VDM Metals

Alloys for the Chemical Process Industry

A company of ACERINOX

Content

Tough demands are our business

Founded in 1930, VDM Metals developed into a world market leader for high performing metallic materials covering the widest product and service portfolio in the industry. The quality of our products and services bases on our integrated production chain in Germany and the United States and a sales network that spans the globe servicing the most demanding industries backed by a strong R&D and application engineering force.

VDM Metals produces high performance alloys for the use in extreme conditions – high temperatures, icy waters, soaring heights and deep underground. Our materials are made to last, resisting heavy mechanical, thermal and chemical stresses, sometimes all three simultaneously. In many key technologies high performance alloys from VDM Metals are indispensable for the industrial-scale implementation and safe control of essential processes in hot or corrosive environments.

Focus on safety and reliability
Our nickel and zirconium materials as well as our high-alloyed special stainless steels are made from a wide spectrum of elements from the periodic table, because the solutions we develop are just as wide-ranging as the demands for which they are required.

Safety and reliability are very important for any project for the chemical process industry. Whether you are working in the area of plant engineering, in the development of new processes or in the field of maintenance: VDM Metals is your ideal partner for demanding materials concepts.

VDM Metals performs extensive test series on each single product according to the respective customer specifications, exploring the mechanical properties as well as the corrosion behavior.

Throughout international markets, pressure equipment such as vessels, piping and their accessories, assemblies and other safety and pressure equipment is strictly regulated. Our quality assurance system has been certified to be in compliance with the European Pressure Equipment Directive (97/23/EC).

Various product forms available
Our materials are delivered as plate and sheet, rod and bar, forgings, strip, powder, wire or welding consumables. Our processing plants and machinery are tailored to specific production requirements and equipped with state-of-the-art process data acquisition systems, ensuring high productivity and production reliability. Our integrated manufacturing chain means that all major production steps are in our own hands – a vital prerequisite for a robust and stable manufacturing process. The result of our efforts: maximum purity, homogeneity, reproducibility and optimum further processing characteristics of our products. Thus, our offering is nothing less than premium materials in any form needed as well as first class services, available anywhere in the world.

Materials for highly demanding applications

VDM Metals is offering high performance materials in the main product forms plate, sheet, powder, strip, rod, bar and wire. These various product forms exhibit excellent fabricability into vessels, heads, trays, tubes, pipes, fasteners, fittings and flanges, etc. which are subsequently manufactured into the different pieces of equipment required by the chemical industry as pressure vessels, reactors, columns, heat exchangers and filters.

At VDM Metals we support our customers during the development of their projects starting with the material selection, where VDM Metals has an abundance of laboratory data and field experience at its disposal. We have a broad know-how regarding all questions of formability and weldability. The supply of material is accompanied with the provision of appropriate welding consumables under our own brand and advice on the most suitable welding processes and parameters.

Amongst others, our alloys are used in the following application fields:

Plants and processes
Corrosion resistant alloys from VDM Metals are successfully used in refineries, in the production of phosphoric acid, phosphate fertilizer, sulfuric acid, nitric acid, in oxidizing and reducing media, acetic acid, salt production, chlorine, caustic soda, vinyl chloride monomer (VCM), plastics production, synthesis of organic compounds and pharmaceutical products.

Industrial furnace construction
The main requirements on metallic materials for high temperature applications are high temperature strength and resistance to high temperature corrosion. Chromium-nickel steels and also, to some extent, ferritic stainless steels often meet these requirements. At very high temperatures or in combination with corrosive environments, nickel alloys must be used because they retain sufficient strength; corrosion resistence in some cases even up to 1,200 °C (2,192 °F).

Flue gas desulfurization
VDM Metals gathered extensive experience in the field of flue gas desulfurization worldwide over the past decades. Our corrosion resistant alloys are used in coal-fired power plants and biomass handling and incineration plants, for all components. For further information, please note our special brochures.

Marine scrubbers
Special stainless steels and nickel alloys are successfully used since many years for the construction of SOx scrubbers on ships. The right material choice is the key to guarantee cost effectiveness and the longevity of the equipment. VDM Metals supports our customers based on our long term experiences with metallic FGD components. These material concepts have been adapted to the specific requirements of the marine scrubbers on ships regarding temperatures, corrosive conditions, fabrication, maintenance and cost aspects. For further information, please note our special brochures.

Heat exchangers
Heat exchangers are utilized for heating up, cooling down and re-heating up of fluids, gases or air. Our materials are used in plate heat exchangers, as well as in tube bundle heat exchangers.

Concentrated Solar Power (CSP) and Geothermal Power
For the construction of solar power plants, several high performance alloys are required, especially for the receivers, receiver tubes, pipes and heat exchangers handling molten solar salts.

High strength – high corrosion alloys from VDM Metals are used for geothermal power generation to handle the sometimes very aggressive brines.

Powder Alloys
We offer many of our conventional alloys for the chemical process industry in powder form for Additive Manufacturing. In the process industry, Additive Manufacturing offers many advantages in terms of complex design geometries of components, prototype construction and fast provision of spare parts.

Alloys and specifications

Corrosion resistant materials /
High temperature materials

The following applies for all alloys:
If you do not find the material you require in the table or the desired product forms, please contact us. We refine existing materials together with our customers or develop new materials in line with special customer requirements.

All mentioned values are approximate values and may deviate.

The indicated typical chemical values may vary from one alloy version to another. Before placing an order the requested analysis should be clarified with VDM Metals.

Our bar materials are also available as forged billet ≥135 mm diameter upon request.

Please contact us.

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Alloys and specifications
Corrosion resistant materials

Nickel

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Nickel 200	N02200	2.4066	Ni ≥ 99.2		•	•	•	•
	N02200	2.4060	Ni ≥ 99.6	ASTM-B-/ASME-SB-160			•	
				ASTM-B-/ASME-SB-162	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				BS 3072 (NA 11)	•			
				DIN 17740	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
VDM® Nickel 201	N02201	2.4068	Ni ≥ 99.2; C max. 0.02		•	•	•	•
	N02205	2.4061	Ni ≥ 99.6; C max. 0.02	ASTM-B-/ASME-SB-160			•	
				ASTM-B-/ASME-SB-162	•	•		
				BS 3072 (NA 12)	•			
				DIN 17740	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
				VdTÜV data sheet 345 (only for 2.4068)	•	•	•	

Nickel-copper alloys

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 400	N04400	2.4360	Ni-32Cu-2Fe-1Mn		•	•	•	•
				ANSI/NACE MR0103/ISO 17945	•	•	•	
				ANSI/NACE MR0175/ISO 15156-3	•	•	•	
				API 5LD	•			
				ASTM-B-/ASME-SB-127	•	•		
				ASTM-B-/ASME-SB-164			•	•
				ASTM-B-/ASME-SB-564 (forgings)			•	
				BS 3072 (NA 13)	•			
				DIN 17743	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
				QQ-N-281D Amd. 2/Class A/Form 1			•	
				QQ-N-281D Amd. 2/Class A/Form 4	•			
				QQ-N-281D Amd. 2/Class A/Form 6	•			
				VdTÜV data sheet 263	•		•	
VDM® Alloy K-500	N05500	2.4375	Ni-30Cu-2.7Al-1Fe-1Mn-0.6Ti				•	
				ANSI/NACE MR0175/ISO 15156-3			•	
				ASTM-B-865			•	
				DIN 17743			•	
				DIN 17752			•	
				QQ-N-286G			•	

• Available product forms. (•) Please contact us with respect to availability.

