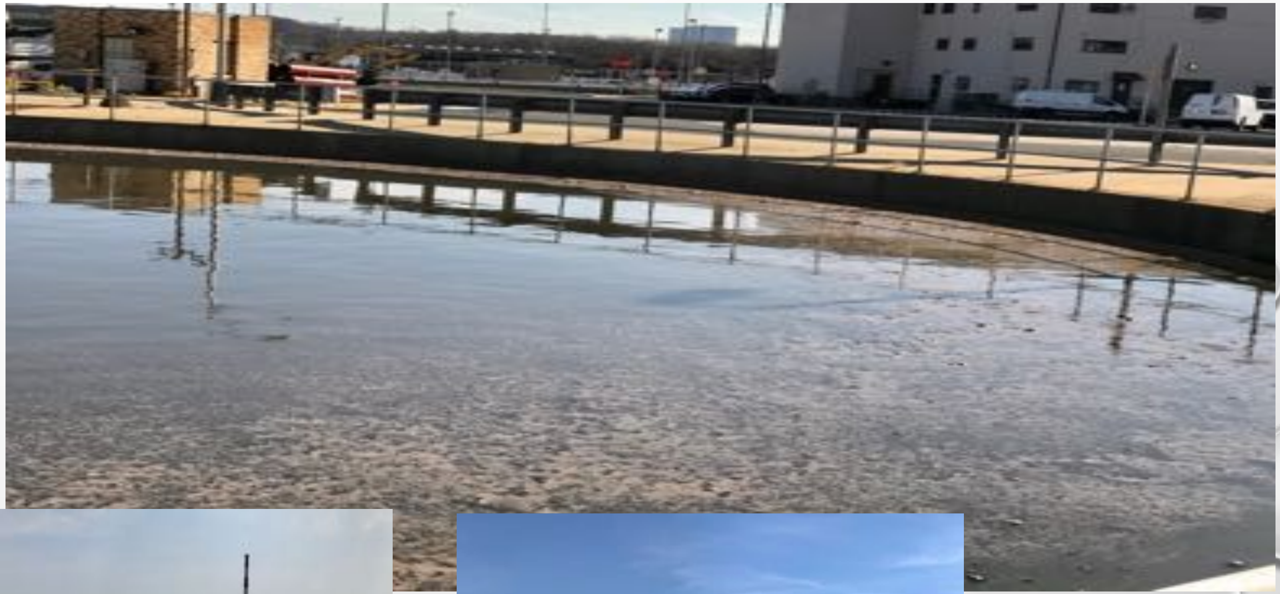
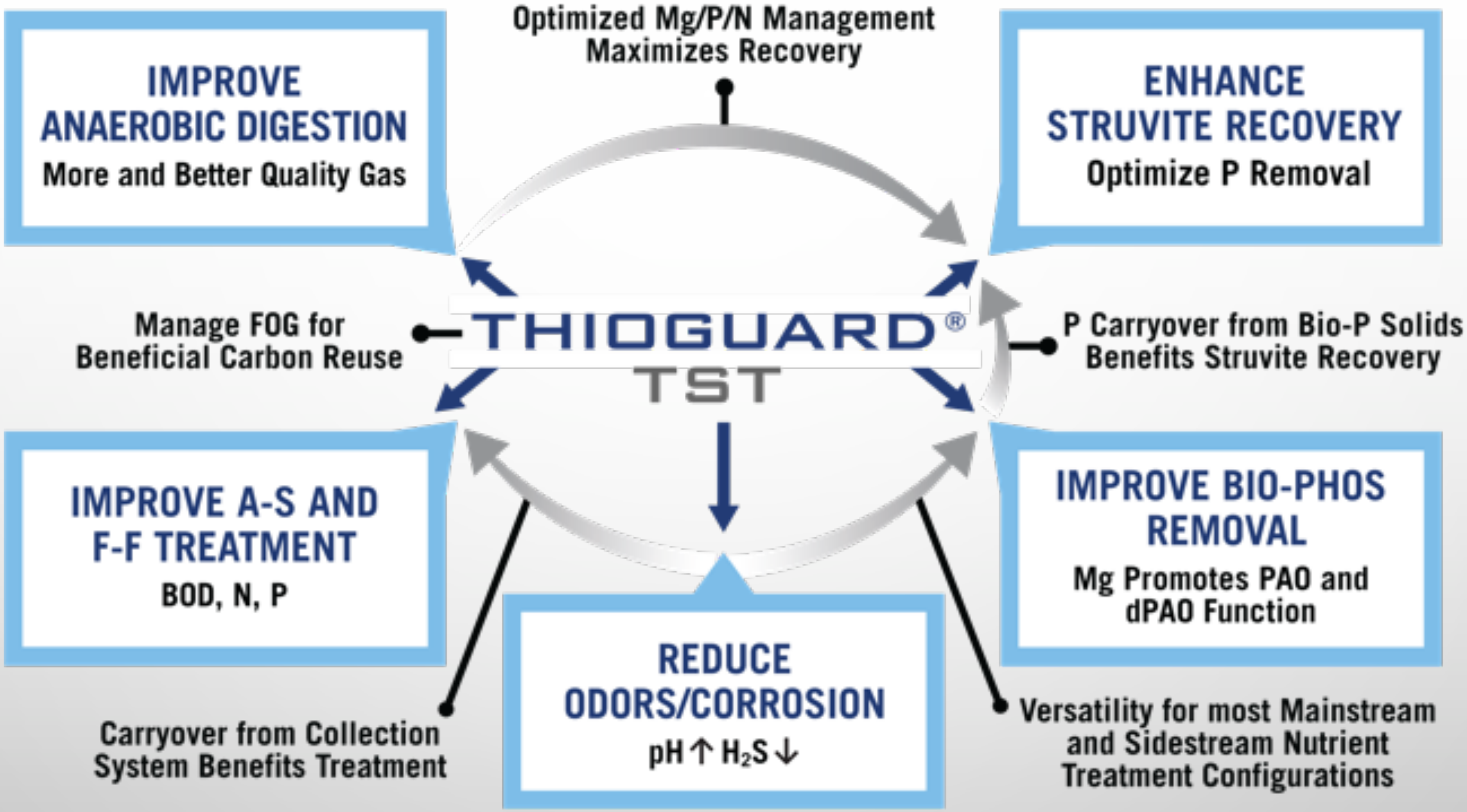
GREASE

