Global Trends in Industrial Markets
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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.
From Vallourec Heat Exchanger Tubes to NEOTISS
Industrial Titanium – Perimeter

**Power Generation**
- Nuclear Power Plant
- Thermal Power Plant

**Desalination**
- Thermal MSF/MED

**Process**
- Chemical
- LNG
- Oil & Gas
- PTA
- Pool Heater
- District Cooling
Ti SWOT for Industrial Market

**Strengths**
- Ti vs. other materials.

**Weaknesses**
- Lack of reliable Ti index
- Design rules not adapted to titanium.

**Opportunities**
- Desalination in Middle East, China, India
- Renewable (Solar CSP)
- Ti differentiation.

**Threats**
- Alternative material/design
- Location
- Nuclear technical issues
- Change of fuel mix
- Delays.

What’s new since last year?
Ti SWOT for Industrial Market: Strengths - Ti relative competitiveness

None differentiated general trend down

- Compared to 2 years ago, Titanium kept its competitive advantage but followed the trend of other materials.

Ni index over 2 years - 40%

Cu index over 2 years - 30%
Ti SWOT for Industrial Market: Opportunity - Titanium differentiation

**Slow Progress**

**NEW GRADES**
- No improvement or new launch on the field.

**NEW PRODUCTS**
- Heat exchange improvement through material deformation
  - Helix tubes
  - Dimpled plates.

**ALTERNATIVE DESIGNS**
- LNG vaporizers
  - Promotion of IFV design using Ti against the most common ORV design.

**NEW PROCESSES**
- Plates Cladding
  - Could favor Ti as becoming a more competitive option.
Ti SWOT for Industrial Market: Weakness – Reliable Ti Index & Design rules

Few improvement since last year

**Ti Index still out of touch**

**Scrap issue**
- In aerospace: scrap integrated into contracts
- In Industry: scrap difficult to correlate with raw material price reality.

**More thermal heat exchange projects in 0.4mm**
Ti SWOT for Industrial Market: Threats - Alternative material / Design

Less favorable environment

- Alternative “new steel” under development claimed “as strong as Ti”
- Negative impact of oil&gas activity drop:

**TI DESALINATION MARKET**
- Middle East countries impacted by low oil prices.

**TI POWER MARKET**
- The clean energy revolution is immune to cheap natural gas.

**TI PROCESS MARKET**
- Petrochemical applications direct impact.
Demand has significantly decreased compared to 2014
- Process strongly down due to low oil price
- Only partly compensated by desalination and Nuclear power consumption.
Stability on power generation, clear trend on process, high fluctuations on desalination
Ti Desalination market: Reminder: titanium consumption depends on the chosen technology & material

- Titanium consumption depends on capacity to convince end users to use thermal technology and to switch material.
- Copper release into the sea in Gulf Coast can favor Ti against other material.

But information are contrasted:

**More than 10 000 km of titanium tubes for Facility D desalination plant in Qatar.**

When fully completed in 2018, Facility D will produce 130 MIGD (million imperial gallons per day) of water. It is located about 15km south of Doha.
Ti Desalination market:
Reminder: titanium consumption depends on the technology & material chosen

- Al Jubail tubes finally remained in Copper Nickel as in the initial design despite titanium competitiveness…
- Ras Laffan RO project has been preferred to Ras Abu Fontas A3 MED project.
- Al Khiran 1 project postponed in Koweit.
Desalination market:
Change of paradigm due to oil&gas crisis and RO technology development

- RO keep growing in the Middle East allowing them to save energy and win flexibility
  - RO technology is good enough for drinking water
  - In the UAE, it is already specified RO for new projects
  - Saudi and Kuwait will probably move in this direction

- In the future, thermal technology may be mainly used for small units for industrial applications

- Among thermal technologies, MED is better positioned due to improved energy efficiency.

