Wyoming Clean Water Plant –

Diffuser Health: How much Can It Affect Your Efficiency?

Process Seminar
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REDMON
ENGINEERING
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Background

Wyoming Clean Water Plant

- Average flow 13 MGD
- Design flow 24 MGD
- EBPR activated sludge facility
- Major upgrade in 2006

Wyoming Clean Water Plant

- Aeration system
  - 3 basins operating
  - 3 MG each
  - 5,100 ceramic diffusers in each tank
  - 5 – 500 HP blowers
  - DO setpoint control
- Electrical Usage
  - $660,000 annual aeration cost (50% of facility electrical usage)

Aeration Evaluation

Aeration Evaluation

- Focus on identifying energy-saving improvements

Assess current flows and loadings

Compare process aeration requirements with actual air supplied

Evaluate existing blowers

Evaluate aeration blower and control systems to identify upgrade alternatives

Aeration Evaluation

- Motivating Issues
  - Current loadings nearing rated capacity
  - Consistently running 3 of 5 blowers

Oxygen Transfer Testing

Oxygen Transfer Testing

- Redmon Engineering
  - Dave Redmon – oxygen transfer specialist
  - Co-developer of offgas analysis equipment and methodology
  - Performs clean water and process water oxygen transfer testing (field and laboratory)
  - Provides laboratory diffuser analysis

Oxygen Transfer Testing

- Field Testing
  - Offgas analysis of ceramic disc diffusers
  - Field measurement of
    - Oxygen transfer efficiency
    - αF factor

Alpha & Fouling Factor

- Wastewater Alpha (α):
  - The ratio of oxygen transfer efficiency in wastewater to that in drinking water
- Fouling Factor (F)
  - Describes how much any fouling of the diffusers reduces the actual oxygen transfer efficiency

Offgas Analysis

- In the case of diffused aeration it involves capturing the gas bubbles as they break the liquid surface.
- The offgas is captured with a floating hood and is drawn to an analyzer where it is analyzed for the content of oxygen.

Offgas Analysis

Offgas Analysis

- Comparison of Gas-Phase oxygen content of supply air & offgas
- Measures oxygen transfer efficiency directly
- OTE = Mass O_2 in – Mass O_2 out /Mass O_2 in

