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Corrosion Resistant Alloys in the Oil & Gas Industry

Source: SBO
Source: Butting
Source: FMC Technologies
Source: Baker Hughes
World Primary Energy Demand

Oil & Gas is still expected to account for around 50% of the world energy demand by 2035. Production of oil and especially gas will continuously grow until then.

Oil Production by Type – Long Term Outlook

The share of deepwater production will double (from 4 to 9%). Also onshore production (incl. shale) is growing.

Meters Drilled per Year – Medium Term Outlook

When comparing total drilling depths in meters, the deepwater share is lower but growing fast. To produce 1 million barrels/day, more onshore metres need to be drilled compared to a deepwater project.

Source: Quest Offshore
# Steel Types and Grades Used in the Oil & Gas Industry

## Carbon Steels
- e.g. E-75, X-95, G-105, S-135

## Alloy Steels
- e.g. 4130, 4145, 4330, 8630, F22

## Stainless Steels
- Martensitic (e.g. 13Cr, Super 13Cr, 410, 420)
- Austenitic Grades (e.g. 304, 316, 347)
- Duplex (22 Cr, e.g. 2205)
- Superduplex (25 Cr, e.g. 2507)
- Precipitation Hardening (e.g. 17-4 PH, 15-5 PH)
- Superaustenitics (e.g. 6Mo grades)
- Non Magnetic Grades (e.g. P530, P550, P750)

## Nickel Alloys
- e.g. Alloy 28, 625, 718, 825, C276

## CRAs
Why is the share of CRAs (stainless steel & nickel alloys) increasing?

The era of easy accessible oil & gas has ended!

- Increasing offshore production
- Rapid growth of ultra-deepwater production
- Increasingly severe operating conditions (higher pressure, higher temperature, higher corrosion)
- Boosting technologies to increase brownfield production

CRA demand is driven by the production/reservoir conditions (sorted by importance):

1. Corrosiveness ($H_2S$, $CO_2$, Chloride)
2. Temperature
3. Pressure

There is no alternative to CRAs!

- Titanium
- Ni Alloys
- 28Cr (Alloy 28)
- Superduplex (25 Cr)
- Duplex (22 Cr)
- 300 series austenitic
- 13Cr, martensitic
- Alloy Steel
- Carbon Steel
Nickel alloys have a low share in tonnage but significantly more in value. With alloy steel it is the other way round.

**Steel Demand in the Oil & Gas Industry by Steel Type in 2012** - Tonnage vs. Value

- Alloy Steel
- Stainless Steel
- Nickel Alloy

*in selected applications as described in detail in the application section of this report. Excluding carbon steel, low alloy structural steel and castings.

Source: SMI – Steel Market Intelligence GmbH
Steel Grades Used in the Oil & Gas Industry by Steel Type (total ~1.4 million tpy excl. Carbon Steel)

**Alloy Steel (496 kt)**
- 4130/4140
- 4145H
- 8630
- F22
- 4330/4340
- Others

**Stainless Steel (848 kt)**
- 300 Series
- 13Cr
- Duplex
- Non-Mag
- Martensitic
- Other

**Nickel Alloy (56 kt)**
- 625
- 718/725
- 825
- 28
- 925
- Others
Product Forms Used in the Oil & Gas Industry by Steel Type (total ~1.4 million tpy excl. Carbon Steel)

**Alloy Steel** (496 kt)
- Seamless Tube & Pipe
- Welded Tube & Pipe
- Forged Products
- Rolled Long Products
- Flat Products

**Stainless Steel** (848 kt)
- Seamless Tube & Pipe
- Welded Tube & Pipe
- Forged Products
- Rolled Long Products
- Flat Products

**Nickel Alloy** (56 kt)
- Seamless Tube & Pipe
- Welded Tube & Pipe
- Forged Products
- Rolled Long Products
- Flat Products
Application Overview

Source: GENESIS Oil & Gas
Examples for CRA Applications: Drilling & Completion

Drill Collars, Heavy Weight Drill Pipes

Stabilizers

Bottom Hole Assembly incl. Drill Bit, Mud Motor, MWD/LWD, Non-Magnetic Drill Collars

