Metallic Material Limits for Wellhead Equipment Used in High Temperature for API 6A and 17D Applications

API TECHNICAL REPORT 6MET
FIRST EDITION, OCTOBER 2010

AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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Introduction

This API-funded project was conducted by a Task Group charged by the Association of Well Head Equipment Manufacturers (AWHEM). The Task Group examined mechanical properties of metallic materials used for API 6A and API 17D wellhead equipment for service above 250 °F. A total of eleven different alloys meeting API 6A, PSL 3 conditions were supplied “in condition” by a variety of suppliers. Materials in this test program included alloys common to the oil and gas industry. The alloys tested included low alloy steels, martensitic, precipitation hardened and duplex stainless steels, and nickel alloys. Yield strength reduction ratios at temperatures of 300 °F, 350 °F, 400 °F, and 450 °F are reported. As a result of testing, yield strength reduction ratios at 300 °F to 450 °F ranged from 92 % to 87 % for the low alloy steels, 92% to 88% for the martensitic stainless steels 81 % to 73 % for super duplex, 99 % to 89 % for the precipitation hardened stainless steel and 94 % to 89 % for the nickel alloys. The reported results represent an average over the different heats for each type of material. These results are intended to expand the data shown in API 6A, Annex G.

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1 Scope

Testing was performed in three phases, presented herein in chronological order as Phase I, II, and III. Initially, all testing was to be completed in two phases, but testing anomalies in Phase II prompted re-testing of some alloys in Phase III.

Alloy candidates were recommended by AWHEM membership for analysis and confirmed by API's approval of New Work Item No. 2003-100786 in June 2002. Several material suppliers and several AWHEM member companies donated material for testing. Metallurgists on the Task Group screened material certificates to ensure a "normal" chemistry without enhancements for the material candidates listed in Table 1, Table 2, and Table 3.

Alloy chemistries from the material certificates for each of the supplied alloy candidates are provided in Table 6 through Table 16, located at the end of this report for readability.

Table 1—List of Alloys Included in Phase I Testing

Material	Yield Strength Class	Application	Bar Size
AISI 4130	75K	Pressure Containing	5 in. ER
AISI 8630	75K	Pressure Containing	5 in. ER
2 1/4 Cr 1 Mo	75K	Pressure Containing	5 in. ER
AISI 4140	75K	Pressure Containing	5 in. ER
AISI 410 SS	75K	Pressure Containing	5 in. ER
F6NM	75K	Pressure Containing	5 in. ER

Table 2—List of Alloys Included in Phase II Testing

Material	Yield Strength Class	Application	Material Size
25 Cr Super Duplex*	110K	Pressure Containing	2.4 in. to 5.5 in. OD
ASTM A453 Gr 660	100K	Pressure Retaining	0.75 in. to 1.5 in. OD
718 (per Spec 6A718)	130K	Pressure Containing	1.25 in. to 8.5 in. OD x 5.5 in.
725/625 Plus	130K	Pressure Containing	0.63 in. to 6.5 in. OD data 9 in.OD test
925	110K	Pressure Containing	1 in. to 6.5 in. OD
* Pitting resistance equivalence number, PREN >40.			

Table 3—List of Alloys Included in Phase III Testing

Material	Yield Strength	Application	Material Size
Nickel Alloy 725/625 Plus	120K	Pressure Containing	1.25 in. to 6.0 in.OD
Nickel Alloy 925	110K	Pressure Containing	1.0 in. to 8.7 in. OD