



KOHLER®



Development of Integrated Reactor Systems for Biological and Electrochemical Treatment of Faecal & Wastewater with Clean Water Recycle

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Pasadena, California**

Caltech



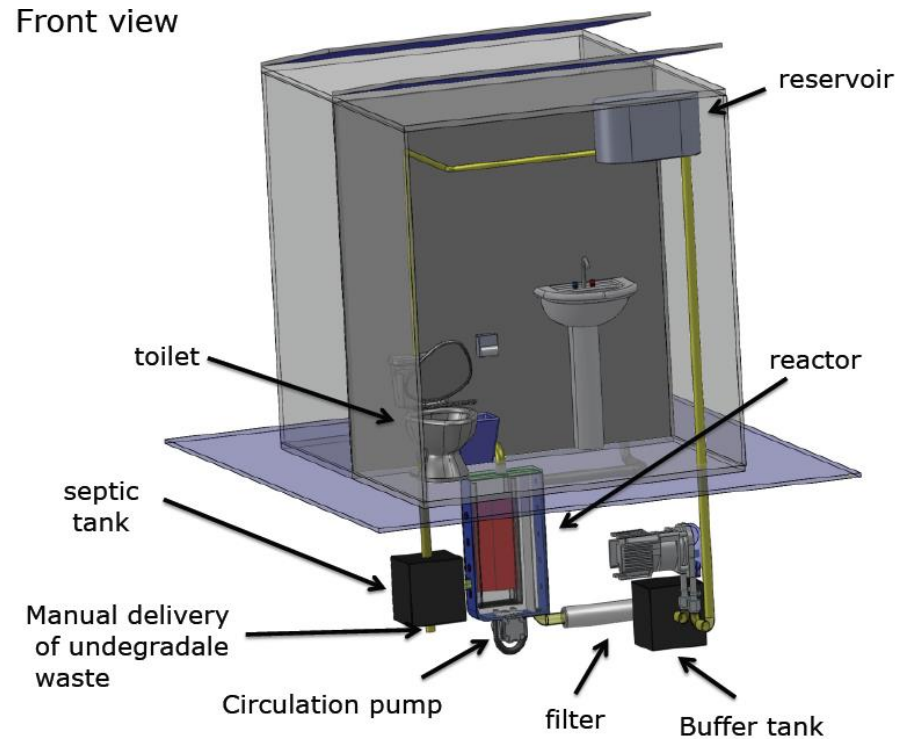
**Vodafone
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Foundation™**



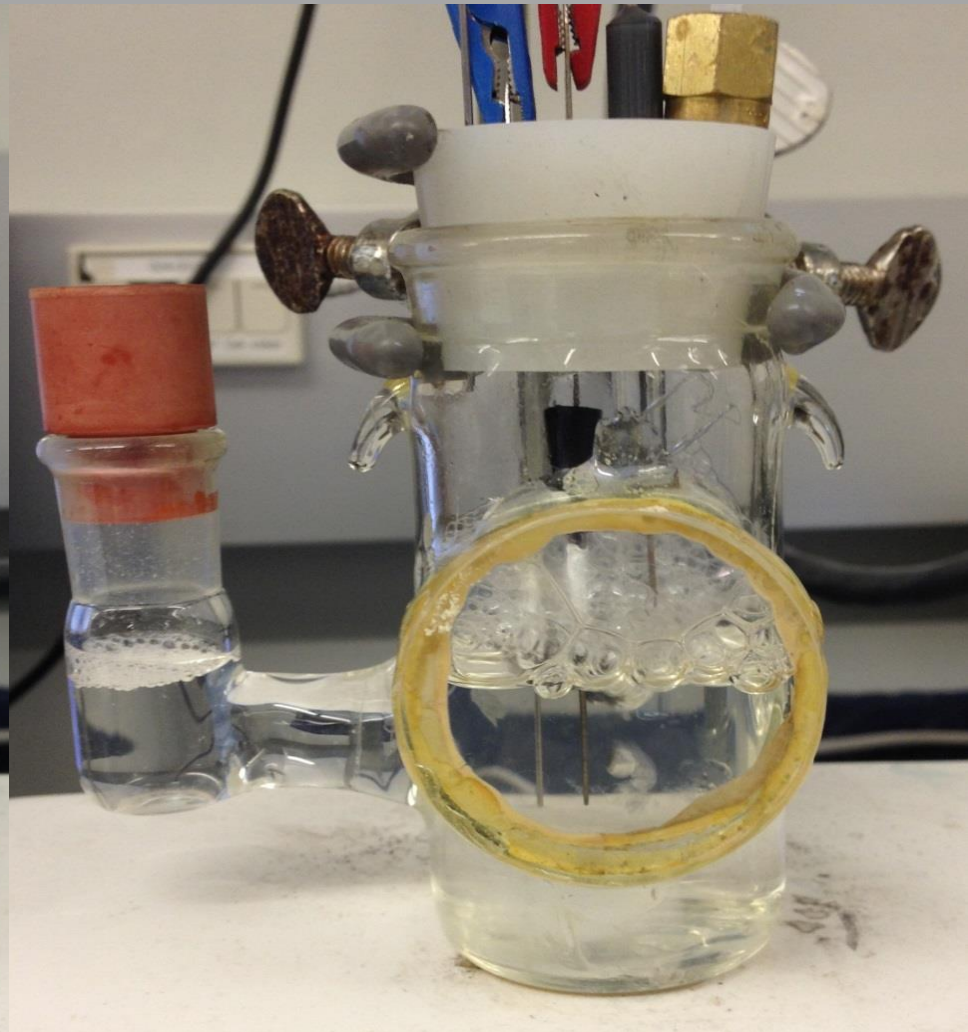
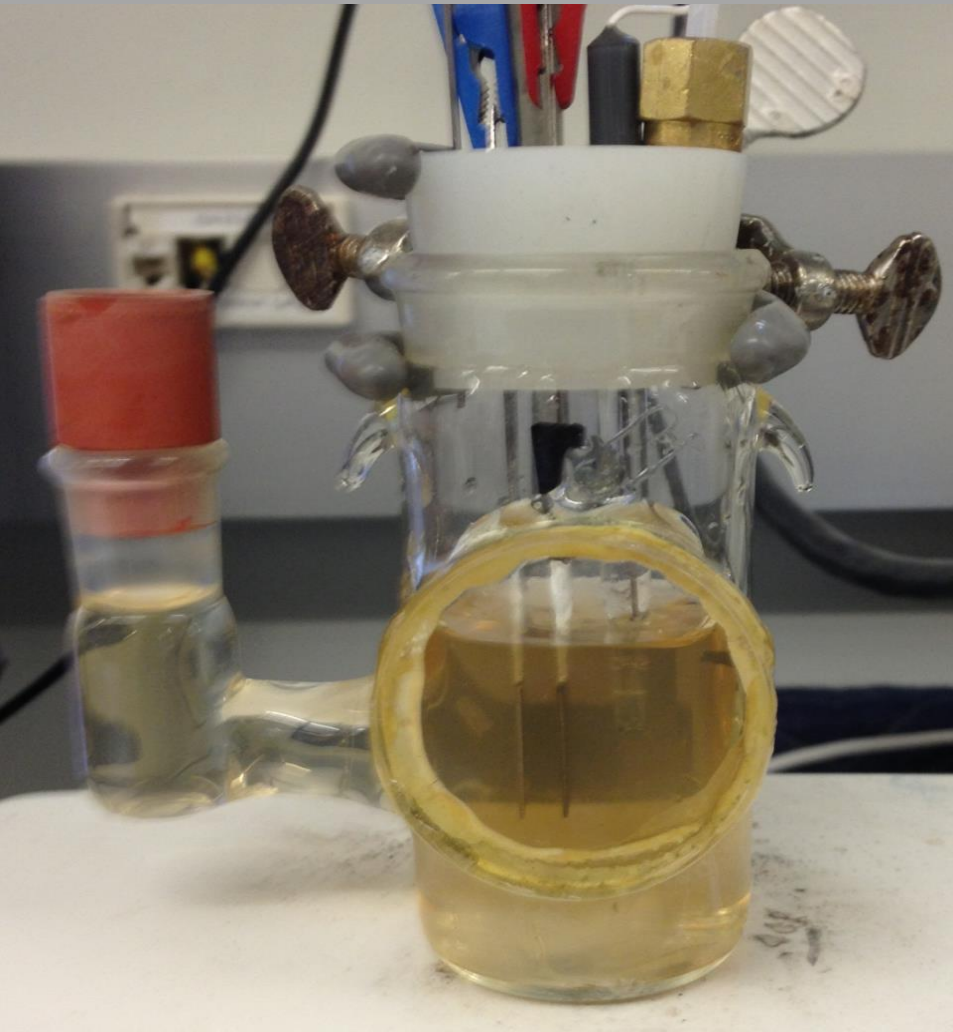
The Solar Toilet Concept, 2011

