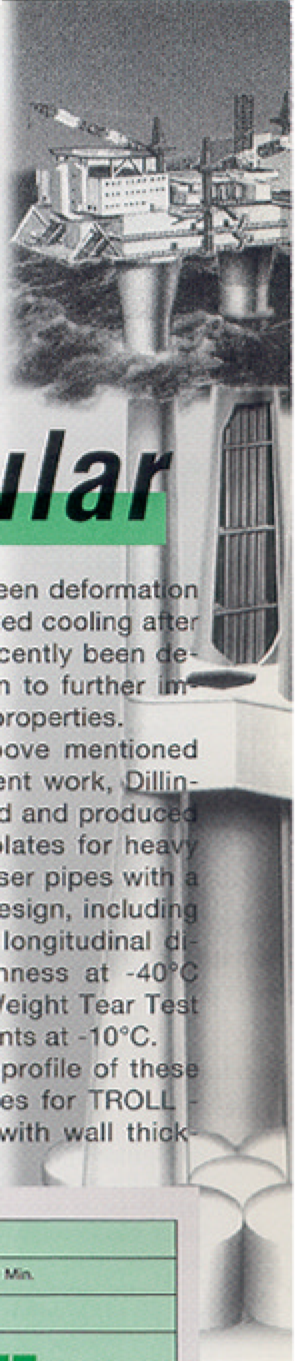
Dillinger Offshore Letter



RISING DEMANDS

What is particular

Riser pipes connect the drilling well with the offshore platform. They transport raw oil and gas, as well as corrosive impurities and have to withstand important pressure. A break of a riser or important leak could cause fire and explosion and would risk the platform and the lives of the people working on it. Not to forget that catastrophical pollution would threaten the environment.

It is no wonder that important requirements are set for the steel to be used for such a vital purpose. The required combination of properties below proves that riser pipes stand for top quality and top grade.

- high strength (Y.S. 450 N/mm2)
- high toughness
- increased wall thickness compared to conventional pipe lines
- excellent weldability
- excellent resistance to fracture
- excellent crack arrest properties
- sourgas resistance

We know that the best way to meet this target is to use thermomechanical (TM) rolling combined with accelerated cooling. Sophisticated improvements of the rolling parameters using intermediate water cooling between deformation steps and accelerated cooling after the rolling, have recently been developed in Dillingen to further improve crack arrest properties.

Based on the above mentioned process development work, Dillinger Hütte developed and produced in recent months plates for heavy wall X65 line and riser pipes with a typical north sea design, including tensile strength in longitudinal direction, high toughness at -40°C and Batelle Drop Weight Tear Test (BDWTT) requirements at -10°C.

The requirement profile of these plates for riser pipes for TROLL - Offshore platform with wall thick-

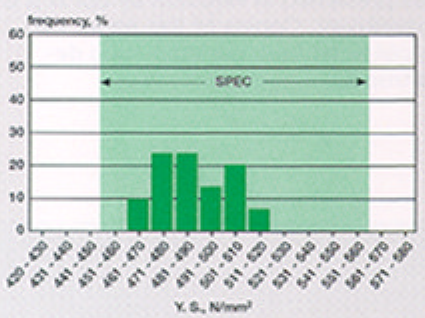


Fig. 1a: Statistical distribution of yield strength (transverse)

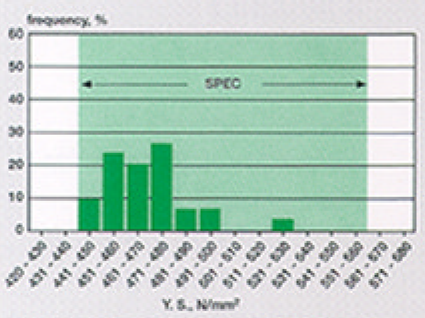


Fig. 1b: Statistical distribution of yield strength (longitudinal)

YS (transv.): 450-560 N/mm2
YS (long.): 440-560 N/mm2
TS (transv.):≥ 530 N/mm2
TS (long):≥ 520 N/mm2
YS/TS: ≤ 0,89
A5:≥ 21 %

ChV (transv.) (-40°C): ≥ 44/59 J
(single/average value)
BDWTT (-20°C) full size:
≥ 75,85 % shear
(single/average)
BDWTT (-37°C) reduced to 3/4":
≥ 75/85 % shear
(single/average)

HV 10 ≤ 235

Tested in as rolled condition (TMCP) and as rolled + (580 ± 20°C, 1h)

Dimensions:
39.7 X 2831 X 6540 mm
39.7 X 2803 X 11840 mm
t/D = 4.4. % (pipe forming)

Table 1: Requirement profile of thick X65 TM-plates for TROLL riser pipes

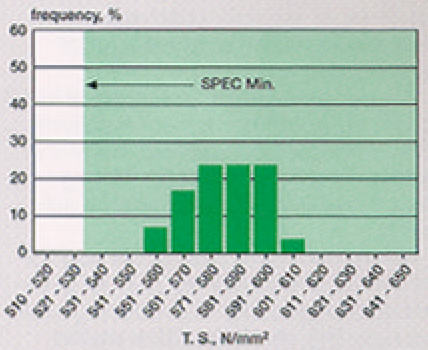


Fig. 2a: Statistical distribution of tensile strength (transverse)

