ABB MEASUREMENT AND ANALYTICS | TECHNICAL DESCRIPTION

Pressure measurement

Corrosion and material selection guide

Engineered solutions for all applications

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2600T
pressure transmitters

Introduction

This document provides an initial point of reference for the selection of the most suitable materials used in ABB pressure transmitters with special focus on corrosion prevention.

For more information

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Wetted parts materials

AISI 316 L stainless steel
AISI 316L stainless steel is the standard material used for the wetted parts of ABB's 2600T family of transmitters. This material has good resistance to corrosion caused by low concentrations of nitric acid and most salt solutions but with some exceptions including nonoxidizing acids such as hydrochloric, hydrofluoric, sulfuric and phosphoric.

The resistance of AISI 316L stainless steel to alkaline solutions, organic acids and other organic compounds may depend on temperature. Halide salts (fluorine, chlorine, bromine and iodine) can cause severe pitting and possibly stress-corrosion cracking.

AISI 316L stainless steel may be available with a specific standards certificate: NACE MR0175 (see the applicable data sheets) for use in oil/gas production where hydrogen sulfide (H_2S) is often present. This standard applies where sufficient partial pressure of H_2S in gas is available (for example, a total process pressure of 400 kPa with H_2S concentration greater than 700 ppm, or a process pressure of 26 MPa and H_2S concentration greater than 10 ppm). NACE MR0175 assures the prevention of sulfide stress corrosion cracking by placing a maximum limit on the hardness of corrosion-resistant materials (including stainless steels) that can be used in specific oil/gas production environments.

Non wetted parts (for example, bolts) are also covered by the NACE MR0175 standard since they affect the effectiveness of containment of the whole instrument even if they are exposed to H_2S far below the limit of applicability of the standard.

The NACE certificate is available for Monel, Hastelloy C and Tantalum. For UREA grade applications, a specific certificate is available for AISI 316L stainless steel: ASTM A262, practice C, Huey test.

Monel
Monel (67Ni-33Cu) has good resistance at ambient temperatures to most of the nonoxidizing acids (hydrofluoric, sulfuric and phosphoric). It also resists nonoxidizing salts. The nickel in the alloy improves its resistance toward alkalis. Hydrogen may penetrate Monel in high hydrogen concentration applications.

When used as a diaphragm material, hydrogen atoms may permeate the diaphragm allowing hydrogen bubbles to form within the fill fluid. Therefore, Monel should not be used as a diaphragm material when the process contains hydrogen.

Hastelloy C
In Hastelloy C (54Ni-16Mo-16Cr), chromium and molybdenum are added to nickel to improve the alloy's resistance to oxidizing conditions.

Hastelloy C is resistant to alkalis, organic acids and other organic compounds. This alloy also provides a considerable degree of resistance in nonoxidizing conditions (for example, phosphoric acid and the acid salts such as nickel and copper chlorides). At moderate temperatures, Hastelloy C also withstands hydrochloric and sulfuric acids in most concentrations.

Both Monel and Hastelloy C have good corrosion resistance against atmospheric conditions and fresh water. In addition, Hastelloy C is resistant to stagnant seawater.

Gold-plated Hastelloy C or Monel or SST
Hastelloy C, like Monel and AISI 316L stainless steel, allows hydrogen to permeate diaphragms therefore should be avoided as a diaphragm material for use in hydrogen service.

Hydrogen atoms can diffuse through very thin transmitter diaphragms and once they reach the fill fluid, they combine to form molecular hydrogen. Because molecular hydrogen is too large to permeate back through the diaphragm it gets trapped and forms bubbles in the fill fluid. These bubbles can severely affect transmitter performance.

Plating the diaphragm with gold provides protection against hydrogen permeation in all cases of high process pressure and temperature which increase the permeation rate.

Another form of protection is available from ABB – a hydrogen preparation in the form of a corrosion-resistant gel. This is applied to the instrument's diaphragm to reduce hydrogen permeation.

Gold plating and corrosion-resistant gel are not available for the single cell family of transmitter.

Tantalum
Tantalum has proved to be a useful material in corrosive applications where AISI 316L stainless steel does not perform satisfactorily (for example, hydrochloric, hydrobromic, boiling hydrochloric, nitric, phosphoric and sulfuric acids).

There are a few exceptions to this such as aluminium fluoride, potassium carbonate and sodium sulfide, where Monel is more suitable.

Tantalum provides good resistance to most acids, chemical solutions and organic compounds.

Liquid metals generally do not affect tantalum. However, tantalum can suffer severe embrittlement if in service with high-temperature oxygen or nitrogen, or with hydrogen at any temperature. Also, it is attacked by strong alkaline solutions and by fused alkalis like sodium hydroxide.

Tantalum has a high melting point and good strength even at high temperatures; this enables thin sections of this very expensive material to be used.

