Centralloy® G 4859

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Features

Centralloy® G 4859 is an air melted iron base alloy with low carbon content, consisting essentially of Fe-Cr-Ni matrix. The composition has been optimised to combine adequate high temperature strength and structural stability.

Due to the balance of niobium and carbon, the cast austenitic iron-chromium-nickel matrix is strengthened by formation of interdendritic MC type carbides with M being mainly Nb. With this optimum control of composition, relaxation in heavy cross sections during weld fabrication and under thermal shock conditions in service, results in superior crack resistance.

In comparison with cast high carbon heat resistant steels the stable austenitic structure of the alloy exhibits excellent tensile and creep ductility values after exposure in the temperature range of 650°C to 1000°C. Also, RT-ductility values are maintained after ageing at these service temperatures.

Product Forms

Centralloy® G 4859 was designed as centrispun tube material to meet specific design criteria in terms of creep rupture strength, thermal fatigue resistance, ductility especially after thermal ageing and weldability. It is available as centrispun tubes, vertically spun, statically cast parts and investment cast product forms.

Other forms may be supplied upon request. Further 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>
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<tbody>
<tr>
<td>Carbon</td>
<td>0.1</td>
</tr>
<tr>
<td>Silicon</td>
<td>1</td>
</tr>
<tr>
<td>Manganese</td>
<td>1.5</td>
</tr>
<tr>
<td>Chromium</td>
<td>20</td>
</tr>
<tr>
<td>Nickel</td>
<td>32</td>
</tr>
<tr>
<td>Niobium</td>
<td>1</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 systems requiring excellent thermal shock resistance combined with sufficient stress rupture strength, creep resistance and ageing ductility.

Main high temperature applications for the material are:

<table>
<thead>
<tr>
<th>Process</th>
<th>Max. Operating Temperature, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam cracking (transfer lines)</td>
<td>1000</td>
</tr>
<tr>
<td>Pyrolysis furnace outlet lines, collectors</td>
<td>1000</td>
</tr>
<tr>
<td>Steam reformer (outlet header)</td>
<td>1000</td>
</tr>
<tr>
<td>Styrene, EDC</td>
<td>1000</td>
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</tbody>
</table>
Physical Properties

Density at 20°C: 8.0 g/cm³

Typical physical properties

<table>
<thead>
<tr>
<th>δ, °C</th>
<th>α, 10⁻⁶/K</th>
<th>λ, W/m K</th>
<th>a, 10⁻⁶m²/s</th>
<th>c_p, J/kg K</th>
<th>E, GPa</th>
<th>ρ, nΩm</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>11.5</td>
<td>3.1</td>
<td>472</td>
<td>172</td>
<td>1010</td>
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</tr>
<tr>
<td>100</td>
<td>3.3</td>
<td>487</td>
<td>155</td>
<td>1040</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>3.6</td>
<td>503</td>
<td>148</td>
<td>1080</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>15.0</td>
<td>16.4</td>
<td>3.9</td>
<td>512</td>
<td>142</td>
<td>1120</td>
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<tr>
<td>400</td>
<td>16.0</td>
<td>18.1</td>
<td>4.2</td>
<td>520</td>
<td>132</td>
<td>1150</td>
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<tr>
<td>500</td>
<td>16.3</td>
<td>19.6</td>
<td>4.4</td>
<td>530</td>
<td>122</td>
<td>1180</td>
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<tr>
<td>600</td>
<td>16.5</td>
<td>21.2</td>
<td>4.6</td>
<td>541</td>
<td>117</td>
<td>1200</td>
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<tr>
<td>700</td>
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<td>22.8</td>
<td>4.9</td>
<td>551</td>
<td>109</td>
<td>1220</td>
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<tr>
<td>800</td>
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<td>103</td>
<td>1240</td>
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<td>18.0</td>
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<td>565</td>
<td>99</td>
<td>1260</td>
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<tr>
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<td>27.3</td>
<td>5.7</td>
<td>571</td>
<td>95</td>
<td>1270</td>
</tr>
</tbody>
</table>

δ: Temperature
α: Mean coefficient of linear thermal expansion
( reference temperature: 20°C)
λ: Thermal conductivity
a: Thermal diffusivity
c_p: Mean specific heat
E: Modulus of Elasticity (dynamic values)
ρ: Electrical resistivity
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: 180 MPa
- Ultimate tensile strength: 440 MPa
- Elongation, (l=5d):
  - 25% for centricast tubes
  - 20% for static castings

Typical Tensile Test Elongation vs. Temperature

Typical Tensile Strength and 0.2% Yield Strength vs. Temperature
Oxidation Resistance

Oxidation Weight Loss vs. Temperature for 10 Thermal Cycles in Air Between Indicated Temperature and Room Temperature

Weight Loss, mg/cm²

Temperature, °C

7 hours hold time per cycle at test temperature

Ageing Behaviour

Effect of Isothermal Ageing Between 550°C and 850°C for 1000 Hours on RT-Tensile Elongation

Elongation (I=5d), %

P=(T+273)⁴(4.67+log t)/100

Temperature, °C

Elongation (I=5d), %
Parametric Stress Rupture Strength

Initial Stress, MPa

LMP = Larson Miller Parameter

LMP = (T/18.3 + log t_r)/1000

Where: T = temperature [K] and t_r = rupture time [h]

Lower scatter band represents 95% confidence level

Average

Lower Scatter Band
Manufacturing Characteristics

Machining
In general terms the machinability of Centralloy® G 4859 is similar to that of other heat resistant alloys with low carbon content.

Welding
Centralloy® G 4859 is readily welded by shielded metal-arc (SMAW), inert gas tungsten-arc (GTAW), and plasma-arc (PAW) processes using matching composition of filler materials.

Approved filler materials are bare welding rods and electrodes. Preheating and postweld heat treatment is not required. Service exposed hardware from a temperature range of 750°C to 1000°C indicates that repair-weldability remains fair and repairs can be made to high quality standards.

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

Industries
• On- and Offshore

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

Contact
schleuderguss@schmidt-clemens.de
Phone: +49 2266 92-258
Fax: +49 2266 92-369

Contact
onoffshore@schmidt-clemens.de
Phone: +49 2266 92-777
Fax: +49 2266 92-509

Contact
sp@schmidt-clemens.de
Phone: +49 2266 92-507
Fax: +49 2266 92-538

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
• Site services and logistics

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