SUSTAINED SOLUBILITY AND IMPROVED FLOWABILITY AND CLARIFIER SETTLING WITH MAGNESIUM HYDROXIDE



GOALS

1. BASIC MECHANISM AND CHEMISTRY OF GREASE CONTROL WITH HYDROXIDE
2. DOSAGE AND TESTING
3. CASE STUDIES


Optimized Mg/P/N Management
Maximizes Recovery
IMPROVE
ANAEROBIC DIGESTION
More and Better Quality Gas
ENHANCE
STRUVITE RECOVERY
Optimize P Removal
Manage FOG for
Beneficial Carbon Reuse
THIOGUARD®
TST
P Carryover from Bio-P Solids
Benefits Struvite Recovery
IMPROVE A-S AND
F-F TREATMENT
BOD, N, P
IMPROVE BIO-PHOS
REMOVAL
Mg Promotes PAO and
dPAO Function
REDUCE
ODORS/CORROSION
pH ↑ H_2S ↓
Carryover from Collection
System Benefits Treatment
Versatility for most Mainstream
and Sidestream Nutrient
Treatment Configurations

HISTORY SO FAR

- TREATING FOR ODORS IN THE COLLECTION SYSTEM FOR 20 YEARS
- ALWAYS NOTICED GREASE WOULD GO AWAY WHEN ADDING FOR ODOR CONTROL.
  NOTE: IT WOULD **NOT REFORM DOWNSTREAM**.
- USED IN PACKAGE WWTP AND INTERCEPTOR WET WELLS
- CONFIRMED EFFECTS DURING OH DIGESTER STUDY
- RECENTLY ASKED TO LOOK AT INSIDE TWO MAJOR FACILITIES
  - ALREADY PERFORMED IN ONE 180+ MGD FACILITY IN MD

CHEMISTRY AND THE MECHANISM OF GREASE CONTROL

Common Hydroxides

This section will discuss the three common sources of hydroxide chemistry encountered in the wastewater industry, their relative strength, handling/safety, quality and application

- Lime – Calcium Hydroxide – $Ca(OH)_2$
- Caustic – Sodium Hydroxide – $NaOH$
- Milk of Magnesia – Magnesium Hydroxide –$Mg(OH)_2$

Lime –Calcium Hydroxide

Lime can be obtained in the powder or slurry form. If sludge sludge disposal and scaling are not a concern, it can be cheap chemical for controlling pH (alkalinity). Within a few feet of the addition point, it can raise the pH anywhere up to 12.5 standard units (s.u.).

- Slurry concentrations up to 40%.
- EPA states that lime addition in some cases can add as much a 50% more sludge for disposal.
- Certain dosages can kill treatment plant bacteria and form sludge through water softening.

Caustic Soda –Sodium Hydroxide

Caustic soda is general supplied in the liquid form with a freezing point of 50 ° F at 50% concentration by weight. If storage can be maintained above freezing and scaling is not a concern, it can be an alternative for controlling pH (alkalinity). Within a few feet of the addition point, it can raise the pH anywhere up to 13 standard units (s.u.) and the concentrated liquid can cause sever burns.

- Increased single charged ions, like sodium, can cause problems with pin floc, dispersion, and settling.
- Accidental overdose will almost certainly kill treatment plant bacteria.

