Morgan Advanced Materials

The Oil & Gas Conference®
August 19, 2014

Dr. Michael Murray, C.T.O.
Contents

• Overview of Morgan Group

• Morgan in the oil and gas market

• Engineered solutions for oil and gas
  • Thermal management
  • Sensor and sonar
  • Connectivity
  • Seals and bearings
  • Wear
An advanced materials company providing technically complex, bespoke solutions to its customers, enabling them to address global trends such as energy demand, healthcare and environmental sustainability.

2013 revenue = GBP958 million (USD1.5 billion)
What we do

• Cutting edge material science
• Sophisticated application engineering
• Solving complex challenges in technically demanding applications
• Collaborating with our customers, to provide custom solutions, enabling their products and processes to perform more efficiently, more reliably and for longer

Driving differentiated, market leading positions
What differentiates us?

- Advanced material science and processing capabilities
- Our applications engineering experience
- A strong history of innovation and reinvention
- Consistent and reliable performance
- A truly global footprint
- We find and invest in the best people
Focusing on technically demanding, growth markets

- Energy
- Transportation
- Electronics
- Security and Defence
- Healthcare
- Industrial
- Petrochemical
Our products give us a leading position in the markets we serve

- Fibre
- Insulating Firebricks / Castables
- Fire Protection
- Engineered Ceramics
- Metallised Ceramics and Assemblies
- Braze Alloys
- Sensors and Transducers
- Speciality Graphite
- Electrical Carbon
- Seals and Bearings
- Composites and Defence Systems
- Molten Metal Systems
Providing products and services to a global customer base

North America: 38%
Europe: 37%
Asia, Rest of World: 25%

2013 Sales by destination
Working closely with our customers in order to provide optimised solutions

- Applications Engineers work with customers to establish operating conditions and design constraints
- Combining our materials expertise, market understanding and expert knowledge of our global manufacturing capabilities, we create innovative engineered solutions for our customers
- Optimally designed end product solutions or prototypes result
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Morgan Advanced Materials works across the oil and gas value stream

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<th>Downstream</th>
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<td>Transportation &amp; Storage</td>
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<td>Land drilling</td>
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<tr>
<td>Production</td>
<td>Oil tank storage</td>
<td>Power Gen plant Distribution</td>
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![Upstream Image](image1.png)  ![Midstream Image](image2.png)  ![Downstream Image](image3.png)
Morgan in the oil and gas market

Morgan Advanced Materials has over 60 years experience in the energy market developing high-performance components

Our products help to ensure the reliability of severe-duty service valves, pumps and tooling products, which in turn enables the petrochemical sector to push the boundaries of oil and gas exploration

Our insulation products provide for protection for offshore exploration and downstream processing
## Engineered solutions for oil and gas

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<td>Thermal Management</td>
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<td>Wear</td>
<td>Hydrocyclones and Valves</td>
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*Image: Three images of engineered materials.*
Morgan’s solutions provide significant value to the oil and gas industry

• Braze alloys extend drill bit life providing higher customer ROI
• Ceramic connector solutions extend life and increase uptime in HPHT applications
• FireMaster® provides high temperature fire resistance with weight and cost savings
• Hydrocyclones in oil field extraction extend equipment life, reducing costs and downtime
• Nilcra™ Zirconia reduces wear in oilfield service equipment
Case study: oil rig safety

Morgan provided 10,000m² of FireMaster® Marine Plus blanket for living quarters of the fixed processing platform on Gudrun oil field. Superior thermal conductivity allowed a very lightweight installation with a high standard of protection.

20%
Lighter than conventional products
Our Seals and Bearings business produces PGS-100 graphite-loaded sintered silicon carbide, which is the material of choice for a wide range of petroleum industry equipment, including use with highly corrosive sour crude at 700°F, conditions in which no other material can currently perform 100% better than any other material.
Morgan supplied Nilcra™ Zirconia components for use in furnace feed valves for hot abrasive Canadian oil sands. The timing for valve replacements was increased from the three months for the best conventional hard metal valves to twelve months.

