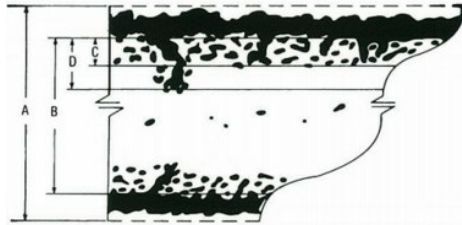


HAYNES[®] 188 alloy

Oxidation Resistance

HAYNES[®] 188 alloy exhibits very good resistance to both air and combustion gas oxidizing environments, and can be used for long-term continuous exposure at temperatures up to 2000°F (1095°C). For exposures of short duration, 188 alloy can be used at higher temperatures.



1. Metal Loss = (A - B)/2
2. Average Internal Penetration = C
3. Maximum Internal Penetration = D
4. Average Metal Affected = ((A - B)/2) + C
5. Maximum Metal Affected = ((A - B)/2) + D

Comparative Oxidation Resistance in Flowing Air, 1008 Hours

Alloy	1800°F (980°C)				2000°F (1095°C)				2100°F (1150°C)			
	Average Metal Affected**		Metal Loss		Average Metal Affected**		Metal Loss		Average Metal Affected**		Metal Loss	
	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm
188	1.1	28	0.1	3	3.7	94	0.5	13	10.7	272	8.6	218
230[®]	1.5	38	0.2	5	3.3	84	0.5	13	4.4	112	1.2	30
X	1.5	38	0.2	5	4.4	112	1.3	33	6.1	115	3.6	91
625	1.9	48	0.4	10	7.8	198	3.5	89	20.2	513	18.3	465
617	2.0	51	0.3	8	3.8	97	0.6	15	5.2	132	1.0	25

*Flowing air at a velocity of 7.0 ft/min (213.4 cm/min) past the samples. Samples cycled to room temperature once per week.

**Metal Loss + Average Internal Penetration

Oxidation Test Parameters

Burner rig oxidation tests were conducted by exposing samples 3/8 in. x 2.5 in. x thickness (9 mm x 64 mm x thickness), in a rotating holder, to products of combustion of No. 2 fuel oil burned at a ratio of air to fuel of about 50:1. (Gas velocity was about 0.3 mach). Samples were automatically removed from the gas stream every 30 minutes and fan-cooled to near ambient temperature and then reinserted into the flame tunnel.

Comparative Burner Rig Oxidation Resistance 1000 Hour Exposure at 1800°F (980°C)

1000 Hour Exposure at 1800°F (980°C), 30 Minute Cycles						
Alloy	Metal Loss		Average Metal Affected		Maximum Metal Affected	
	mils	µm	mils	µm	mils	µm
188	1.1	28	3.2	81	3.9	99
230[®]	2.8	71	5.6	142	6.4	163
617	2.4	61	5.7	145	6.9	175
625	3.7	94	6.0	152	6.6	168
X	4.3	109	7.3	185	8.0	203

Comparative Burner Rig Oxidation Resistance at 2000°F (1095°C) for 500 Hours

500 Hour Exposure at 2000°F (1095°C), 30 Minute Cycles						
Alloy	Average Metal Loss Per Side		Average Metal Affected		Maximum Metal Affected	
	mils	µm	mils	µm	mils	µm
230®	7.1	180	9.9	251	11.8	300
188	10.9	277	13.1	333	14.1	358
X	11.6	295	14.0	356	15.1	384
617	13.3	338	20.9	531	21.2	538
625	Consumed					

188 comparative burner rig

*625 was consumed

Water Vapor Oxidation Data

Air + 20% H ₂ O at 1800°F (982°C), 1008 hours, cycled weekly				
Alloy	Metal Loss		Average Metal Affected	
	mils	µm	mils	µm
214®	0.04	1	0.64	16
230®	0.19	5	1.59	40
625	0.36	9	1.66	42
188	0.18	5	1.48	38
X	0.27	7	1.77	45
617	0.39	10	1.99	50
556®	0.35	9	1.85	47
HRa€120®	0.38	10	2.08	53
800HT	2.47	63	5.07	129
HRa€160®	0.77	20	5.57	141