GLOBAL TRENDS IN INDUSTRIAL MARKETS

TITANIUM EUROPE 2018 CONFERENCE – SEVILLA – MAY, 15th 2017

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

We want to thank all of them for their contribution.
INDUSTRIAL TITANIUM – CURRENT MARKET

Slight increase compared to 2016
Decrease of desalination and recovery of process
20% below the peak year
INDUSTRIAL TITANIUM FORECAST ACCURACY

7% Drop of volume forecast over 5 years mainly due to Desalination

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SWOT 2017

Strengths

- Ti increased competitiveness against other materials
  - Alternative products, designs and processes

Weaknesses

- Perceived as Commodity Material
  - Lack of reliable index
  - Design rules not adapted
  - Scrap issue

Opportunities

- Ammonia Heat Exchanger
  - Nuclear investments China, Middle East and Russia
  - Automotive Market
  - Shipyard rebirth

Threats

- Weak Players on Market
  - Clean energy revolution
  - Reverse Osmosis technological development
  - Process applications and Middle East market strongly linked to oil and gas
Since Ras Al Khair, titanium increases its competitive advantage with a relative stability compared to others.

Anyway, for the second consecutive year, all other materials are strongly increasing:

- Difficult to predict the trend over medium to long term.
- Titanium existing indicators are less reliable compared to other metals as Nickel or Copper.
AMMONIA IN REFRIGERATION

- Fewer CFCs and HCFCs are available for environmental reasons
- Ammonia is a more effective replacement for refrigeration:
  - Safe for the environment, with an ODP GWP rating of 0 even if a poison in high conc.
  - Substantially less expensive than CFCs or HCFCs
  - 3-10% more efficient refrigerant than CFCs, requesting as such lower operating costs.
  - An ammonia-based design with narrower diameter tubes will cost 10-20% less to build.
- Ammonia is not compatible with the use of Copper tube (SCC)
- Copper and CuNi will be changed to CS, SS and Titanium
TITANIUM PERCEIVED AS COMMODITY MATERIAL

- Less specifications from end user
- International Standard handled by local fabricators
- No care of origin or traceability
- No specified process requested
- Old stock allowed
WEAK PLAYERS ON MARKET

Lack of partnership spirit and long term view from loss making Customers

THREATS
TREND ON MARKETS

Power
- Nuclear
- Thermal
- Renewable

Desalination
- MSF/MED

Process
- Refineries
- Chem
- LNG

Others
- Ship
- Automotive
- Other

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POWER: TI USE

- Nuclear: 0.162 Ti tubes kg/MW
- Coal: 0.051 Ti tubes kg/MW
- Gas Combined Cycle: 0.036 Ti tubes kg/MW
- Gas Single Cycle Hydro, Wind, Solar: Variable, limited

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Shifts to less carbon-intensive energy, like natural gas, nuclear and renewable.
Coal plant development across the world drops for second consecutive year

- New constructions are down by 73% between 2015 and 2017, due in large part to tighter restrictions in China and lack of private financing in India

- Asia still leads the world in building new coal power (Vietnam, Indonesia, Bangladesh…)

- Based on the two decades long trend of coal retirements, the global fleet of coal-fired power plants should begin to decline in 2022
China huge nuclear program takes time to restart.

• No new reactor project has been approved for more than two years and delays are accumulated:
  • The AP1000 program is more than three years behind schedule,
  • The EPR project has also been subject to a series of delays and construction issues,

• The Nuclear construction will restart from middle 2019 if the test result of AP1000 is ok

• Expected boom from 2020 followed by an average of 5 units per year

28 units of AP1000 are blocked
India Nuclear development

- India is the second growing nuclear market after China
  - 6 GW installed
  - +15 GW by 2022 and +63 GW by 2032

