Centralloy® HT E
MATERIAL DATA SHEET
Centralloy® HT E

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Product Forms

Centralloy® HT E was designed as centrispun tube material to meet specific design criteria in terms of carburisation, coking and oxidation resistance, creep rupture strength and weldability. Other forms e.g. statically cast and investment cast products may be supplied upon request. Additional information regarding these topics and maximum and minimum sizes may be obtained from the sales department.

Chemical Composition(*)

<table>
<thead>
<tr>
<th>Element</th>
<th>Mass Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>0.45</td>
</tr>
<tr>
<td>Chromium</td>
<td>30.00</td>
</tr>
<tr>
<td>Nickel</td>
<td>45.00</td>
</tr>
<tr>
<td>Niobium</td>
<td>0.50</td>
</tr>
<tr>
<td>Aluminium</td>
<td>4.00</td>
</tr>
<tr>
<td>Iron</td>
<td>Balance</td>
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</tbody>
</table>

(*) This is a typical composition which may be slightly modified according to the application.

Applications

Tubular components requiring very high creep rupture strength combined with outstanding oxidation and excellent carburisation resistance. Centralloy® HT E is designed to withstand operating temperatures >1150°C. The combined strengths of Centralloy® HT E are initially targeting customers in the applications cited below:

- Radiant coils for steam cracker furnaces
- Furnace rollers
- General engineering for high temperature and hot corrosion environments, such as glass industry, waste incineration, and others
Features

Centralloy® HT E is a cast nickel-base alloy containing chromium, aluminium, niobium, titanium and other minor alloying elements. The alloy has excellent structural stability, very good high temperature stress rupture strength and excellent carburisation/oxidation resistance.

The presence of carbon leads to the formation of a series of carbides: chromium-rich carbides of the M$_7$C$_3$ and M$_{23}$C$_6$ types and niobium-rich carbides of the MC type. These have a profound influence on properties due to decomposition and re-precipitation reactions in service which produce secondary carbides in a rather uniform dispersion. Through this mechanism, dislocation movement is impeded with the result of significant strengthening at elevated temperatures.

Centralloy® HT E with its increased aluminium content performs excellently in oxidising as well as reducing/carburising atmospheres. The Centralloy® HT family is a development of S+C and is patented worldwide.

From a thermodynamic standpoint, aluminium oxide scales are known as the most stable protective scales of metallic materials. The slow growth rate of the scale ensures the materials survival in long-term service applications. For the use of these materials in the petrochemical industry, this new protective mechanism has the advantage of increased service life. Under typical steam cracker conditions coking rates in carbon rich atmospheres are significantly reduced.
**Physical Properties**

**Density at 20°C:** 7.6 g/cm³

**Typical physical properties**

<table>
<thead>
<tr>
<th>δ, °C</th>
<th>α, 10⁻⁶/K</th>
<th>E, GPa</th>
<th>c_p, J/kg K</th>
<th>λ, W/m K</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>–</td>
<td>178</td>
<td>492</td>
<td>10.4</td>
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<tr>
<td>100</td>
<td>13.3</td>
<td>172</td>
<td>508</td>
<td>11.5</td>
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<td>200</td>
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<tr>
<td>300</td>
<td>14.5</td>
<td>162</td>
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<td>14.4</td>
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<tr>
<td>400</td>
<td>14.6</td>
<td>156</td>
<td>545</td>
<td>16.1</td>
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<tr>
<td>500</td>
<td>14.8</td>
<td>150</td>
<td>568</td>
<td>18.1</td>
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<tr>
<td>600</td>
<td>15.3</td>
<td>144</td>
<td>594</td>
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<td>700</td>
<td>16.1</td>
<td>138</td>
<td>620</td>
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<tr>
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<td>17.1</td>
<td>130</td>
<td>644</td>
<td>23.2</td>
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<td>24.4</td>
</tr>
<tr>
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<td>18.4</td>
<td>112</td>
<td>680</td>
<td>25.6</td>
</tr>
<tr>
<td>1100</td>
<td>18.7</td>
<td>102</td>
<td>700</td>
<td>27.2</td>
</tr>
</tbody>
</table>

**Mechanical Properties**

(only for wall thickness less than 25 mm, in the as cast conditions)

**Tensile properties**

Minimum tensile properties at 20°C:
- 0.2% Yield strength: 400 MPa
- Ultimate tensile strength: 550 MPa
- Elongation, (l = 5d): 3.0% for centricast tubes and static castings

![Typical Tensile Strength and 0.2% Yield Strength vs. Temperature](image-url)
Oxidation Resistance

Typical Tensile Test Elongation vs. Temperature

Cyclic Oxidation (45min at 1150°C, 15min at RT in air)
Parametric Stress Rupture Strength

LMP = Larson Miller Parameter
LMP = \( T (21.5 + \log t_r)/1000 \)
Where: \( T \) = temperature [K] and \( t_r \) = rupture time [h]
Lower Scatter Band represents 95% confidence level
Carburisation Resistance

Manufacturing Characteristics

Welding
Matching filler materials are commercially available. These welding consumables have high strength properties at elevated temperatures with good retained ductility. Besides fillerless PAW, GTAW and MAW have been satisfactorily used. Preheating and postweld heat treatment of the joint is not necessary. For dissimilar weld joints to austenitic materials suitable filler materials are recommended. Further information will be supplied upon request.

Health, Safety and Environmental Information

The operation and maintenance of welding equipment should conform to the provisions of relevant national standards for the protection of personnel and environment.

Mechanical ventilation is advisable and under certain conditions in confined spaces, it is necessary during welding operations to prevent possible exposure to hazardous fumes, gases or dust that may occur.

Nickel- and iron-base materials may contain, in varying concentrations, the elements chromium, iron, manganese, molybdenum, cobalt, nickel, tungsten and aluminium. Metal dust from welding, grinding, melting and dross handling of these alloy systems may cause adverse environmental and in case of inhalation health effects.

The information in this publication is as complete and accurate as possible at the time of publication. Variations in properties can occur to production and process routes. However, no warranty or any legal liability for its accuracy, completeness and results to be obtained for any particular use of the information herein contained is given. Where possible the test conditions are fully described. Where reference, is made to the balance of the alloy's composition it is not guaranteed that this balance is composed exclusively of the element mentioned, but that it predominates and others are present only in minimal quantities. The creep rupture data are frequently insufficient to be directly translatable to specific design or performance applications without examination and verification of their applicability and suitability by professionally qualified personnel. The primary units for property data are based on those of the SI-system.
Industries
• Petrochemicals
• Iron-ore direct reduction

Services
• Installation Services

Industries
• Power technology
• Industrial furnace construction
• Separation technology
• Pump manufacturing
• Machine and plant construction

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Further Services
• Metallurgy and material engineering
• Material analysis and examinations
• Metallurgical defect analysis
• Process and material consulting
• Design of tubes and tube systems

• Material welding services
• Mechanical machining
• Heat treatment
• Convection zones

Production sites
Germany, Spain, Czech Republic, Malaysia, Saudi Arabia