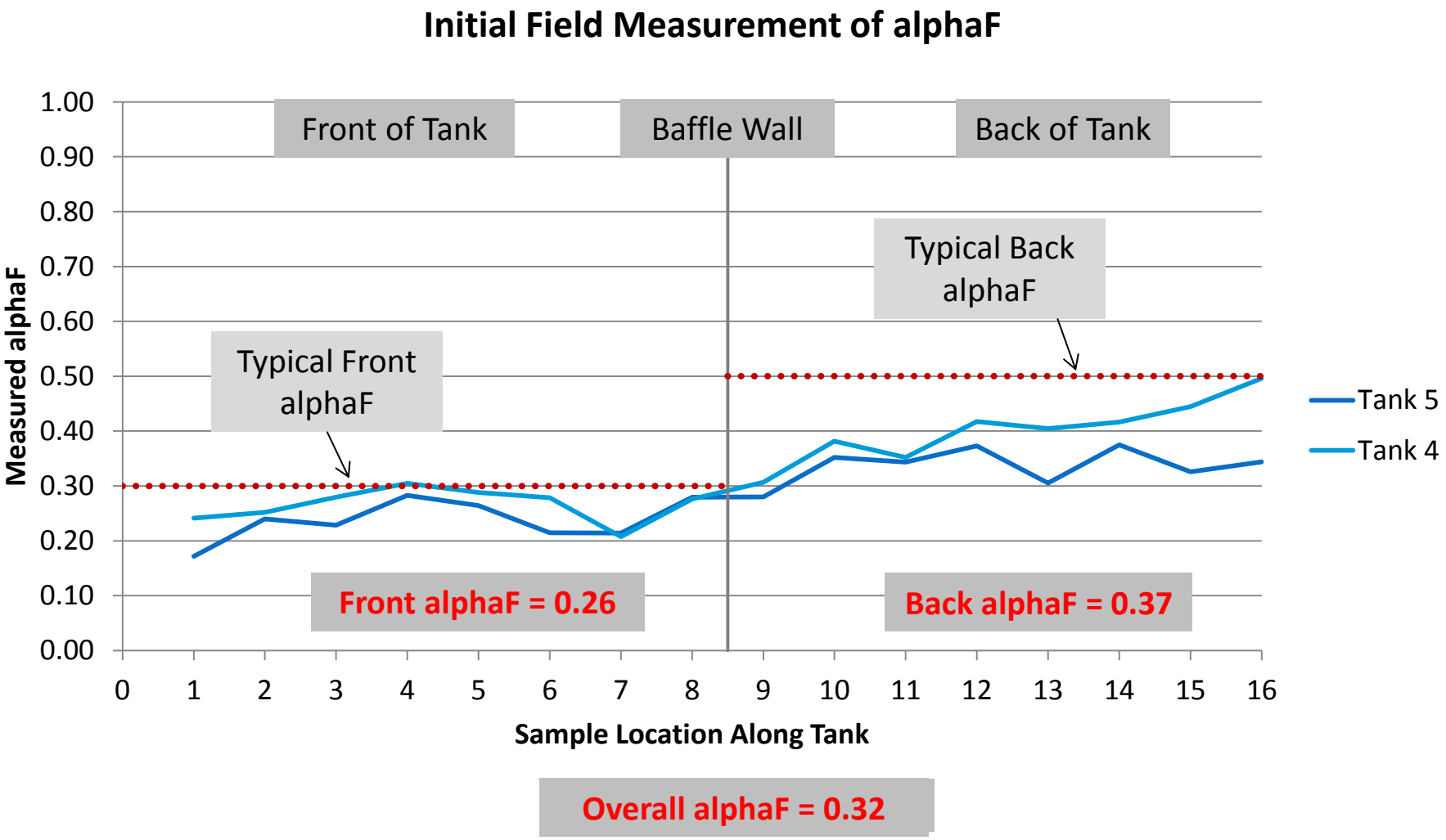
Offgas Analysis

- Multiple locations are tested to get a representative sampling of the basin.
- Each location measures OTE, gas flow, & dissolved oxygen.
- The field values of OTE are corrected to standard conditions (SOTEpw).
- In addition alpha and oxygen uptake rate are computed for each location.

Wyoming MI Dec 2015

BASIN	CELL	Ave. DO (mg/l)	Airflow/Diffuser (scfm)	OTEf (%)	SOTEpw (%)	Alpha(F)
4	1	0.56	1.30	7.23	7.94	0.24
4	2	2.75	1.34	8.10	11.20	0.34
4	Overall	1.66	1.32	7.67	9.57	0.29
5	1	0.37	1.20	8.39	9.04	0.27
5	2	2.70	1.58	9.37	13.00	0.40
5	Overall	1.53	1.39	8.88	11.02	0.33

