

			MATERIALS SPECIFICATION	
REV:	SECTION:	UNS NUMBER:	PREPARED BY:	APPROVED BY:
1	Stainless Steels	S42000	Carolyn Cepuch	
NAME:			DATE:	
13 Cr Stainless Steel			07/26/11	

1.0 Scope

This specification pertains to a grade 80ksi martensitic stainless steel, described in API 5CT and ISO 11960, that is broadly used for casing and tubing in standard and CO₂ environments. Its use in other environments is limited by factors such as temperature, H₂S, pH and chlorides. 13 Cr is a softer metal, therefore is acceptable to be considered for high CO₂ and sour environments.

2.0 References

ExproSoft AS, 2009, L80 13 Cr, Retrieved May 9,2011 at

<http://www.exprobase.com/Default.aspx?page=276>

NACE MR0175: Standard Material Requirements- Sulphide Stress Cracking Resistant Metallic Materials for Oilfield Equipment.

API 5CT: American Petroleum Institute specification- seamless and welded steel casing, tubing and liners for the oil and gas industry.

ISO 11960: Petroleum and Natural Gas Industries - Steel Pipes for Use as Casing or Tubing for Wells.

ASTM A370: Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

ISO 15156-3: Petroleum and natural gas industries - Materials for use in H₂S-containing environments in oil and gas production

3.0 Material Requirements

Chemical composition: The chemical composition will meet the requirements listed below in weight percent.

	C	Si	Mn	P	S	Ni	Cr	Cu
MIN	0.15	--	0.25	--	--	--	12.0	--
MAX	0.22	1.0	1.0	0.02	0.01	0.05	14.0	0.25

Mechanical Properties: The mechanical properties shall meet the requirements listed in the table below, determined at the mid radius for bars or strip sections for tubular and flat products following ASTM A370.

Hardness, Rockwell C (ISO 15156-3 limit)	22.0
Yield Strength (MPa)	551
Tensile Strength (MPa)	655

13 Cr products are quenched and double tempered (at a temperature above 590°C). The higher the temperature used, the less hard the steel becomes.

4.0 Quality and Test Requirements

Visual Inspection: The surfaces shall be visually examined to ensure that it is free of cracks, laps, seams or other defects.

Using stainless steels for threaded connections may cause issues with galling.

13 Cr steel is a susceptible material to:

- Sulphide Stress Cracking
- Pitting and Crevice Corrosion
- Other General Corrosion at low pH

13 Cr steel is a resistive material to:

- Stress Corrosion Cracking
- CO₂ Corrosion

5.0 Applications

13 Cr steel is widely used in standard and CO₂ environments. For use in sour conditions the hardness must be less than 22HRC. This material is not recommended for use in above 100°C temperatures.

			MATERIALS SPECIFICATION	
REV:	SECTION:	UNS NUMBER:	PREPARED BY:	APPROVED BY:
1	Steels	G41400	Carolyn Cepuch	
NAME:				DATE:
4140 High Tensile Steel				07/26/11

1.0 Scope

4140 is a 1% chromium - molybdenum medium hardenability general purpose high tensile steel, characterised by high strength and good impact properties with good machinability. It is used in most industry sectors for a wide range of applications and is the most commonly used material in plunger lift systems. It is a good material for sweet environments and can accommodate highly sour conditions. 4140 has very good wear and is slightly harder than Cr 13. The low hardness version of the Venturi product line typically ranges from 20-23HRC. For sweet service applications they can be hardened to 38HRC. The desired hardness' can be achieved through various heat treat processes.

2.0 References

Interlloy Pty Ltd, n.d., Retrieved May 9, 2011 at

http://www.interlloy.com.au/data_sheets/hollow_bar/4140.html

NACE MR0175: Standard Material Requirements- Sulphide Stress Cracking Resistant Metallic Materials for Oilfield Equipment.

3.0 Material Requirements

Chemical Composition: The chemical composition will meet the requirements listed below in weight percent.

	C	Si	Mn	Cr	Mo	P	S
MIN	0.38	0.04	0.75	0.80	0.15	--	--
MAX	0.43	0.15	1.00	1.10	0.22	0.04	0.015

Mechanical Properties: The mechanical properties shall meet the requirements listed in the table below, while in hardened and tempered condition.

Hardness, Rockwell C	Min: 18* Max: 55
Yield Strength (MPa)	758
Tensile Strength (MPa)	862
Elongation	14.0%

*For fully annealed.

There are multiple heat treatments that are appropriate for 4140 steel.

Annealing (at 800°C- 850°C) is used to induce ductility, soften material, relieve internal stresses, refine the structure by making it homogeneous, and improve cold working properties.

Hardening (at 840°C-875°C) is used to increase hardness which is directly proportional to yield stress at the location of the strain imposed.

Stress Relieving (at 680°C -700°C) is typically used to remove residual stresses which have accumulated from prior manufacturing processes.

Pre hardened and tempered 4140 can be further surface hardened by flame or induction hardening (at 840°C- 870°C) and by nitriding (at 490°C-530°C), which can result in a surface hardness of up to Rc 60.

4.0 Quality and Test Requirements

Visual Inspection: The surfaces shall be visually examined to ensure that it is free of cracks, laps, seams or other defects.

4140 Steel is characterized by its extremely smooth surface finish, excellent wear and corrosion resistance.

Be cautious of using plungers with a high Rockwell number in highly corrosive environments such as CO₂ or H₂S, as it can become brittle and is susceptible to cracking.