Alloys and specifications
Corrosion resistant materials

Nickel-iron-chromium-molybdenum-copper alloys

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 20	N08020	2.4660	Fe-35Ni-20Cr-3.5Cu-2.5Mo-0.35Nb		•	•	(•)	•
				ANSI/NACE MR0103/ISO 17945	•			
				ANSI/NACE MR0175/ISO 15156-3	•			
				ASTM-B-/ASME-SB-463	•	•		
				ASTM-B-/ASME-SB-472			(•)	
				ASTM-B-/ASME-SB-473			(•)	•
				DIN 17744	•	•	(•)	•
				DIN 17750	•	•		
				DIN 17752			(•)	
				DIN 17753				•
VDM® Alloy 825	N08825	2.4858	Ni-30Fe-23Cr-3Mo-2Cu-0.9Ti		•	•	•	•
				ANSI/NACE MR0103/ISO 17945	•	•	•	
				ANSI/NACE MR0175/ISO 15156-3	•	•	•	
				API 5LD	•	•		
				ASTM-B-/ASME-SB-424	•	•		
				ASTM-B-/ASME-SB-425			•	•
				ASTM-B-/ASME-SB-564 (forgings)			•	
				BS 3072 (NA 16)	•			
				DIN 17744	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
				VdTÜV data sheet 432	•	•	•	

Custom made stainless steels

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 316 L	S31603	1.4435	Fe-18Cr-14Ni-2,7Mo		•	•	(•)	•
				ASTM A240/240M / ASME SA-240/ SA-240M	•			
				DIN 17440	•			
				DIN EN 10028-7	•			
				DIN EN 10088-2	•			
				DIN EN 10088-2	•	•		
				DIN EN 10088-3			(•)	•
				VdTÜV data sheet 483			(•)	

High-alloyed special stainless steels

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 28	N08028	1.4563	Fe-31Ni-27Cr-3.5Mo-1.2Cu		•	•	(•)	•
				ANSI/NACE MR0103/ISO 17945	•			
				ANSI/NACE MR0175/ISO 15156-3	•			
				ASTM-B-/ASME-SB-709	•	•		
				DIN EN 10028-7	•	•		
				DIN EN 10088-2	•	•		
				DIN EN 10088-3			(•)	•
				VdTÜV data sheet 483			(•)	

Corrosion resistant materials

High-alloyed special stainless steels

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 926	N08926	1.4529	Fe-25Ni-20.5Cr-6.5Mo-0.9Cu-0.2N		•	•	(•)	•
				ANSI/NACE MR0103/ISO 17945	•			
				ANSI/NACE MR0175/ISO 15156-3	•			
				ANSI/NACE MR0175/ISO 15156-3	•	•		
				API 5LD	•	•		
				ASTM-B-/ASME-SB-625	•	•		
				ASTM-B-/ASME-SB 649			•	•
				ASTM-B-625	•			
				DIN EN 10028-7	•	•		
				DIN EN 10088-2	•	•		
				DIN EN 10088-3			•	•
				DIN EN 10222-5 (forgings)			•	
				VdTÜV data sheet 502	•	•	•	
VDM® Alloy 31	N08031	1.4562	Fe-31Ni-27Cr-6.5Mo-1.2Cu		•	•	•	•
				ANSI/NACE MR0103/ISO 17945	•			
				ANSI/NACE MR0175/ISO 15156-3	•			
				API 5LD	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				ASTM-B-/ASME-SB-625	•	•		
				ASTM-B-/ASME-SB-649			•	•
				SEW 400	•	•	•	•
				VdTÜV data sheet 509	•	•	•	
VDM Alloy 31 Plus®	N08034	2.4692	Ni-29Fe-27Cr-6.5Mo-2Mn-1.2Cu-0.2N		•	•	•	
				VdTÜV data sheet 583/1	•			
				ASTM B625	•	•		
				ASME Code-Case 2991	•	•	•	
VDM® Alloy 33	R20033	1.4591	Cr-32Fe-31Ni-1.6Mo-0.7Cu-0.4N		•	•	(•)	•
				ASTM-B-/ASME-SB-625	•	•		
				ASTM-B-/ASME-SB-649			(•)	•
				VdTÜV data sheet 516	•	•	(•)	

Nickel-chromium-molybdenum alloys

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 22	N06022	2.4602	Ni-21Cr-13.5Mo-3Fe-3W		•	•	•	•
				ANSI/NACE MR0103/ISO 17945	•	•		
				ANSI/NACE MR0175/ISO 15156-3	•	•	•	
				ASTM-B-/ASME-SB-564 (forgings)			•	
				ASTM-B-/ASME-SB-574			•	
				ASTM-B-/ASME-SB 575	•	•		
				DIN 17744	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				VdTÜV data sheet 479	•	•	•	

Alloys and specifications
Corrosion resistant materials

Nickel-chromium-molybdenum alloys

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 625	N06625	2.4856	Ni-21.5Cr-9Mo-4.5Fe-3.5Nb		•	•	•	•
				ANSI/NACE MR0103/ISO 17945	•	•	•	
				ANSI/NACE MR0175/ISO 15156-3	•	•	•	
				API 5LD	•	•		
				ASTM-B-/ASME-SB-443	•	•		
				ASTM-B-/ASME-SB-446			•	•
				ASTM-B-/ASME-SB-564 (forgings)			•	
				BS 3072 (NA 21)	•			
				DIN 17744	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
				VdTÜV data sheet 499	•	•	•	
VDM® Alloy C-4	N06455	2.4610	Ni-16Cr-16Mo-1Fe		•	•	•	•
				ANSI/NACE MR0103/ISO 17945	•			
				ANSI/NACE MR0175/ISO 15156/3	•			
				ASTM-B-/ASME-SB-574			•	
				ASTM-B-/ASME-SB-575	•	•		
				DIN 17744	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
				VdTÜV data sheet 424	•	•	•	
VDM® Alloy C-276	N10276	2.4819	Ni-16Cr-16Mo-5Fe-4W		•	•	•	•
				ANSI/NACE MR0103/ISO 17945		•		
				ANSI/NACE MR0175/ISO 15156-3	•	•	•	
				API 5LD	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				ASTM-B-/ASME-SB-574			•	•
				ASTM-B-/ASME-SB-575	•	•		
				DIN 17744	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
				VdTÜV data sheet 400	•	•	•	
VDM® Alloy 59	N06059	2.4605	Ni-23Cr-16Mo-1.3Fe		•	•	•	•
				ANSI/NACE MR0175/ISO 15156-3	•	•	•	
				ANSI/NACE MR0103/ISO 17945	•			
				API 5LD	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				ASTM-B-/ASME-SB-574			•	
				ASTM-B-/ASME-SB-575	•	•		
				DIN 17744	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
				VdTÜV data sheet 505	•	•	•	

