GLOBAL TRENDS IN INDUSTRIAL MARKETS

ITA CONFERENCE – VIENNA
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They are believed to be reliable, but Neotiss makes no representation or warranty regarding the accuracy, completeness or reliability.

You rely on these projections and other information in this presentation at your own risk, and Neotiss assumes no duty to update any of this information should expectations change.

We have used for this presentation among other sources testimonies of some of our customers and suppliers.

We want to thank all of them for their contribution.
INDUSTRIAL TITANIUM - PRODUCTS

- Bars
- Slabs
- Plates
- Sheets
- Tubes
- Wires
- Coils
INDUSTRIAL TITANIUM – 2018 STATUS

- Current MT of Titanium used for industrial market is fluctuating from 30 kMT to 80 kMT according to studies.
- Fluctuation due to:
  - Different definitions for Industrial applications: medical, sport, military…
  - Risk of double counting: Bars and seamless tubes, hot rolled coils and welded tubes.
  - Stockist buffer effects.
  - Exhaustivity of products considered: only major pieces or down to valves, springs, screws…
- Neotiss rules:
  - Industrial applications excluding medical, sport, glasses, military.
  - Only main large pieces.
  - Focus on main industrial countries.
INDUSTRIAL TITANIUM – 2018 STATUS PER PRODUCT TYPE

60 400 MT

- Bars
- Flat Products
- Tubes
- Others
INDUSTRIAL TITANIUM – 2018 STATUS PER COUNTRY & MARKET

North America

Europe

Japan

South Korea

Russia

China

India

Other

• Review trend per market, country and product.

• Based on:
  • Neotiss market review.
  • Customers & suppliers interviews.
  • Ongoing tenders.
  • BP Energy Outlook 2019.
  • EIA Annual Energy Outlook 2019.

INDUSTRIAL TITANIUM - PERIMETER

Power
Nuclear / Thermal Renewable

Desalination
MSF/ MED

Oil & Gas
Production/ Refineries / LNG

Chemistry
Electrochemistry PTA

HVAC
Ammonia Heat Exchangers

Shipbuilding
Hull/ Pumps/Valves

Automotive
Mufflers/Spring/ fuelcells

Others
Architecture/ Bicycle/Wheelchair

1 POWER: TI USE PER APPLICATION

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Ti tubes MT / MW</th>
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<tbody>
<tr>
<td>NUCLEAR</td>
<td>0.162</td>
</tr>
<tr>
<td>COAL</td>
<td>0.051</td>
</tr>
<tr>
<td>GAS COMBINED CYCLE</td>
<td>0.036</td>
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<tr>
<td>Renewable Energy</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td></td>
</tr>
<tr>
<td>Geothermal</td>
<td></td>
</tr>
<tr>
<td>Bio Energy</td>
<td>0.051</td>
</tr>
<tr>
<td>Wind Power</td>
<td>0.000</td>
</tr>
<tr>
<td>Hydropower</td>
<td></td>
</tr>
<tr>
<td>Wave &amp; Waster power</td>
<td>0.000</td>
</tr>
<tr>
<td>OTEC</td>
<td></td>
</tr>
<tr>
<td>Up to 30</td>
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<td>Solar</td>
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<tr>
<td>PV</td>
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<tr>
<td>CSP</td>
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<td>Variable</td>
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<tr>
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<tr>
<td>Variable</td>
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</tbody>
</table>

1 POWER: ENERGY CONSUMPTION GLOBAL TREND

- Without energy savings the need in 2040 would be 28 Billion toe:
  + 2 Billion toe for population growth
  + 12 Billion toe for GDP increase per head

- Different scenarios according to CO2 reduction efforts:
  - Evolving transition
  - More energy
  - Less globalization
  - Rapid transition

- Growth over the coming 20 years impacted by the scenarios: from 30% to 70%

- Fuel mix impacted by the scenarios:
  - Renewable from 17% to 30%
  - Coal from 6% to 22%
1 POWER: FUEL SHARES IN POWER

- More Clear trend in power including for Evolving Transition (ET) scenario:
  - Renewable energy up from 8% to 30%
  - Gas stable around 21% of share
  - Hydro & Nuclear reduction from 27% to 22%
  - Coal energy drop from 40% to 28%
1 POWER: COAL DEMAND TREND

- India and Asia still show significant Coal powerplants
- China with a more virtuous growth
2018-19 Peak years for Ti in India. Several projects concluded in India over the period for Super Critical units. (Ennore, North Chennai, Tuticorin...). Representing over 1000MT of Ti.

