

A DIGITAL CONTROL SYSTEM FOR OPTIMAL OXYGEN TRANSFER EFFICIENCY

APPENDIX E: TECHNOLOGY TRANSFER INFORMATION

Prepared For:

California Energy Commission
Public Interest Energy Research Program

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PIER FINAL PROJECT REPORT

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Documenting Improved Aeration Efficiency Using Off-gas Analyses

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Outline

◆ Introduction

- The modern wastewater treatment not only focus on effluent quality, but also energy consumption

◆ Background

- Terminology & literature review
- Off-gas analysis

◆ Methodology

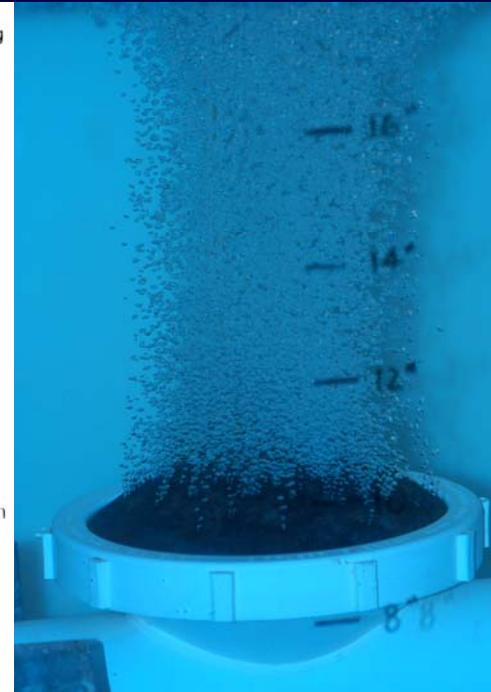
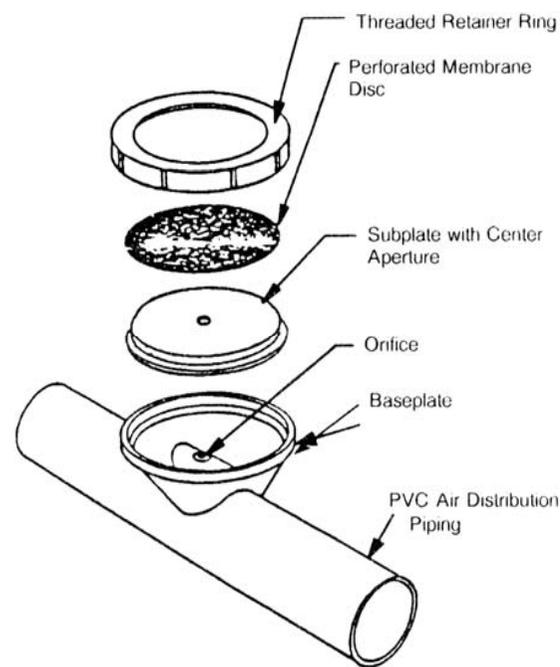
- Real-time Off-gas Monitoring System
- Field Experiments

◆ Results and Discussion

Introduction

◆ Activated Sludge Process

- Aeration needs energy (45~75% of the total)
- Fine-pore diffusers to increase aeration efficiency



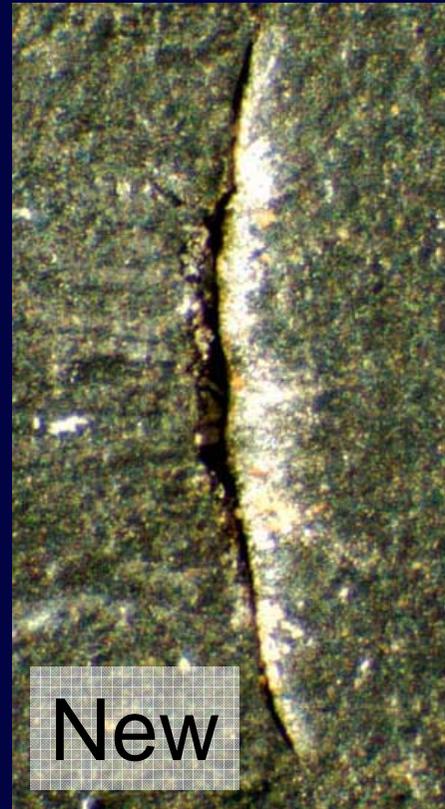
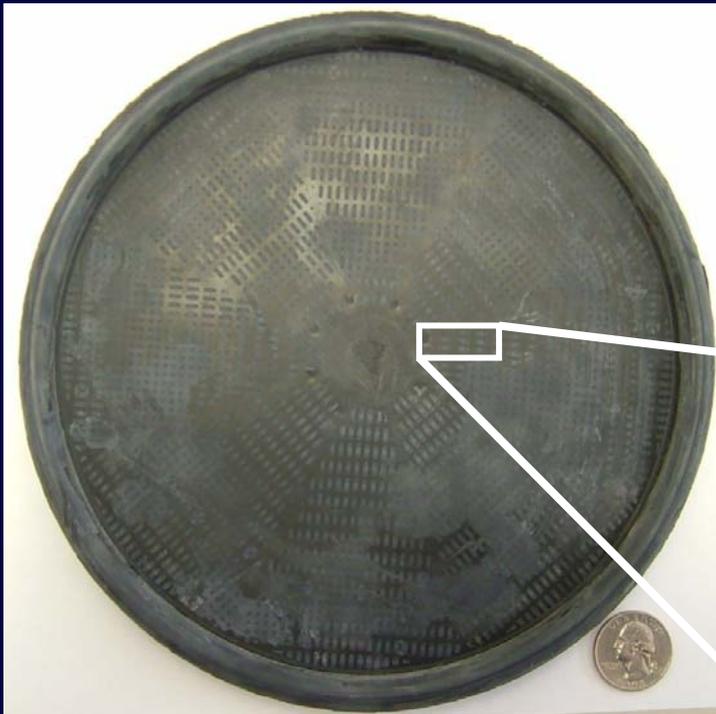
Terminology

