WELCOME
TO THE MARCH EDITION
OF THE 2016
M&R SEMINAR SERIES
BEFORE WE BEGIN

• SAFETY PRECAUTIONS
  • PLEASE FOLLOW EXIT SIGN IN CASE OF EMERGENCY EVALUATION
  • AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE

• PLEASE SILENCE CELL PHONES OR SMART PHONES

• QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION

• PLEASE FILL EVALUATION FORM

• SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2016 Seminar Series)

• STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)
ZHIGUO YUAN, Ph.D.

**Current:** Director of the Advanced Water Management Centre (AWMC) at The University of Queensland, Brisbane, Australia

**Experience:**
- *Postdoctoral research fellow,* in wastewater management at Ghent Univ., Belgium
- *Postdoctoral research fellow, Deputy Director,* and Professor at AWMC of The University of Queensland, Australia
- *Founder,* three biotechnology businesses namely SeweX, Cloevis and Lodomat

His research has delivered documented savings of over $400 million to the Australian water industry

**Education:** Ph.D. in aeronautical engineering, Beijing University of Aeronautics and Astronautics, Beijing, China.

**Professional:** International Water Association (IWA) Fellow

Named as one of Australia’s Top 100 Most Influential Engineers for 2015.

Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE).

**Publication:** over 280 fully refereed journal papers including a paper in Nature (2013) and Science (2014). His h-index is 52 (Scopus, Feb 2016), with over 8200 citations.

**Award:** 2015 ATSE Clunies Ross Award

IWA 2014 Global Project Innovation Award (Applied Research Category)
Innovative Solutions to Corrosion and Odor Problems in Municipal Sewer Networks

Professor Zhiguo Yuan, FTSE, IWA Fellow
Director, Advanced Water Management Centre
The University of Queensland
Presentation outline

- Brief introduction to AWMC @ UQ
- Sewer research outcome highlights
- On-going activities
Introduction to AWMC @ UQ

- A significant water research center
  - >100 staff and PhD students
  - Annual budget $8-9m
- Excellent synergy between fundamental and applied research
  - Delivered substantial industry benefits
  - 70 - 90 journal articles annually, papers in Nature and Science
- Three spin-offs
  - SeweX, Cloevis and Lodomat
Introduction to AWMC @ UQ

Urban water management

<table>
<thead>
<tr>
<th>Sewer corrosion &amp; odour management</th>
<th>NextGen urban water technologies</th>
<th>Integrated urban water management</th>
<th>Resource efficient agri-industry</th>
<th>Biotechnology</th>
<th>Urban water, health &amp; environment nexus</th>
</tr>
</thead>
</table>

...
13 year research on sewer corrosion and odour

- ~$30m research since 2003
- > $400m cost savings by the Australian water industry
- Australian industry partners collectively serve 2/3 of the Aus. population, also overseas partners
- Two spin-offs (SeweX and Cloevis)
- > 100 papers including one in Science
- Several prestigious awards
Sewer research scope

**Corrosion Theme**: Corrosion processes
- Dependency of corrosion rate on key factors
- Model predicting corrosion rate
- Remaining service time estimation
- Coating materials

**Liquid Theme**: Liquid phase technologies to minimize production/emission of $\text{H}_2\text{S}$ and other odorous compounds

**Gas Theme**: Ventilation technology

**Modelling Theme**: Models to predict the production, emission and transport of the compounds

**Knowledge Management Theme**: Capture all knowledge and transfer to industry through a web-based system
An integrated research approach

Fundamental laboratory investigations + …
An integrated research approach

... + extensive field studies
An integrated research approach

2 gravity mains: $L=300m$, $\Phi=250mm$  
2 rising mains: $L=300m$, $\Phi=100mm$

Innovation Center @ Luggage Point WWTP, Brisbane
An integrated research approach

... + advanced modelling
Outcomes: new knowledge

- Reactions in sewer biofilm
  - Submerged biofilms & processes
  - ‘Corrosion’ biofilms & processes
Outcomes: new knowledge

● Reactions in sewer biofilm
  – Submerged biofilms & processes
  – ‘Corrosion’ biofilms & processes

● How the commonly used chemicals work
  ▶ Oxygen, nitrate, iron salts, Mg(OH)_2, caustic
  ▶ Guidelines

● Composition of odorous sewer air
  ▶ Largest datasets
  ▶ Performance of odour treatment units
Outcomes: new tools

- Models
  - SeweX model as a planning and optimisation tool
  - Corrosion model to predict corrosion rate
  - SeweX and corrosion model to balance between corrosion and mitigation costs