Corrosion resistant materials

VDM® Alloy 2120 MoN	N06058	2.4700	Ni-20.5Cr-19Mo-0.5Fe-0.075N		•	•	•	(•)
				ASTM-B-564			•	
				ASTM-B-574			•	
				ASTM-B-575		•		
				ASTM-B-/ASME-SB-575	•			
				VdTÜV-WB-586	•	•		
				ASME Code-Case 2983	•	•	•	

Nickel-chromium alloys

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 600*	N06600	2.4816	Ni-16Cr-9Fe-0.07C		•	•	•	
				ANSI/NACE MR0103/ISO17945	•		•	
* also available with reduced C content (VDM® Alloy 600 L, UNS N06602, DIN EN 2.4817)				ANSI/NACE MR0175/ISO 15156/3	•			
				ASTM-B-/ASME-SB-166			•	
				ASTM-B-/ASME-SB-168	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				BS 3072 (NA 14)	•			
				DIN 17742	•	•	•	
				DIN 17750	•	•		
				DIN 17752			•	
				DIN EN 10095	•		•	
				VdTÜV data sheet 305	•	•	•	
VDM® Alloy 690	N06690	2.4642	Ni-29Cr-9Fe		•		•	(•)
				ASTM-B-/ASME-SB-166			•	
				ASTM-B-/ASME-SB-168	•			
				ASTM-B-/ASME-SB-564 (forgings)			•	
				DIN 17742	•		•	(•)
				DIN 17750	•			
				DIN 17752			•	
				DIN 17753				(•)

Nickel-molybdenum alloys

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy B-2	N10665	2.4617	Ni-27Mo-1.8Fe-0.7Cr		•		•	(•)
				ASTM-B-/ASME-SB-333	•			
				ASTM-B-/ASME-SB-335			•	(•)
				ASTM-B-/ASME-SB-564 (forgings)			•	
				DIN 17744	•		•	(•)
				DIN 17750	•			
				DIN 17752			(•)	
				DIN 17753				(•)
				VdTÜV data sheet 436	•		•	

Zirconium (industrial grade)

VDM Metals designation	UNS	DIN EN	Specification	Product form			
				Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Zr 700	R60700	–		•			
			ASTM-B-/ASME-SB-551	•			
VDM® Zr 702	R60702	–		•			
			ASTM-B-/ASME-SB-551	•			

Alloys and specifications
High temperature materials

Nickel alloys and special stainless steels

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 800	N08800	1.4876	Fe-30.5Ni-20.5Cr-max.0.7Al+Ti		•	•	•	•
				ASTM-B-/ASME-SB-408			•	
				ASTM-B-/ASME-SB-409	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				VdTÜV data sheet 412	•	•	•	
VDM® Alloy 800 H	N08810	1.4876/ 1.4958	Fe-30.5Ni-20.5Cr-max.0.7Al+Ti		•	•	•	
				ANSI/NACE MR0103/ISO 17945	•			
				ANSI/NACE MR0175/ISO 15156-3	•			
				ASME Code Case 1325	•			
				ASTM-A-/ASME-SA-240	•			
				ASTM-B-/ASME-SB-408			•	
				ASTM-B-/ASME-SB-409	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				BS 3072 (NA 15H)	•			
				DIN EN 10028-7 (only for 1.4958)	•	•		
				DIN EN 10095 (only for 1.4876)	•	•	•	
				DIN EN 10302	•	•	•	
				VdTÜV data sheet 412 (only for 1.4876)	•	•	•	
				VdTÜV data sheet 434 (only for 1.4876)	•		•	
VDM® Alloy 800 HP	N08811	1.4959	Fe-30.5Ni-20.5Cr-1Al+Ti		•	•	•	
				ASTM-B-/ASME-SB-408			•	
				ASTM-B-/ASME-SB-409	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				DIN EN 10028-7	•	•		
				DIN EN 10088-2	•			
				DIN EN 10302	•	•	•	
VDM® Alloy DS	–	1.4862	Fe-36.5Ni-17.5Cr-2Si-0.07C		•			
				Bs-3072	•			
VDM® Alloy 330	N08330	1.4886	Fe-35.5Ni-19Cr-1.2Si-0.06C		•			
				ANSI/NACE MR0103/ISO 17945	•			
				ANSI/NACE MR0175/ISO 15156-3	•			
				ASTM-B-/ASME-SB-536	•			
				DIN EN 10095	•			
				SEW 470	•			
VDM® Alloy 330*	N08330	1.4864	Fe-34.5Ni-16Cr-1.7Si-0.1C		(•)		•	•
				ASTM-B-/ASME-SB-511			•	
				DIN EN 10095	(•)		•	
				SEW 470	(•)		•	•
VDM® Alloy N08120	N08120		Ni-25Cr-35Fe-0.2N-0.05C		•			
				ASTM-B-ASME-SB-409	•			

• Available product forms. (•) Please contact us with respect to availability. * with reduced Cr content

High temperature materials

Nickel alloys and special stainless steels

VDM Metals designation	UNS	DIN EN	Typical chemical composition, in %	Specification	Product form			
					Plate/ sheet	Strip	Rod/ bar	Wire
VDM® Alloy 600 H	N06600	2.4816	Ni-16Cr-9Fe-0.07C		•	•	•	
				ASTM-B-/ASME-SB-166			•	
				ASTM-B-/ASME-SB-168		•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				DIN 17742	•	•	•	
				DIN 17750	•	•		
				DIN 17752			•	
				VdTÜV data sheet 305	•	•	•	
VDM® Alloy 601	N06601	2.4851	Ni-23Cr-14Fe-1.4Al		•	•	•	•
				ASTM-B-/ASME-SB-166			•	•
				ASTM-B-/ASME-SB-168	•	•		
				DIN 17742	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN 17753				•
				DIN EN 10095	•	•	•	•
VDM Alloy 602 CA®	N06025	2.4633	Ni-25Cr-10Fe-2.2Al-0.17C-0.1Y-0.1Zr		•	•	•	•
				ASTM-B-/ASME-SB-166			•	•
				ASTM-B-/ASME-SB-168	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				DIN 17742	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN EN 10302	•	•	•	•
				VdTÜV data sheet 540	•	•	•	
VDM® Alloy 617	N06617	2.4663	Ni-22Cr-11.5Co-9Mo-1.1Al-1Fe		•	•	•	
				ASTM-B-/ASME-SB-166			•	
				ASTM-B-/ASME-SB-168	•	•		
				ASTM-B-/ASME-SB-564 (forgings)			•	
				DIN 17744	•	•	•	
				DIN 17750	•	•		
				DIN 17752			•	
				DIN EN 10302	•	•	•	
				VdTÜV data sheet 485	•	•	•	
VDM® Alloy 617 B	N06617	2.4673	Ni-22Cr-11.5Co-9Mo-1Fe-1Al-0.003B		•		•	
				ASTM-B-/ASME-SB-168	•			
				VdTÜV data sheet 573	•		•	
VDM® Alloy C-263	N07263	2.4650	Ni-20Co-20Cr-5.8Mo-2.2Ti-0.5Al		•	•	•	•
				DIN 17744	•	•	•	•
				DIN 17750	•	•		
				DIN 17752			•	
				DIN EN 10302	•	•		•
				GE B50A774-S2	•			
VDM® Alloy 699 XA	N06699	2.4842	Ni-Cr-30Al		•		•	(•)
				ASTM-B-0166			•	•
				ASTM-B-0168	•			
				ASTM-B-0472 (billets)			•	
				ASTM-B-0564 (forgings)			•	

Additive manufacturing
Powder alloys

For Additive Manufacturing, we also offer selected alloys in powder form for applications in the chemical process industry. The material properties and areas of application of the powder materials are often identical to the conventional product forms, which are explained in detail in the following chapter (pp. 17-29).