- ◆ **MCRT** = Mean Cell Retention Time
- ◆ **OTR** = Oxygen Transfer Rate (mass O₂/time)
- ◆ **OTE** = Oxygen Transfer Efficiency (%)
(OTE = OTR / Total Oxygen Supplied)
- ◆ **SOTE** = OTE at standard conditions
(20°C, 0 mg/l DO, 1 atm, 0 salinity, etc.)
- ◆ **Alpha factor (α)** – water quality estimate
($k_L a_{\text{Process water}} / k_L a_{\text{Clean water}}$)

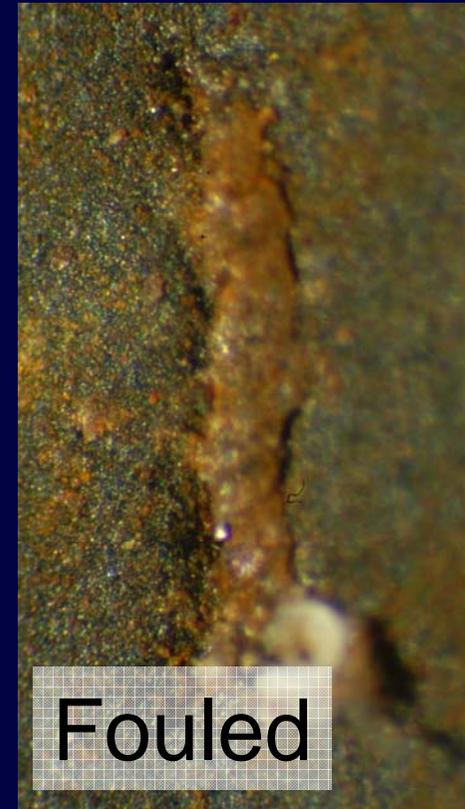


Diffuser Fouling

- ◆ Fouled pore
- ◆ Diffuser cleaning test



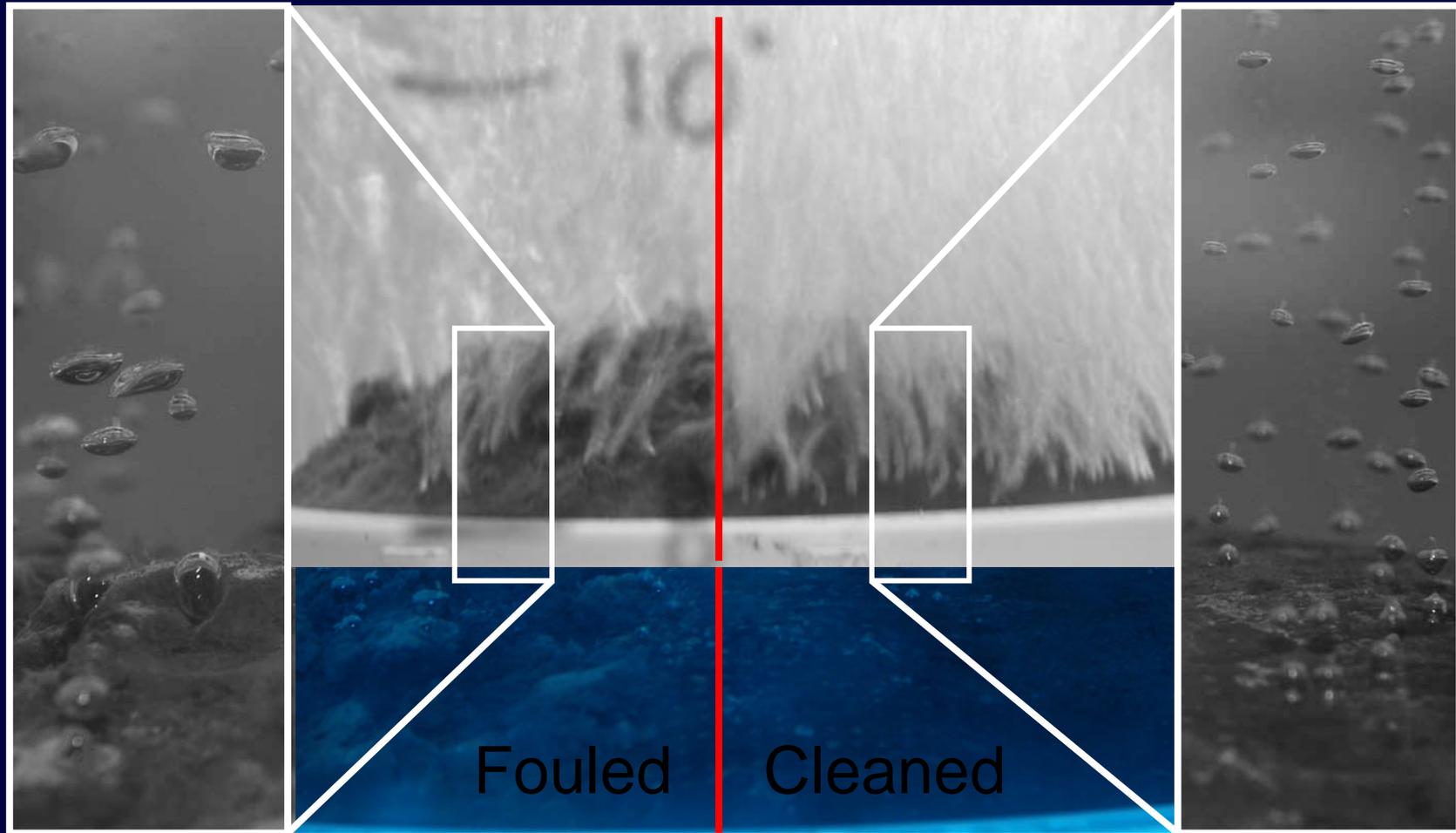
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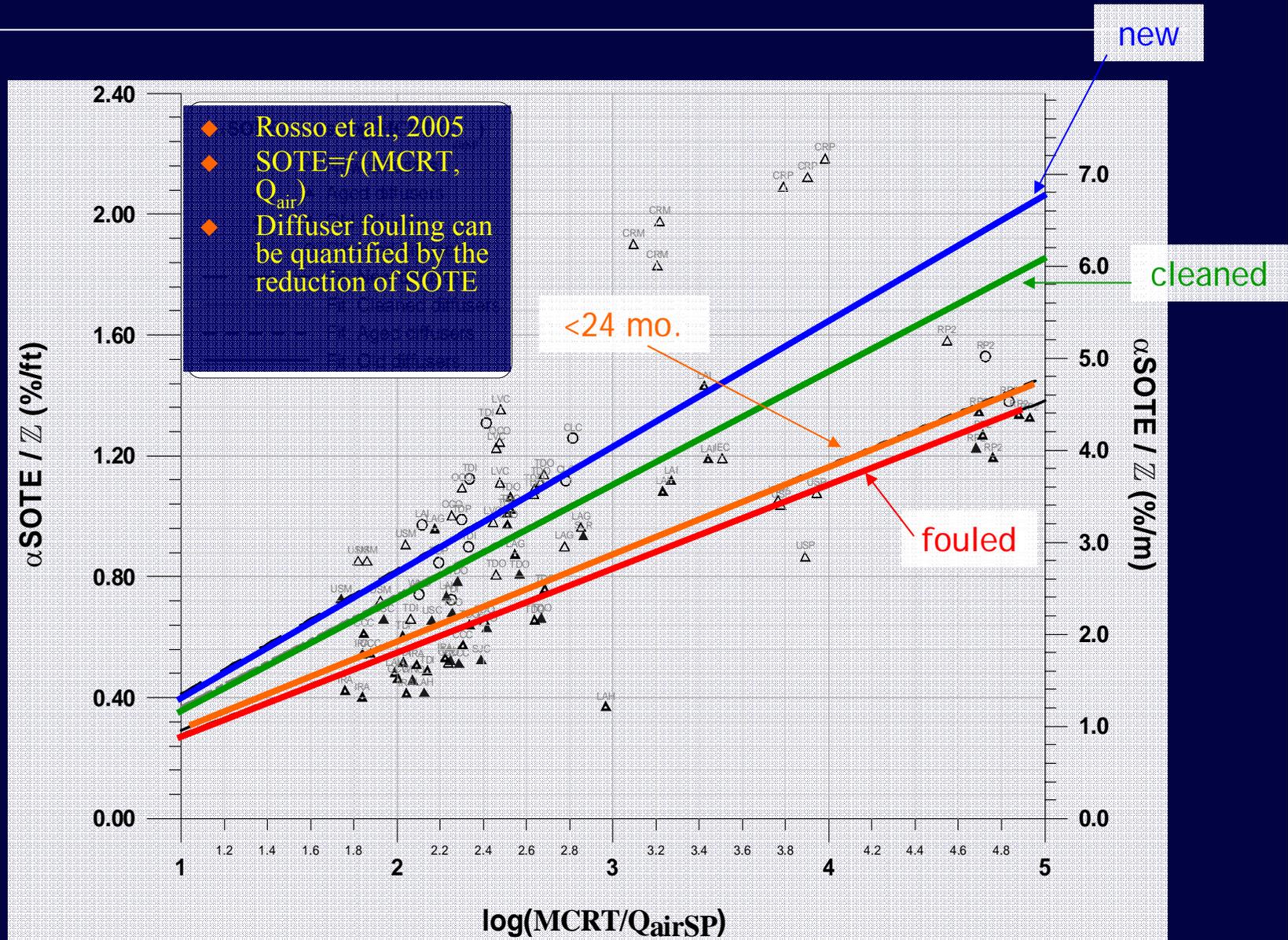
Fouled