self-contained, decentralized waste treatment

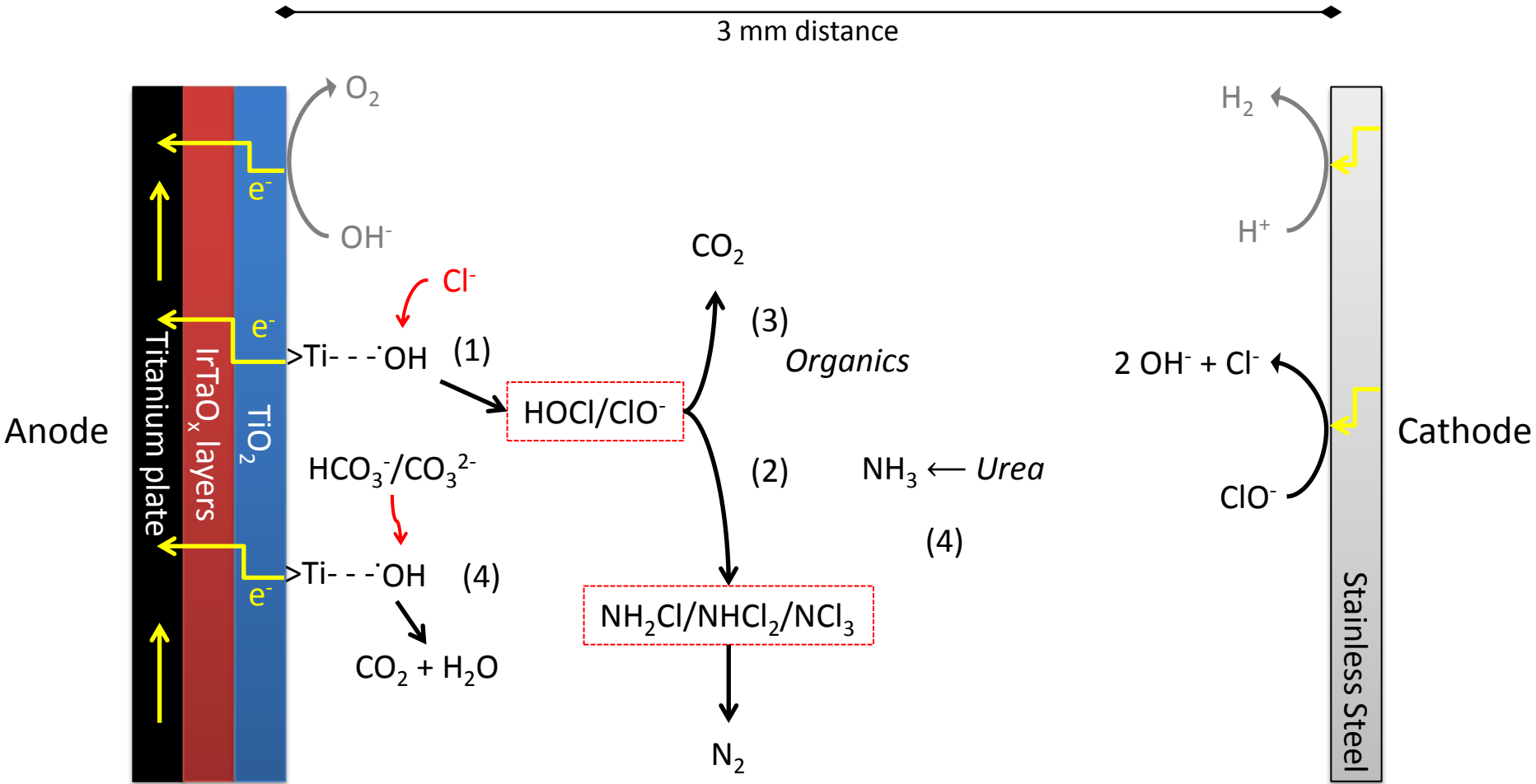
- Anaerobic Bioreactor
- Aerobic Bioreactor
- Electrochemical Reactor
- Disinfection
- Filtration
- Water Recycling
- Closed-loop System
- Electronic Controls



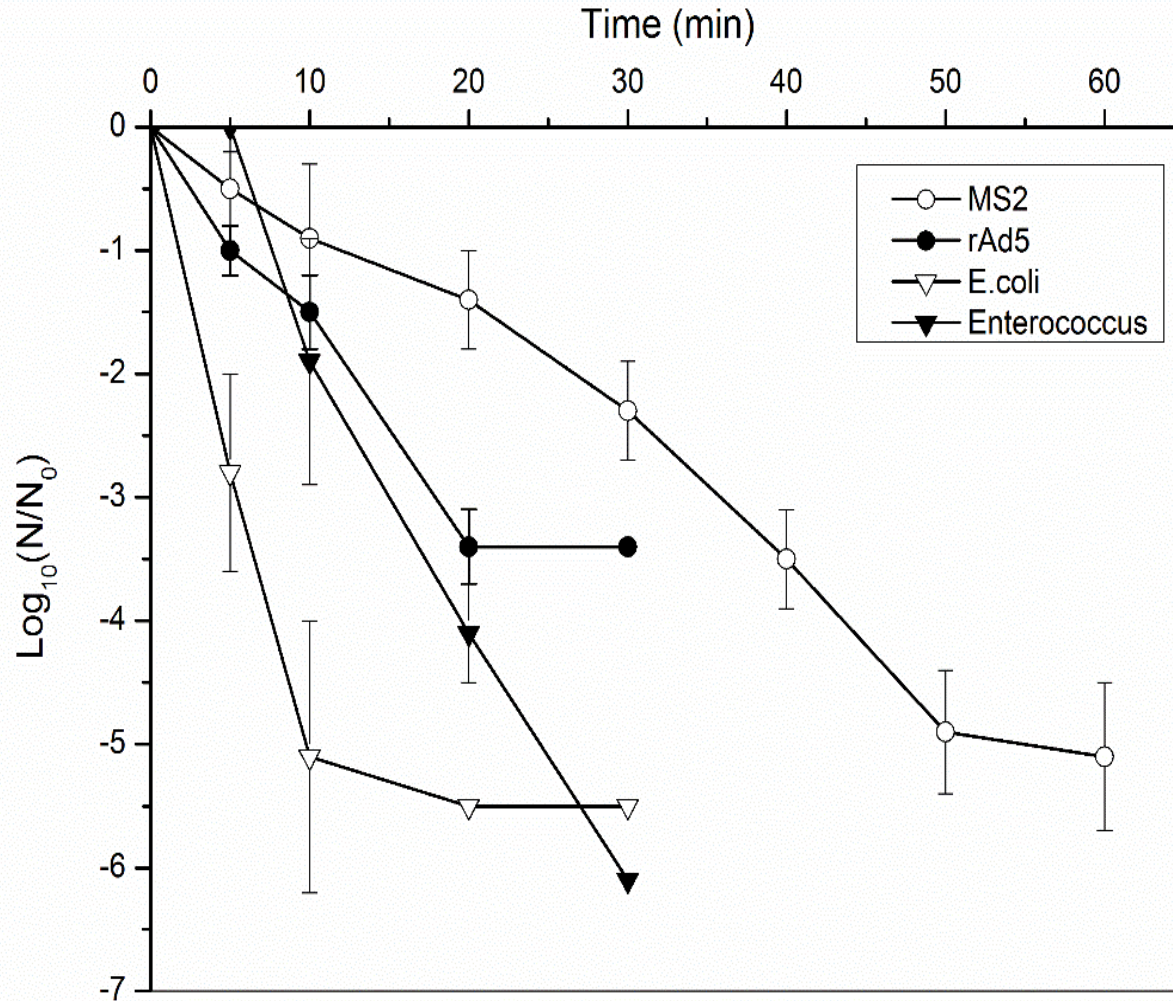
Electrochemical Treatment of Wastewater



Overview of Key Electrochemical Reactions

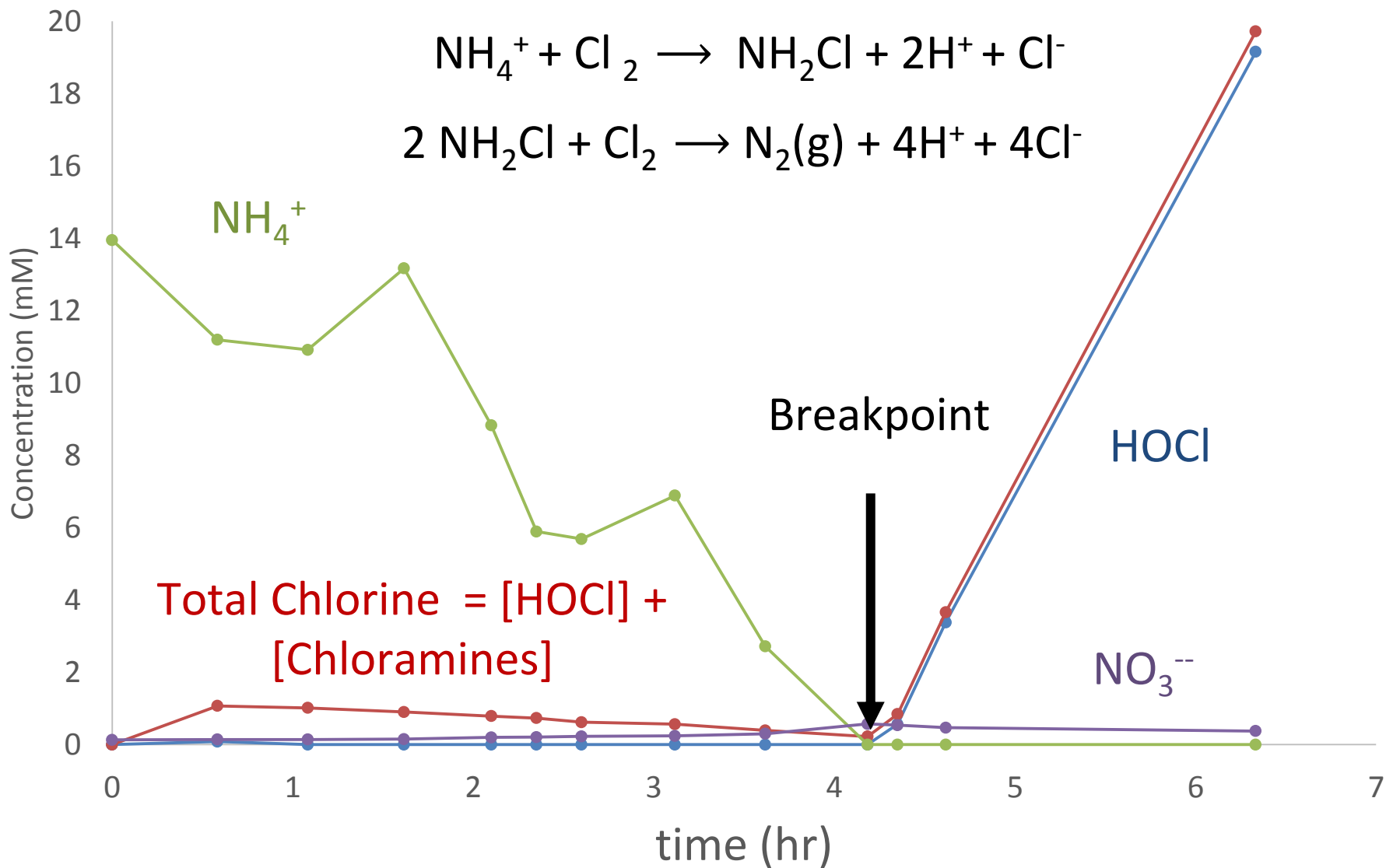
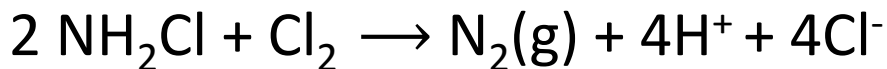


