

# Chapter 15:



## Solutions for challenging environment: Part 2: Corrosive Environments

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This chapter is focusing on challenges and solutions for corrosive environments which can often be found in on- and off-shore applications such as on ships or oil rig platforms. Besides components made from corrosion resistant materials are also widely required in the chemical and food industry.



### What is rust?

Rust is a layer formed by oxidation on the surface of metals. Rust generally refers to iron rust, which is a mixture of hydrated iron oxides and iron hydroxides formed on the iron surface by the action of water and oxygen. The formation of iron rust can be observed not only on iron objects, but also on the surface of iron-containing minerals (ores), rocks and waters containing iron compounds. In addition to moisture, rusting is also promoted by the carbon content of the air, as well as by acids and salts.

There are several ways to prevent rusting. One method is galvanizing, coating (galvanizing or zinc plating, tin plating), enamelling or painting. Alternatively, stainless steel and/or acid resistant material can be used.

### Corrosion of aluminium

There is also corrosion with aluminum. Basically, aluminum components are protected by the naturally forming aluminum oxide layer. However, acidic, wet, saline, ... environmental conditions cause aluminum components to corrode on their surface; aluminum hydroxide forms. Various galvanic surface coatings such as **anodizing**, **hard anodizing** or **ematalizing** reduce or prevent corrosion. Even for aluminum components, there is the possibility of further protecting the surface with varnishes or coatings.

Another source of corrosion in aluminum is contact corrosion. Due to the relatively low potential of aluminum, special care must be taken with the material pairing so that equipotential bonding does not lead to corrosion on the aluminum component.

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### How to choose the right material?

It is influenced by, but not limited to, the following factors:

- What kind of processing will the stainless or acid resistant material be subjected to? (cutting, bending, welding, riveting, etc.)
- How long and how often will the substance be exposed to the environment? (continuous, occasional, intermittent, etc.)
- What environmental effects will the material be exposed to? (air humidity, alkali, acid, detergents, fresh water, salt water)

With all this in mind, it can be said, in general, that if the environmental impact is onerous, it is essential to choose a more resistant material, designated 316 or respectively.

In order to proof the corrosion resistance of the Hafner valves, we performed a salt spray chamber test according to ISO 9227:2006 for various materials and coatings. It turned out that the Hafner 316L stainless steel as well as EMATAL coated aluminium valves are well suited. Both types passed the test.



*Aluminium- anodized valve  
after 720 hours in salt spray  
chamber*

**Strong corrosion**



*Aluminum – EMATAL valve  
after 720 hours in salt spray  
chamber*

**No visible corrosion**



*316L stainless valve  
after 720 hours in salt spray  
chamber*

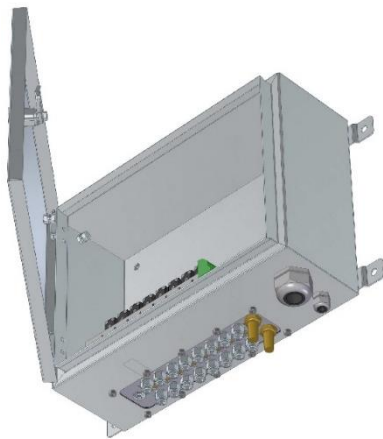
**No visible corrosion**

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Depending on the application it can be beneficial to put the valves and other components into a stainless steel control cabinet. By doing so the components don't necessarily have to be made from corrosion resistant material. In case the application is in cold areas, a heating system can be used which allows to use components with a normal temperature range specification. This usually has a positive influence on the costs.



Example of a Hafner cabinet:

- Housing made from stainless steel 1.4301
- IP 66
- Option: special manifold with all ports to the outside. No tubing inside the cabinet required!

### Chemical resistance charts can help with the selection of the material

Various chemical resistance charts exist on the internet. They can help selecting the right body- and sealing material.

The following exemplary list shows the compatibility of some common materials used in Hafner valves and substances. All information in the table are subject to change.

