BICHLOR™ Electrolyser

Designed by Operators for Operators

Dr Derek Armstrong
Global Sales and Marketing Manager
Speakers Profile

- PhD in Electrochemistry from Cambridge University
- 24 years experience in ICI/INEOS
- Worked exclusively in the Chlorine Chain
  - Chlor-alkali Electrolysers
  - Electrode coatings
  - EDC technology
  - Perchlorethylene /Trichlorethylene
  - Low Bromine Chlorine
  - Chlorinated Paraffin
  - Water treatment technology
- Currently Global Sales and Marketing for INEOS Technologies Ltd
INEOS

**Turnover**
$54 Billion

**Employees**
17,000

**Production**
60 Million Tonnes

**Heritage**
AMOCO, BASF, BAYER, BOREALIS, BP, DEGUSSA, DOW, ENICHEM, ERDOLCHEMIE, HOECHST, ICI, INNOVENE, LANXESS, MONSANTO, NORSK HYDRO, SOLVAY

**Sites**
65 sites in 16 countries

**INEOS Growth**

![Graph showing INEOS growth from 1999 to 2014.](image-url)
INEOS Technologies - licensing arm of INEOS

**EMPLOYEES**

450 +

**HERITAGE**

INEOS Technologies have expertise in:-

- Plant design
- Equipment design
- Process optimisation
- Catalyst selection & production
- Commissioning
- After sales support
- Extensive pilot plant facilities in USA, Europe & Asia
INEOS Chlor alkali experience = 118 years

United Alkali Company (1897)

chlor-alkali (1926)

EVC

PVC/VCM/EDC (1986)

PVC/VCM/EDC (1986)

chlor-alkali (2001)

Stauffer

EDC/VCM (1989)

Cl₂/EDC/VCM/PVC
**BiChlor - Global Presence**

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>kMTPA</th>
<th>Start up</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF Chlor Alkali</td>
<td>USA</td>
<td>110</td>
<td>2014</td>
</tr>
<tr>
<td>Skymine</td>
<td>USA</td>
<td>90</td>
<td>2014</td>
</tr>
<tr>
<td>OLIN</td>
<td>USA</td>
<td>200</td>
<td>2011</td>
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<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>kMTPA</th>
<th>Start up</th>
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</thead>
<tbody>
<tr>
<td>Luzhou</td>
<td>China</td>
<td>100</td>
<td>2009/13</td>
</tr>
<tr>
<td>Xinglong</td>
<td>China</td>
<td>275</td>
<td>2011/12</td>
</tr>
<tr>
<td>Fuhua Tonga</td>
<td>China</td>
<td>150</td>
<td>2009</td>
</tr>
<tr>
<td>Chengdu Chem</td>
<td>China</td>
<td>105</td>
<td>2008/16</td>
</tr>
<tr>
<td>Wuhan</td>
<td>China</td>
<td>100</td>
<td>2011</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>Tasnim mass</td>
<td>Bangladesh</td>
<td>80</td>
<td>2011/15</td>
</tr>
<tr>
<td>Coogee</td>
<td>Australia</td>
<td>50</td>
<td>2010/15</td>
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More than 120 licensees world wide
BiChlor Electrolyser – Actual view
BiChlor Electrolyser – Enhanced Attributes

- Zero Gap Technology
- Electrolyser output up to 50,000 MTPA per electrolyser
- Effective Area of modules 3.4 m²
- Normal operating current density 6.0 kA/m²
- Normal Operating Pressure range up to 300 mbarg

**BiChlor** electrolyser have the largest module area. This reduces the number of modules required per tonne NaOH.
Looking inside the BiChlor electrolyser – Key Features

- Modular
- Dimple Pan Design
- Short current path and uniform current distribution
- Electrode coatings
- Advanced Sealing
INEOS Modular Design Enables:

• **Fully Wetted Membrane**
  • Gas/Liquor interface above the membrane
  • Avoids damage and pin-holing of membrane
  • Prevents mixing of Cl₂ / H₂ to avoid explosions

• **Pressure testing before use (to detect and eliminate leaks)**

• **Maintenance work carried out away from the cell room**
  • No risk of electrical shock
  • Clean and safe work area
  • No work carried out on top of the electrolyser
  • Replacement modules can be prepared for rapid electrolyser turn around
Dimple pan design

- **Reduced electrical resistance by**
  - Maximising use of nickel post in cathode pan
  - Minimising use of titanium post in anode pan

- **Strength**
  - Resistant to distortion during in-pan re-coating
  - Resistant to pressure

- **Self alignment of modules at commissioning**
Module construction showing dimples and “spider” structures

Cross Section through module
Module construction showing dimples and “spider” structures

- Each anode and cathode has hundreds of dimples
- Each dimple on the anode and cathode has a offset distribution ‘spider’ attached to it
- Insulated pins redirect the current through the spiders ‘legs’

Benefits
- Membrane fully supported no “flapping”
- Openness of contact points ensures even current distribution with no “hot spots” and no localised high concentration of product formation
- Prevents pinching of membrane
Bichlor open mesh cathode structure