Milk of Magnesia–Magnesium Hydroxide

Magnesium Hydroxide can provide alkalinity as a slurried hydroxide ranging 58-59% by dry solids weight or as a Magnesium Oxide powder. The slurry has a freezing point at or just below that of water. Overdosing of the slurry will have little impact on the biology or effluent discharge limits.

- Magnesium is a big part of the energy production in biology.
- For batch systems visited once or twice a week, a couple days worth of chemical can be added all at once.
- No reportable spill amounts or fish kills.

Greatest Advantage/Caution

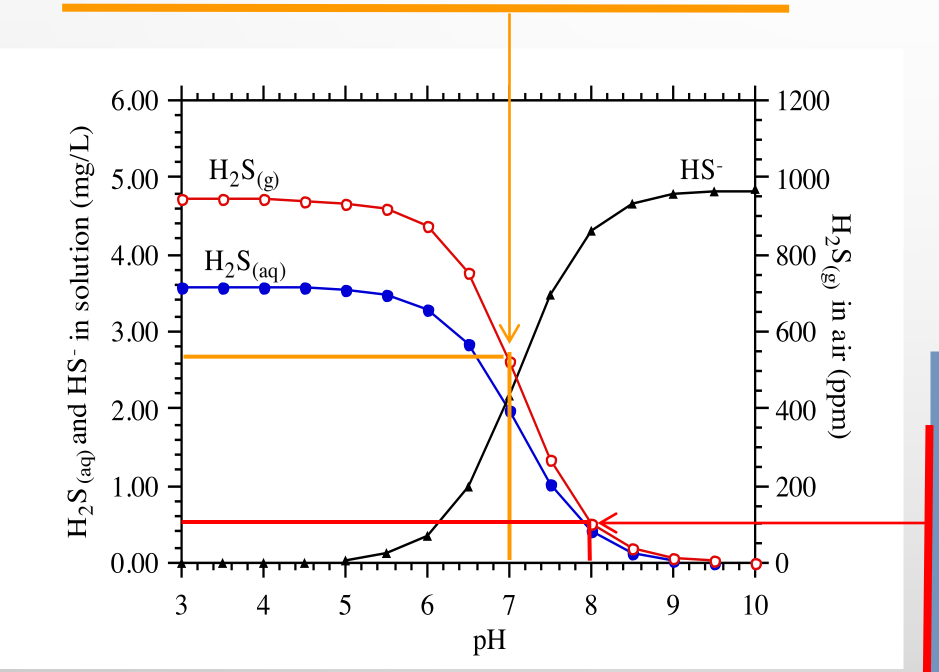
Caution

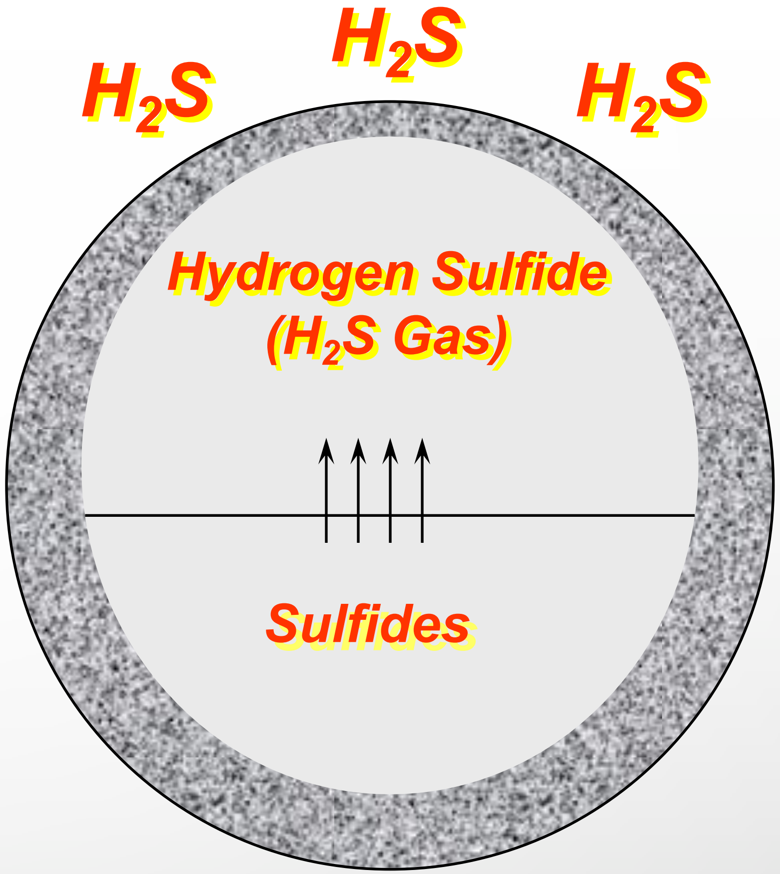
- Caustic – chemical burn risk
- Lime – softening/scaling/sludge costs
- Milk of Magnesia – turbidity

Advantage

- Caustic - completely soluble
- Lime - get it anywhere
- Milk of Magnesia - doesn’t drive pH above 9 su

In water at pH 7, about 50% of the dissolved sulfide converts to H_2S gas.