Disinfection Achieved within 2 Hours



Breakpoint Chlorination & Nitrogen Removal

Caltech Prototype Wastewater, +3.3 V, 50 A, 80 mM Cl⁻

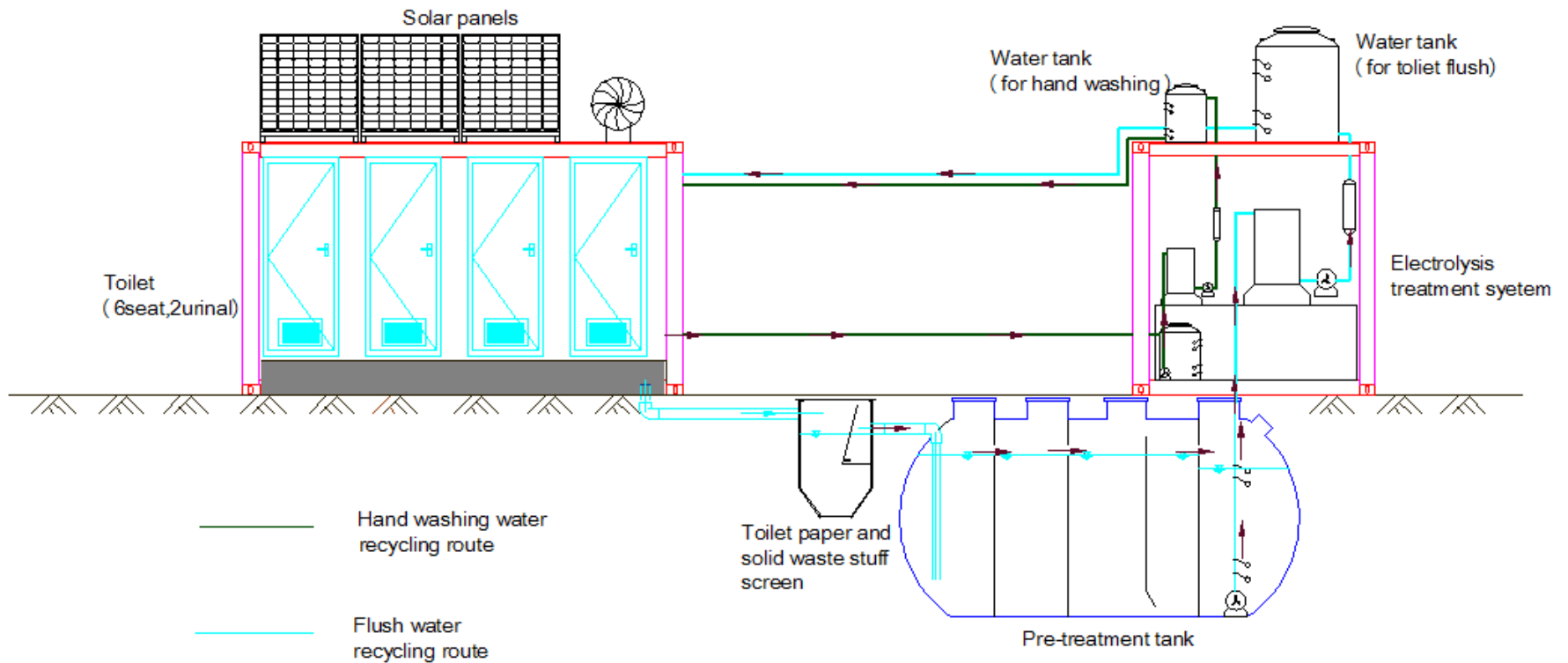




2nd Generation Prototypes

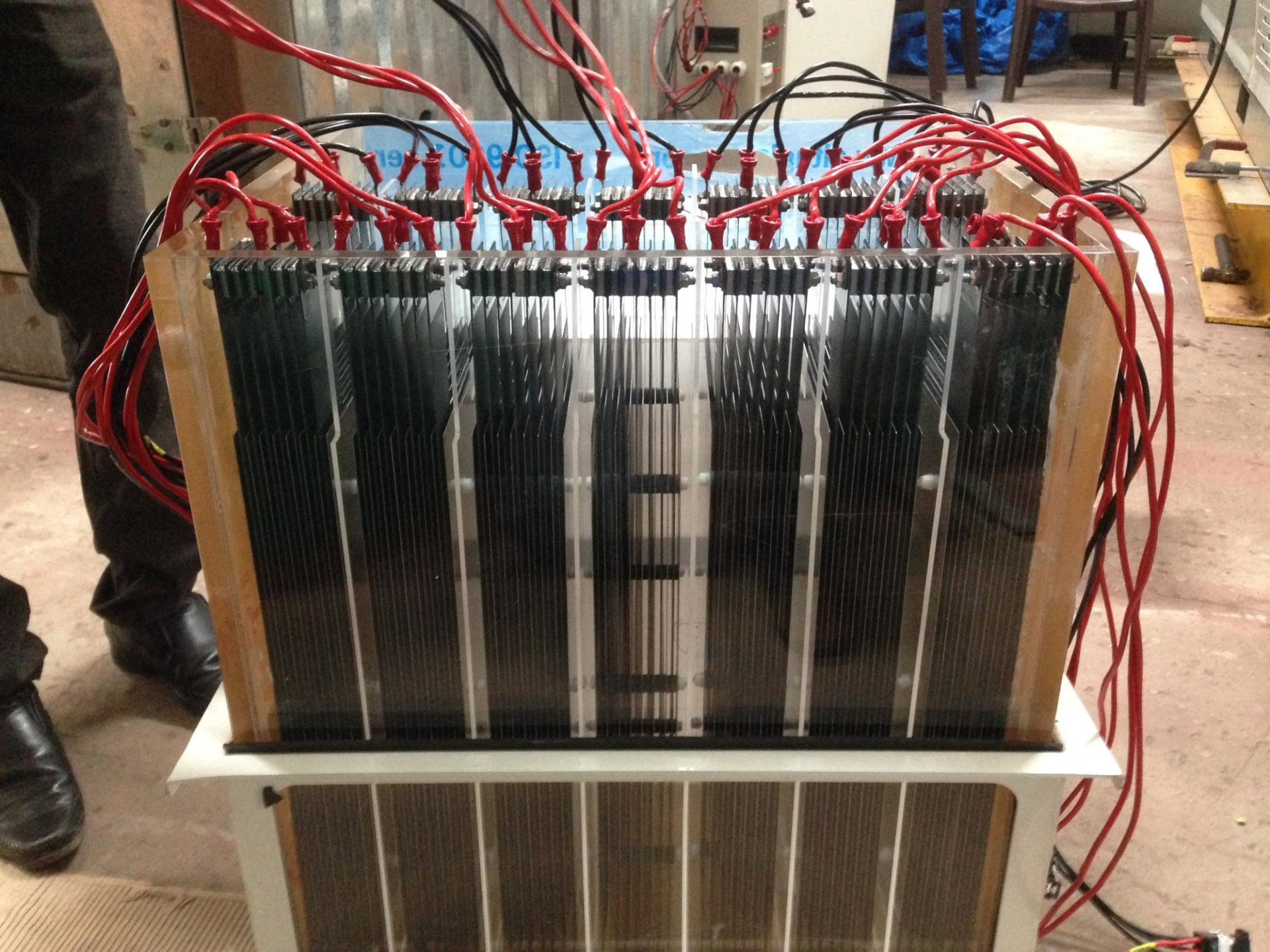


Third-Generation Prototype Flow Diagram