Field Off-Gas Testing

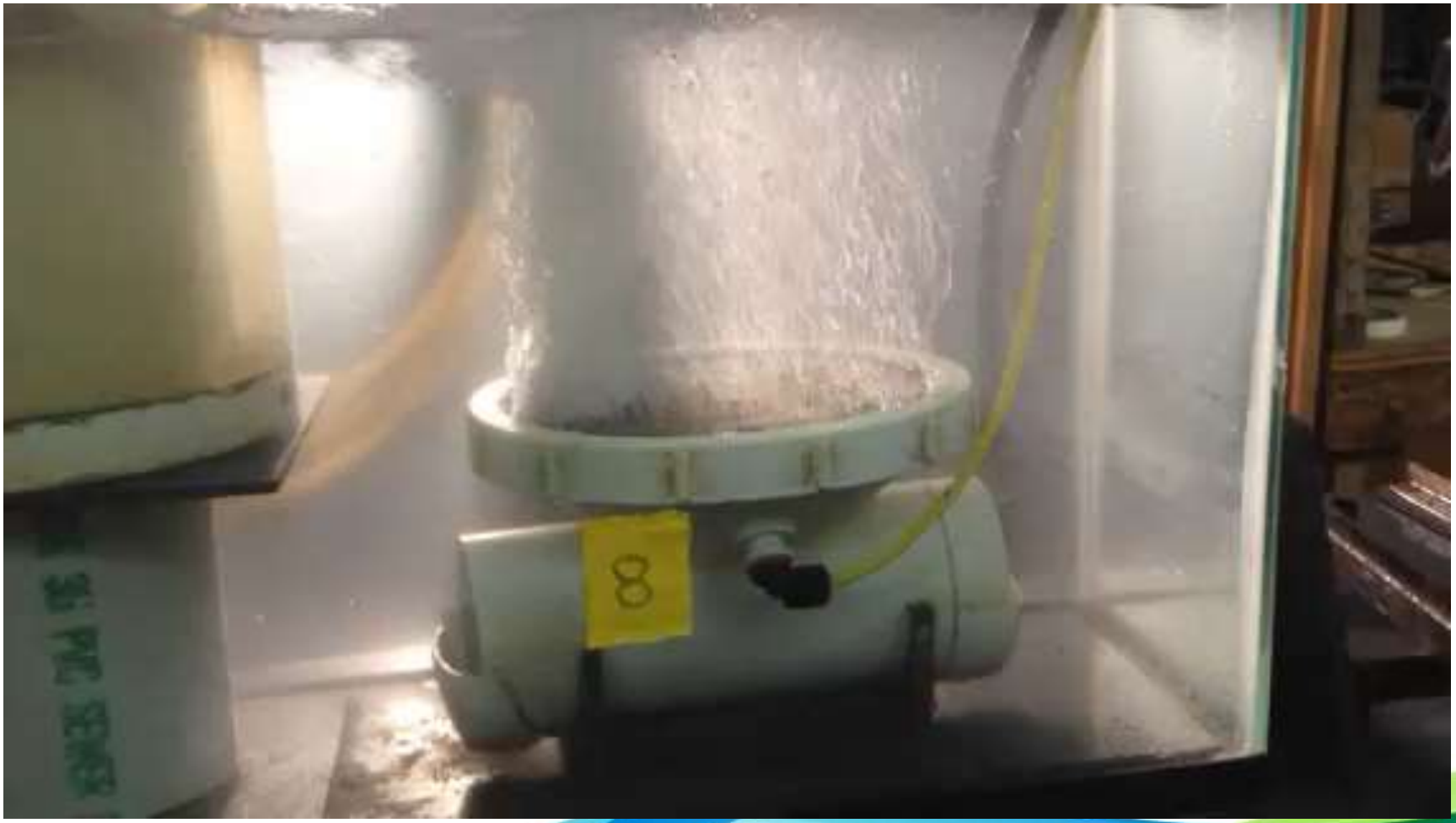


Diffuser Data

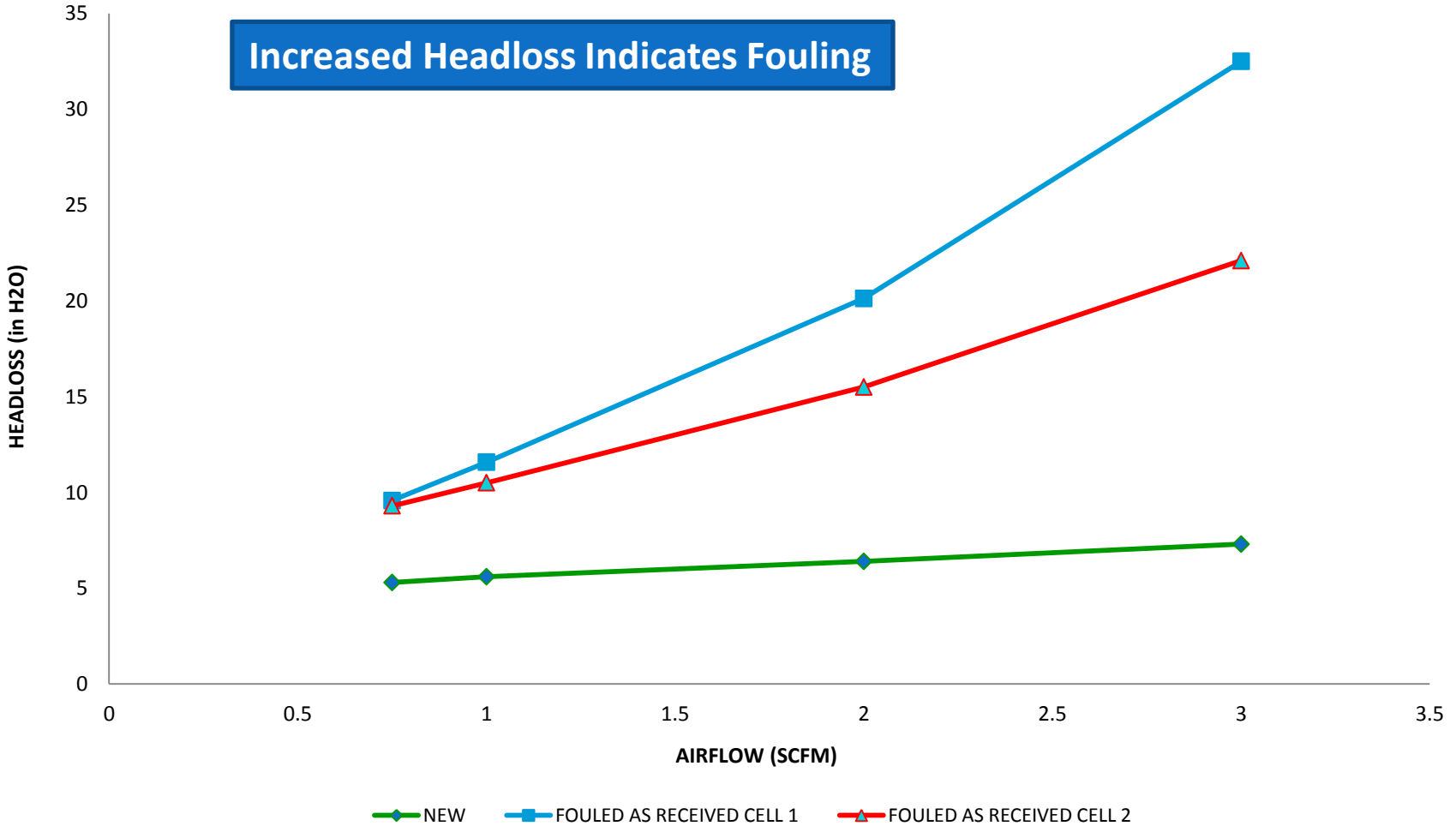
CONDITION	DWP 0.5 (in wc)	DWP 1.0 (in wc)	DWP 2.0 (in wc)	DWP 3.0 (in wc)	SOTEcw (%)	Fouling Factor
New	5.30	5.60	6.40	7.30	19.35	1.00
Cell 1 Fouled	9.60	11.60	20.15	32.50	13.95	0.72
Cell 2 Fouled	9.30	10.50	15.50	22.10	16.45	0.85

