

VDM® Aluchrom 4 18 YHF

Aluchrom® 4 18 YHf

Aluchrom® 4 18 YHf is a high-temperature ferritic stainless steel alloyed with medium aluminum content and improved workability. Due to additions of yttrium and hafnium the alloy possesses good high temperature resistance.

Aluchrom® 4 18 YHf is characterized by:

- good oxidation resistance under isothermal and cyclic conditions
- good workability

Designations and standards

Country	Material designation	Specification		
		Chemical composition	Strip	
National standards				
D DIN EN	W.-Nr. 1.4737 X6 CrAl 18-4			

Table 1 - Designations and standards.

Chemical composition

	Ni	Cr	Fe	C	S	Mn	Si	Al	Y	Zr	Hf	P	Cu
min.		17.0	bal.					3.5					
max.	0.5	19.0		0.08	0.03	0.5	0.6	5.0	0.15	0.15	0.15	0.04	0.5

Table 2 – Chemical composition (wt.-%).

Physical properties

Density	7.3 g/cm ³	0.264 lb/in. ³
Melting range	1516 °C (Solidus) - 1531 °C (Liquidus)	2761 °F (Solidus) - 2788 °F (Liquidus)

Temperature (T)		Electrical resistivity		Thermal conductivity		Specific heat		Coefficient of thermal expansion between 20 °C and T	
°C	°F	$\mu\Omega \cdot \text{cm}$	$\frac{\Omega \cdot \text{circ mil}}{\text{ft}}$	$\frac{\text{W}}{\text{m} \cdot \text{K}}$	$\frac{\text{Btu} \cdot \text{in.}}{\text{ft}^2 \cdot \text{h} \cdot ^\circ\text{F}}$	$\frac{\text{J}}{\text{kg} \cdot \text{K}}$	$\frac{\text{Btu}}{\text{lb} \cdot ^\circ\text{F}}$	$\frac{10^{-6}}{\text{K}}$	$\frac{10^{-6}}{^\circ\text{F}}$
20	68	122	734						
100	212	123	740	15.4	8.9	518	0.124	10.9	6.1
200	392	124	746	16.5	9.5	549	0.131	11.3	6.3
300	572	125	752	17.7	10.2	586	0.140	11.6	6.4
400	752	127	764	18.6	10.8	634	0.151	12.0	6.7
500	932	128	770	19.6	11.3	702	0.168	12.4	6.9
600	1112	132	794	25.3	14.6	891	0.213	12.7	7.1
700	1292	133	800	22.2	12.8	703	0.168	13.2	7.3
800	1472	134	806	23.5	13.6	679	0.162	13.8	7.7
900	1652	135	812	24.7	14.3	675	0.161	14.3	7.9
1000	1832	136	818	26.1	15.1	680	0.162	14.8	8.2

Table 3 – Typical physical properties at room and elevated temperatures.

Mechanical properties

0.2% Yield strength $R_{p0.2}$		Tensile strength R_m		Elongation A	Hardness HV
MPa	ksi	MPa	ksi	%	(For information only)
≥ 420	≥ 60.9	≥ 550	≥ 79.8	$A_{50} \geq 18$ $A_5 \geq 25$	170 – 220

Table 4 - Minimum mechanical properties in the soft-annealed condition for strip at room temperature.

Product	0.2% Yield strength $R_{p0.2}$		Tensile strength R_m		Elongation A
	MPa	ksi	MPa	ksi	%
Strip	480	69.6	600	87.0	22 (A_{50}) 30 (A_5)

Table 5 - Typical mechanical properties for strip at room temperature.

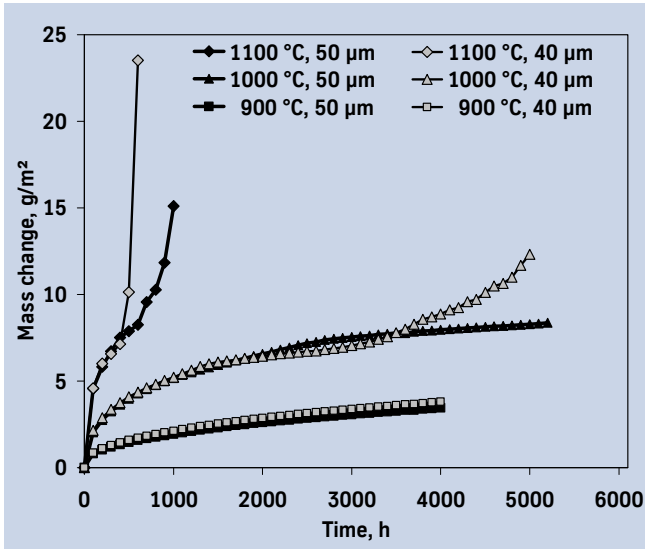


Fig. 1 - Mass change during discontinuous oxidation tests (100 h cycles) of Aluchrom® 4 18 YHf of 40 µm and 50 µm strip thickness at 900 °C, 1000 °C and 1100 °C in air as a function of time measured on samples simulating catalytic converters. (typical values).