Water at pH 8.0, retains over 90% of the dissolved sulfide.

Saponification

BREAK DOWN……………….Decompose

By raising the pH of the wastewater to 8 or higher, Magnesium Hydroxide breaks fats (FOG) down into a mild soap and glycerol. Glycerol is then consumed at the plant or in the collection system by the biology.

FATTY ACID

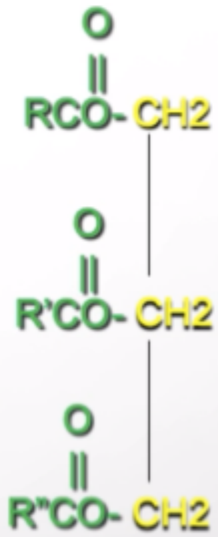
GLYCEROL

CARBOXYLATE SALTS - SOAP

DECOMPOSE GREASE

SAPONIFICATION MECHANISM

Low-density, long-chain fatty acids accumulate on the water surface of low velocity structures and can build up on pipe walls causing occlusion and eventually SSOs.



FATTY ACID

DECOMPOSE GREASE

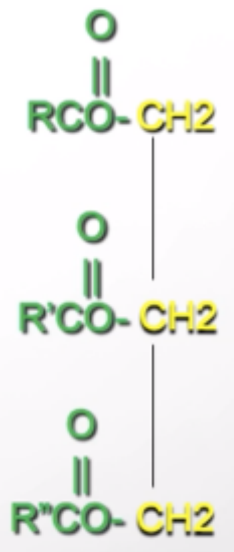
SAPONIFICATION MECHANISM

THIOGUARD ($Mg(OH)_2$) slowly releases hydroxyl ions which breakdown low-density, large-chain fatty acids (FOG) into glycerol and various types of soap, both of which are more readily digested by bacteria in wastewater.

OH-

OH-

OH-



TG HYDROXYL IONS

FATTY ACID

DECOMPOSE GREASE

SAPONIFICATION MECHANISM

THIOGUARD ($Mg(OH)_2$) slowly releases hydroxyl ions which breakdown low-density, large-chain fatty acids (FOG) into glycerol and various types of soap, both of which are more readily digested by bacteria in wastewater.

CARBOXYLATE SALTS - SOAP

GLYCEROL

DECOMPOSE GREASE

SAPONIFICATION MECHANISM

The mild soaps that are produced further facilitate the breakdown of accumulated blankets by solubilizing FOG's.

CARBOXYLATE SALTS - SOAP

GLYCEROL - TO DIGESTERS

DOSAGE DETERMINATION

OLD HISTORY

- THE AFORE MENTIONED PHENOMENON IS NOT UNCOMMON IN **THIOGUARD ODOR STUDIES** WHERE GREASE IS PRESENT.
- THERE THE SAME **PH (8-8.2)** WHERE YOU HAVE OPTIMUM H_2S GAS REDUCTION, GREASE/FOG IS CHEMICALLY BROKEN DOWN.
- THE GREASE IS BROKEN INTO **SOAP AND GLYCEROL**.
- THE **SOAP** THEN ACTS ON EXISTING GREASE.
- GLYCEROL IS AN EASILY CONSUMED **CARBON SOURCE** BY THE MICRO-ORGANISMS IN THE COLLECTION SYSTEM AND WWTP PREVENTING THE SAME AMOUNT OF GREASE REFORMATION.
- WWTP **PHS AT 8.0** ARE ALSO GAINING ACCEPTANCE TO IMPROVE THE BIOLOGICAL ENVIRONMENT.

CALCULATING/ESTIMATING DOSAGE

The best way to get a good approximation of how much magnesium hydroxide you will need for odor control is to do a jar test to an endpoint of 8.2 su with a wastewater sample from the point where the odor is a problem. The same target pH applies for grease control.

- **For odor control**: the rule of general thumb dosage for gravity or force-main odor control is 50-60 gallons of slurry per MGD. (Full range is 30-100 gallons per MGD). If using MgO powder, that is 30 dry lbs per 100,000 gallons of wastewater. Depending on the amount of grease and BOD in the system, these amounts could be as much as 30% higher.

- **For alkalinity supplementation**: 1 gallon of slurry provides approximately 13 lbs of alkalinity as Calcium Carbonate (that's about 5 lbs of MgO powder). So you get about 1.5 ppm carbonate alkalinity for every gallon (or 5 lbs of MgO) into 1 MGD of wastewater. Every ppm of Ammonia then requires about 7.14 ppm of alkalinity as Calcium Carbonate.