Nevertheless, the present election in India is generating some uncertainties. India is a risky country for contracts and payment terms. Cancelled or postponed projects are generating significant cost all through the supply chain limiting the financial interest of the market.

A worldwide level, new constructions are down by 73% since 2015. The global fleet of coal-fired power plants should begin to decline in 2022.
1 POWER: GAS DEMAND TREND

- Global positive trend worldwide
- Push in USA with local shale gas supply
1 POWER: GAS DEMAND FACTS

Coal plant development across the world drops for second consecutive year

- Hassyan 6 phases CCGT for DEWA. Once completed, the plant will become the world’s largest IWPP plant with a whopping capacity of 9000 MW and 700 MIGD

- Cleanest and most efficient way of producing electricity from fossil fuels. Half the CO2 of Coal

- Investment of $500-1000/kW against $2500 for Coal and $5000 for nuclear

- As fast to install as renewable against 3 years for Copal and 6 years for Nuclear

- Several projects at final stage in UK, Malaysia, Thailand, Pakistan and Turkmenistan.
1 POWER: NUCLEAR DEMAND TREND

- About 50 power reactors are currently being constructed in 15 countries.
- Over 100 power reactors with a total gross capacity of about 120,000 MWe are on order or planned, and over 300 more are proposed.
- Nuclear activity driven by China and Russia.
- Interesting development in India or United Arab Emirates.
Difficulty around the AP1000 design still not totally solved, blocking several projects.

Cold hydrostatic testing has begun at unit 5 of the Fuqing nuclear power plant in China's Fujian province. The first of two demonstration Hualong One reactors under construction at the site.

Xiapu 1 Titanium ordered in 2018. 4 units moving ahead in 2019: Tianwan 7/8 and Xudapu 3/4

Chinese EPC fighting to win export projects.
1 POWER: RENEWABLES DEMAND TREND AND FACTS

- Fast growth for all technologies
- Significant opportunities for Titanium with new design open to innovative material and solutions:
  - OTEC
  - Geothermal
  - Fuel cells
- Even if a present niche, the contribution will grow rapidly over coming years.
- OTEC still under development is offering the largest potential for Titanium heat exchangers.
- Geothermal with magma based energy at 500°C like in Alaska or Hawai are ideal locations for Titanium alloys tubular goods as well as springs or snap-rings.

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- Renewable

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- Production/
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**Chemistry**
- Electrochemistry
- PTA

**HVAC**
- Ammonia Heat
- Exchangers

**Shipbuilding**
- Hull/
- Pumps/Valves

**Automotive**
- Mufflers/Spring/
- Fuel cells

**Others**
- Architecture/
- Bicycle/Wheelchair

2 DESALINATION: TI USE PER APPLICATION

3 TECHNOLOGIES

Reverse Osmosis

No tubing required

Thermal MSF

Constraint: Ti for heat reject section + occasionally for low temp. stage
Ti versus Copper Alloy

Ti from 3.5 to 6 kg/(m³/d)

Thermal MED

Constraint: Ti for Top tube rows to avoid erosion from sprays.
Ti versus Stainless Steel or All Brass

Ti from 0 to 1.2 kg/(m³/d)

=> MSF is more favorable to titanium

- Relative cost of titanium to Copper Alloys is better than to Al Brass
- More critical in case of tube leakage cause seawater is inside the tubes
- Higher pressure and corrosive environment

2 DESALINATION: TREND

Desalination market is confirmed to be erratic and unpredictable

- Main market remain Middle East with some potential in China.
- Large RO unit: Rabigh 3 in Kingdom of Saudi Arabia with a capacity of 600 km3/day.
- Among the 17 identified projects in Middle East: 6 are RO, 4 are MED and 7 are not defined yet.
- Development of mix design RO/MED with smaller thermal units.
- Trends on material choice:
  - Titanium is challenged by AlBrass. Competitiveness issue.
  - The trend is to shift to thinner thicknesses.
  - Real commodity market.
2 DESALINATION: FACTS
Some Projects to follow in Middle East

- After two years without thermal desalination project one project launched in 2018: ADNOC Takreer (UAE) Part 1….but nothing significant since then.