Diffuser cleaning test



Literature Review

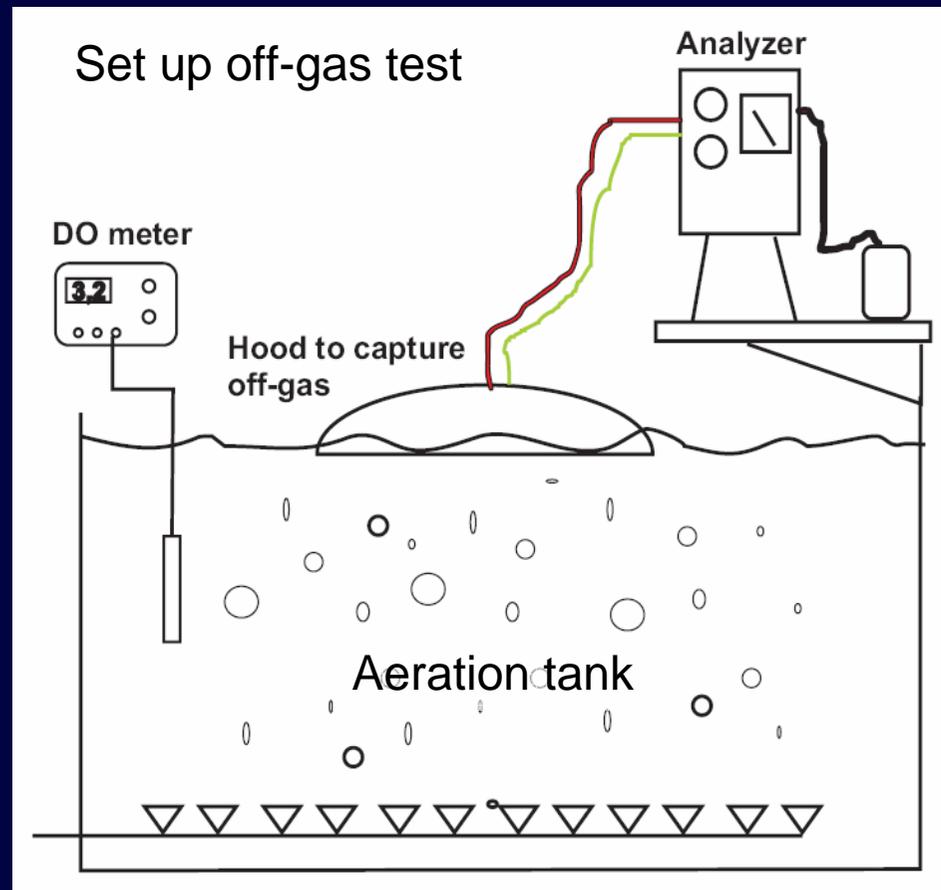


Diffuser Cleaning

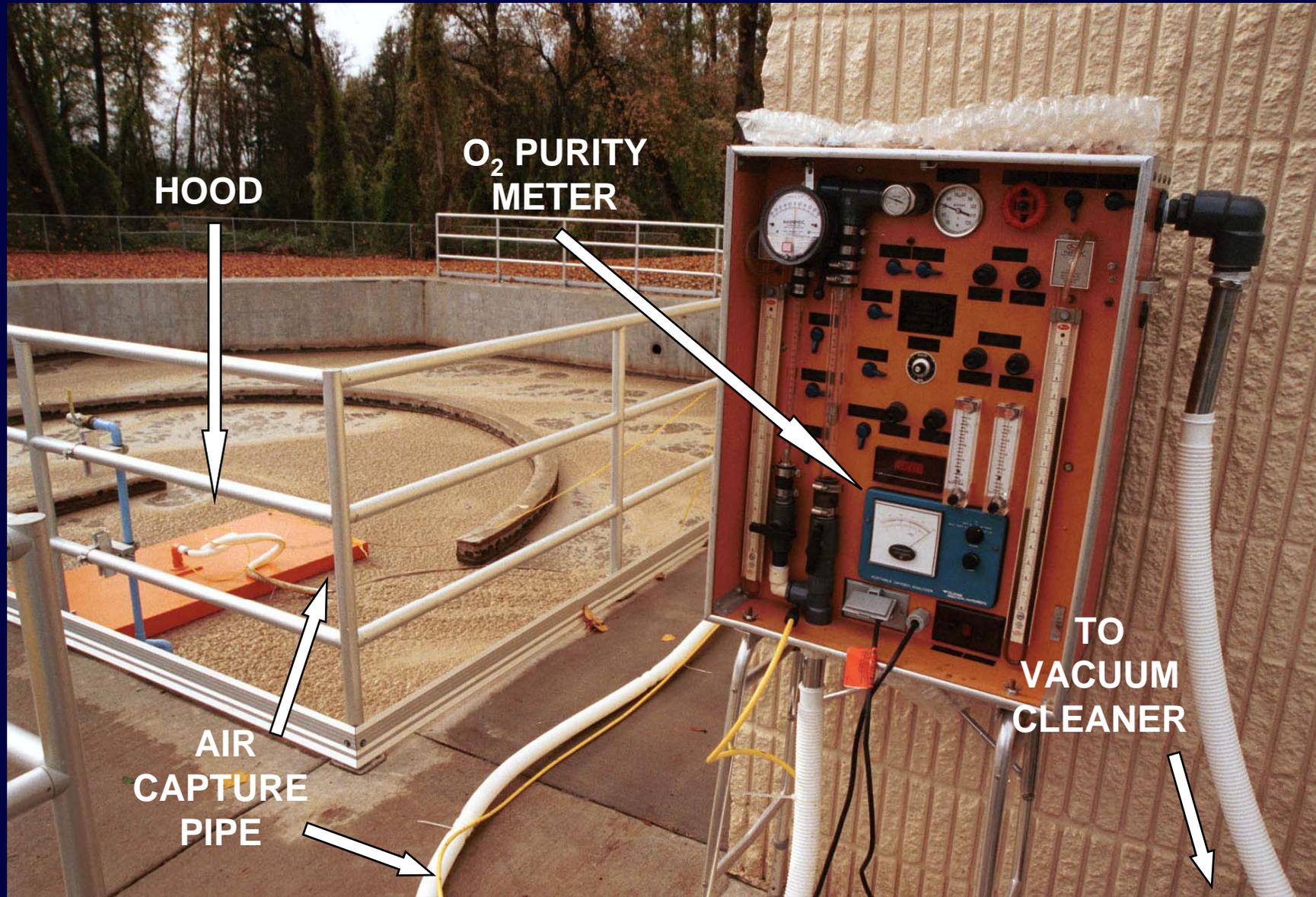


Off-gas Test

- ◆ Off-gas test is an easy way to measure SOTE
 - Accurate
 - Real-time
- ◆ Developed by Redmon et al., 1983
- ◆ Basic theory
$$OTE = \frac{O_{2in} - O_{2out}}{O_{2in}}$$
- ◆ ASCE, 1997