NEW HISTORY

IT'S NO ACCIDENT ANYMORE

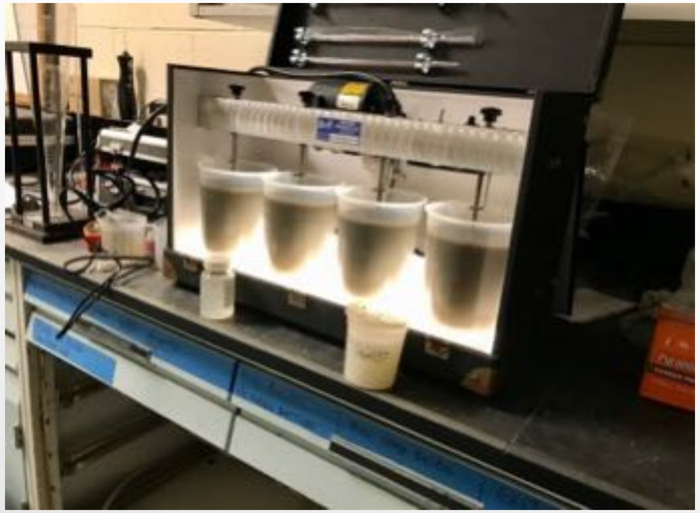
1. Focus on softening or complete decomposition.
2. What are effects downstream?
3. What are effects on gas production and quality for anaerobic digesters?

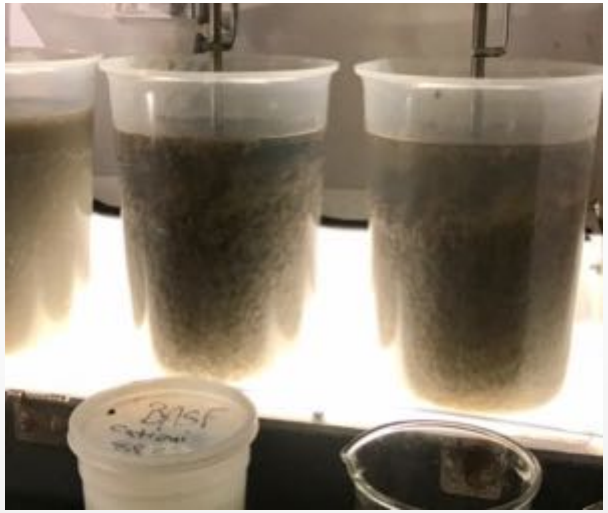
JAR TESTING PROTOCOL (THICKENER/CLARIFIER CLEANING SIMULATION)

- CONFIRM VOLUME OF EACH
  BASIN BEING CLEANED

- ESTIMATE AMOUNT OF GREASE IN EACH BASIN TO BE CLEANED (SURFACE AREA AND THICKNESS)
- GATHER SAMPLE OF GREASE TO BE USED FOR IN JAR TESTING
- JAR TEST TO DETERMINE OPTIMAL AMOUNT OF THIOGUARD ($Mg(OH)_2$) FOR GREASE DECOMPOSITION
  (6-8 HRS AT WWTP LABORATORY LOCATION)
- **BEST PRACTICES - FINDINGS, REMEDIATION AND APPLICATION PILOT RECOMMENDATIONS**