Eco-san

公厕请进

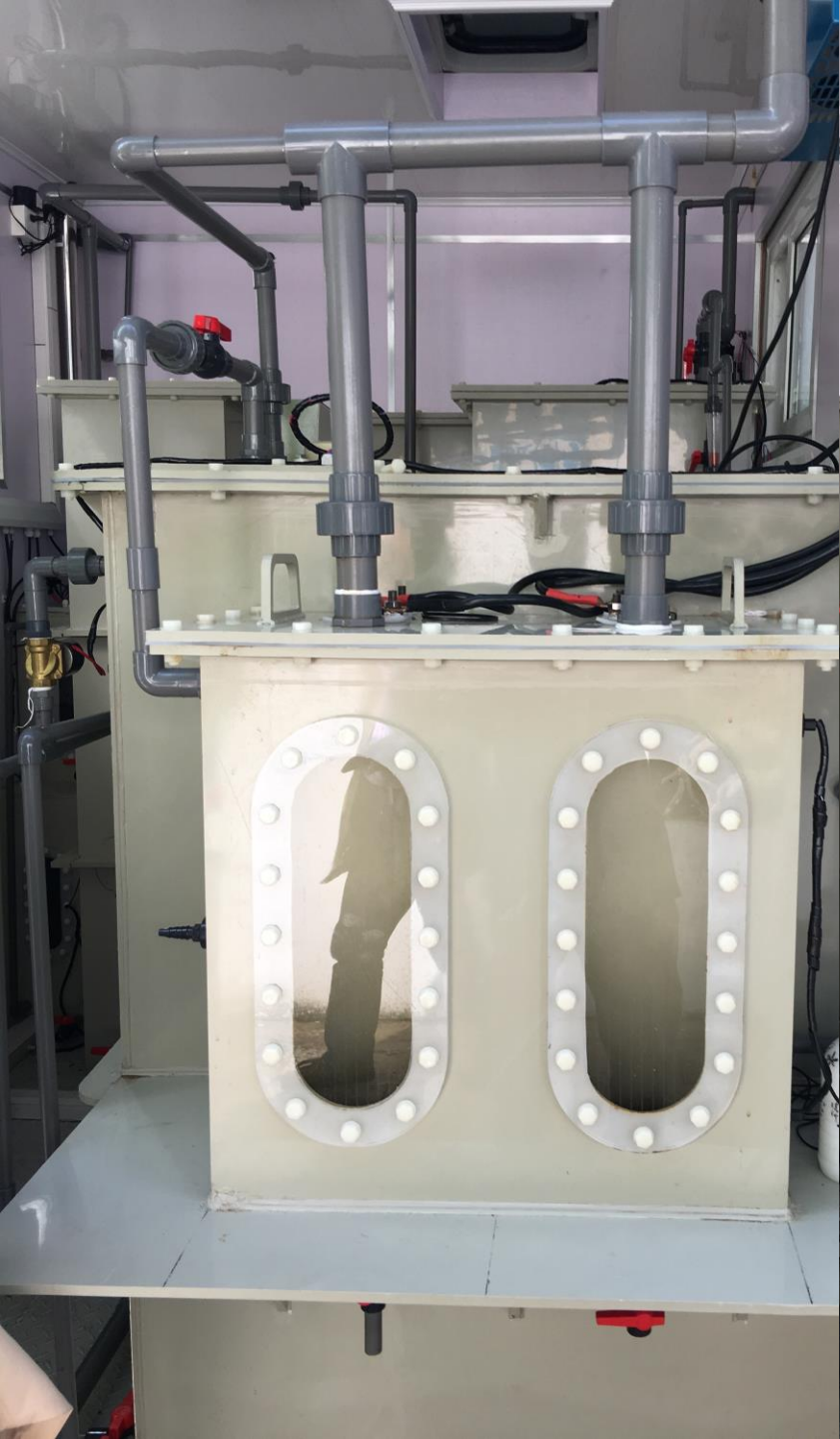


Eco-san
Ecological Toilet /生态厕所/

卫生间
Toilet









V/C

请您使用后做好记录，谢谢！



仅用于洗手，请勿
饮用及清洗瓜果！
谢谢配合！

因厕所特殊的处理
系统，所以请将厕纸
扔进纸篓！谢谢配合！

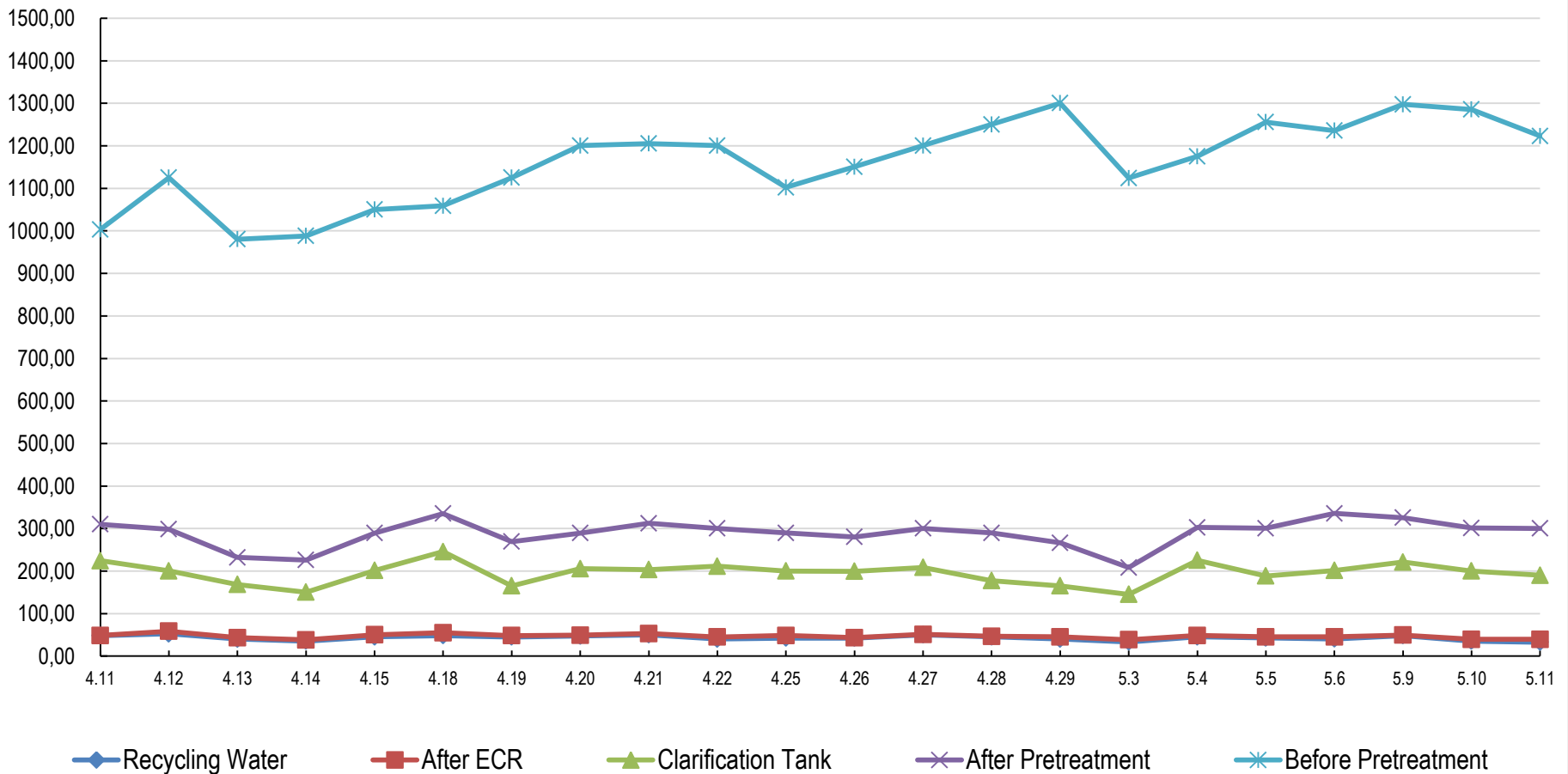
冲厕处

请轻按

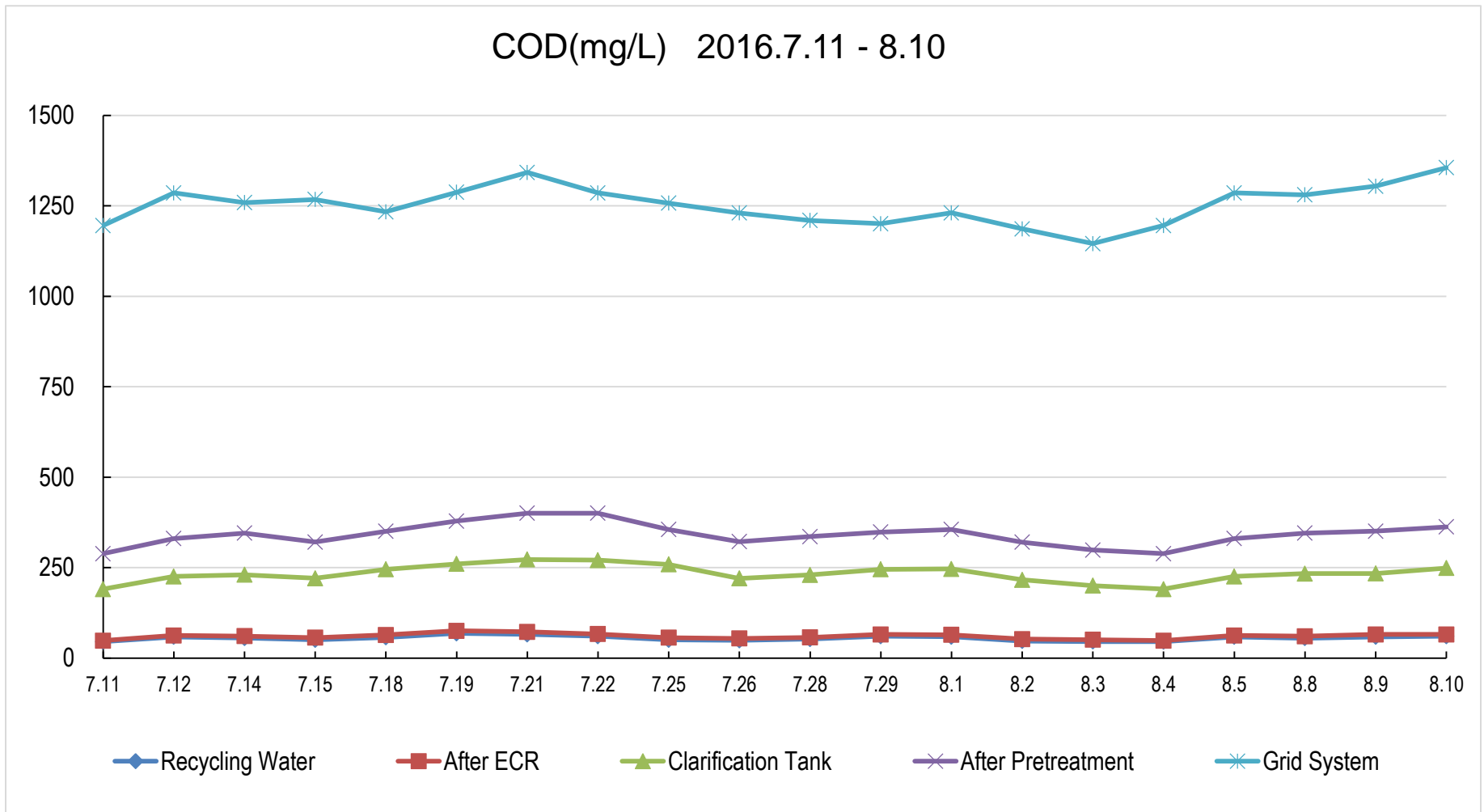