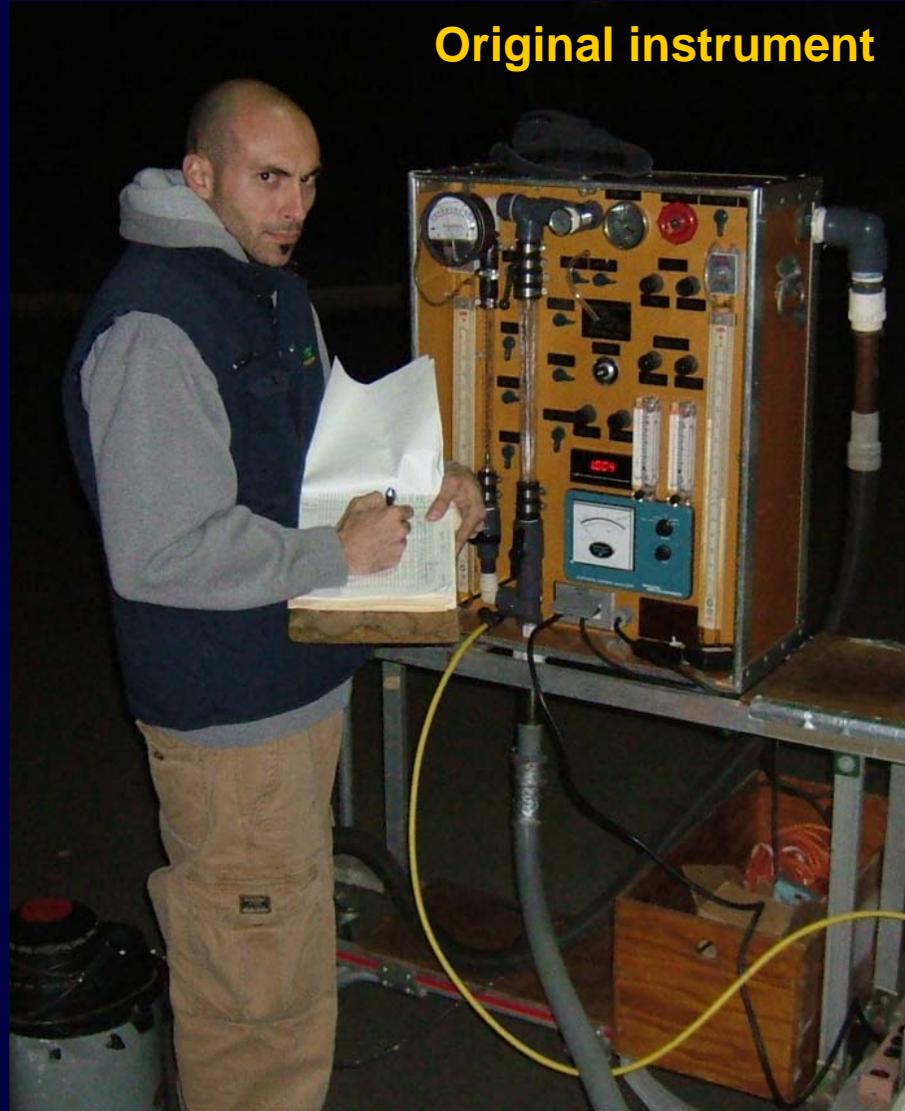


Off-gas Test



Instrument sizes

Original instrument



Field-scale 1.0



Field-scale 2.0

Project Outcomes

- ◆ An easy-to-operate off-gas monitoring system

- Automatic analyzer
- Real-time measurement
- Small Hood