Designation	DIN EN	UNS	Typical chemical composition, in %					Product form	
			Ni	Cr	Fe	Mo	Other	Powder	Particle size distribution
VDM® Powder 625	2.4856	N06625	61	21,5	4,5	9	Nb 3,5	•	15 – 53 µm / 50 – 150 µm*
VDM® Powder 926 L	1.4529	N08926	25	20,5	45	6,5	Cu 0,9; N 0,2	•	15 – 53 µm / 50 – 150 µm*
VDM® Powder 718	2.4668	N07718	54	19	17	3	Nb 5,3; Ti 1; Al 0,5	•	15 – 53 µm / 50 – 150 µm*
VDM® Powder 718 CTP	2.4668	N07718	54	19	17	3	Nb 5; Ti 1; Al 0,5	•	15 – 53 µm / 50 – 150 µm*
VDM® Powder 59	2.4605	N06059	59	23	1,3	16		•	15 – 53 µm / 50 – 150 µm*
VDM® Powder 31 Plus	2.4692	N08031	34	27	29	6,5	Cu 2,1; Mn 2; N 0,2	•	15 – 53 µm / 50 – 150 µm*
VDM® Powder CoCr Mp1	–	R31538	0,01	28	0,75	6	Co 65; Si 1; Mn 1	•	15 – 53 µm / 50 – 150 µm*
VDM® Powder 699 XA	2.4842	N06699	63	30	2,5	–	Al; Mn 0,5; Si 0,5; Ti 0, 6; Nb 0,5; Cu 0,5; Zr 0,1; C 0,1	•	15 – 53 µm / 50 – 150 µm*

* Further particle size distributions are available on request. Please contact us.

Corrosion resistant materials

Nickel and nickel alloys have useful resistance to a wide variety of aqueous corrosive environments typically encountered in the chemical process industry and energy technology. Nickel by itself is a versatile corrosion resistant metal. More importantly, its metallurgical compatibility over a considerable composition range with a number of other metals as alloying elements has become the basis for many binary, ternary, and other complex nickel alloy systems, having very unique and specific corrosion resistant behaviour for handling the modern day corrosive environments of the chemical process industry.

Corrosion resistance depends on the chemical composition of the alloy, the alloy's micro-structural features, the chemical nature of the environment, and the nature of the alloy / environment interface.

One of the main alloying element is chromium, which is necessary for a stable passive surface layer, upon which the corrosion resistance depends. After chromium, molybdenum is the most important alloying element by increasing the resistance to general corrosive attack in reducing media. Together with chromium it is of paramount importance for pitting and crevice corrosion resistance.

Nickel alloys

Nickel

VDM® Nickel 200
DIN EN 2.4060 / 2.4066, UNS N02200
VDM® Nickel 200 is unalloyed nickel with a carbon content of max. 0.15 %. Unalloyed nickel is traditionally referred to as ‘pure nickel’.

VDM® Nickel 201
DIN EN 2.4061 / 2.4068, UNS N02201, N02205
VDM® Nickel 201 is unalloyed nickel with restricted carbon content of max. 0.02 %. This alloy should be used instead of VDM® Alloy 200 at temperatures above 315 °C (600 °F). The material has been approved for use in pressure vessel applications for service temperatures from -10 to 600 °C (14 to 1,112 °F).

Unalloyed nickel features excellent resistance to many corrosive media, especially to caustic alkalis, halides and a large number of organic compounds, combined with suitable mechanical properties and high thermal conductivity. The principal application of unalloyed nickel is in the stages of manufacture and handling of sodium hydroxide which requires the highest corrosion resistance.

Therefore the cathodes in the electrolysis cell used in the membrane process are made of nickel sheets. The downstream units for concentrating the liquor are also made of nickel. Unalloyed nickel is the preferred material of construction for caustic soda evaporators where the austenitic stainless steels cannot be used. Also the vertical tubes of the fixed bed reactors in the production of vinyl chloride monomer are made of unalloyed nickel.

Nickel-copper alloys

VDM® Alloy 400
DIN EN 2.4360, UNS N04400
VDM® Alloy 400 is a nickel-copper alloy with excellent corrosion resistance to many reducing media combined with useful mechanical properties. It is particularly resistant to unaerated hydrofluoric acid to neutral and alkaline salt solutions.

VDM® Alloy 400 is in use in uranium refining and isotope separation in the nuclear fuel production. It is a standard material for the concentration and crystallization of salt, for the production of vinyl chloride monomer (VCM), for MDI and TDI production and petroleum refining. VDM® Alloy 400 is also used for feedwater heaters, steam generator tubing and for sheathing risers and platform steel columns in offshore oil and gas production. The material has been approved for use in pressure vessel applications for service temperatures from -10 to 425 °C (14 to 797 °F).

VDM® Alloy K-500
DIN EN 2.4375, UNS N05500
VDM® Alloy K-500 is a nickel-copper alloy, precipitation-hardenable through additions of aluminium and titanium. Precipitation hardening approximately triples the material’s yield strength and doubles its tensile strength when compared with Alloy 400, whilst retaining the excellent corrosion resistance of the latter.

Applications include high strength and corrosion resistant components such as pump and propeller shafts, valve components for shipbuilding and offshore applications.

Nickel-iron-chromium-molybdenum-copper alloys

VDM® Alloy 20
DIN EN 2.4660, UNS N08020

VDM® Alloy 20 is a niobium-stabilized nickel-chromium-iron-molybdenum-copper alloy with a remarkably high content of copper. This improves its corrosion resistance to sulfuric acid and provides a useful corrosion resistance to many sulfuric acid media. The material is used for vessels, heat exchangers and piping systems, in sulfuric acid containing processes as occurring in sulfuric acid, phosphoric acid and hydrofluoric acid production and refining.

VDM® Alloy 825
DIN EN 2.4858, UNS N08825

VDM® Alloy 825 is a titanium-stabilized nickel chromium-iron-molybdenum-copper alloy with good resistance to stress corrosion cracking and moderate resistance to pitting and crevice corrosion. VDM® Alloy 825 is a traditional but very versatile material with useful performance in a broad range of process media as sufficiently low concentrated phosphoric acid solutions, nitric acid and sodium hydroxide, and has established itself as a standard material for moderately aggressive sulfuric acid applications. The material has been approved for use in pressure vessel applications for service temperatures from -10 to 450 °C (14 to 842 °F). For the use in upstream and midstream applications in the oil and gas industry you will find more details in our oil and gas brochure.