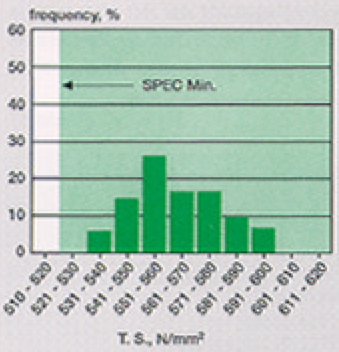
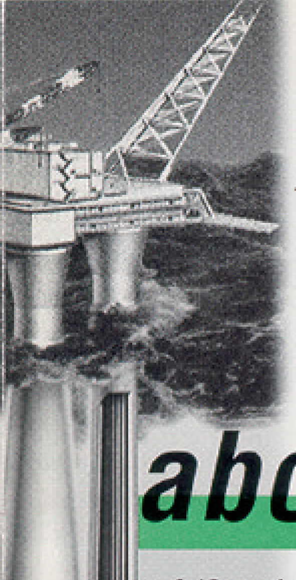


Fig. 2b: Statistical distribution of tensile strength (longitudinal)



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about riser pipes?

ness of 40mm is given in table 1.

The average ladle chemistry which was used for that steel type is shown in table 2.

The decisive elements of that approach are well defined usage of microalloying elements, a high level of steel cleanliness (P, S), low carbon content and Ni and Cu as additional alloying elements, with benefits both for tensile and toughness properties.

Using a well defined 3 stage TM rolling process together with intermediate accelerated cooling to temperatures lower than Ar3 leads to optimized production results on plate as shown in fig.1 to fig. 4 (in as rolled condition). The requirement on yield to tensile strength ratio was also fulfilled in all tested plates.

As it can be seen from the figures, the requirement profile could be fulfilled without any risk. For the BDWTT, both the full size and the reduced specimen (19.05mm, reduced from both sides according to STATOIL R-SF-860) tested at -37°C showed reproducible and satisfying results.

In fig. 5 the BDWTT results from the pipe are presented showing 100% shear at -27°C.

In a next step, Dillinger Hütte investigated the possibilities to realize a typical north sea requirement profile on riser pipe plates with a wall thickness up to 50mm. We will report on these investigations in one of the next offshore letters.

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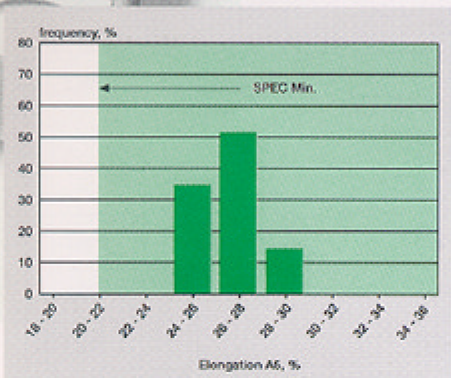

Fig. 3a: Statistical distribution of elongation (transverse)

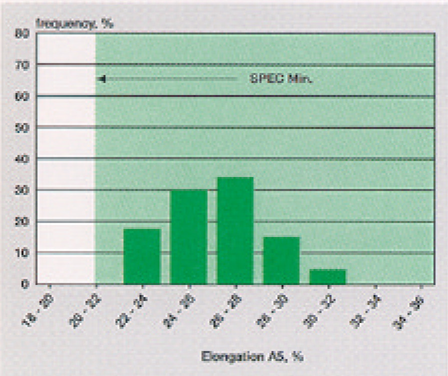

Fig. 3b: Statistical distribution of elongation (longitudinal)

C	0,07
Si	0,30
Mn	1,50
P	0,008
S	0,0006
Al	0,03
N	0,005
Cr	0,04
Ni	0,40
Cu	0,20
V	0,04
Nb	0,03
Ti	0,002
CE	0,38
Pcm	0,19

Table 2: Typical ladle chemical analysis used for TROLL riser pipe plates

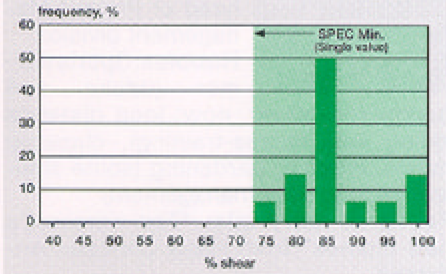

Fig.4a: Statistical distribution of BDWTT results (single values), fullsize specimen (-20°C)

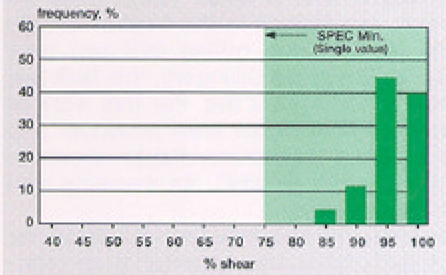

Fig.4b: Statistical distribution of BDWTT results (single values), 19,05 mm specimen reduced from both sides (-37°C)

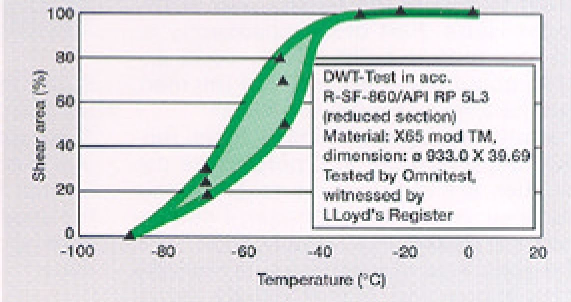

Fig. 5: BDWTT-results from the pipe