IN LABORATORY JAR TESTING

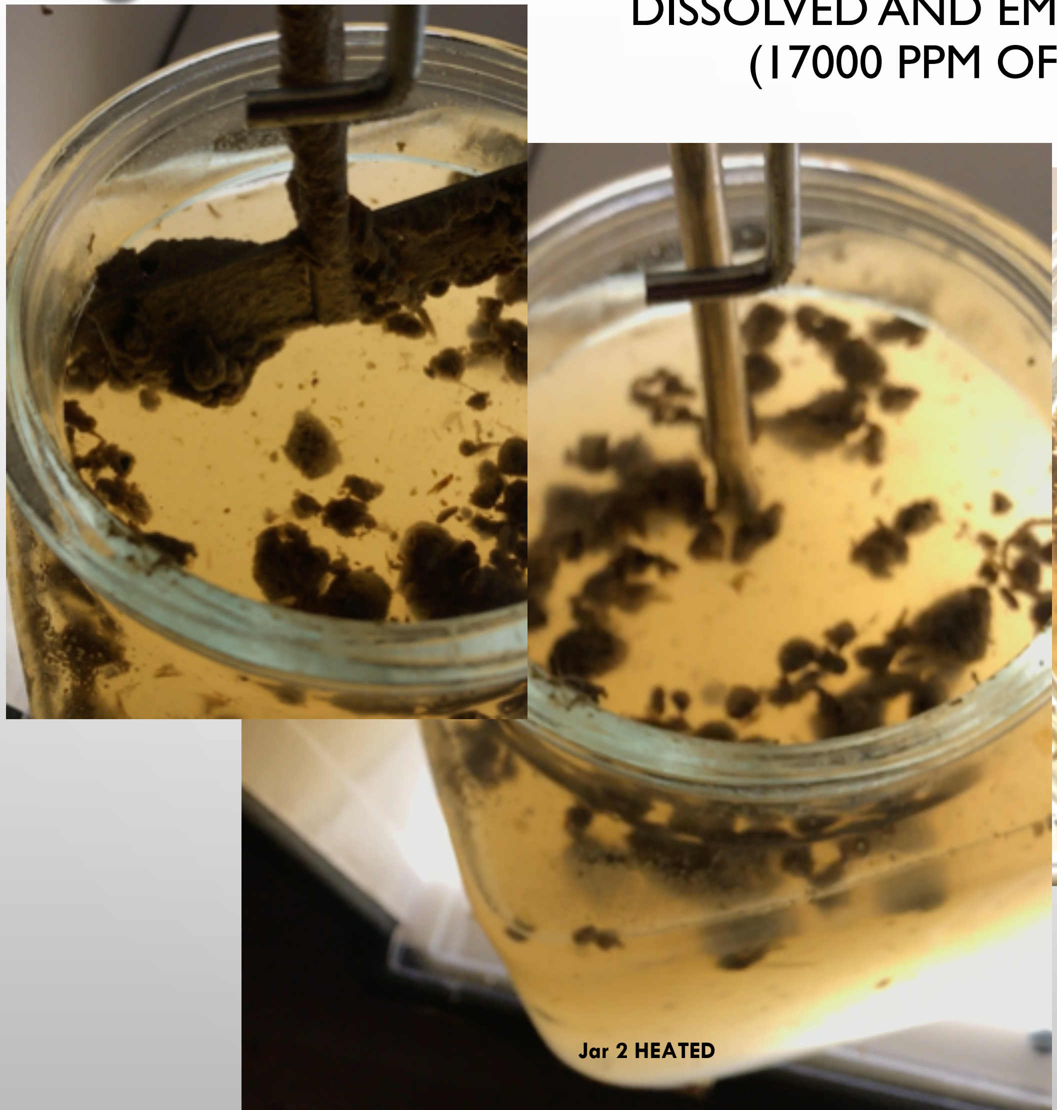




On the following page is an illustration of the results of jar testing done to determine how much $MgOH_2$ slurry is needed to dissolve grease and break out to settle any debris that has been cemented into the grease blanket.

1500 GALLONS PER MILLION OF THIOGUARD® ($Mg(OH)_2$) BEFORE AND AFTER HEATING (98-110 °F)

DISSOLVED AND EMULSIFIED UP TO 51000 PPM OF PST SKIMMINGS
(17000 PPM OF SKIMMINGS INITIAL CONCENTRATION)