Fouled Cell 1 Diffuser

Fouled Cell 2 Diffuser

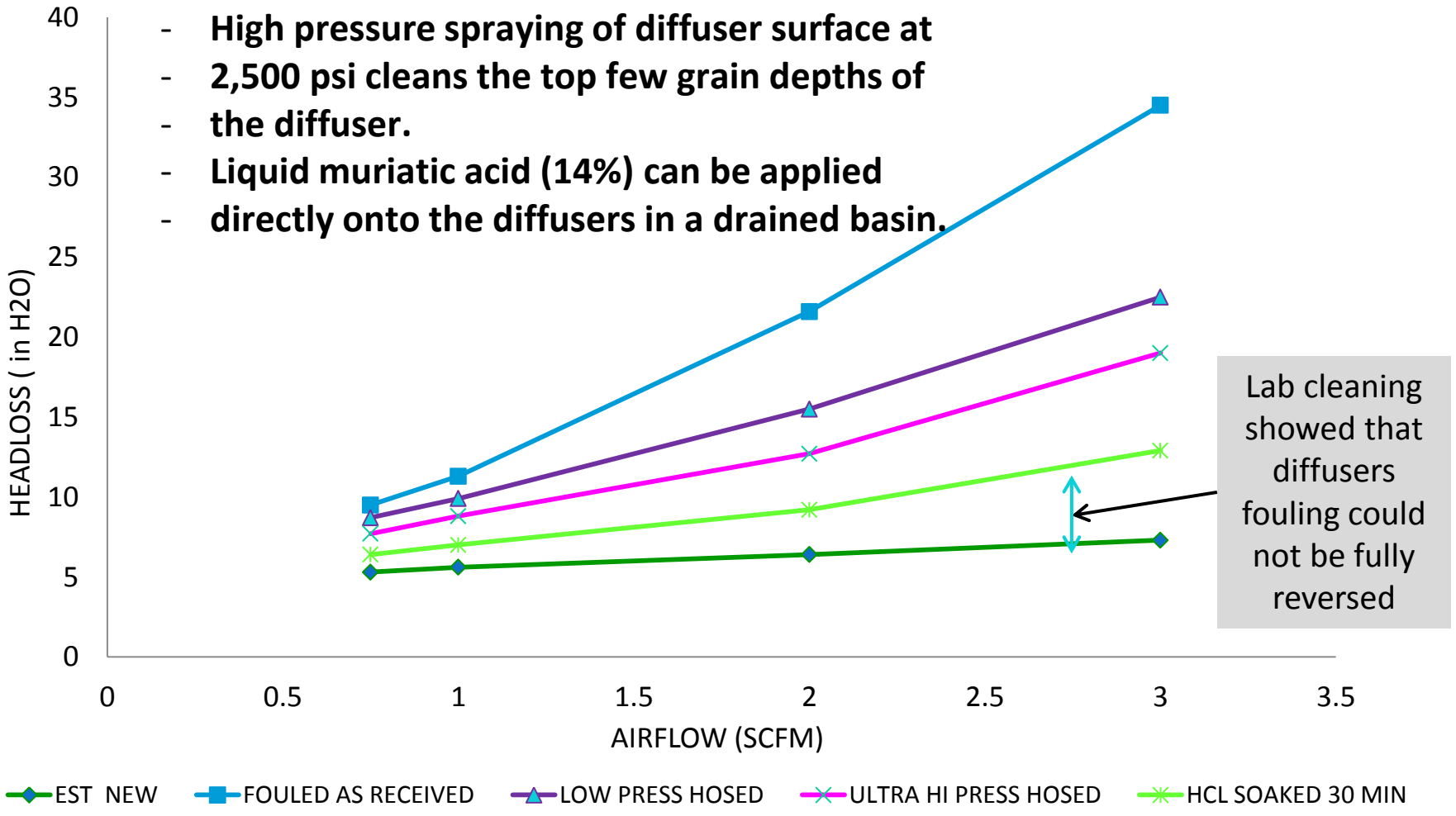


Lab Testing – Diffuser Headloss



Lab Testing – Diffuser Cleaning

- **High pressure spraying of diffuser surface at**
- **2,500 psi cleans the top few grain depths of**
- **the diffuser.**
- **Liquid muriatic acid (14%) can be applied**
- **directly onto the diffusers in a drained basin.**



Lab cleaning showed that diffusers fouling could not be fully reversed

Identified Project

- On the basins of the laboratory testing it was recommended to replace all ceramic diffusers with membrane diffusers
  - New diffusers will restore fouling factor F

Initial Estimated Project Values				
	Project Cost	Estimated Savings	Payback	Consumers Rebate
Diffuser Replacement	$220,000	$100,000	2 years	$105,000

Overview of Diffusers

- **Ceramic Diffusers**
  - Long Life
  - Physical Cleaning is Difficult
  - Fouling Increase by Power Outages

- **Membrane Diffusers**
  - Shorter Life
  - Easier Physical Cleaning
  - Reduces Fouling from Outages Due to Flex of Material