Elementary School Testing Results

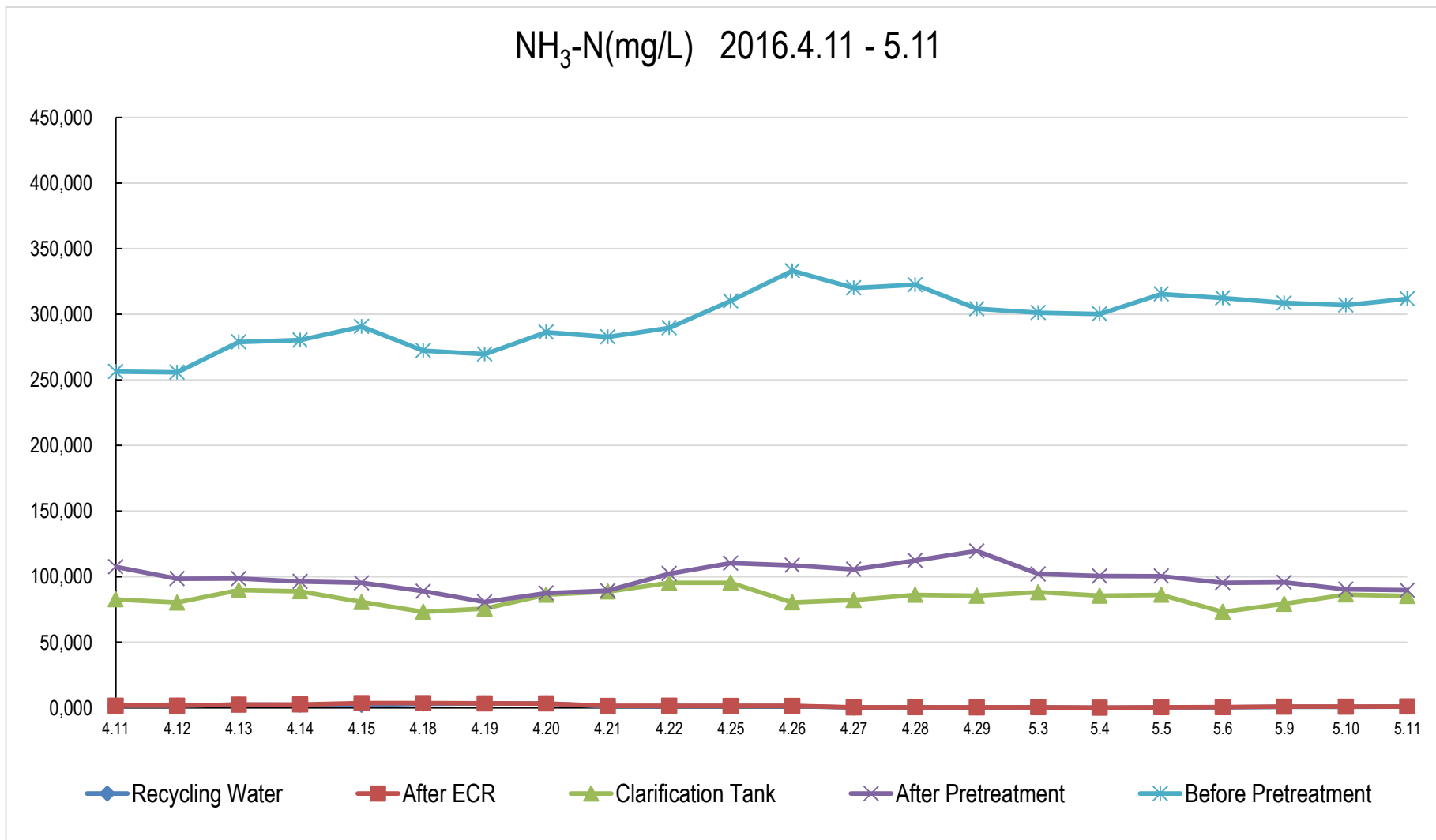
COD(mg/L) 2016.4.11 - 5.11



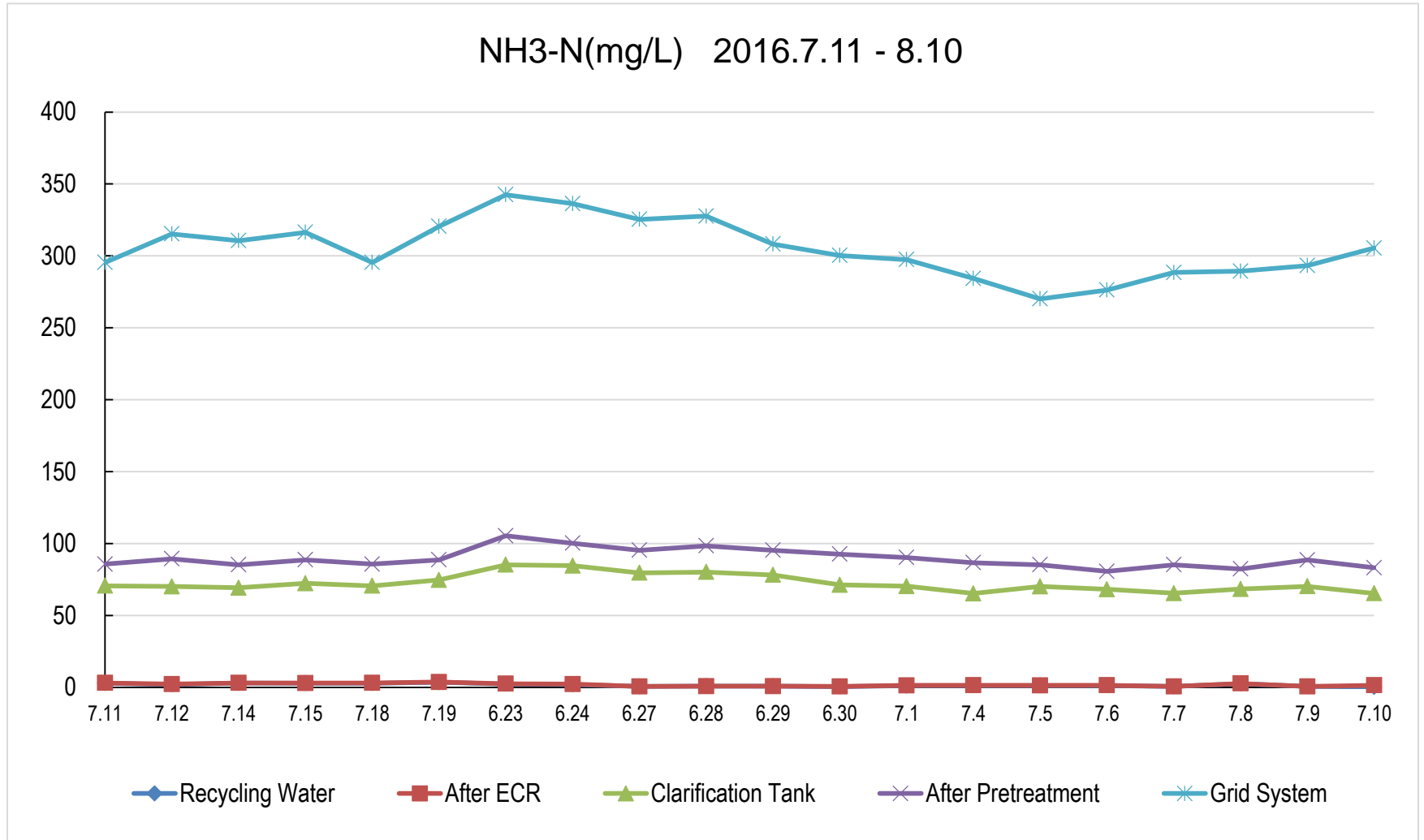
Prototype 2 Testing at Industrial Park



Elementary School Testing Results

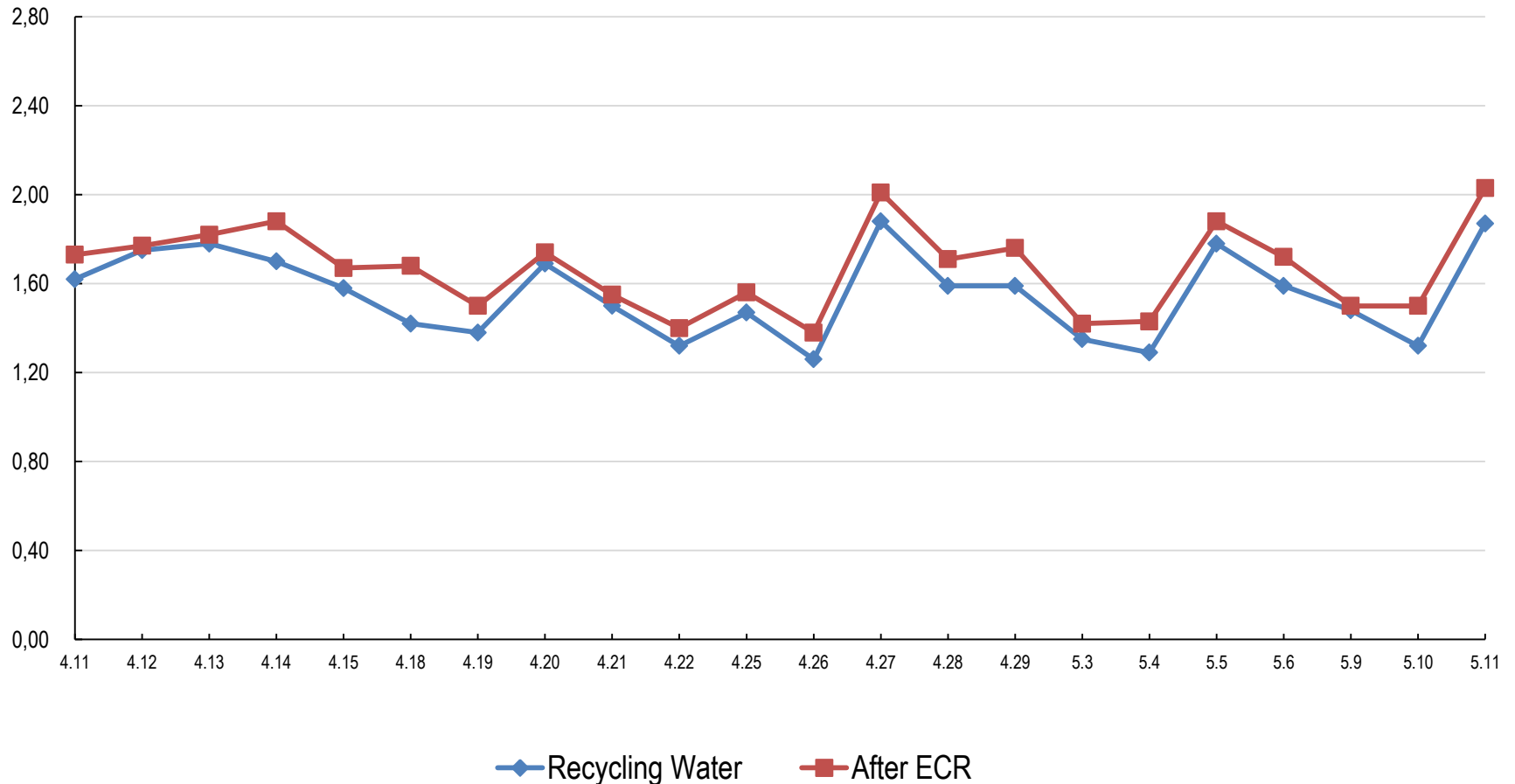