High-alloyed special stainless steels

Custom made stainless steel

VDM® Alloy 316 L
DIN EN 1.4435, UNS S31603

VDM® Alloy 316 L is an austenitic stainless steel grade with a low Carbon content for improved resistance against intergranular corrosion after welding. The Molybdenum addition results in a better corrosion resistance in halide containing media compared to 304 types of stainless steel.

For polished surfaces, as requested from the watch industry, a special remelted grade with high cleanliness and low delta ferrite content is available. For the nuclear industry a version with low Cobalt content is also available.

High-alloyed special stainless steels

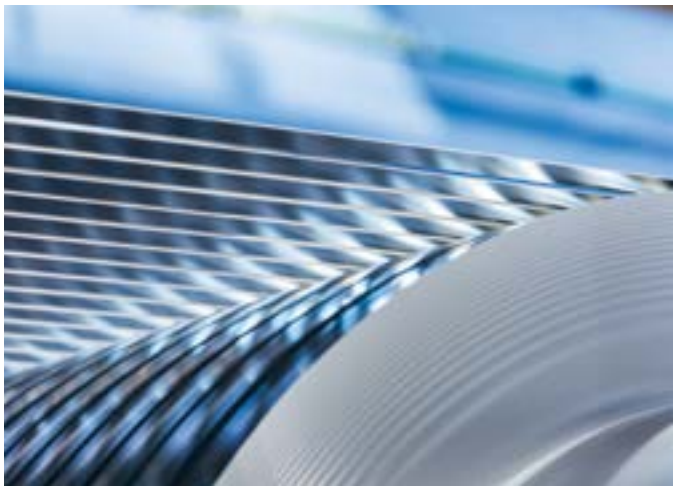
VDM® Alloy 28
DIN EN, 1.4563, UNS N08028

VDM® Alloy 28 is an austenitic nickel-chromium-iron-molybdenum-copper-alloy with moderate resistance to pitting, crevice corrosion and stress-corrosion cracking. This material is used in the production and processing of not too heavily contaminated phosphoric and sulfuric acids. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 550 °C (-320 to 1,022 °F). For the use in upstream and midstream applications in the oil and gas industry you will find more details in our oil and gas brochure.

VDM® Alloy 926
DIN EN 1.4529, UNS N08926

VDM® Alloy 926 is an austenitic iron-nickel-chromium-molybdenum-copper-nitrogen alloy similar to VDM® Alloy 904 L, but with an increased molybdenum content of about 6.5 % and an addition of about 0.2 % nitrogen for substantially improved resistance to pitting, crevice corrosion and chloride-induced stress-corrosion cracking. The material is firmly established for seawater and product piping systems, for flue-gas desulfurization installations in fossil-fired power plants, for seawater desalination.

VDM® Alloy 926 also finds widespread use in applications involving chloride-contaminated media at moderate temperatures, such as sulfuric and phosphoric acids, for the concentration and crystallization of salt, and in the production of fine chemicals. The material has been approved for use in pressure vessel applications for service temperatures from -196/-10 to 400 °C (-320/14 to 752 °F).



High-alloyed special stainless steels

VDM® Alloy 31
DIN EN 1.4562, UNS N08031

VDM® Alloy 31 is a newly developed 6.5 % molybdenum-containing austenitic nickel-iron-chromium alloy with excellent resistance to pitting and crevice corrosion, superior not only to conventional 6 % molybdenum-containing stainless steels but also to nickel-alloys such as VDM® Alloy 625. The alloy is resistant to pitting corrosion in seawater up to 90 °C (194 °F) and offers outstanding resistance to sulfuric acid solutions, even when highly contaminated.

VDM® Alloy 31 has given outstanding performance under particularly aggressive conditions of phosphoric acid production and is probably the most cost-effective material suitable for this kind of environment. Despite the high molybdenum content, the alloy shows resistance to nitric acid (Huey test) comparable to that of VDM® Alloy 28. VDM® Alloy 31 is also suitable for use in heat exchangers cooled by contaminated water, such as seawater or brackish water at moderate temperature. In terms of the pitting resistance equivalent PREN, its performance in aerated chloride-containing media e.g. seawater is by far superior to that of VDM® Alloy 825. It is widely used in the salt manufacturing industry.

Its extremely high resistance to local attack in acidic chloride containing solutions gives it increasing application in flue-gas desulfurization systems where it is preferred for the spray levels and control and shut-off systems for ducts and dampers but also for absorbers operating under demanding conditions in modern coal-fired power stations. For marine scrubber VDM® Alloy 31 is a well established material for single and dual loop scrubbers. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 550 °C (-320 to 1,022 °F).

VDM Alloy 31 Plus®
DIN EN 2.4692, UNS N08034

VDM® Alloy 31 has been developed into an advanced VDM Alloy 31 Plus® version with improved fabrication characteristics but maintaining or even improving the excellent corrosion behaviour of the material. The main characteristics of VDM Alloy 31 Plus® is a lower and therefore more user friendly sigma-solvus temperature achieved by means of carefully balanced composition with increased nickel content and optimized addition of nitrogen. Advantages of VDM Alloy 31 Plus® over VDM® Alloy 31 are that it requires a lower cooling rate and can be technically hot roll bonded using conventional methods and equipment. VDM Alloy 31 Plus® is also available as seemles tubes. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 500 °C (-320 to 932 °F).

VDM® Alloy 33
DIN EN 1.4591, UNS R20033

VDM® Alloy 33 is an austenitic alloy with highest chromium content and excellent resistance to corrosion in different acid and alkaline environments, in particular in mixed acids and hot caustic soda solutions. In mixed HNO_3/HF acids the corrosion resistance is superior to high-chromium nickel alloys. This makes the material highly interesting for the construction of pickling lines and related equipment. In NaOH solutions the alloy is applicable to conditions where stainless steels fail. VDM® Alloy 33 exhibits high yield strength and excellent toughness properties.

The material has been approved for use in pressure vessel applications for service temperatures from -196 to 450 °C (-320 to 842 °F).

Nickel alloys

Nickel-chromium-molybdenum alloys

VDM® Alloy 22
DIN EN 2.4602, UNS N06022

VDM® Alloy 22 is a nickel-chromum-molybdenum alloy derived from VDM® Alloy C-276, with a higher chromium content for better resistance to oxidizing media. This alloy is recommended for equipment for handling oxidizing, contaminated hot sulfuric and phosphoric acids as well as other mixed oxidizing solutions, acetic acid, acetic anhydride and other contaminated organic acids. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 400 °C (-320 to 752 °F).