300% Increase in time between valve replacements
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Superwool® Fiber offers up to 40% lower thermal conductivity than competitive insulation at 1000°C

Superwool® Plus™ and FireMaster® Marine Plus™ offer:
- Superior insulation performance
- Up to 40% weight and volume savings
Fire protection for off-shore platforms and floating production storage

- FireMaster Marine Plus blanket provides many benefits:
  - An average weight saving of 20 tonnes in living quarters and 40 tonnes in the support structure
  - Highly efficient sound insulation
  - Differentiated through comprehensive testing, product performance and manufacturing tolerances
Morgan’s superior insulation properties provide valuable time in the event of a fire

- Protection for off-shore platforms, floating production storage and liquid natural gas terminals
- Morgan is the only insulation company in the market to produce a complete fire protection system
- We provide custom engineered systems which have been through comprehensive testing and certification
Insulating fiber innovation path

° C

1750

1400

750

Differentiation and margin generation

Sol Gel

Next generation low bio persistent fiber

RCF

Superwool® XT*

Superwool® Plus & HT*

Traditional alumina/silica

New low bio-persistence (*patented)

Innovation path
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Sensors for flow metering

- Water flow
- Gas flow
- Air flow
- Pressure sensors
- Air-in-line sensors
Morgan’s sensors work effectively in harsh environments

Environmental specifications:
- Up to 150 degrees C continuous in 95% humidity environment
- Pressure specification on housings tested to 100 bar
- Fully customisable housing and connectors

Morgan provides vertically integrated manufacturing capability with detailed application knowledge developed from extensive in-house system modeling
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Morgan’s ceramic feed throughs and connectors are used in sub-sea and oil exploration

Morgan’s ceramic to metal single pin feed throughs and connectors are designed for high performance and reliability
- High dielectric strength, voltage and current
- High levels of hermeticity
- High mechanical strength
- Performance in operating temperatures ranging from cryogenic -250°C to +450°C
- Chemical resistance to corrosive and caustic environments

Ceramics provide significant benefits over glass and polymer feed throughs in all the above characteristics, especially at elevated temperatures and under thermal cycling
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Silicon Carbide materials

**PR2000**
Reaction Bonded Silicon Carbide

- **Silicon carbide matrix**
- **Silicon**

**PS5000**
Pressureless Sintered Silicon Carbide

**PGS100**
Graphite Loaded Pressureless Sintered Silicon Carbide

- **Silicon carbide matrix**
- **Graphite inclusion**

**Balanced wear and lubrication properties for high PV applications**

**Silicon carbide material with the widest range of applications**

**Self lubricating silicon carbide material for limited dry run survivability and thermal shock resistance**
Morgan PGS silicon carbide reduces seal face wear - up to 2x service length of competitive product

Morgan PGS silicon carbide
- extends the service length of seal faces by reducing wear
- improves dry running survivability

Seal Face Wear Against sSiC

 PG S100
 Graphite Loaded
 Pressureless Sintered
 Silicon Carbide

Silicon carbide matrix
Graphite inclusion

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Our ceramic materials are suitable for high wear applications

- Oxide Ceramic Materials
- Silicon Carbide Materials
- Carbon and Graphite Materials
- Toughened Zirconia Materials
Morgan’s Nilcra™ Zirconia

- Z-Max Ball Valve
  - Strong and tough
  - Highly resistant to chemical corrosion
  - Superior abrasion resistance
  - Maximum size capability
    500mm outer diameter with
    75mm cross section

Transformation Toughening makes Morgan’s Nilcra™ Zirconia the toughest, most reliable structural ceramic in the world
Morgan’s hydrocyclones extend equipment life, reducing operating costs and downtime

• Hydrocyclones:
  • De-sanding
  • De-oiling

• Providing the following benefits:
  • Joint strength and high flexural resistance
  • High wear resistance
  • Tight tolerance to filter particles from 5µm to 20µm

Morgan’s Deranox® 975 alumina, joining technology and designs ensure leak-free assembly and a long service life, greatly exceeding prior industry norms
Questions?