Downhole Tools incl. Packers, Screens, Subsurface Safety Valves, Liner Hangers

Source: VAM Drilling

Source: Rimor

Source: SBO

Source: Baker Hughes
Examples for CRA Applications: BOP Parts

Body
Source: Ringmill

Flange
Source: Shanghai Qimiao

Ram
Source: SMI Manufacturing

Operating Piston

Annular BOP Parts
Examples for CRA Applications: Wellhead Parts

- Tubing Hanger
  - Source: FMC

- Tubing Head
  - Source: SMI Manufacturing

- Casing Head
  - Source: SMI Manufacturing

- High Pressure Housing
  - Source: Cameron

- Seal
  - Source: FMC

- Casing Hanger
  - Source: FMC
Examples for CRA Applications: Tree and Manifold Parts

- Master Valve Block (Source: FMC)
- Wing Valve Block (Source: FMC Technologies)
- Tree Cap (Source: Cameron)
- Manifold Block (Source: SMI Manufacturing)
- Subsea Trees (Source: FMC Technologies)
- Manifold (Source: Cameron)
Examples for Applications: Risers, Flowlines, Umbilicals

Drilling Riser

Source: Aker Solutions

Flying Leads

Source: Oceaneering

Umbilicals

Source: Aker Solutions

Flowlines with CRA cladding

Source: Butting

Flexible Risers

Source: Total

Riser Stress Joint

Source: Subsea Riser Products
Examples for Applications: Flanges & Connectors

Collet Connector

Stab Connectors

Stab Plates

Flowlines with CRA cladding

Clamp Connector

Hydraulic Couplings
Examples for Applications: Control Units

BOP Control System

Well Control Panel

Umbilical Termination

Subsea Control Module

Control Lines

Sources:
- Oceaneering
- Proserv
- Parker
- Rimor
- KME
The Oil & Gas Materials Supply Chain
Example downhole hardware in Houston

Steel Mills

Distributors

Major Equipment Producer

Independent Big Machine Shops

Independent Small Machine Shops

Oil Company
The Oil & Gas Materials Supply Chain
Example non magnetic drill collars & downhole hardware

Stock Points

best
worst

Raw Materials
Meltshop, Remelting & Pre-forming, Testing
Forging, Rough Machining of Component, Testing
Heat Treatment, Final Machining, Test
Assembly of Component, Testing
Field Installation, Testing
Stainless steel and nickel alloys demand for oil & gas applications will grow faster than the alloy steel demand. Stainless steel and nickel alloys are more related to offshore drilling.

**Forecast: Steel Demand in the Oil & Gas Industry by Steel Type (2007 – 2018)**

<table>
<thead>
<tr>
<th>Historic</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Alloy Steel</td>
<td></td>
</tr>
<tr>
<td>Total Stainless Steel</td>
<td></td>
</tr>
<tr>
<td>Total Nickel Alloys</td>
<td></td>
</tr>
<tr>
<td>Total meters drilled offshore</td>
<td></td>
</tr>
<tr>
<td>Total meters drilled onshore</td>
<td></td>
</tr>
</tbody>
</table>

The graph shows the projected growth in steel demand for oil & gas applications from 2007 to 2018, with stainless steel and nickel alloys demand expected to grow faster than alloy steel demand. The forecast indicates a higher demand for these materials, particularly in offshore drilling applications.
After a temporary slowdown of projects, a lot of flowline projects are in the pipeline from 2015 to 2018. Especially the demand for clad pipes will grow fast which could result in long delivery times.

**Forecast: Seamless and Welded Tube & Pipe**
*(stainless steel and nickel alloys, 2007 – 2018)*

The chart shows the forecast for seamless and welded tubes and pipes from 2007 to 2018. The index is based on 2007. Historical data is presented for comparison.

- **Seamless**
- **Welded**
- **Clad**
- **Total meters drilled offshore**
- **Km of rigid flowlines & SCR**
Available multiclient-reports from SMI - Steel Market Intelligence

**Corrosion Resistant Steels & Alloys in the Oil & Gas Industry**

- Market Volumes for CRA 2008 – 2012
- CRA Market Structures
  (Steel types, grade details, dimensions)
- Applications for CRA in Oil & Gas
- Macro Trends and Drivers
- Market Forecast 2012 – 2017
- Prices and Price Trends
- Buyers of CRA in the Oil & Gas Industry
- Suppliers of CRA in the Oil & Gas Industry
If you have questions or if you would like to purchase the in-depth market study ‘Corrosion Resistant Steels and Alloy in the Oil & Gas Industry’ please contact:

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THANK YOU!