VDM® Alloy 625
DIN EN 2.4856, UNS N06625

Originally developed for high temperature applications, this nickel-chromium-molybdenum alloy is now also widely used in the chemical process industry and energy technology. Its high mechanical strength and good resistance to acids and alkalis permit the manufacture of thin-walled components with good heat transfer characteristics. Its excellent resistance to pitting, crevice and intercrystalline corrosion, and its virtual immunity to chloride-induced stress-corrosion cracking, make this material ideal for the manufacture of components exposed to seawater and to highly concentrated aggressive salt solutions and brines e. g. in the production of potash. The alloy is used in the phosphate and phosphoric acid industry because of its corrosion and erosion resistance to phosphate slurries with fairly high impurity content and to superphosphoric acid. Furthermore VDM® Metals 625 is still basic material for furnaces, boilers, waste incineration and other chloride containing high temperature applications.

The material has been approved for use in pressure vessel applications for service temperatures between -196 and 450 °C (-320 to 842 °F). °F). For the use in upstream and midstream applications in the oil and gas industry you will find more details in our oil and gas brochure.

VDM® Alloy C-4
DIN EN 2.4610, UNS N06455

VDM® Alloy C-4 is a nickel-chromium-molybdenum alloy which combines the excellent corrosion resistance of VDM® Alloy C-276 with improved stability, due to considerably reduced tungsten and iron contents. Precipitation processes are retarded, which makes this material more resistant to corrosion in the as-welded condition.

This alloy is a European development of VDM® Alloy C-276. Applications in the chemical process industry include production of fertilizers and pesticides as much as of pharmaceutical intermediates and production of organic and inorganic chemicals in general including MDI and TDI.

In the titanium free version that is supplied by VDM Metals the alloy is free from titanium nitrides. This enables a uniformly smooth surface to be obtained by electro-polishing as needed in pharmaceutical applications and under special conditions, e.g. for current feeding rollers in electrolytic galvanizing. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 400 °C (-320 to 752 °F).

VDM® Alloy C-276
DIN EN 2.4819, UNS N10276

VDM® Alloy C-276 is a nickel-chromium-molybdenum alloy with tungsten, which exhibits excellent resistance to pitting and crevice corrosion, uniform corrosion and stress-corrosion cracking, in a wide variety of chemical process media, and to reducing acid media in particular. Owing to its good corrosion resistance in predominantly reducing media, even in the presence of halogens, it has succeeded as a true workhorse in conquering a wide range of applications in the chemical industry.

The application of VDM® Alloy C-276 includes plate-type heat exchangers in sulfuric acid production, which operate at reduced temperatures. In other applications, VDM® Alloy C-276 is used for its resistance to hydrochloric acid solutions, e.g. in the production of VCM.

Moreover, this type of alloy has good resistance to acetic acid at all concentrations and temperatures and is used for handling oxidizing acetic acid solutions and in places where acetic acid occurs in combination with inorganic acids and salts, which restrict the use of stainless steels. The material has also proved itself in environmental technology as in flue gas desulfurization where it is used to a considerable extent in raw gas inlet, scrubbers, dampers, agitators, ducts and so on. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 400 °C (-320 to 752 °F).

Nickel-chromium-molybdenum alloys

VDM® Alloy 59
DIN EN 2.4605, UNS N06059

VDM® Alloy 59 is an advanced nickel-chromium-molybdenum alloy with outstanding corrosion resistance over a wide range of oxidizing and reducing conditions, where other nickel-chromium-molybdenum alloys have reached their limits. The material has seen a victorious career in flue gas desulfurization applications where it is used successfully in the sections of highest corrosive attack as raw gas inlet, absorber, heat exchangers, dampers, fasteners and as welding filler metal. Its high resistance to crevice corrosion in seawater makes it an interesting alternative to titanium as material of construction of seawater cooled plate heat exchangers. Other applications include organic synthesises, effluent treatment, acid recovery systems, phosphoric acid processing and acetic acid production.

The alloy is more resistant to hydrochloric acid than other nickel-chromium-molybdenum alloys and suitable for application in the production of VCM, MDI and TDI. Moreover it is suitable as material of construction in the various steps of hydrofluoric acid and aluminium fluoride production. Owing to its high corrosion resistance both in oxidizing and in reducing media, its easy passivation ability and its low sensitivity to chloride contaminations in sulfuric acid solutions the alloy is an ideal material of construction for multi-purpose equipment in the production of fine and specialty chemicals.

As material for tank containers for the transport of dangerous goods VDM® Alloy 59 possesses the most versatile corrosion resistance and can be used for transportation of a multitude of corrosive substances. The combination of outstanding corrosion resistance and excellent workability make VDM® Alloy 59 also a most suitable metallic material of construction where it is difficult to form small structures that allow no corrosion loss during service, e.g. to be built in micro-channel reactors and compact diffusion-bonded heat exchangers. It offers particularly high metallurgical stability, making it generally suitable for use in the as-welded condition. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 450 °C (-320 to 842 °F).

VDM® Alloy 2120 MoN
DIN EN 2.4700, UNS N06058

VDM® Alloy 2120 MoN is a new nickel-chromium-molybdenum alloy that was developed with improved localized corrosion resistance and increased uniform corrosion resistance in certain acids over the Ni-Cr-Mo alloys in common use until now. Corrosion resistance and mechanical properties were deliberately improved, while good fabrication and weldability characteristics were maintained. It is the first nickel-chromium-molybdenum alloy to contain nitrogen as an alloying element constituent. In addition it contains the highest molybdenum content of this alloy family resulting in excellent corrosion resistance in reducing environments. The high chromium and molybdenum contents together with the alloying with nitrogen result in a pitting resistance equivalent number (PREN) of about 86, surpassing all nickel-chromium-molybdenum alloys. Preferred applications are in flue gas desulfurization, sulfuric acid, hydrochloric acid, acid mixtures even when contaminated with chlorides and geothermal technologies. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 450 °C (-320 to 842 °F).

Nickel-chromium alloys

VDM® Alloy 600

DIN EN 2.4816, UNS N06600

The alloy has excellent resistance to intercrystalline corrosion and extremely high resistance to stress corrosion cracking at elevated temperatures. It can handle dry chlorine gas and hydrogen chloride. In the production of titanium dioxide it is used for almost all components in contact with hot chlorine or hot titanium tetrachloride due to its resistance to chlorine gas containing oxygen. In the chemical process industry the alloy is used in the production and processing of sodium hydroxide (caustic soda), vinyl chloride monomer (VCM), MDI and TDI production and in dehydration towers in magnesium plants. The material has been approved for use in pressure vessel applications for service temperatures from -10 to 450 °C (14 to 842 °F).

VDM® Alloy 690

DIN EN 2.4642, UNS N06690

VDM® Alloy 690 is a nickel-chromium-iron alloy with a chromium content of approximately 30 %. The most important application is steam generator equipment of nuclear pressurized water reactors as steam generation tubes, partition plates, stub runners and radial guides. The high chromium content makes it particularly suitable for the handling and storage of strongly oxidizing media, as in reprocessing of nuclear fuels. The material exhibits outstanding resistance to intercrystalline corrosion and to attack by fluoride-contaminated hot nitric acid, as well as to caustic cracking, for example in oxygen-containing sodium hydroxide solutions.