- Several MED/MSF projects to come with uncertain schedule:
  - ADNOC Takreer Part 2 (UAE) for 62km3/d
  - Jubail 3 in Saudi Arabia for 1200km3/d
  - Facility E in Qatar for 600km3/d
  - Az Zour North 2 & 3 in Kuwait for 750km3/d
  - Al Khiran in Kuwait for 570km3/d

- Still some potential for Titanium even if size and sustainability is questioned.
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3 OIL&GAS: TREND
Linked to Barrel price

Brent prices recovering since early 2019 but at a level since below October 2018

Positive trend for LNG
3 OIL&GAS: FACTS
Opportunities to develop the consumption of titanium

- Substitution of copper alloys by titanium. Example: Shell refinery in Rotterdam where propylene condenser in copper alloys is being replaced by condensers with titanium finned tubes.

- New design: development of grade12 as alternative to advance SS grades.
4 CHEMISTRY : PTA TREND & FACTS

- Significant increase of projects in China due to:
  - Restriction on import of recycled PET bottles/scrap plastic for environmental reasons.
  - End of large investment program launch in 2009 with some unused interesting financings.

- Spot opportunities for large volumes over the coming few years.

Terephthalic Acid (PTA) output per country:

- **China**
- **Taiwan**
- **India**
- **USA**
- **South Korea**
- **ROW**

Average PTE plant run rates:
4 CHEMISTRY : ELECTROLYTIC TREND & FACTS

- Associated Ti consumption as Electrode.
- The caustic soda market is expected to grow by 7% per year over the coming years.
- Demanding application with high-temperature, high-concentration chloride under which pure titanium can face crevice corrosion. Large supply from Japan with over 50% market share.
- Asia-Pacific is the main market with China as main consumer.
5 HVAC: TREND & FACTS

- HVAC is the faster growing heat exchanger segment mainly driven by construction industry and increased government investments.

- Fluorinated greenhouse gas reduction is pushing Ammonia heat exchanger which is in favor of Titanium against CuNi.

- Two risks:
  - Aero exchangers alternative
  - CuNi substitution by Carbon Steel instead of Ti.

Fast growing market with potential advanced design (finned tubes...), grade 7 or 12....

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Some good signs on market:
  - Hyundai Heavy Industries has made a profit in Q1 2019, reversing from its loss position 2018.
  - Qatar Petroleum has launched a tender for up to 100 LNG carrier newbuildings.

Analysts forecast the global shipbuilding market to grow over 2% per year for the several years to come with main demand coming from commercial ships and Asia.

Large market in Russia with over 2MT of Titanium. Good positioning of Korean and Japanese Shipyards, development of Chinese

Significant consumption of Ti grade 1 expected for the coming years
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Two parallel markets for Titanium:

1) Sport cars and large motorbikes:
   - Mufflers
   - Fuel Tanks
   - Engine Parts: connecting rod, valve, retainer, body, suspension spring

2) Electric cars:
   - Hydrogen Fuel Cell
   - 0.1mm graphite coated Ti coil 40kg/car with potential 800,000 cars in 2030...

Electric cars will allow automotive to move from a niche to a major market for Titanium
8 OTHERS: TREND & FACTS

- Bicycle & wheelchair:
  - Growing markets using special grades with preferably seamless tubes.

- Architectural applications:
  - For roofing or wall cladding.
  - Pure Ti Grade 1 or 2 are most often used.
  - Difficulty to control the uniform appearance of product.
  - Adapted to polluted urban environment and coastal locations.

Growing niches requesting perfect product appearance (color, ovalization...).
THANK YOU

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