Strip casting of stainless steels

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INTRODUCTION

FLAT PRODUCTS OF STAINLESS STEELS ARE CONVENTIONALLY MANUFACTURED BY CONTINUOUS CASTING, HOT ROLLING, HOT BAND ANNEALING, PICKLING, COLD ROLLING AND RECRYSTALLISATION.

IN THE LAST YEARS STRIP CASTING HAS INCREASINGLY ATTRACTED ATTENTION.

IT OFFERS THREE IMPROVEMENTS IN COMPARISON TO THE CONVENTIONAL METHOD.

1.) IT ALLOWS TO CAST STEEL SHEETS WITH THE SAME THICKNESS AND WIDTH AS THOSE PRODUCED BY HOT ROLLING. THIS MEANS THAT THE HOT ROLLING PROCESS IS BYPASSED.

2.) THE STRIP CAST STEEL REVEALS A WEAK INITIAL TEXTURE AND A NEGLIGIBLE THROUGH-THICKNESS TEXTURE GRADIENT. THESE FEATURES ARE BENEFICIAL FOR THE STRENGTH AND THE DEEP DRAWING PROPERTIES OF THE FINAL SHEET. THE LATTER ASPECT IS OF SPECIAL RELEVANCE FOR THE AVOIDANCE OF THE SO CALLED RIDGING PHENOMENON IN FERRITIC STAINLESS STEELS [2,3]. THIS EFFECT DETERIORATES THE SURFACE QUALITY OF CONVENTIONAL SHEETS.

3.) IT IS ECONOMICALLY NOT FAVOURABLE TO PRODUCE SMALL AMOUNTS OF HIGHLY ALLOYED STAINLESS STEELS BY CONTINUOUS CASTING AND HOT ROLLING.

strip cast  
hot rolled  

microstructure, austenite
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Stainless steel

microsegregation

macrosegregation

segregation, strip cast austenite
Raabe Stainless steel


Surface, flat section

Flat sections, hot rolled austenite
s=0.5, flat section

flat sections, hot rolled austenite
s=0.5, flat section

flat sections, hot rolled austenite
s=0.5, flat section


flat sections, strip cast austenite
s = 0.5, flat section

flat sections, strip cast austenite

s=center layer, flat section


flat sections, strip cast austenite
s=center layer, flat section

flat sections, strip cast austenite

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Stainless steel

longitudinal section

ε=50%

ε=60%

ε=70%

ε=80%


austenite, strip cast, cold rolled
The chemical composition of the austenitic stainless steel in mass % is as follows:

<table>
<thead>
<tr>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>Fe</th>
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</thead>
<tbody>
<tr>
<td>0.05</td>
<td>0.76</td>
<td>1.37</td>
<td>18.10</td>
<td>0.24</td>
<td>8.54</td>
<td>balance</td>
</tr>
</tbody>
</table>

Martensite in the cold rolled hot band sample:

As the thickness reduction increases, the volume percentage of martensite also increases.


Austenite, strip cast, cold rolled
ε = 80%, 30 min, 850°C

flat section

strip cast, cold rolled + annealed austenite

Raabe
Stainless steel

$\varepsilon = 80\%,$
30 min,
850°C

flat section

strip cast, cold rolled + annealed austenite

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Journal</th>
<th>Year</th>
<th>Volume</th>
<th>Pages</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Raabe, K. Lücke</td>
<td>Scripta Metall.</td>
<td>1992</td>
<td>26</td>
<td>1221–1226</td>
<td>Texture and microstructure of hot rolled steel</td>
</tr>
<tr>
<td>D. Raabe, K. Lücke</td>
<td>Steel Research</td>
<td>1992</td>
<td>63</td>
<td>457–464</td>
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<td>D. Raabe, M. Hölscher, F. Reher, K. Lücke</td>
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<td>1993</td>
<td>29</td>
<td>113–116</td>
<td>Textures of strip cast Fe-16% Cr</td>
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</table>
D. Raabe, K. Lücke: Materials Science and Technology 9 (1993) 302–312
„Textures of ferritic stainless steels“

„Relationship between rolling textures and shear textures in f.c.c. and b.c.c. metals“

„Inhomogeneity of the crystallographic texture in a hot rolled austenitic stainless steel“

„Microstructure and crystallographic texture of strip cast and hot rolled austenitic stainless steel“

„Textures of strip cast and hot rolled ferritic and austenitic stainless steel“

„Experimental investigation and simulation of rolling textures of Fe-11wt.% Cr“
„Experimental investigation of the transformation texture in hot rolled ferritic stainless steel using single orientation determination“

„Texture and microstructure evolution during cold rolling of a strip cast and of a hot rolled austenitic stainless steel“