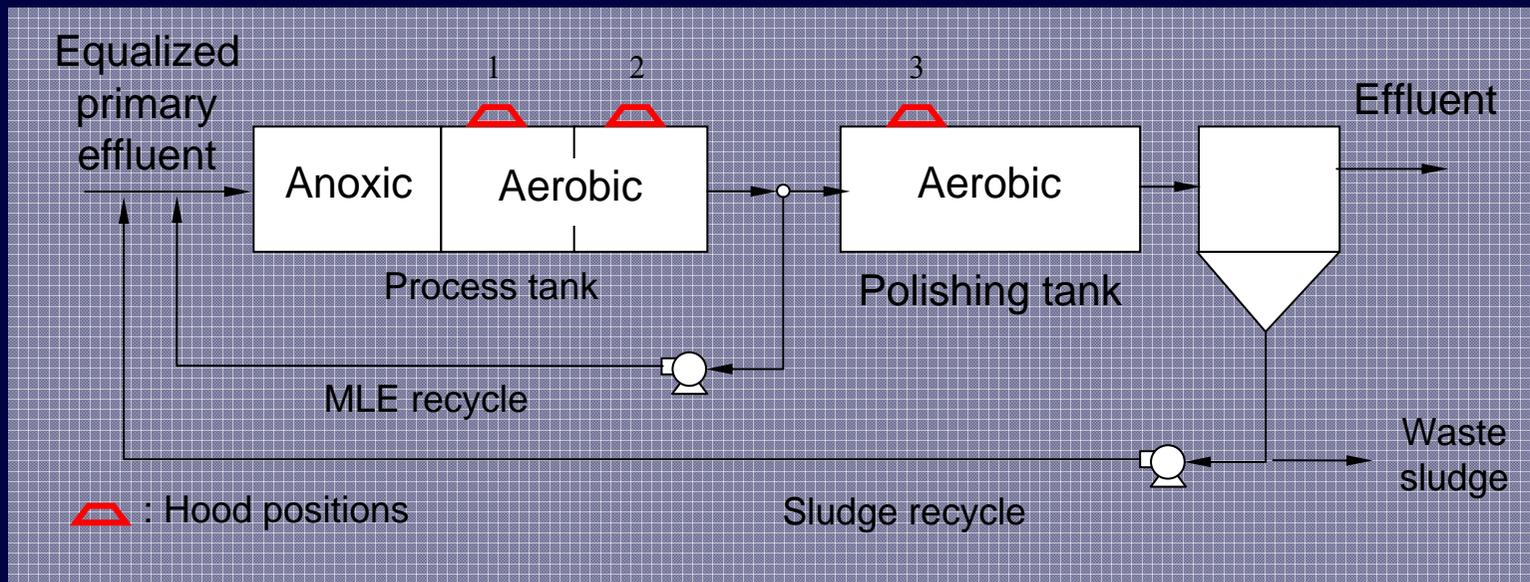


Original
11ftx3ft
~100lbs

- Maintains accuracy

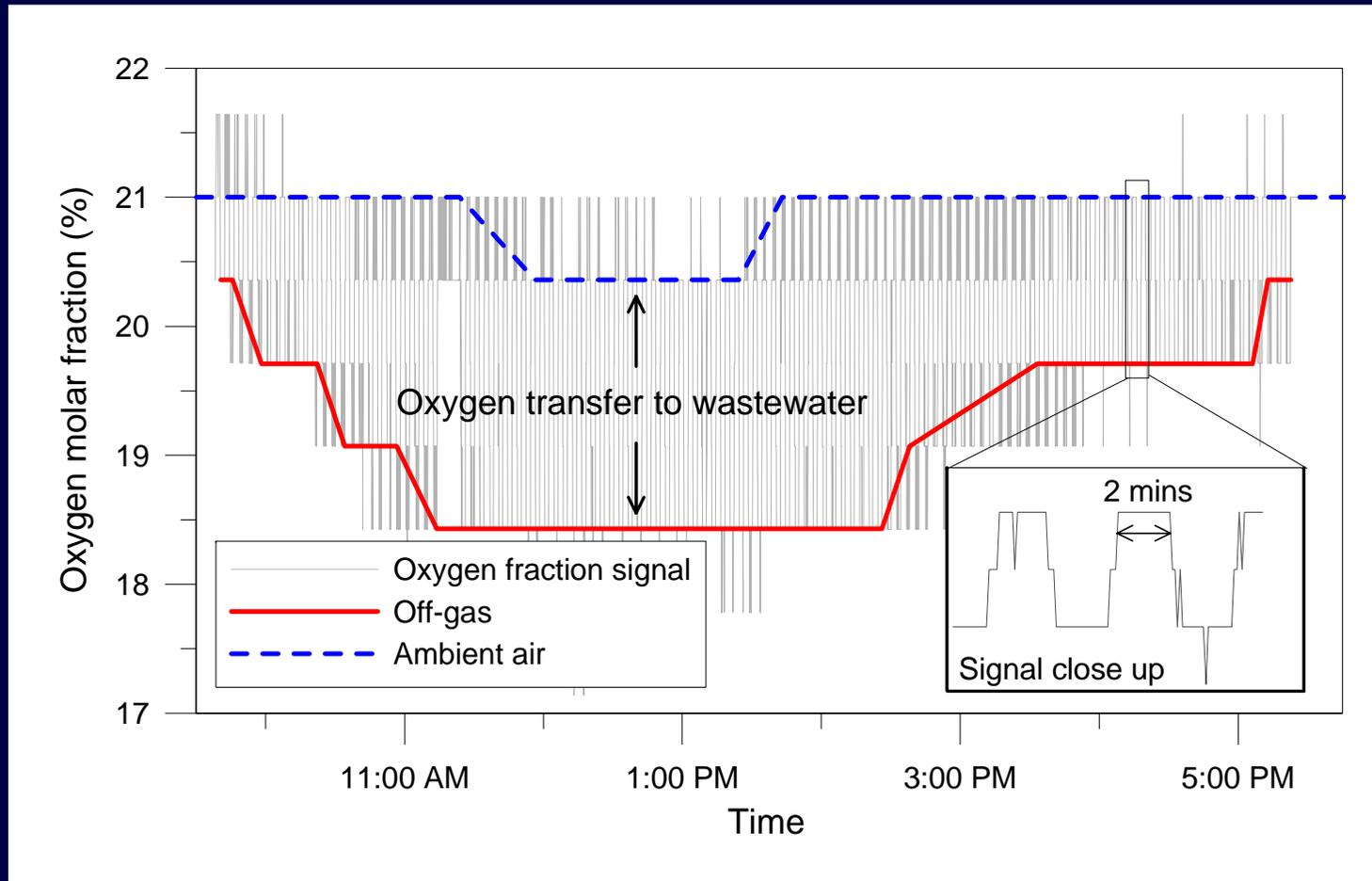
Field Experiment

- ◆ 10 MGD treatment plant
- ◆ Aeration uses fine-pore diffusers
- ◆ Grab sample and off-gas test 1/hr for 24 hrs