Prototype 2 Testing at Industrial Park

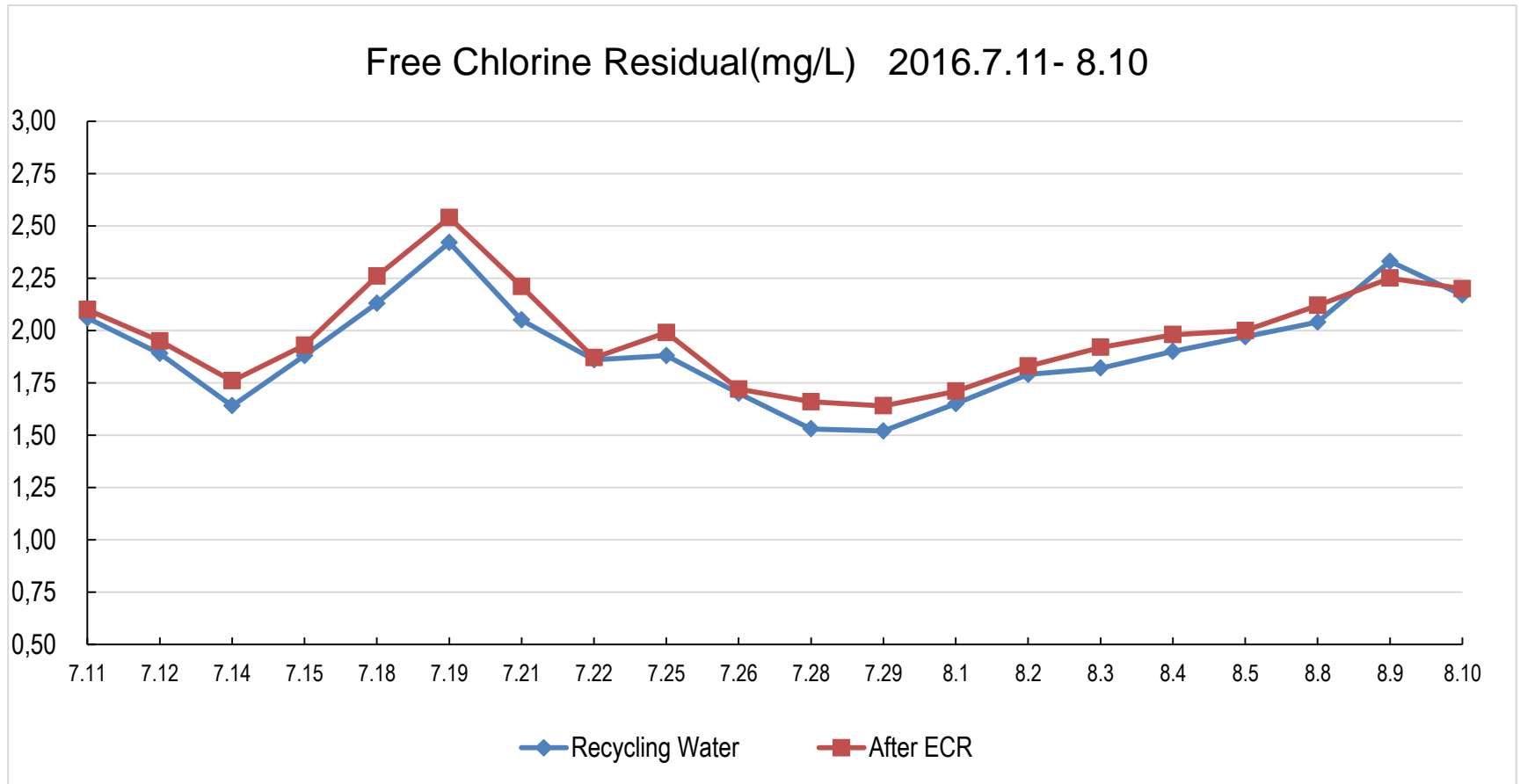


Elementary School Testing Results

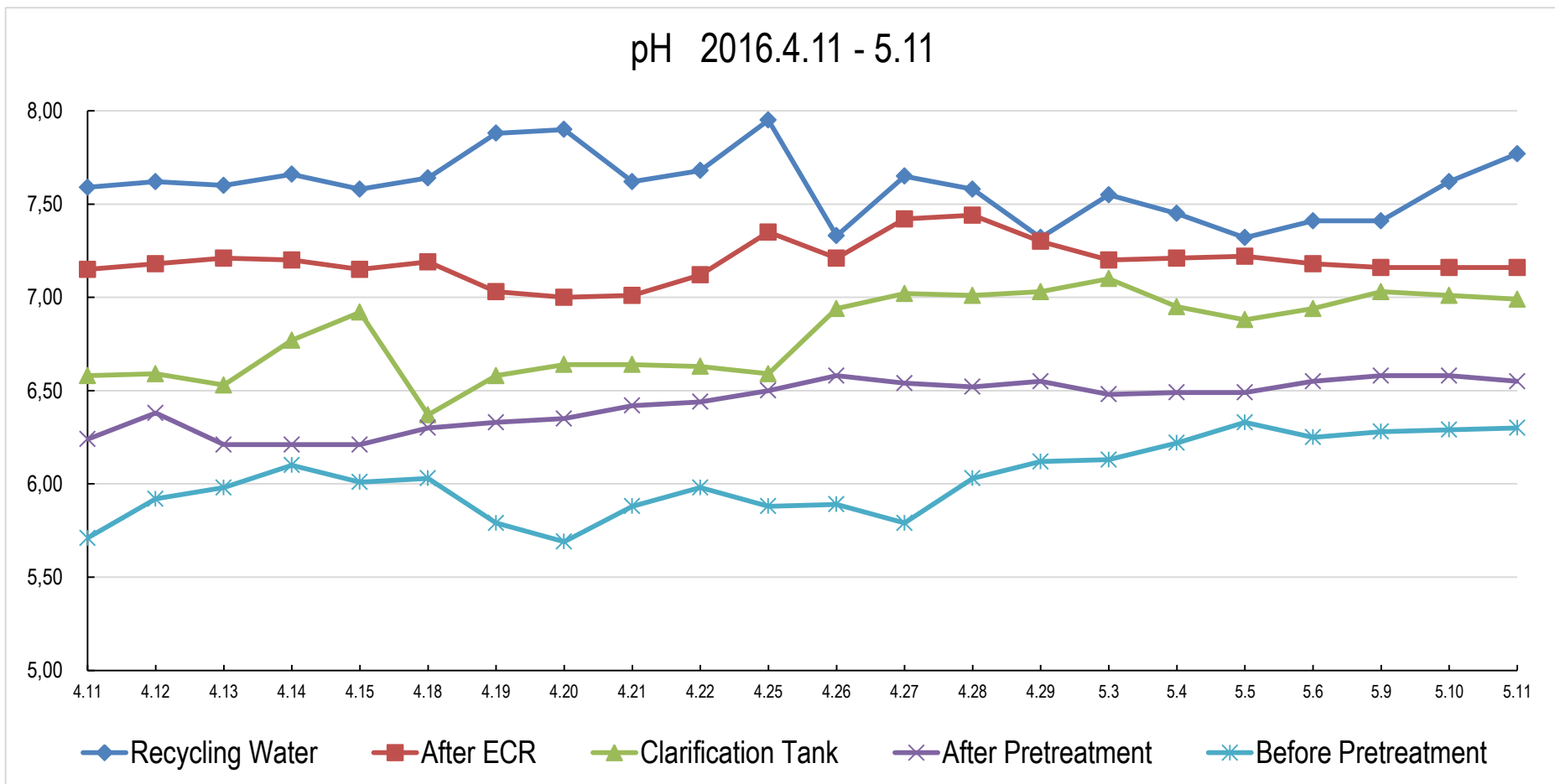
Free Chlorine Residual (mg/L) 2016.4.11 - 5.11



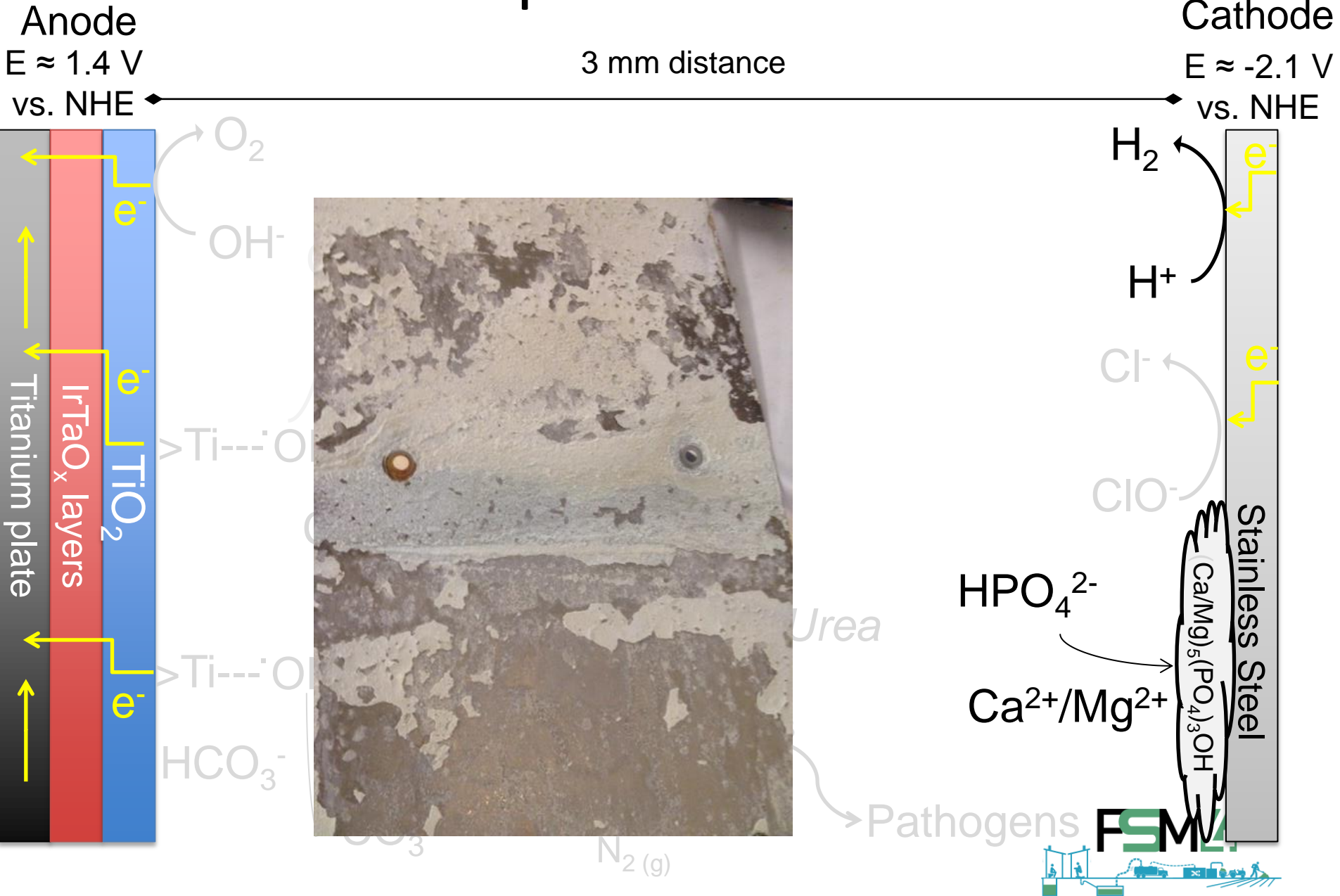
Prototype 2 Testing at Industrial Park