	Methane	Natural gas	Seawater
<b>Valve body:</b>			
Anodized Aluminum	+	+	-
Stainless steel 1.4404	+	+	+
Brass	+	+	o
PA (pilot head)	+	+	+
<b>Sealing material:</b>			
NBR	+	+	+
PUR	o	o	o
FKM/FPM	+	+	+

- + Resistant
- o Conditionally resistant
- Not resistant

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**Lubricant:** Hafner uses the grease type Molykote 55 for most of its valves. Please note that grease can also react with other substances and has to be checked as well.

**EPDM:** Valves with EPDM seals are not available as it is not resistant to mineral oil products.

### Marking of stainless and acid resistant materials

People call stainless and acid resistant materials in different ways. Some call it "KO", some can associate it with an AISI number, and some know them as 1.43xx or 1.44xx. The following table shows what the substance designations mean:

AISI	DIN/W.Nr	UNI	AFNOR	MSZ
301	1.4310	X10CrNi18-8	Z11CN17-08	KO 32
303	1.4305	X10CrNiS18 09	Z8CNF 18-09	KO 36 S
304	1.4301	X5CrNi1810	Z6CN1809	KO 33
304L	1.4306	X2Crnl1911	Z2CN1810	KO 41 LC
309S	1.4833	X6CrNi2314	Z15CN2413	H 7
310S	1.4845	X8CrNi2521	Z12CN2520	H 9
316	1.4401	X5CrNiMo1712	Z6CND1711	-
316L	1.4404	X2CrNiMo1712	Z2CND1712	KO 38 LC
316Ti	1.4571	X6CrNiMoTi1712	Z6CNDT1712	KO 35 Ti
321	1.4541	X6CrNiTi1810	Z6CNT1810	KO 36 Ti
409	1.4512	X2CrTi12	-	-
410	1.4006	X7Cr14	Z8C13FF	KO 2
420	1.4021	X20Cr13	Z20C13	KO 11
420F	1.4028	X30Cr13	Z30C13	KO 12
430	1.4016	X6Cr17	Z8C17	KO 3
430F	1.4104	X12CrMoS17	Z10CF17	KO 3 S
434	1.4113	X5CrMo17	Z8CD1701	KO 6

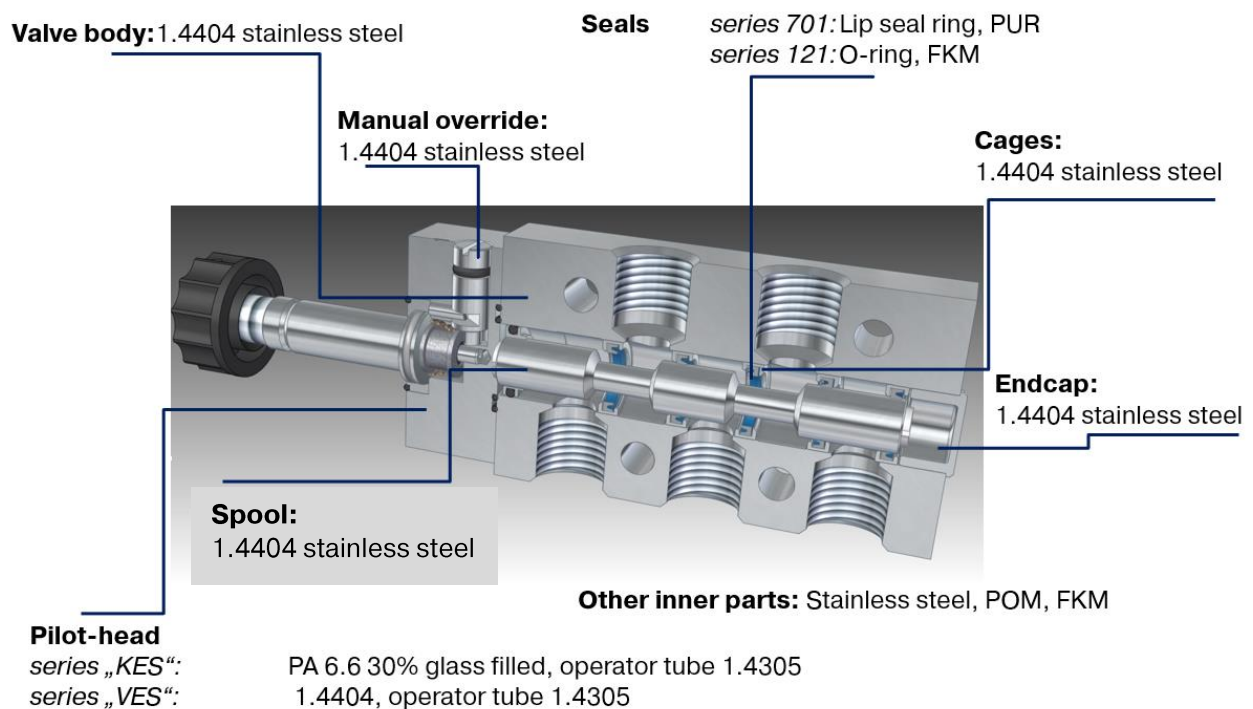
- **AISI:** The American Iron and Steel Institute (AISI) is an association of North American steel producers. Its predecessor organizations date back to 1855, making it one of the oldest trading associations in the United States. The current form of AISI was adopted in 1908 by Elbert H. Gary, President of the United States Steel Corporation.