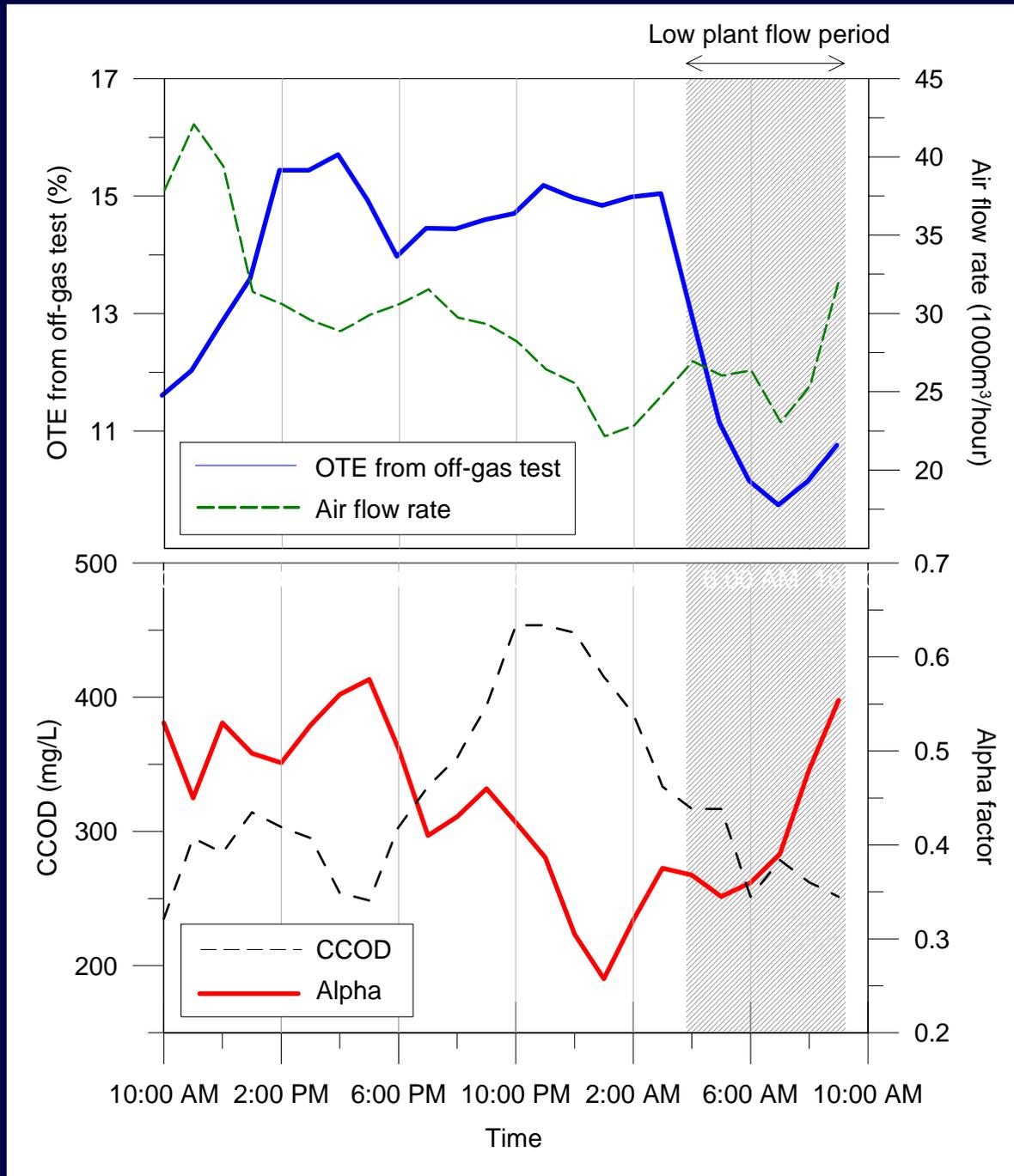
Field Results

◆ Recorded Signals

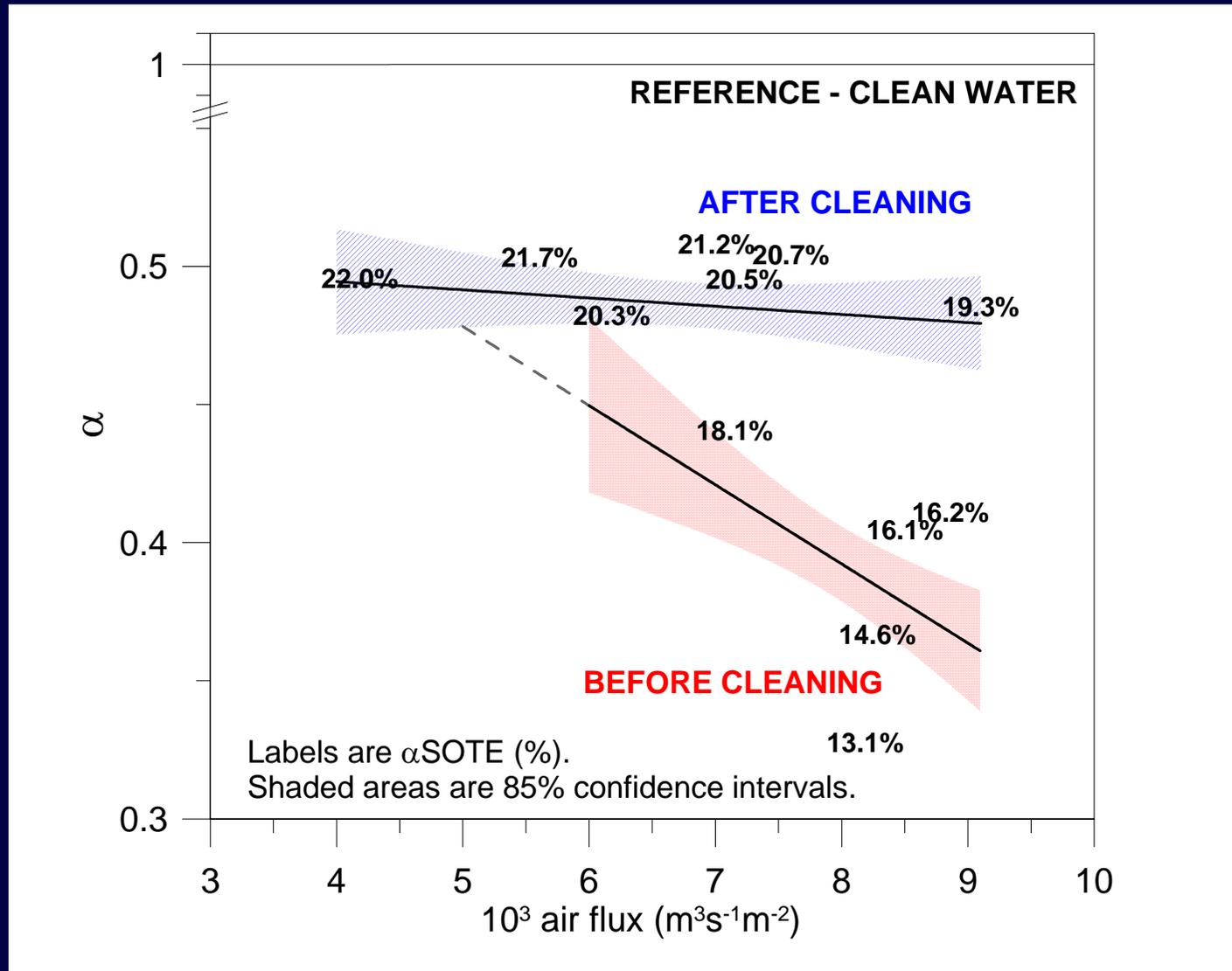


Results

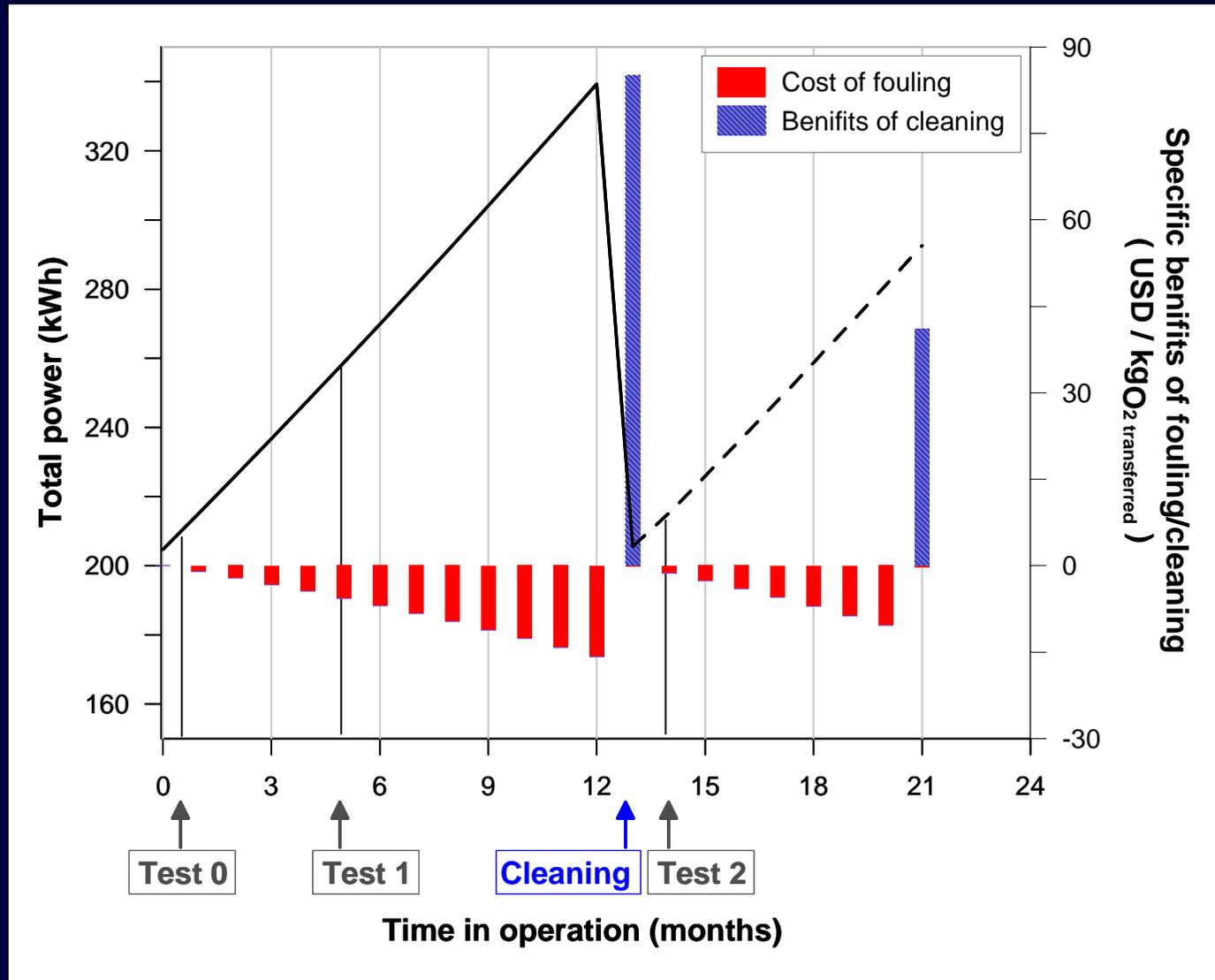
- ◆ Comparison 24-hour data
 - OTE vs. Air flow rate
 - CCOD vs. Alpha
- ◆ The results confirmed our former long-term observations