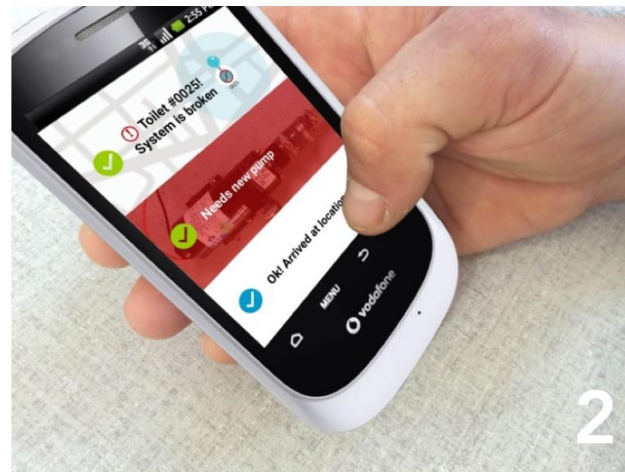
Elementary School Testing Results



Phosphate Removal



Smart Phone System Monitoring



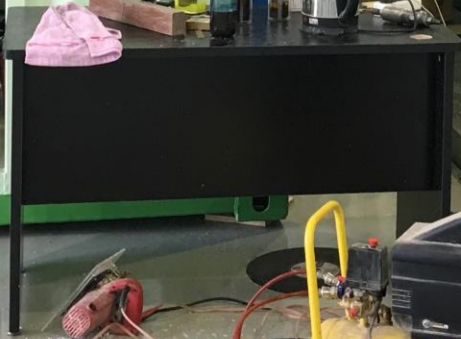




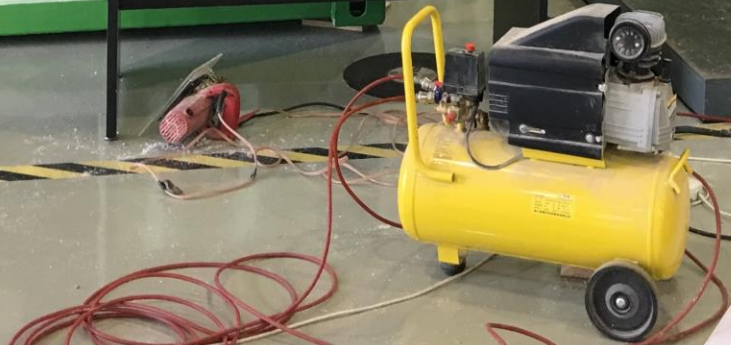
制件单位:
Manufacturer:
宜昌艾科森生态环保设备有限公司
Yang Eco-sanitary Manufacture Co., Ltd.