Jar 2 HEATED

CLARIFIER CASE STUDY

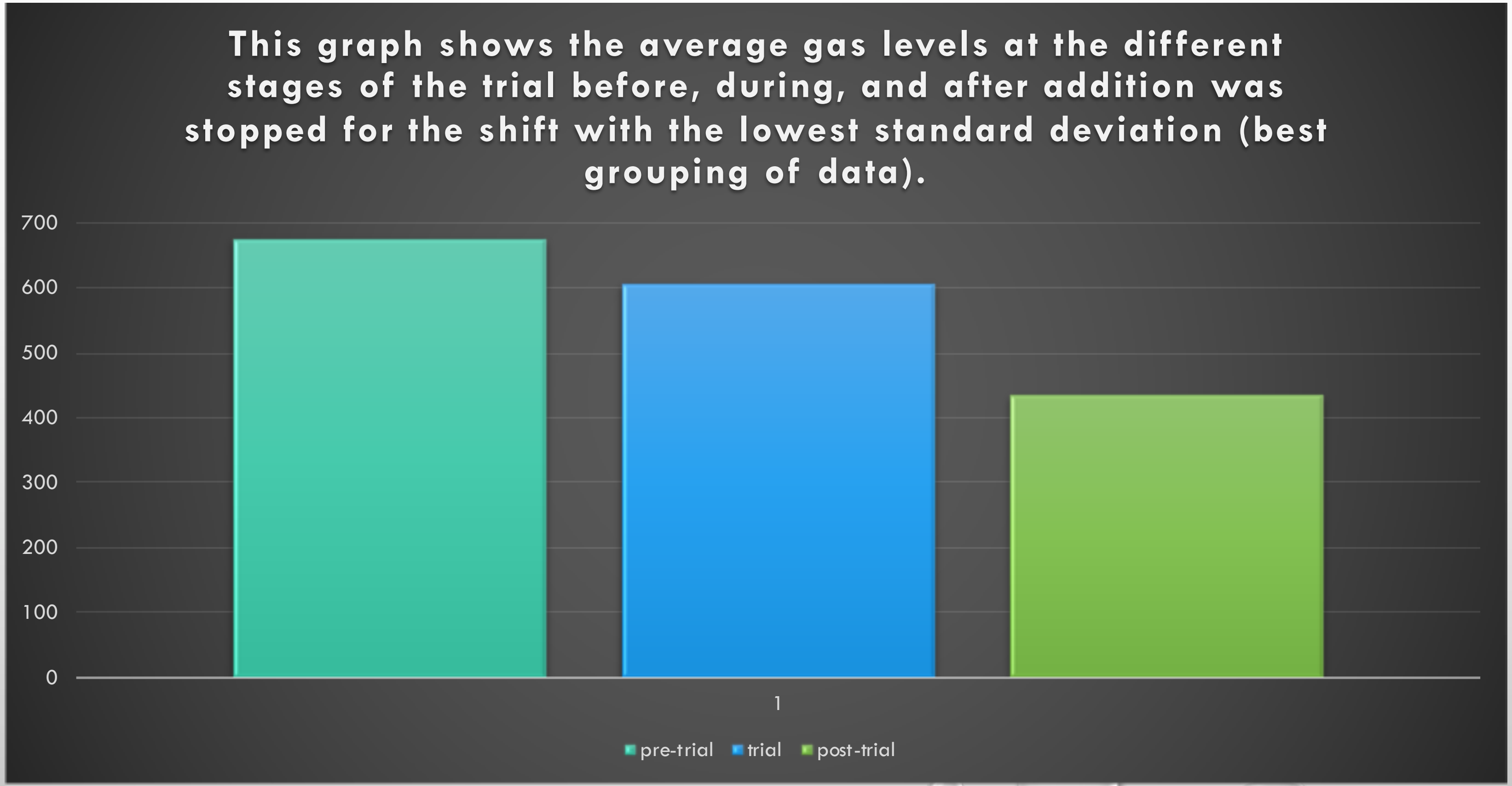
- APPLY TO GREASE BLANKET SURFACE
- ELEVATE CLARIFIER WASTEWATER
- AGITATE

REMEDIATION – SAPONIFICATION MECHANISM

IMPROVED DIGESTION

WHAT WAS THE RESULTING GAS RESPONSE

~35% REDUCTION IN HYDROGEN SULFIDE CONTENT



FOCUS ON DIGESTER 1 RESPONSE

LAB Digester Data Daily 1/1/2018 - 2/28/2018	Digester #1 Ph S.U.	Digester #1 Alkalinity MG/L	Digester #1 Alkalinty-Dup QC MG/L	Digester #1 Volatile Acids MG/L	Digester #1 Volatile Acids QC-Dup MG/L	Digester #1 Vol Acid:Alkalinity Ratio	Digester Volatile Reduction (Cake) %
2/9/2018	7.3	3950	3970	130	160	0.032911392	43.01163362
2/10/2018							
2/11/2018							
2/12/2018	7.6	4280	4290	120	120	0.028037383	45.98820538
2/13/2018	8.3						
2/14/2018	7.4	4630	4650	110	130	0.023758099	45.62450688
2/15/2018	8.5	4850	4810	360	350	0.074226804	48.06044189
2/16/2018							24.92748368
2/17/2018	7.4	4350	4360	150	160	0.034482759	
2/18/2018							
2/19/2018							
2/20/2018	7.5	3810	3940	100	130	0.026246719	19.91947934
2/21/2018	7.3	3820		120		0.031413613	
2/22/2018							28.12878657
2/23/2018	7.3	3290	3330	110	110	0.03343465	
2/24/2018							
2/25/2018							
2/26/2018	7.3	3120	3140	160	170	0.051282051	
2/27/2018							
2/28/2018							
Pre trial Average	7.30	3850.00	4046.67	150.00	160.00	0.039	42.8
Trial Average	7.84	4527.5	4527.5	185.0	190.0	0.040	46.6
Post trial Average	7.35	3510.0	3470.0	122.5	136.7	0.036	28.1