- SCORe-CT for chemical testing

- Corrosion chambers

- Analytical tools
  - Reliable chemical analysis of sulfur species
  - On-line dissolved sulfide sensor
  - On-line dissolved methane sensor
Outcomes: new tools

- **H₂S adsorption**
- **H₂SO₄ formation**
- **Gas transfer (Emission/Reaeration)**
- **Biofilm**
- **Gas Transport**
- **Air**
- **Wastewater**
- **Sediment**
- **Sewer Biofilm**

**Biological Processes**
- Sulfur Cycle, Carbon Cycle and Nitrogen Cycle under both aerobic and anaerobic conditions

**Physico-Chemical Processes**
- Chemical oxidation, precipitation, iron-pairing reactions (in progress), weak acid-base equilibrium
Outcomes: new tools

Application of the SeweX model to one catchment saved SWC $90 millions
Outcomes: new tools

Application of the SeweX model to one catchment saved SWC $90 millions
Outcomes: new technologies

• Cloevis
• Chemical free methods
• On-line control of chemical dosing
  ▶ Easy 15 – 40% savings in chemical consumption
• ...
Outcomes: new technologies

Sulfide control through biofilm inactivation and removal
Outcomes: new technologies

Second trial in Australia in 2014: Unitywater says “Cloevis solved an impossible problem”

Similar results were obtained in several case studies in the US by USP Technologies.
Outcomes: new technologies

- In-situ Fe\(^{2+}/Fe^{3+}\) production (on-going research)
Outcomes: new technologies

- In-situ Fe$^{2+}$/Fe$^{3+}$ production (on-going research)
Outcomes: new technologies

- On-line control algorithms for chemical dosing ($O_2$, $NO_3^-$, $Fe_{2+}/Fe_{3+}$, $Mg(OH)_2$)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>No dosing</th>
<th>Profiled dosing</th>
<th>Feed-forward dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewage flow (ML/d)</td>
<td>21</td>
<td>20.9</td>
<td>20.9</td>
</tr>
<tr>
<td>pH</td>
<td>7.4 ± 0.2</td>
<td>7.3 ± 0.2</td>
<td>7.4 ± 0.2</td>
</tr>
<tr>
<td>Average TDS (mgS/L)</td>
<td>1.65</td>
<td>0.13</td>
<td>0.07</td>
</tr>
<tr>
<td>90% TDS (mgS/L)</td>
<td>3.08</td>
<td>0.46</td>
<td>0.23</td>
</tr>
<tr>
<td>Iron dosage (L/day)</td>
<td>0</td>
<td>433</td>
<td>318</td>
</tr>
</tbody>
</table>

25% chemical saving! Annual saving can be higher due to rainfalls.
Enduring impact

The SCORe Symposium – Saving Dollars and Scents
Brisbane, July 8-9, 2013
Enduring impact

Web-based knowledge management system
On-going activities

- Application of knowledge, tools and technologies
  - SeweX and Cloevis

- New research projects
  - An integrated approach to iron salts in urban water systems
  - Optimal integration of centralised and decentralised water and wastewater systems
  - Anti-corrosion concrete
  - Network-wide chemical dosing control
  - Sewage epidemiology
An integrated approach to iron salt use in urban water systems

\[ \text{Al}_2(\text{SO}_4)_3 \]
NOM removal

Drinking water production

Drinking water distribution / consumption

Sewer networks

Wastewater treatment plant

Waste sludge

Disposal

![Bar chart showing sulfate levels in different water sources](image)

Source: Science
An integrated approach to iron salt use in urban water systems

$\text{Al}_2(\text{SO}_4)\text{Cl}_3$ NOM removal

Drinking water production → Drinking water distribution / consumption → Sewer networks → Wastewater treatment plant

Waste sludge → Disposal
An integrated approach to iron salt use in urban water systems
Interactions between centralised and decentralised systems

- Impact on water supply infrastructure
- Water demand reduction & alternative water sources
- Impact on sewage collection and treatment infrastructure

- Can we shift this peak?
- Flow rate (L/s)
- Normal flow vs reduced flow
- Hour of Day vs Time (day)
Anti-corrosion concrete

Xiaoyan Sun
Yuan/Jiang/Bond
Anti-corrosion concrete

H$_2$S, O$_2$

NO$_3^-$

NO$_2^-$

H$^+$

SO$_4^{2-}$

Low surface pH

SPS176J (old Wet Well)
Network-wide chemical dosing control
Sewage epidemiology
Acknowledgements for partners’ support

- Partners outside Australia
  - DC Water
  - Brown & Caldwell
  - USP Technologies
  - Aquafin NV
  - PUB, Singapore
Thank You

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