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- **DIN and W-No:** DIN steel specifications are German standards developed by the "Deutsches Institut für Normung", the "German Institute for Standardization". The Institute is a member of the European Committee for Standardization (CEN) and the International Organization for Standardization (ISO).
- **UNI:** This set of standards of the Italian Standard includes carbon and alloy steels, boilers and other pressure vessels, sheets and strips, high-strength low-alloy steels, heat-treated steels, hot and cold-rolled sheets for cold forming and spring steels
- **ANFOR:** Association Française de Normalisation is a member of the French Standards Organization and of the International Organization for Standardization.

### General construction of HAFNER stainless valves:



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The Hafner stainless steel valves carry the suffix “VES”:



- Hand lever valve | Type HV-HVR | 3/2 mono and bistable, designs 5/2, 5/3



- example: HV 311 701 **VES**

- Pneumatic controlled | Type P | designs 3/2, 5/2, 5/3



- example: P 320 701 **VES**

- Electrically operated | Type MH | designs 3/2, 5/2, 5/3



- example: MH 510 701 **VES**

- NAMUR design | Type MNH | 3/2, 5/2 and NAMUR FLEX design



- example: MNH 310 701 **VES**

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### Stainless Steel Versions of Cylinders

- The round tubes of the R-Series and A-Series are made from AISI 304 material whereas the piston rod is made from AISI 303 material. The covers, on the other hand, are made from anodized aluminium.

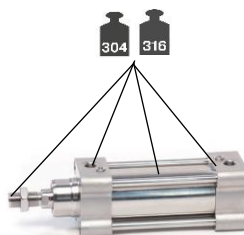


- We can also supply a completely stainless steel version of the R-series. If the piston rod gets in contact with a more hazardous material, then a completely stainless steel version is required, in which the material of the piston rod is made of AISI 316. The covers and the nut are made of AISI 304 material.



- The H-Series ISO 15552 Profile Cylinders are manufactured with a CK45 hard chrome piston rod in standard design. On request, the piston rod is available in stainless steel, AISI 304 or AISI 316 grade. The "X" grafted in the end of the model number indicates if it is a completely stainless H-Series cylinder.

Example: HIFX 32/50



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- Our compact cylinders with diameters of  $\varnothing$  20 ... 200 are available in stainless steel.
  - Quality material of cylinder tube:
    - $\varnothing$ 20,  $\varnothing$ 25: AISI 304
    - $\varnothing$ 32...100: AISI 316
    - $\varnothing$ 125...200: AISI 304
  - Material of piston rod:
    - $\varnothing$ 20...100: AISI 316
    - $\varnothing$ 125...200: AISI 304



### Fittings in Stainless Steel

Stainless steel fittings are available in a wide range. They can be offered with push-in connection as well as compression fittings for solid tubing.

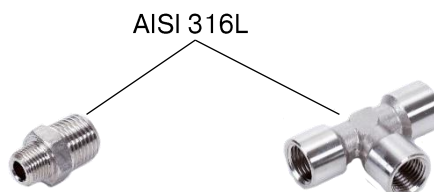
- Connectors of the 900 Series:



- Connectors of the 60000 Series:



- Accessory fittings:





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- Silencers, flow control silencers:

