About us

A speciality chemicals company and a world leader in sustainable technologies

Global, established in 1817, FTSE 100, British company

£11.2 billion revenue and underlying profit before tax of £427.3 million for year ended 31st March 2014

12,000 employees, 30 countries
Divisional Structure

Emission Control Technologies
- Light Duty Catalysts
- Heavy Duty Catalysts
- Stationary Emissions Control

Process Technologies
- Chemicals
  - Chemical Technologies (JM Davy)
  - Syngas
  - Chemical Catalysts (inc. Formox)
- Oil and Gas
  - Refineries
  - Purification
  - Tracerco

Precious Metal Products
- Services
  - Platinum Marketing and Distribution
  - Refining
- Manufacturing
  - Noble Metals
  - Colour Technologies
  - Chemical Products

Fine Chemicals
- Active Pharmaceutical Ingredient (API) Manufacturing
- Catalysis and Chiral Technologies
- Research Chemicals

New Businesses
- New Business Development
- Water
- Battery Technologies
- Fuel Cells
History of Pd Membranes at JM

Self-supporting Pd membranes
Mobile H₂ generator

Flat foil Pd membranes
On site H₂ generator

Self-supporting Pd membranes
On site H₂ production

Flat foil Pd-alloy membranes
H₂ generation

Composite Pd-alloy membranes
On-board reformer

Composite Pd-alloy membranes
Coal gasification
Fuel cell

Composite Pd-alloy membranes
Coal gasification


Current Project Objective

CO + H₂ + Contaminants → Pre-treatment

Other Experiments

CO₂ + H₂ → Pd Membrane Skid

HP CO₂ → Sequestration / Industrial Uses

H₂ 15 - 20 lb/day

DOE Award No.: DE-FE0004895
In the 1990’s
• Scaled-up Pd-ceramic membrane manufacture
  • 140cm\(^2\) tubes and supplied single tubes in housings.

Present
• New Pd membrane synthesis setup under construction: up to 1 m long membranes
• Leak detection using He
• High temperature membrane aging under H\(_2\) atmosphere
Membrane Synthesis

Long synthesis procedure
- Number of steps: > 70
- Less steps?
- Lower cost?

“Art” of membrane synthesis?
- Better understanding
- Improve reproducibility
- Better scalability

Pre-treatment

Grading

Sensitization & Activation

Electroless plating
Pre-treatment

Influence of pre-treatment methods
- Method 1
  - Best pre-treatment results
  - Better reproducibility
- Method 2
  - Comparable
  - Better reproducibility

Influence on grading
- Method 1
  - Very poor grading quality
- Method 2
  - Comparable
Grading

Improving grading layer
- Additional grading layer
- Concentration
- Procedure
- Method

Influence on dense membrane
- Grading influence dense layer
- Better grading
  - Lower He permeance
  - Thinner dense layer
Initial test at NCCC – Single membrane

Does Pd membrane works in IGCC flow sheet?

- Pure Pd membrane
  - Unstable --- Pin hole formation

- PdAu membrane
  - Slight decline in flux
  - High purity H₂

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Ma at al., *Energy Fuels* 2013, 27, 4150–4160.
Conclusion

Pd membrane utilized downstream of coal gasifier

Pd membrane capabilities at JMTC

- Synthesis of membrane up to 1 m in length
- Previous experience in Pd membrane
- Competences in coating, PGM metal technology and manufacturing.
  - Reproducibility and scalability
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Engineering Design of Advanced H2–CO2 Pd and Pd/ Alloy Composite Membrane Separations and Process Intensifications