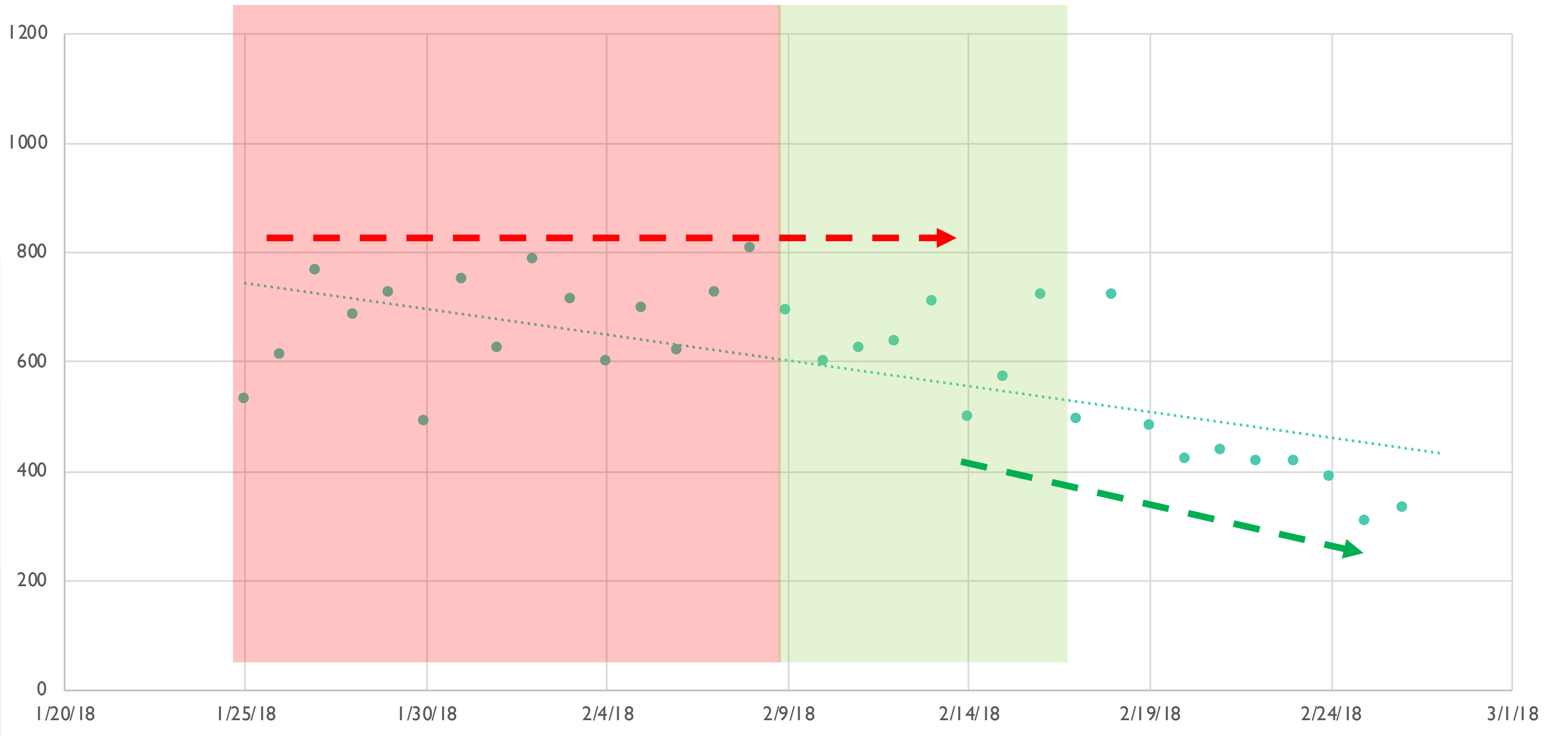
NOTE FROM DIGESTER SESSION YESTERDAY:

When this kind of addition is being done, a reduction in overall gas volume is NOT necessarily a bad thing.

Reducing CO_2 and H_2S?

TREND IN GAS LEVELS

This graph shows the data for the entire period of data collection so far from the shift with the lowest standard deviation (best grouping of data).



COLLECTION SYSTEM CASE STUDY

REAL WORLD GREASE REDUCTION WITH THIOGUARD

TIME LAPSE PHOTOS,

EIGHT YEARS GONE IN EIGHTY DAYS

STARTUP AT 200 GAL/MGD

LARGE PIECES CAN BE SEEN WITH COVERAGE IN NEARLY HALF THE WELL

AFTER 1ST MONTH AT 150 GALLONS/MGD

GREASE BALLS REDUCED IN SIZE AND COVERAGE IS DOWN TO COVER 1/4 OF THE WELL

ANOTHER 50 DAYS AT 100 GALLONS/MGD

SOME LARGER PIECES REMAIN BUT MOST HAS BEEN REDUCED TO LIGHT FOAM

STARTUP AT 200 GAL/MGD

CLOSE UP OF WET WELL PIPE

AFTER 1ST MONTH AT 150 GALLONS/MGD

GREASE BALLS REDUCED IN SIZE AND COVERAGE IS DOWN TO A QUARTER OF THE WELL

ANOTHER 50 DAYS AT 100 GALLONS/MGD

SOME LARGER PIECES REMAIN BUT MOST HAS BEEN REDUCED TO LIGHT FOAM.

SUMMARY

- DECIDE ON WHETHER YOUR GOAL IS SOFTENING OR COMPLETE BREAKDOWN
  - THIS DETERMINES DOSAGE
- HYDROXIDE MILDLY SAPONIFIES FATTY ACIDS (FOG)
- COMPLETE BREAKDOWN OF FOG TO GLYCEROL MAKES "JET FUEL" FOR DIGESTERS
- RAISING PH TO ANAEROBIC DIGESTERS CAN REDUCE PRODUCT GAS H2S AND CO2
- A MAINTENANCE DOSAGE IN THE COLLECTION SYSTEM CAN REDUCE ODORS AS WELL AS GREASE
  - MAINTENANCE DOSAGE COULD BE AS MUCH AS 30% LESS THAN AT STARTUP