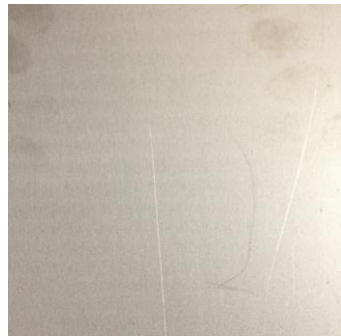
高浓度难处理废水专科



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Electrode Manufacturing - Entrustech



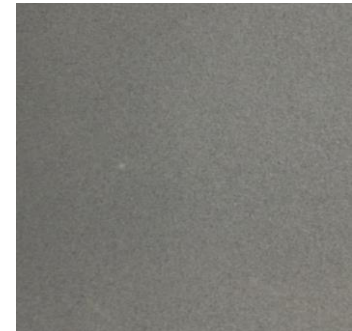
Bare Ti



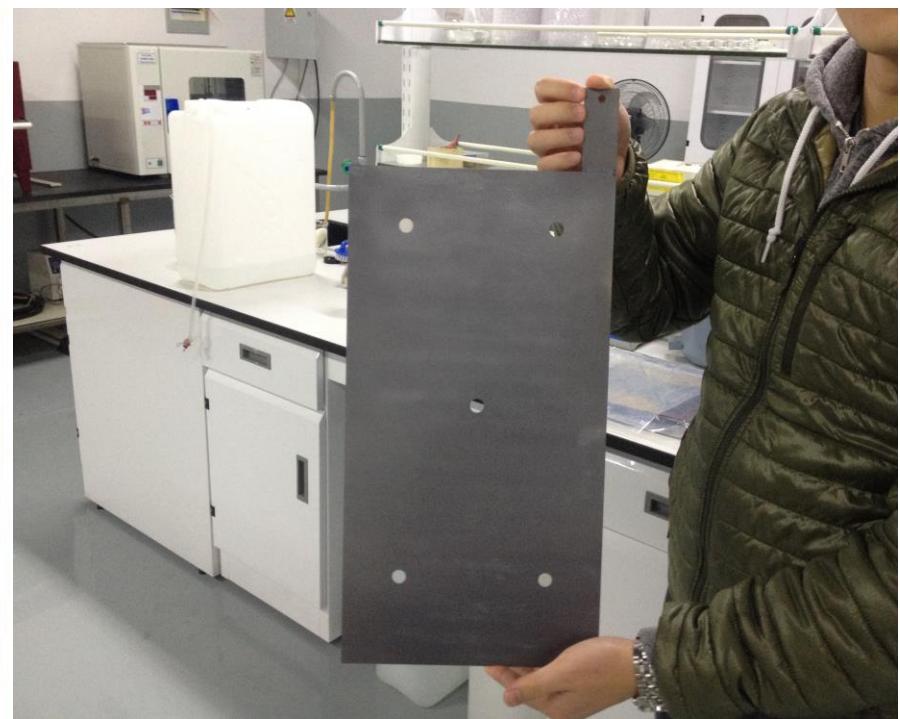
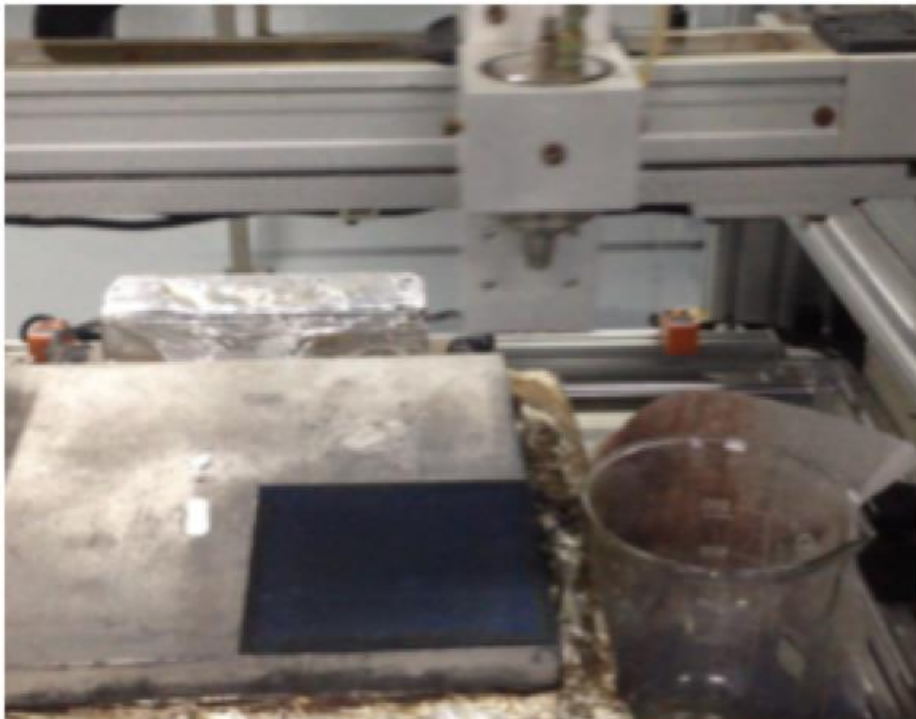
Sand Blasting



$\text{Ir}_{0.7}\text{Ta}_{0.3}\text{O}_2$
Brush Coating



TiO_2
Spray Coating





A tall, grey control panel stands on the left side of the laboratory. It features a digital display at the top, several analog meters, and a grid of buttons and indicator lights. A green light is illuminated on the left side of the panel. The panel is mounted on a white cabinet.

A long, white laboratory table with a black top edge holds several experimental units. Each unit consists of a stainless steel chamber mounted on a clear acrylic base. The units are connected by a network of black tubes and wires. Blue-handled valves are visible on the tubes. The units are arranged in a row, and the table has white cabinets underneath.

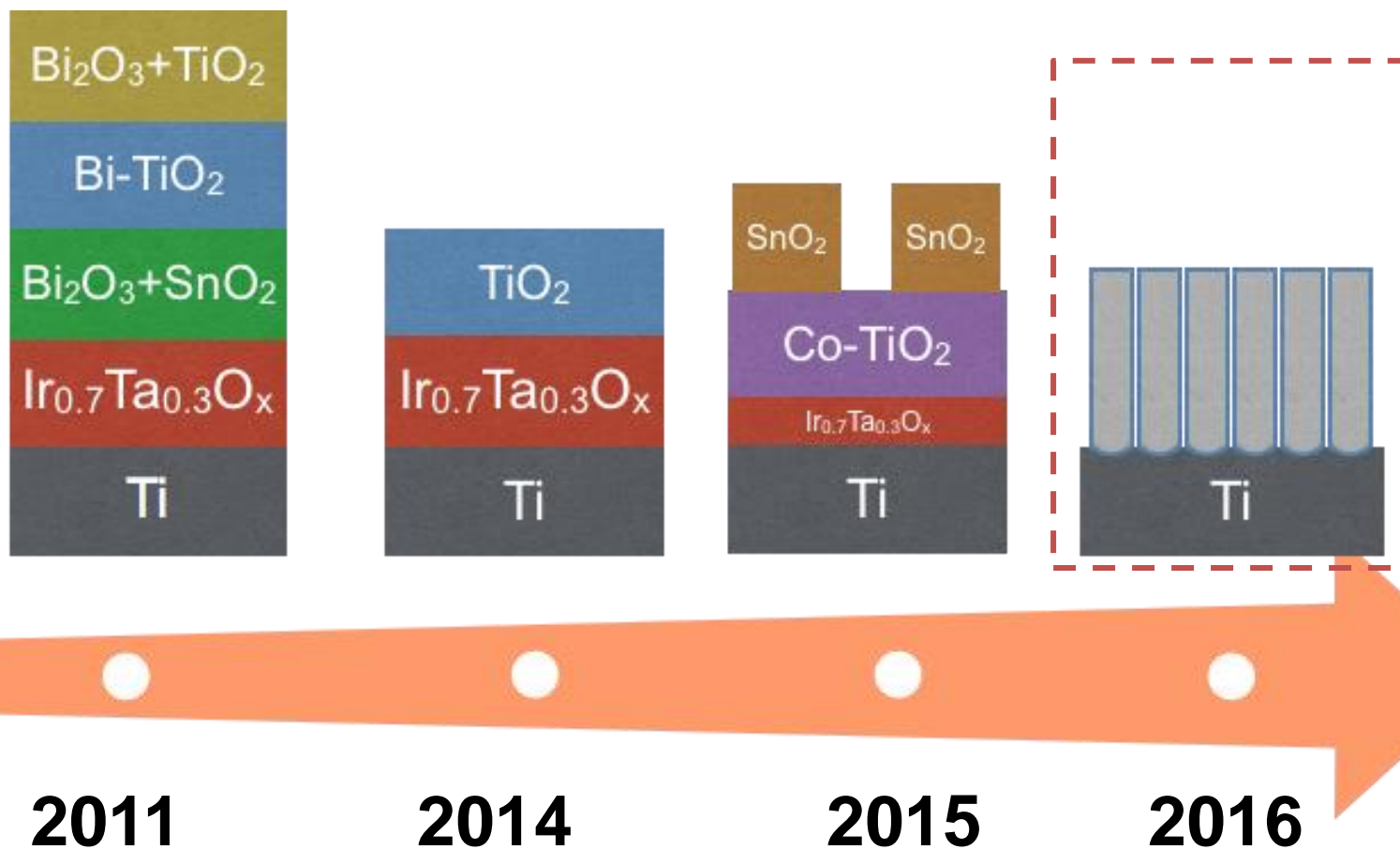
A white cabinet with a black top edge is located on the far left. A black fan is placed on top of the cabinet. The cabinet has a single drawer and a door.

A rectangular window with a black frame is located on the left wall. It provides a view of green trees outside.

A rectangular window with a black frame is located on the back wall. It provides a view of the outdoors.

A large rectangular window with a black frame is located on the right wall. It provides a view of the outdoors and has a white blind partially visible.

Anode Improvements 2011- 2017



Conclusions

- Human waste can be treated to water reuse standards res
- Most fecal matter is processed biological
- Electrochemical disinfection & oxidation for water reuse
- Calcite and hydroxyapatite deposition on cathodes
- High residual reactive chlorine levels cause corrosion
- Maximum number of users per day ranges from 300 to 600
- Smart phone control and system diagnosis
- Field testing and problems dictate design changes



Acknowledgements

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Eco-San, Yixing, China