- New Nuclear Power Plants forecast
  - Indian PWHR:
    Chutka (2 x 700), Gorakpur (4 x 700),
    Kaiga (2 x 700), Mahi Banswara (4 x 700)
  - International reactor: All technologies considered
    Mithi Virdi (6 x ESBWR 1000),
    Jaitaipur (6 x EPR 1750), Kovada (6 x AP1000),
    Kuddankulam (2 x VVER 1000), Haripur (6 x VVER1000)

- Only part on seashore with Titanium condenser
NUCLEAR POWER : FACTS

There are reasons to believe nuclear will rebound after some years of controversies

• Nuclear giants are reorganizing
  • Restructuring of the former Areva into Framatome and Orano
  • Brookfield Asset Partners of Canada agreed to buy Westinghouse Electric Company,
  • CNNC merged in China with CNEC

• Trend towards SMR (Small Modular Reactors)
  • 9 projects under development in China
  • UK government announced funding for modular reactor development
  • Ukraine had signed a MOU with SMR developer Holtec International
  • The government of Canada announced a road-mapping exercise
to explore SMRs potential
RENEWABLE POWER : FACTS

Ocean Thermal Energy Conversion

Still several projects in the air but significant delays: capital intensive + technical challenges.

India’s OTEC project is coming up in Kavaratti (Lakshadweep archipelago) after 35 years of initial plans.

The total OTEC potential around India can be up to 180 000 MW.

Source: DCNS Energies
**DESALINATION: TI USE**

3 TECHNOLOGIES

- **Reverse Osmosis**
  - No tubing required

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

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

=> MSF is more favorable to titanium

- Relative cost of titanium to Copper Alloys is better than to All Brass
- More critical in case of tube leakage cause seawater is inside the tubes
- Higher pressure and corrosive environment
Technology trend not in favor of titanium

- RO will remain the main technology: lower energy consumption and modular
- MSF technology declining

Some opportunities anyway for titanium consumption with MED

- Mix RO/MED units
- MED units will remain especially in the Arabian Gulf due to seawater quality
- Present MED operation temperature is below 70°C allowing the use of aluminum brass
- Design trend to downsize MED plants while increasing the operation temperature. In this case, the demand for titanium tubes would increase.

Some Revamping with Ti replacing Copper Alloy

- Some opportunities mainly in Middle East
Desalination market is confirmed to be erratic and unpredictable

- No desalination project decided in 2017 for the second consecutive year
- Several projects with uncertain schedule:
  - Takreer in UAE
  - Facility E in Qatar
  - Jubail 3 in Saudi Arabia
  - Az Zour North 2 & 3 in Kuwait
  - Al Khiran in Kuwait
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Ti consumption in Metric Tons

- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
More equipment using titanium in process compared to power reference

- Steam Condenser
- HC Condenser
- Refring Evaporator
- Component Cooler
- Oil Cooler
- Reactor
- Inter Changer
- Evaporator
Market recovery is there even if not at expected rate

- Increasing chemical demand over the coming years is confirmed

- Oil prices should increase slightly

Source: Exxon Mobil
Opportunities to develop the consumption of titanium

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

**AIR COOLERS**
- Traditionally using titanium in the USA for the air coolers and traditionally using copper nickel in Europe
- Titanium has strong technical advantages and is competitive, strong opportunity on European market
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Usage of titanium is developing in a growing market:
- Sports Car Mufflers
- Fuel Tanks
- Engine Parts: connecting rod, valve, retainer, body, suspension spring

Development of electric cars is an opportunity for titanium:
- Titanium underbody in Tesla Model S

Selling Hydrogen Fuel Cell as for the Toyota Miraï
- 0,1mm graphite coated Ti coil 40kg/car with potential 800 000 cars in 2030…
• For 2015 alone, Korea’s big three shipbuilders reported losses US$5.5 billion

• In Feb 2017 Korea’s Hanjin shipping company bankrupted

• Since end 2016 the Korean government rolled out support plans for this industry

• Market Recovery in 2017 after years of struggle

Significant consumption of Ti expected for the coming years
INDUSTRIAL TITANIUM DEMAND TILL 2021

Ti consumption in Metric Tons

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THANK YOU

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