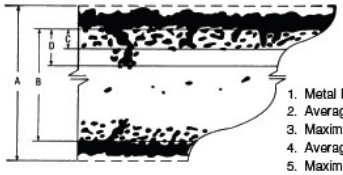
HAYNES® 230® alloy

Oxidation Resistance

HAYNES® 230® alloy exhibits excellent resistance to both air and combustion gas oxidizing environments, and can be used for long-term continuous exposure at temperatures up to 2100°F (1150°C). For exposures of short duration, 230 alloy can be used at higher temperatures.

Schematic Representation of Metallographic Technique used for Evaluating Oxidation Tests



Comparative Dynamic Oxidation

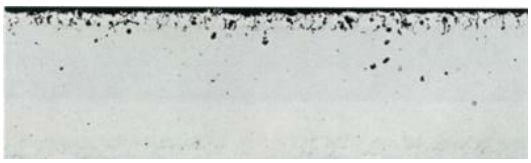
Alloy	1600°F (870°C), 2000 h, 30-min cycles				1800°F (980°C), 1000 h, 30-min cycles				2000°F (1090°C), 500 h, 30-min cycles				2100°F (1150°C), 200 h, 30-min cycles			
	Metal Loss		Average Metal Affected		Metal Loss		Average Metal Affected		Metal Loss		Average Metal Affected		Metal Loss		Average Metal Affected	
	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm
188	1.1	28	2.9	74	1.1	28	3.2	81	10.9	277	13.1	333	8	203	9.7	246
230®	**0.9**	**23**	**3.9**	**99**	**2.8**	**71**	**5.6**	**142**	**7.1**	**180**	**9.9**	**251**	**6.4**	**163**	**13.1**	**333**
617	2	51	7.8	198	2.4	61	5.7	145	13.3	338	20.9	531	13.8	351	15.3	389
625	1.2	30	2.2	56	3.7	94	6	152	-	-	Consumed		-	-	-	-
556®	1.5	38	3.9	99	4.1	104	6.7	170	9.9	251	12.1	307	11.5	292	14	356
X	1.7	43	5.3	135	4.3	109	7.3	185	11.6	295	14	356	13.9	353	15.9	404
HR-120®	-	-	-	-	6.3	160	8.3	211	-	-	-	-	-	-	-	-
RA330	2.5	64	5	127	8.7	221	10.5	267	15.4	391	17.9	455	11.5	292	13	330
HR-160®	-	-	-	-	5.4	137	11.9	302	12.5		18.1	460	8.7	221	15.5	394
310SS	6	152	7.9	201	16	406	18.3	465	-	-	-	-	-	-	Consumed	
800H	3.9	99	9.4	239	22.9	582	Through Thickness		-	-	Consumed after 300 h		-	-	Consumed	

Burner rig oxidation tests were conducted by exposing samples of 3/8” x 2.5” x thickness (9mm x 64 mm x thickness), in a rotating holder to the products of combustion of 2 parts No. 1 and 1 part No. 2 fuel 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.

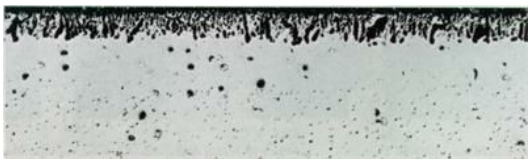
Comparative Oxidation in Flowing Air 2100°F (1150°C) for 1008 Hours

Microstructures shown are for coupons exposed for 1008 hours at 2100°F (1150°C) in air

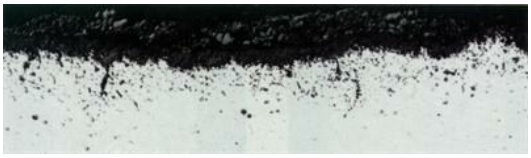
flowing 7.0 feet/minute (2.1 m/minute) past the samples. Samples were descaled by cathodically charging the coupons while they were immersed in a molten salt solution. The black area shown at the top of each picture represents actual metal loss due to oxidation. The data clearly show HAYNES 230 alloy to be superior to both INCONEL alloy 601 and alloy 800H, as well as the other heat-resistant materials listed in the table above.