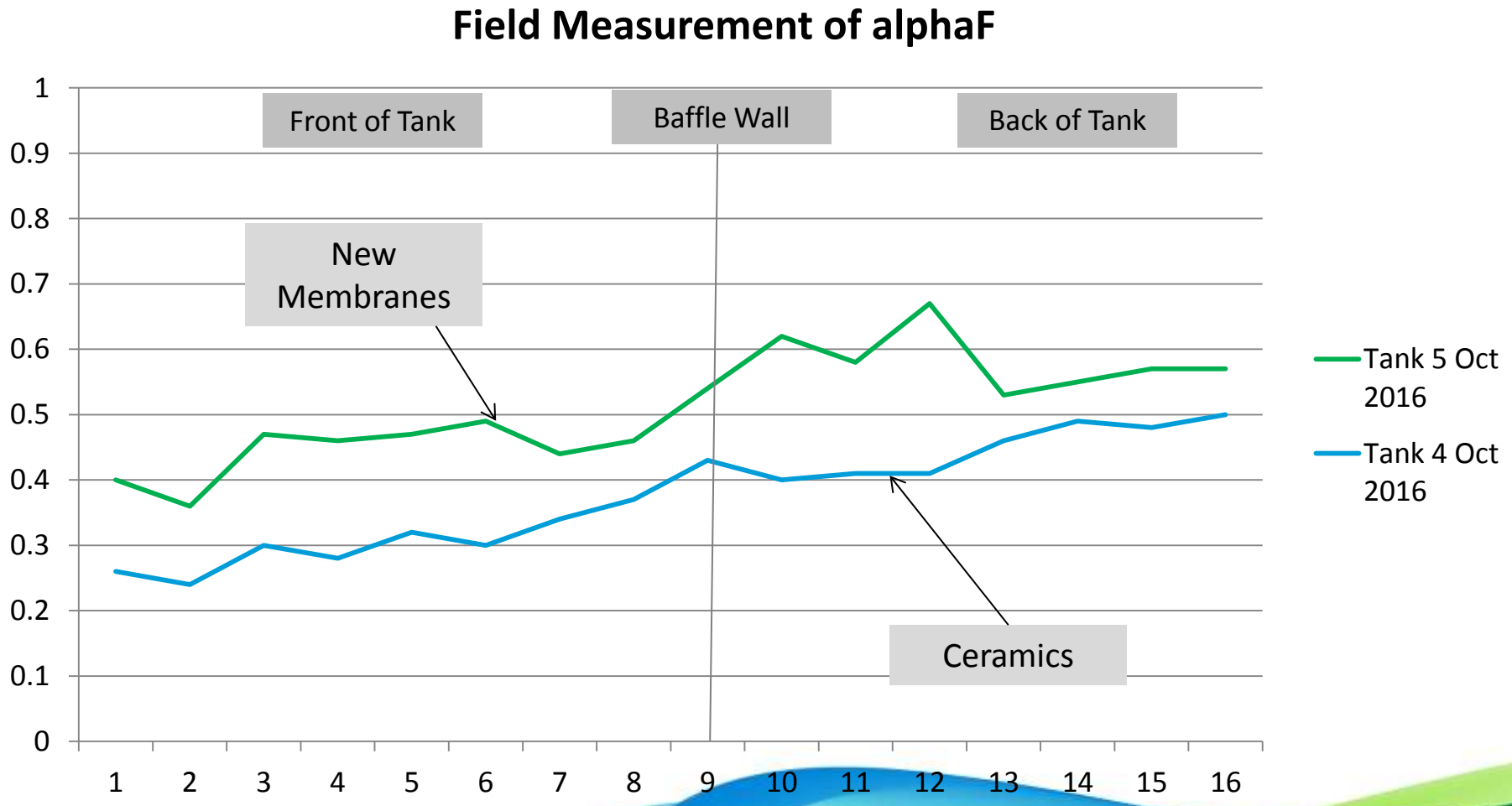

BEFORE
AFTER

Results

Wyoming MI Oct 2016

	BASIN	CELL	Ave. DO (mg/l)	Airflow/Diffuser (scfm)	OTEf (%)	SOTEpw (%)	Alpha(F)
Ceramics	4	1	0.53	1.85	9.08	9.59	0.30
	4	2	1.49	1.77	12.13	14.18	0.45
	4	Overall	1.01	1.82	10.60	12.00	0.38
Membranes	5	1	0.96	1.58	13.03	14.44	0.44
	5	2	3.16	1.52	13.09	18.97	0.58
	5	Overall	2.06	1.55	13.06	16.70	0.51

Follow-up Testing



Results

- Power monitors installed since August for verification
- Diffusers in two remaining aeration basins were installed in late October

Revised Project Values				
	Project Cost	Estimated Savings	Payback	Rebate Applied for
Diffuser Replacement	$220,000	$138,000	< 2 years	$110,000

Testing Benefits

- Offgas analysis in combination with laboratory diffuser testing is a powerful tool in optimizing fine bubble aeration system performance.
- Diffuser testing can identify the impact of service life on performance and aid in developing an optimum cleaning frequency and cleaning methodology