24-hour Test – $SOTE_{\text{off-gas}}/SOTE_{\text{clean water}}$

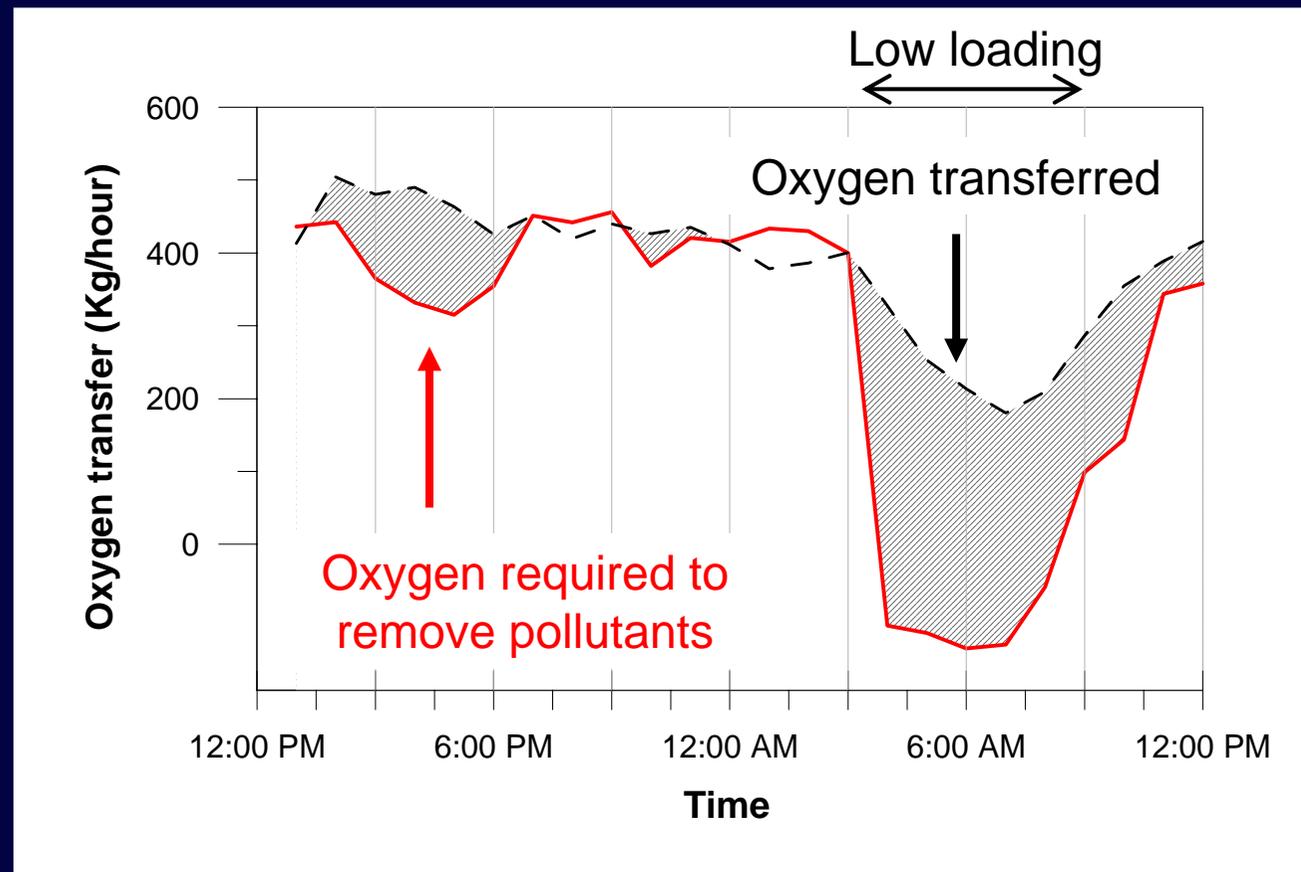


Long Term – Cleaning Frequency



24 hrs – Plant Operation

- ◆ Real-time monitoring system provides useful information for plant operation



Conclusions

- ◆ 24-hour experiments confirmed our previous observations
- ◆ Energy-saving potential quantified
- ◆ Our database as a valuable tool for accurate design and specification of aeration systems and plant operation
- ◆ Current work on feasibility of blower upgrade

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