230® alloy
Average Metal Affected
= 3.4 mils (86 µm)



INCONEL alloy 601
Average Metal Affected
= 5.3 mils (135 µm)



Alloy 800H
Average Metal Affected
= 8.9 mils (226 µm)

Water Vapor Testing

Alloy	1008 hours @ 1600F Cycled 1x/week in air+10%H_2O				1008 hours @ 1600F Cycled 1x/week in air+20%H_2O				6 months @ 1400F Cycled 1x/week in air+10%H_2O			
	Metal Loss		Average Metal Affected		Metal Loss		Average Metal Affected		Metal Loss		Average Metal Affected	
	mils per side	mm per side	mils per side	mm per side	mils per side	mm per side	mils per side	mm per side	mils per side	mm per side	mils per side	mm per side
230®	**0.07**	**0.002**	**0.53**	**0.013**	**0.03**	**0.001**	**0.21**	**0.005**	**0.05**	**0.001**	**0.35**	**0.009**
625	0.11	0.003	0.5	0.013	0.04	0.001	0.27	0.007	-	-	-	-
X	0.03	0.001	0.5	0.013	0.04	0.001	0.3	0.008	-	-	-	-
253MA	0.66	0.017	1.59	0.040	0.08	0.002	0.68	0.017	-	-	-	-
800HT	-	-	-	-	-	-	-	-	0.12	0.003	0.82	0.021
347SS	0.86	0.022	1.48	0.038	0.18	0.005	0.18	0.005	0.46	0.012	1.26	0.032

Amount of metal affected for highâ€temperature sheet (0.060 â€ 0.125”) alloys exposed for 360 days (8,640 h) in flowing air.

Alloy	1600°F				1800°F				2000°F				2100°F			
	Metal Loss*		Average Metal Affected		Metal Loss*		Average Metal Affected		Metal Loss*		Average Metal Affected		Metal Loss*		Average Metal Affected	
	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm
625	0.3	8	1.4	36	-	-	-	-	-	-	-	-	-	-	-	-
230®	0.2	5	1.4	36	0.1	3	2.5	64	3.4	86	11	279	28.5	724	34.4	874
617	0.3	8	1.6	41	-	-	-	-	-	-	-	-	-	-	-	-
HRâ €120®	0.3	8	1.6	41	0.5	13	3.3	84	18.1	460	23.2	589	33.6	853	44	1118
25	0.3	8	1.7	43	-	-	-	-	-	-	-	-	-	-	-	-
188	0.2	5	1.8	46	-	-	-	-	-	-	-	-	-	-	-	-
556®	0.3	8	1.9	48	0.5	13	6.2	157	15	381	24.1	612	-	-	-	-
X	0.3	8	2.2	56	0.2	5	2.8	71	17.1	434	26.2	665	51.5	1308	55.4	1407
800HT	0.4	10	2.9	74	-	-	-	-	-	-	-	-	-	-	-	-
HR-160®	-	-	-	-	1.7	43	13.7	348	7.2	183	30.8	782	12	305	45.6	1158

*Metal loss was calculated from final and initial metal thicknesses; i.e. ML = (OMT – FMT) /2

Static Oxidation Comparison

Alloy	Comparative Oxidation Resistance in Flowing Air, 1008 Hours*															
	1800°F (982°C)				2000°F (1093°C)				2100°F (1149°C)				2200°F (1204°C)			
	Metal Loss		Average Metal Affected		Metal Loss		Average Metal Affected		Metal Loss		Average Metal Affected		Metal Loss		Average Metal Affected	
	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm	mils	µm
230®	0.2	5	1.5	38	0.5	13	3.3	84	1.2	30	4.4	112	4.7	119	8.3	211
188	0.1	3	1.1	28	0.5	13	3.7	94	8.6	218	10.7	272	5.2	132	48.2	1224
601	0.4	10	1.7	43	1.3	33	3.8	97	2.8	71	6.5	165	4.4	112	7.5	191
617	0.3	8	2	51	0.6	15	3.8	97	1	25	5.2	132	10.7	272	12.6	320
X	0.2	5	1.5	38	1.3	33	4.4	112	3.6	91	6.1	115	-	-	-	-
800HT	0.5	13	4.1	104	7.6	193	11.6	295	12.4	315	15	381	-	-	-	-
446 SS	-	-	-	-	13	330	14.4	366	-	-	>21.5	>546	-	-	-	-
316 SS	12.3	312	14.2	361	-	-	>17.5	>445	-	-	>17.5	>445	-	-	-	-

*Metal Loss + Average Internal Penetration

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