



## CRA 2550E Grade 140 for High-Pressure & High-Temperature Severe Sour Service

The ongoing exploration and development of deeper offshore reservoirs has necessitated the development of higher strength materials able to handle more elevated burst and collapse pressures, temperatures, and partial pressures of hydrogen sulfide. However, within the industry specifications, API 5CRA/ISO 13680 and NACE MR0175/ISO 15156, there has been little advancement of higher strength tubular products used for casing, tubing, coupling stock, and accessories. For sour service, API 5CRA/ISO 13680 currently limits these products to grades 110 & 125.

Corrosion Resistant Alloys has developed CRA 2550E Grade 140, which satisfies the quality requirements of API 5CRA/ISO 13680 and NACE MR0175/ISO 15156 for sour service. Assuring compliance to these specifications requires a very restrictive range of mechanical properties. We achieve this through a tightly restricted chemical composition, premium melting processes, and closely controlled thermomechanical processing. In addition to the consistent mechanical properties, the clean microstructure obtained provides increased resistance to stress corrosion, as demonstrated by the tests results provided in the following table.

**Summary of Slow Strain Rate Testing**

Size	Yield Strength	Temp	H2S pp	CO2 pp	Chlorides	Time to Failure	Red. in Area
inches	(ksi)	(F)	(psi)	(psi)	mg/L	ratio to inert	ratio to inert
4.21"OD x 0.92"WT	151	401	500	500	180,000	0.98/1.02	0.87/0.91
8.38"OD x 0.64" WT	144	401	1000	500	180,000	0.94/1.03	0.87/1.00
7.80"OD x 0.82"WT	142	350	600	1200	-	0.98/0.94	0.94/0.90
7.80"OD x 0.82"WT	142	350	400	800	w/elemental sulfur	0.87/0.99	0.80/0.75

The need for higher strength bar products for equipment and accessories in sour service has been addressed by NACE MR0175/ ISO 15156 and API6CRA through the addition of 718 bar grades 140 & 150. However, there have been several documented hydrogen embrittlement failures of 718 and other precipitation-hardened nickel alloys which have not been experienced with solid solution strengthened nickel alloys such as CRA 2550E. Furthermore, CRA 2550E has demonstrated excellent hydrogen embrittlement resistance in the high strength grade 140 condition. For lower completion equipment and other components, heavy wall CRA 2550E tubulars should be considered as an alternative to bar products. In addition to reducing the risk of environmental cracking, manufacturing from tubulars reduces material loss and machining costs.



Summary of Hydrogen Embrittlement Slow Strain Rate Testing					
3.5% NaCl @ -1.1V					
Size	Yield Strength	Temp	Time to Failure	Red. in Area	Elongation
inches	(ksi)	(F)	ratio to inert	ratio to inert	ratio to inert
4.21"OD x 0.92"WT	151	Room Temp	1.00/1.00	1.00/1.00	0.96/1.00

Applications other than high-pressure, high-temperature wells may also benefit from utilizing CRA 2550E-140. The high strength may allow for the use of thinner wall tubulars to reduce the weight on the string or increase flow capacity. With a minimum PREN of 45, CRA 2550E has also found application in injection wells where high pitting corrosion resistance is required. It is particularly advantageous where the intent is to alternate between a sour service production well and injection.

**Alternative High-Strength Tubulars**

For sweet service or injection wells, Corrosion Resistant Alloys provides duplex stainless steels in 140 grade. For the most extreme corrosive environments, or where even higher strength is required, we offer alloy C276. CRA has produced C276 grade 160 as large as 10" OD x 0.73" wall thickness.

\*While every effort has been made to ensure the accuracy of the above review, assessment, conclusions, and report, the appropriateness of their application and their interpretation remain the sole responsibility of the user.