- BiChlor electrolyzers have always used an open mesh cathode
- This provides the following advantages
  - Enhanced catholyte circulation
  - Eliminates stagnation of catholyte
- This means no “hot spots” are generated and that all new high performance membranes can be used to optimise energy efficiency and reduce power consumption
INEOS COATINGS
KEY FACTS

INEOS manufactures all its own coatings

All INEOS coatings can be tailored to customers membrane cycles

- Anodes – 8, 10, 12 years
- Cathodes – 8, 10, 12, 15, 16 years

INEOS coatings are currently installed in the following electrolysers
- INEOS
- UHDE
- AK
- MGC

INEOS HAS BEEN MANUFACTURING CHLOR ALKALI ELECTRODES FOR 118 YEARS
INEOS ANODE coatings have been designed to provide a chlorine over-voltage of 20-30mV lower than typical commercial coatings. This represents a 1% power saving for customers (eg based on $80 per MWh a 100kte plant would save $120k/year)
INEOS Anode Coating – LOW ALKALINE WEAR

INEOS ANODE coatings have been designed to provide significantly superior alkaline wear performance over other commercially available chlor-alkali anode coatings.

With the move to zero gap where the membrane lies directly up against the membrane good alkaline wear resistance in very important for coating life as the surface of the membrane is alkaline.
### INEOS Anode Coating – LOW CHLORATE IN BRINE

<table>
<thead>
<tr>
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<th>INEOS</th>
<th>Competitor</th>
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<tbody>
<tr>
<td>Chlorate (g/l)</td>
<td>0.05</td>
<td>0.3</td>
</tr>
<tr>
<td>Hypochlorite (g/l)</td>
<td>0.8</td>
<td>1.5</td>
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INEOS **ANODE** coatings have been designed to provide a very low level of chlorate (and hypochlorite) in brine.

This translates to less chemical usage for chlorate destruction but more importantly lower chlorate in caustic, stopping evaporator corrosion.
INEOS Cathode Coating – HIGH RESISTANCE TO WEAR

- Non-precious metal coatings normally last 4-8 years
- INEOS precious metal coating shows virtually no loss (warrantied for 16 years)
- >18 years experience in our FM mono-polar technology
- 13 years experience on BICHLOR™ with no measurable loss
The INEOS CATHODE Coating has an exceptionally high resistance to reverse currents making it the ideal cathode coating for all zero gap electrolysers.
Continued focus on performance
Advanced Sealing

- **Gasket structure evolved over > 25 years**
  - Constructed of EPDM rubber with PTFE protection at the interfaces with the electrolytes
  - Designed to minimise anode flange crevice corrosion
  - Profiled at point of contact with membrane
  - Diminished risk of leakage of products
As Operators what are we looking for?

- Successful Lifespan
- Safe Operation
- Reliability
- Efficiency
With BiChlor you benefit from

**Safe Operation**
- Designed for safety
- Easy access to electrolyser components, e.g. headers
- Module maintenance away from the electrolyser area
- Module design prohibits chlorine and hydrogen explosions

**Reliability**
- Proven electrolyser design
- Membranes guaranteed for 4 years minimum
- Anode and cathode life up to 16 years
- Performance backed up by product volume guarantees
- Engineering and Technical back up help from INEOS team
- Access to INEOS Technical service team at start up and whilst in production

**Efficiency**
- Leading position on power consumption
- Performance backed up by product quality guarantees
Plus: Our Commissioning and Technical Service offering

- **Extensive commissioning support**
  - Lead commissioning manager plus support as required
  - Operator training
  - Overview of frame and module build
  - Electrolyser start-up

- **Technical service support is part of the deal**
  - No extra cost for standard level of support
  - Designated Technical Service Manager
  - Your link to our full technical team

- **Regular contact**
  - Visits at least once per year
  - Phone & e-mail
  - Performance evaluation and operating advice
  - Technical support
  - Electrolyser maintenance planning

- **Customer forum every 2 years – highly valued by our clients**
INEOS will Bring Deep Understanding of Chlor-Alkali to your Project

- Design of wider chlor-alkali plant, whether for a technology conversion or new installation is by now generally understood

- Deep understanding of the chemical engineering science around the electrolysis section of the plant is required to ensure optimal design

- Several key areas, identified here, require very careful consideration to ensure prolonged efficient operation of the plant

- Operating Experience + Technical Expertise → Optimal Cellroom design
Where can INEOS add value?

- Plant performance assessment
- Plant capacity assessment
- Vendor analysis and selection
- Technology knowledge
- Optioneering and financial analysis
- Feasibility studies
- Hazard studies and technical risk
- SIL/LOPA
- Dynamic modelling
- Troubleshooting
- Operating skills

Flowchart:
- Process Definition
- Process Design
- Front End Engineering
- Detailed Engineering
- Procurement and Construction
- Commissioning
- Expert process engineering
- Layout analysis
- PDPs
In summary

- INEOS can provide the skills, knowhow and equipment to help build and operate a successful plant
  - Support to project feasibility studies
  - Supply of first class engineering services
  - Supply of BICHGOR™ Electrolysers
  - Continued after sales support

JOIN THE INEOS FAMILY – “by operators for operators”
Thank you & Enjoy the remaining Conference