Nickel-molybdenum alloys

VDM® Alloy B-2

DIN EN 2.4617, UNS N10665

VDM® Alloy B-2 is a nickel-molybdenum alloy with exceptional resistance to reducing media such as hydrochloric acid at different temperatures and concentrations as well as medium concentrated sulfuric acid. In the chemical process industry this alloy is employed in processes using reducing chloride catalysts such as $AlCl_3$ or, where HCl is a by-product, as in styrene, bisphenol A, chloroprene and MDI syntheses and also in the acetic acid production.

Due to its extremely low carbon and silicon contents, the alloy is resistant to knife-line corrosion and to selective attack in the heat-affected zone and can therefore be used in many cases in the as-welded condition. In the 1990's the fabricability of the alloy has been considerably improved by VDM Metals by closely controlling the iron and chromium contents. The material has been approved for use in pressure vessel applications for service temperatures from -196 to 400 °C (-320 to 752 °F).

Zirconium

Zirconium is the metal of the 21st century. It readily forms a thin and extremely protective oxide layer which makes the material quite acid resistant, withstanding not only oxidizing acids like nitric acid but also up to 60 % phosphoric acid and up to 70 % sulfuric acid, depending upon contaminants.
It will also resist hydrochloric acid in the liquid phase. Zirconium is used in the chemical industry in processes where nickel alloys or stainless steels fail.
Zirconium is easily fabricated. Thoroughly shielded inert gas welding is required.
VDM Metals has a close cooperation with Sandvik Materials Technology in order to enable supply of complete packages with seamless tubes and offer our customers all the advantages of being a VDM Metals customer.

Zirconium (industrial grade)

VDM® Zr 700
UNS R60700

VDM® Zr 702
UNS R60702

Apart from nuclear applications, where its low coefficient of thermal neutron absorption represents a special advantage, zirconium is used in the chemical industry in processes where nickel alloys or stainless steels are unable to cope. This includes hydrochloric, sulfuric and nitric acids, formic acid, and the synthesis of acetic acid. Other applications are in urea production, in handling of strong alkaline environments, salt solutions and a number of other aggressive organic solutions.

Zirconium is resistant to hydrochloric acid at all concentrations and temperatures also considerably above the boiling temperature range. In sulfuric acid of concentration up to approx. 70 % Zirconium exhibits excellent corrosion resistance and in the lower concentration range it stays resistant well above the boiling temperature. In addition, today's manufacturing techniques allow the fabrication of very large solid and explosive clad Zirconium columns, heat exchangers, reactor vessels, piping and support equipment.

A typical application is the main reactor for production of acetic acid by means of the carbonylation process where the exothermic reaction takes place at temperatures of 180 to 200 °C (356 to 392 °F). Heat exchangers and the first columns are also manufactured from Zirconium.

Zirconium has also been used in the sulfuric acid pulp digestion process taking advantage of it's corrosion resistance above the sulfuric acid boiling temperature. VDM® Zr 702 is the conventional manufacturing grade (0.16 % oxygen max.). VDM® Zr 700 is a lower oxygen grade (0.10 % oxygen max.) and used for explosive cladding due to its higher ductility. Zirconium has been approved for use in pressure vessel applications for service temperatures from -10 to 250 °C (14 to 482 °F).

High temperature materials

Heat resistant alloys are characterized by their specific resistance to the attack of hot gases and combustion products above 550 °C (1,022 °F). This specific resistance requires the formation of protective oxide layers on the surface. Of the three elements aluminium, silicon and chromium which can be used for the formation of the protective oxide layers, chromium can be used most universally. However, aluminium has to be used for service temperatures in oxidizing atmospheres above 1,000 °C (1,832 °F).

The addition of small amounts of yttrium and of rare earth elements, e.g. cerium, increases the adhesive strength of the protective oxide layer. Addition of silicon is effective, mainly in the initial stages of oxidation, as it contributes to a very rapid oxide film formation. Increasing nickel content produces increasing resistance to uniformly carburizing gases but has a more detrimental effect with regard to resistance to sulfur bearing media.

High temperature high strength materials have outstanding mechanical properties at high temperatures under long-term loading; this implies high resistance to creep and a high creep rupture strength, even at temperatures above approximately 550 °C (1,022 °F). However, in many applications high temperature, high strength properties and specific resistance to the attack of hot gases and combustion products above 550 °C (1,022 °F), i.e. heat resistance as defined above, are required simultaneously.

Nickel alloys and special stainless steels

Nickel alloys and special stainless steels

VDM® Alloy 800

DIN EN 1.4876, UNS N08800

VDM® Alloy 800 is a widely used material of construction for furnaces and heat-treating equipment such as baskets and trays. In chemical and petrochemical processing the alloy is used for heat exchangers and other piping systems.

It has proven to be a universal solution for applications in alternately oxidizing and carburizing, and simultaneously sulfur bearing media such as coal processing and in crude oil processing. According to VdTÜV data sheet 412 it can be used in pressure vessel applications between -10 and 600 °C (14 and 1,112 °F) in the soft annealed condition.

VDM® Alloy 800 H

DIN EN 1.4876 / 1.4958, UNS N08810

The chemical compositions of the VDM® Alloy 800 grades 1.4876 / UNS N08800 (see previous section) and 1.4958 / UNS N08810 are closely related. One difference is in the carbon content. According to EN 10095, the carbon content of grade 1.4876 is 0.12 % max., whereas according to EN 10302 the carbon content of grade 1.4958 is between 0.03 – 0.08 %. According to VdTÜV data sheet 412 the grade 1.4876 can be used in pressure vessel applications between -10 and 900 °C (14 and 1,652 °F) in the solution annealed condition. The VdTÜV data sheet 412 also provides creep strength data up to 900 °C (1,652 °F).

When comparing the VdTÜV data sheets 412 (grade 1.4876) and 434 (grade 1.4876 with increased creep strength properties that may be assumed to be valid for grade 1.4958 as well) the increased creep strength data above 600 °C (1,112 °F) provided by VdTÜV data sheet 434 are significantly higher than those shown in VdTÜV data sheet 412. However, there is no difference with respect to heat resistance. VDM® Alloy 800 H exhibits excellent resistance to carburizing, oxidizing and nitriding atmospheres and is used for service temperatures of 600 to 950 °C (1,112 to 1,745 °F). VDM® Alloy 800 H is widely used as a material of construction for industrial furnaces e.g. oven fans.

This alloy is the workhorse of the petrochemical industry, used for the production of pyrolysis tubes in ethylene furnaces, for headers and connecting pipes (pigtails) in catalytic hydrocarbon cracking, for components in cracking furnaces producing vinyl chloride, diphenyl and acetic anhydride, and for transfer lines, valves, fittings and other parts exposed to corrosive attack at temperatures above 600 °C (1,112 °F). The alloy is also in use for pipes and tube sheets in styrene production. In addition, it is finding application for burners for burning off reaction products.

Nickel alloys and special stainless steels

Nickel alloys and special stainless steels

VDM® Alloy 800 HP
DIN EN 1.4959, UNS N08811

VDM® Alloy 800 HP is a grade of VDM® Alloy 800 H with somewhat higher average contents of carbon, titanium and aluminium for maximum creep strength in the temperature range 700 to 1,000 °C (1,292 to 1,832 °F) according to ASME. The heat resistant properties are similar to those of VDM® Alloy 800 H.