5.0 Applications

Gas composition is an important factor in determining the hardness required. Standard hardness ranges from 28-38HRC for sweet environments. In corrosive environments, a lower hardness is required; usually less than 23 HRC.

			MATERIALS SPECIFICATION	
REV:	SECTION:	UNS NUMBER:	PREPARED BY:	APPROVED BY:
1	Stainless Steels	S17400	Carolyn Cepuch	
NAME:				DATE:
17-4PH Stainless Steel				07/26/11

1.0 Scope

S17400 is a precipitation hardening martensitic stainless steel whose grade combines high strength, hardness and corrosion resistance. 17-4PH is used in a wide range of applications including offshore foils and mechanical components.

2.0 References

Sandmeyer Steel Company, 2011, Retrieved May 9, 2011 at

<http://www.sandmeyersteel.com/images/17-4PH-Spec-Sheet.pdf>

MatWeb, LLC, Retrieved May 9, 2011,

<http://www.matweb.com/search/datasheet.aspx?matguid=d3029183533b4e5fa7df551ae4015394&ckck=1>

NACE MR0175: Standard Material Requirements- Sulphide Stress Cracking Resistant Metallic Materials for Oilfield Equipment.

3.0 Material Requirements

Chemical Composition: The chemical composition will meet the requirements listed below in weight percent.

	Cr	Cu	Fe	Ni
Mass Percent	0.17	0.035	0.755	0.04

Mechanical Properties: The mechanical properties shall meet the requirements listed in the table below.

Hardness, Rockwell C	33
Yield Strength (MPa)	760
Tensile Strength (MPa)	1030
Elongation	8.0%

There are two acceptable heat treatments for 17-4PH Stainless Steel under NACE MR0175: Double H1150 heat treatment results in slightly less strong but tougher steel than single aged treatment. It also relieves any residual stress the machining process may have imparted. The maximum hardness resulting from this process is 33 HRC.

H1150M heat treatment is a similar process using different time for the second heat treat; again the maximum hardness resulting from this process is 33 HRC. (The Venturi 17-4 SS plungers undergo the H1150M heat treat process)

33HRC is the maximum hardness that resistance to sulphide stress-cracking is given at.

4.0 Quality and Test Requirements

Visual Inspection: The surfaces shall be visually examined to ensure that it is free of cracks, laps, seams or other defects.

Using stainless steel for threaded connections may cause issues with galling.

17-4PH Stainless Steel can be susceptible to Stress corrosion cracking and Sulphide stress cracking unless the recommended heat treat processes are applied.

5.0 Applications

17-4PH is able to withstand corrosion better than any of the other standard hardenable stainless steels. It is readily used in sour environments due to its corrosion and degradation resistance.

			MATERIALS SPECIFICATION	
REV: 1	SECTION: Titaniums	UNS NUMBER: R56400	PREPARED BY: Carolyn Cepuch	APPROVED BY:
NAME: Grade 5 Titanium				DATE: 07/26/11

1.0 Scope

Grade 5 titanium's shear strength and surface wear properties are the best of the readily available commercial titanium grades in plunger lift applications. Regarding plunger lift applications titanium's use is not necessarily for longer wear, but can be regarded as a risk management tool. Risk management must be considered when dealing with wells that have the ability to generate extreme velocities (i.e. low pressure, low rate wells). Titanium is half the specific gravity of steel, reducing impact on well equipment. This reduction of mass may also result in enhanced performance due to the lower mass being easier to lift. Grade 5 titanium is often used for downhole drilling tools.

2.0 References

MatWeb, LLC, Retrieved May 9, 2011,

<http://www.matweb.com/search/DataSheet.aspx?MatGUID=4b86c47a545247afae3da55d62381f89>

ASTM B265: Standard Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate.

3.0 Material Requirements

Chemical Composition: The chemical composition will meet the requirements listed below in weight percent. The composition range remains the same whether solution heat treated and aged or solution annealed.

	Al	C	H	Fe	N	O	Ti	V	Other
MIN	0.055	--	--	--	--	--	0.87725*	--	--
MAX	0.0675	0.0008	0.00015	0.004	0.0003	0.002	0.91*	0.045	0.003

*Elemental Compositions in accordance with ASTM B265

Mechanical Properties: The mechanical properties for both solution heat treated and aged and solution annealed grade 5 titanium shall meet the requirements listed in the table below.

	Solution Heat Treated	Solution Annealed
Hardness, Rockwell C	41	36
Yield Strength (MPa)	1100	880
Tensile Strength (MPa)	1170	950
Elongation	10.0%	14.0%
Reduction of Area	20.0%	36.0%

The solution heat treated and aged treatments will make a stronger alloy, however will reduce ductility, Stress Corrosion Cracking and fracture toughness compared to the solution annealing treatment.

4.0 Quality and Test Requirements

Visual Inspection: The surfaces shall be visually examined to ensure that it is free of cracks, laps, seams or other defects.

Gr.5 Titanium is a very resistive material to:

- Pitting and crevice corrosion
- Sulphide stress cracking
- Stress corrosion cracking
- Fatigue corrosion
- Erosion and Cavitation

Gr.5 Titanium is a susceptible material to:

- Abrasive and adhesive wear
- Fretting

5.0 Applications

This grade of titanium may be used in acidic and sour environments due to its resistivity to corrosion. Its lightweight quality makes it a preferred choice to low pressure wells to reduce risk of damage to bottomhole equipment.