→ Less titanium consumption for desalination applications in the coming years
Paris climate deal signed by nearly 200 nations

What has been agreed to: aim to limit the increase to 1.5°C

Main consequence for Power Generation market:

- Renewable will account for ~80% of power generation investment to 2030 in major economies

- Not much has been said about nuclear power. Its capacity to provide base load power makes it a stable and low-carbon energy supply. However, safety and investment concerns don’t play in favor of Nuclear.
No new coal-fired power plant allowed to be build.

U.K. government announced that coal-fired power generation will cease by 2025.

“Plans to reduce its greenhouse gas emissions by 37% by 2030 […] Following the Fukushima accident, there are limits now to the extent that Korea can make use of nuclear energy”. The country decided to increase the production of renewables.

China decided “to lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level”. Developing nuclear power, expanding the use of natural gas, developing renewable and modernizing its coal-fired plants by 2020.

“India decided to reduce the emissions intensity of its GDP by 20–25%, over 2005 levels. […] The aim is to achieve 175 GW renewable energy capacities in the next few years”. They focused on renewable and nuclear power.

Ti Power market: Impact of COP21
Ti Power market:
The increasing part of renewable energy

- The installed base of fossil fuel power plants will represent a lower part of the fuel mix
- Nuclear share will stay stable
Ti Power market:
Nuclear remains a key source of energy for many countries

- North America: 2.3 GW
- South America: 0.5 GW
- Europe: 8.7 GW
- Middle East: 10 GW
- Russia + CIS: 8.5 GW
- India: 2.7 GW
- China: 37 GW
- Rest of Asia: 11 GW

Nuclear share will remain stable thanks to large investments in China, Middle East, and Russia.
CSP SOLAR POWER

- Concentrating Solar Power (CSP) technology converts concentrated solar radiation into heat to produce electricity.

- Some tubes requirement, including in titanium.

OCEAN THERMAL ENERGY CONVERSION

- Uses the T° difference between cooler deep and warmer surface seawaters to run a heat machine and generate electricity.

- Titanium first choice as unmatched corrosion resistance to seawater.
Ti Power market:
Titanium consumption per fuel

- Most of renewable projects will not use titanium
- Nuclear will remain the key driver of titanium consumption
Many process applications are strongly linked to oil & gas market:
- LNG plants
- Deepwater platforms and FPSO
- OCTG. Tubing for oil & gas wells.
- Sensitive heat exchangers in petrochemical & chemical facilities
  - PTA (Pure Terephthalic Acid)
  - Urea, fertilizer plan
  - Chlorine plants

→ Low oil price and depressed oil&gas market, drop Ti consumption on process market for these associated applications.
Even if some applications still consume large amount of titanium like the 5th gas train in Kuwait which has just been awarded, these kind of projects remain limited. Previous gas train in Kuwait was awarded 5 years ago.

GAS TRAIN

- Mina Al-Ahmadi Refinery.
- Separation of liquid products (Propane, Butane and KNG) from the feed & supply lean gas to the end users (Power Plants) & Petrochemicals (Ethane)
- Several hundred Tons of welded and seamless Ti tubes.
Ti Process market

**OCTG – HPHT WELLS**
- Titanium offers:
  - Light / Corrosion resistance / Low T° expansion
  - Uniform mechanical / Erosion resistance
- Good alternative to nickel-base alloys as downhole tubulars for HPHT and deep wells.
- But limited new projects as long as oil barrel will remain below 60US$.

**UREA - FERTILIZER**
- Ti good corrosion resistance in urea + tolerates low oxygen levels.
  - Used in Ammonia Strippers or Urea reactors.
- Large production capacity coming on-line from 2008 wave of investment in China and Middle East.
- Limited new investments foreseen in coming years.
Ti Process market: New applications – Automotive Market

- Ti found its first application to the engine parts of racing cars in the early 80’s.
- Then expanded to the muffler systems of sport bikes, engine valves, springs...
- More recently fuel-cell vehicles titanium materials show opportunities of volume & application development.

→ Ability to grow to represent several thousand of metric tons over coming years
THANK YOU