VDM® Alloy DS
DIN EN 1.4862

VDM® Alloy DS is an iron-nickel-chromium alloy with about 18 % chromium and an addition of about 2.2 % silicon. It has excellent resistance to oxidation and carburization. The silicon content provides resistance to internal oxidation in case of atmospheres which alternate between oxidizing and reducing. Initially the alloy had been developed for woven furnace conveyor belts meanwhile it finds use in a multitude of applications for heat treating equipment e.g. baskets, trays and fixtures. Typical application temperatures are in the range of 550 to 950 °C (1,022 to 1,742 °F)

VDM® Alloy 330
DIN EN 1.4886, UNS N08330

VDM® Alloy 330 is an alloy similar to the aforementioned VDM® Alloy DS but somewhat higher in chromium and with less silicon. It is an excellent material for applications in industrial furnaces where it can be used for conveyor systems, muffles, baskets and fixtures where resistance to oxidation, embrittlement and distortion is required. Typical application temperatures are in the range of VDM® Alloy DS.

VDM® Alloy N08120
UNS N08120

VDM® Alloy N08120 is a nickel-chromium-alloy used in industrial heating application. It is a solid solution strenghtened alloy with additions of carbon and nitrogen. VDM® Alloy N08120 has good resistance to carburization and sulfidation and is providing high mechanical strength at temperatures up to 1,100 °C (2,012 °F).

VDM® Alloy 600 H
DIN EN 2.4816, UNS N06600

VDM® Alloy 600 H is a material with many applications in furnace construction. High temperature solution treatment gives the alloy higher creep rupture strength than VDM® Alloy 600 being recommended for service above 700 °C (1,292 °F). The material is especially suitable for low-oxygen nitrogen bearing atmospheres as they occur in ammonia cracking and in nitrogen bearing bright annealing units due to its relatively low tendency towards nitrogen pick-up. The alloy is also a popular material for halogen-bearing atmospheres up to temperatures of approximately 800 °C (1,472 °F).

VDM® Alloy 601
DIN EN 2.4851, UNS N06601

This material combines excellent heat resistance with improved creep-rupture strength for service temperatures above 500 °C (932 °F). The alloy is used for heat treatment furnace muffles and components, such as trays, baskets and fixtures, oxygen preheaters in titanium dioxide production (chloride route), insulating cans in ammonia reformers and catalyst support grids in nitric acid production, combustion chambers in solid waste incineration, components of waste gas detoxification systems, tube supports and ash handling components, industrial gas turbine components, components in exhaust gas systems, flare stack tips and furnace rollers for ceramic tile production. Another important application is in radiant heater tubes for the heating of annealing furnaces.

VDM Alloy 602 CA®
DIN EN 2.4633, UNS N06025

VDM Alloy 602 CA® is a high strength, high temperature material specifically developed for use in industrial furnace construction and the petrochemical industry. Because of its high carbon content and the addition of zirconium, this material exhibits outstanding strength characteristics in the high temperature range above 1,000 °C (1,832 °F), as well as excellent resistance to oxidizing and carburizing atmospheres. Precipitation of primary carbides ensures its high temperature creep strength. Typical applications include radiant tubes, hydrogen-bright-annealing muffles, moulds for vitrification of

radioactive waste, methanol and ammonia synthesis, enamelling furnace internals and pigtails. This alloy is also used to produce uncooled furnace rolls for continuous roller-hearth annealing furnaces, operating predominantly in the range of 1,100 to 1,200 °C (2,012 to 2,192 °F).

In addition VDM Alloy 602 CA® has found applications due to its favourable resistance to metal dusting e.g. in processes in the petrochemical industry and as prefabricated parts in plants for direct reduction of iron ores.

VDM® Alloy 602 MCA (2.4833) is a version with a slightly reduced carbon content and has therefore a much better formability for deep drawing and similar applications.

VDM® Alloy 617

DIN EN 2.4663, UNS N06617

VDM® Alloy 617 is a carbide- and solid-solution-strengthened nickel-chromium-cobalt-molybdenum alloy which combines extremely high creep-rupture strength with exceptional resistance to carburization, very good resistance to oxidation and excellent metallurgical stability up to 1,100 °C (2,012 °F). It is used in energy technology applications including non-rotating components in gas turbines, flame tubes and heat-treatment equipment.

The alloy has also been considered and tested as material of construction for helium heat exchangers operating at 950 °C (1,742 °F) to extract process heat from high temperature nuclear reactors. In the process industry VDM® Alloy 617 is in use for catalyst supports in nitric acid production and for certain high temperature chemical processes for the dehydrogenation reactor in styrene production.

VDM® Alloy 617 B

DIN EN 2.4673, UNS N06617

Due to controlled chemistry and additions of boron, VDM® Alloy 617 B has an increased 100.000 h creep rupture strength at intermediate temperatures of 600 to 800 °C (1,112 to 1,472 °F). VDM® Alloy 617 B has also an increased resistance to stress relaxation cracking compared to VDM® Alloy 617. VDM® Alloy 617 B has been selected for valves, boiler tubes and super heater tubes, pipes and headers in boilers for coal fired power plants in 700 °C (1,292 °F) technology and has already proven its suitability in test loops. VDM® Alloy 617 B is also an option for high temperature tubes in solar-thermal power plants.

VDM® Alloy C-263

DIN EN 2.4650, UNS N07263

VDM® Alloy C-263 is a precipitation-hardenable nickel-chromium-cobalt-molybdenum alloy with about 2 % titanium. It is characterized by high strength, good weldability and good oxidation resistance up to about 850 °C (1,562 °F). Applications include non-rotating parts for gas turbines, such as rings, exhaust cones, casings, transition liners and combustion chambers.

In addition the alloy is used as material of construction for fan wheels in heavy duty convection ovens. VDM® Alloy C-263 has the greatest chance to become the material of choice for applications in the next-but-one generation of 700 °C (1,292 °F) coal-fired power stations.

VDM® Alloy 699 XA

DIN EN 2.4842, UNS N06699

VDM Alloy 699 XA is a nickel-chromium-aluminum alloy, characterized by excellent resistance to Metal Dusting, good creep resistance and good weldability.

VDM® Alloy 699 XA is a new alloy for application in the petrochemical industry under metal dusting conditions. It was developed based on current understanding of the metal dusting mechanism and a strong focus on industrial needs for workability, especially production of seamless tubes and weldability properties. It contains 30% Cr, 2% Al and less than 2.5% Fe. Based on innovative alloying concepts, a remarkable longer time to first pit formation compared to VDM® Alloy 602 CA and VDM® Alloy 690 was achieved in a highly carburization metal dusting environment of 37% CO, 9% H_2O, 7% CO_2, 46% H_2, at 600 °C (1.112°F) and 20 bar. VDM® Alloy 699 XA has been produced by VDM as hot and cold rolled plate, welding wire and rods, forged bars and billets, and rolled bars; it is also available as seamless tube.

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