HAYNES® 556® alloy for Fossil Energy System Applications Tech Brief

For Fossil-Fuel-Fired Energy Systems

Many power plant facilities today are burning difficult to handle fuels such as high-sulfur coal and fuel oil.

Difficult to handle, in as much as process internals are too often subject to both reducing carburizing atmospheres and sulfidizing environments which lead to early failure. This can mean frequent replacement or maintenance for components such as burner buckets, grates, tube supports, rapper bars, soot blowers, and numerous other traditional boiler internals. And, in the never fluidized bed technology facilities, in-bed tubulars and support hardware require materials which can stand up to even harsher environments.

HAYNES® 556® alloy is one of few materials to combine excellent design strength with broad spectrum resistance to most key forms of high-temperature corrosion. This resistance includes carburizing atmospheres, sulfidizing environments, chlorine-contaminated process gases and several others, proven in such demanding uses as internals in municipal waste incinerators.

556® alloy is covered by ASME Boiler Code Case No. 2010 for use to 1200°F (650°C), with extension to 1650°F (900°C) coverage soon to be proposed. It is currently in service in several boiler and fluidized-bed facilities, and on test in many others.

Product Description

HAYNES® 556® alloy is an iron-nickel-chromium-cobalt alloy that combines effective resistance to sulfidizing, carburizing, and chlorine-bearing environments at high temperatures with good oxidation resistance, fabricability, and excellent high-temperature strength. It has also been found to resist corrosion by molten chloride salts and molten zinc.

HAYNES® 556® alloy is highly useful for service at elevated temperature in moderately to severely corrosive environments. Applications include tubing and structural members in waste heat recuperators, super heaters, and internals in municipal and chemical waste incinerators; power plant burner buckets, cair nozzles, and fluidized bed combustor heat exchangers and internals; high-speed furnace fans, galvanizing bath hardware and brazing fixtures; and high-temperature rotary calciners and kilns. There are also additional uses in the chemical petrochemical process and pump and paper industries.

Proposed Design Stresses For 100,000-Hour Life at 1500°F (815°C)

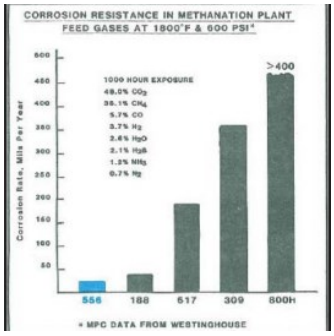
Alloy	Stress	
-	mils	MPa
556®	23	3.4
X	20	2.9
800HY	15	2.2
304	10	1.4
316	9	1.3

Sulfidation Resistance for 215-Hour Exposure (Ar-5%H_2-5%CO-1%CO_2-0.15%H_2S) 1400°F (760°C)

Alloy	Maximum Metal Affected	
-	mils	µm
556®	3.8	97
310	9.1	231
800H	11.2	284
625	12.6	320
600	21.7	551
X	29.5	749

Nominal Composition

Iron:	Balance
Nickel:	20
Cobalt:	18
Chromium:	22
Molybdenum:	3
Tungsten:	2.5
Tantalum:	0.6
Nitrogen:	0.2
Silicon:	0.4
Manganese:	1
Aluminum:	0.2
Carbon:	0.1
Lanthanum:	0.02
Zirconium:	0.02



Typical Tensile Properties, Plate

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		Elongation
°F	**°C**	**ksi**	**MPa**	**ksi**	**MPa**	**%**
RT	RT	55	375	116	805	51
1000	540	31	210	90	625	60
1200	650	31	210	83	575	57
1400	760	29	200	69	470	53
1600	870	28	190	49	340	69
1800	980	19	130	31	210	84
2000	1095	9	60	16	110	95

Typical Rupture Properties, Plate

Test Temperature		Typical Rupture Properties: Stress Required to Produce Rupture in Hours Shown					
		100 h		1,000 h		10,000 h	
°F	**°C**	**ksi**	**MPa**	**ksi**	**MPa**	**ksi**	**MPa**
1400	760	25.0	172	17.5	121	11.9	82
1500	815	17.0	117	11.8	81	7.8	52
1600	870	11.5	79	7.5	52	4.9	34
1700	915	7.6	52	4.8	33	3.0	21
1800	980	4.8	33	3.0	21	1.9	13

Typical Room Temperature Physical Properties

Physical Property	British Units	Metric Units
Density	0.297 lb/in^3	8.23 g/cm^3
Electrical Resistivity	37.5 µohm-in	95.2 µohm-cm
Modulus of Elasticity	29.7 x 10^6 psi	206 GPA

Thermal Conductivity	77 Btu-in/ft^2-h-°F	11.1 W/m-°C
Specific Heat	0.111 Btu/lb-°F	464 J/Kg-°C

Environmental Resistance

Oxidation in Air - Excellent at 2000°F (1095°C)

Sulfidation - Second only to Co-base alloys

Molten Chloride Salts - Equal to alloy X

Chlorination - Very good to 1650°F (900°C)

Carburization - Equal to alloy 800H

Molten Zinc - Best Available