Metallurgical structure

Aluchrom® 4 18 YHf has a body-centered-cubic structure.

High temperature corrosion resistance

Aluchrom® 4 18 YHf is a ferritic chromium steel with additions of about 4 % aluminium and up to 0.15 % yttrium and hafnium respectively. Due to the additions of yttrium and hafnium Aluchrom® 4 18 YHf possesses a dense, well adhering Al_2O_3 -layer, which ensure an excellent high temperature resistance (Figure 1) against oxidation even at the reduced aluminium content of about 4 %.

Applications

Aluchrom® 4 18 YHf is used mainly as a metallic substrate for automotive catalytic converters. Other applications are heating elements and furnaces.

Fabrication and heat treatment

Due to the reduced aluminum content Aluchrom® 4 18 YHf can easier be hot- and cold-worked and machined in comparison to Aluchrom® YHf with 6 % aluminium.

Cold brittleness may occur after use at temperatures exceeding 1000 °C and also after use at temperatures between 400 and 550 °C.

Heating

Production pieces must be clean and free from all kinds of contaminants before and during any heating operation.

Aluchrom® 4 18 YHf may become embrittled if heated in the presence of contaminants such as sulfur, phosphorus, lead and other low-melting-point metals. Sources of such contaminants include marking and temperature-indicating paints and crayons, lubricating grease, fluids, and fuels.

Fuels must be as low in sulfur as possible. Natural gas should contain less than 0.1 wt.-% sulfur. Liquid fuels with a sulfur content not exceeding 0.5 wt.-% are suitable.

Due to their close control of temperature and lack of contamination, thermal treatments in electric furnaces under vacuum or in an inert gas atmosphere are to be preferred. Treatments in an air atmosphere and alternatively in gas-fired furnaces are acceptable though, if contaminants are kept at low levels so that a neutral or slightly oxidizing furnace atmosphere is attained.

A furnace atmosphere fluctuating between oxidizing and reducing conditions must be avoided as well as direct flame impingement on the metal.

Hot working

Aluchrom® 4 18 YHf should be hot-worked in the temperature range 1050 to 850 °C (1920 to 1560 °F), followed by water quenching or rapid air cooling, in particular the temperature range 560 °C – 400 °C (1040 – 750 °F) should be passed through quickly.

Hot bending is preferably carried out at 200 to 300 °C (390 to 570 °F). Temperatures in excess to 400 °C should be avoided.

Cold working

The material should be in the soft annealed condition.

Intermediate annealing may be necessary with high degrees of cold forming.

Heat treatment

Soft annealing of Aluchrom® 4 18 YHf should be carried out at temperatures above 800 °C (1470 °F). For optimum properties the material should be water quenched after annealing. Small dimensions can also be cooled down rapidly in air.

For any thermal treatment operation the precautions concerning cleanliness mentioned earlier under 'Heating' must be observed.

Machining

Aluchrom® 4 18 YHf should be machined preferably in the soft annealed condition

Descaling and pickling

Oxides of Aluchrom® 4 18 YHf and discoloration adjacent to welds are more adherent than on standard stainless steels.

Grinding with very fine abrasive belts or discs is recommended. Care should be taken to prevent tarnishing.

Availability

Aluchrom® 4 18 YHf is available as strip.

Strip¹⁾

Thickness mm	Width ³⁾ mm	Coil I.D. mm
0.02 - ≤ 0.10	4 - 200 ⁴⁾	300 400
> 0.10 - ≤ 0.25	4 - < 720 ⁴⁾	300 400 500
> 0.25 - ≤ 0.6	6 - < 750	400 500 600
> 0.60 - ≤ 1.0	8 - < 750	400 500 600
> 1.0 - ≤ 2.0	15 - < 750	400 500 600

¹⁾ Cut-to-length available in lengths from 250 to 4000 mm

²⁾ Maximum thickness: bright annealed - 2 mm
cold rolled only - 2 mm

³⁾ Wider widths subject to special enquiry

⁴⁾ Wider widths up to 730 mm subject to special enquiry

Conditions

cold rolled, soft annealed and pickled or bright annealed²⁾

Thickness inches	Width ³⁾ inches	Coil I.D. inches
0.0008 - ≤ 0.004	0.16 - 8 ⁴⁾	12 16
> 0.004 - ≤ 0.010	0.16 - 14 ⁴⁾	12 16 20
> 0.010 - ≤ 0.024	0.24 - 30	16 20 24
> 0.024 - ≤ 0.040	0.32 - 30	16 20 24
> 0.040 - ≤ 0.080	0.60 - 30	16 20 24

¹⁾ Cut-to-length available in lengths from 10 to 158 in.

²⁾ Maximum thickness: bright annealed – 0.080 in.
cold rolled only – 0.080 in.

³⁾ Wider widths subject to special enquiry

⁴⁾ Wider widths up to 29 in. subject to special enquiry

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