PFA
ABB offers another unique solution to corrosive application – a PFA-coated AISI 316L stainless steel remote seal transmitter. PFA corrosion resistance is outstanding and a coating of between 0.2 and 0.3 mm can solve severe corrosion problems in a cost-effective way, eliminating the use of more expensive metals.

The only limitation to the use of PFA is its maximum process temperature limitation of 250 °C (482 °F) (though 200 °C (392 °F) is the recommended maximum) and a minimal effect on accuracy at higher temperatures.

Gasket
The most widespread material for the transmitter gasket is PTFE because of its general corrosion resistance against most materials. However, PTFE is not recommended for use in process temperatures that vary regularly because of PTFE's limited elasticity that can cause components to loosen over time. In these processes, Viton is preferred. Special materials are also available – asked your local ABB representative for details.

Housing

Marine environments are a high corrosion risk due to the presence of chloride, an ion that causes accelerated galvanic corrosion of an aluminium housing because of aluminium alloy's copper content.

For marine applications, aluminium with a low copper content (<0.1 %) can be specified. Stainless steel is also available as a housing material for use in more severe environments.

Materials suitability

The following tables detail the suitability of materials used in pressure transmitters against process media.

Key:
A = Generally suitable: corrosion rate <0.12 mm (0.005 in) per year.
B = Concentration and temperature limited
NR = Not recommended
blank = No data available
Numbers indicate the maximum allowable temperature in ° C (° F) for a generally suitable material.

Material	AISI 316L stainless steel	Hastelloy C	Monel	Tantalum	PTFE	Elastomer (Viton)
Acetaldehyde	B	A	A	A	A	A
Acetic acid 0.25%	B	A	22	A	A	NR
Acetic acid 50%	B	A	100	A	A	NR
Acetic acid 99.7%	B	A	NR	A	A	NR
Aluminum chloride	NR	B	B	A	A	A
Aluminum fluoride	NR	A	A	NR	A	A
Aluminum hydroxide	B	B	B	NR	A	A
Aluminum nitrate	A	A	A	A	A	21 (72)
Aluminum potassium Sut.	A	NR	B	A	A	21 (72)
Ammonium bisulfate					A	A
Ammonium chloride	NR	B	B	A	A	A
Ammonium fluoride	A	NR	B	NR	A	A
Ammonium hydroxide	A	A	B	NR	A	A
Ammonium nitrate	A	B	NR	A	A	66
Ammonium phosphate	B	A	B	A	A	
Ammonium sulfate	NR	B	NR	A	A	21 (72)
Ammonium sulfide	A			A	A	
Ammonium sulfite	B	B	NR	A	A	A
Barium chloride	NR	NR	B	A	A	A
Barium hydroxide	A	NR	B	NR	A	NR
Barium nitrate	A	B	B	A	A	A
Barium sulfate	B	B	B	A	A	
Barium sulfide	NR	-	NR	A	A	A
Beef sugar liquor	A	-			A	A
beer	A	A	A	A	A	
Black liquor	NR	A	NR	A	A	A
Blood	A	A	A	A	A	A
Borax	B	NR	A		A	A
Boric acid	A	A	B	A	A	21 (72)
Brine	NR	A	NR	A	A	A
Butyric acid	B	A	B	A	A	NR
Cadmium bromide	NR	A			A	82 (180)
Cadmium chloride	B	A		A	A	82 (180)
Cadmium nitrate	A	A			A	A
Cadmium sulfate	NR	A			A	A

Material	AISI 316L stainless steel	Hastelloy C	Monel	Tantalum	PTFE	Elastomer (Viton)
Calcium carbonate	B	B	A	A	A	A
Calcium chlorate	B	A	A	A	A	
Calcium chloride	NR	A	B	A	A	A
Calcium fluoride	A	A	A	NR	A	
Calcium hydroxide	A	A	A	A	A	71 (160)
Calcium hypochlorite 6 %	NR	NR	NR	A	A	71 (160)
Calcium nitrate	B	B	A	A	A	A
Calcium sulfate	B	B	B	A	A	71 (160)
Carbolic acid	B	A	B	A	A	A
Cellulose acetate	A	A	A	A	A	NR
Chlorinated water	B	A	NR	A	A	A
Chlorine Dioxide	B	NR	A	A	A	
Chromic acid	NR	NR	NR	A	A	NR
Cider	A	A	A	A	A	A
Citric acid (all concentrations)	B	A	B	A	A	A
Citric acid 10 %	A	100 (212)	A	A	A	A
Clay slurry	A	A			B	A
Coal and water slurry	B	A			NR	A
Coffee	A	A	A		A	A
Coke syrup	A				A	A
Copper chloride	NR	NR	NR	A	A	A
Copper cyanide	B	B	A	A	A	A
Copper fluoride	NR	NR			A	
Copper nitrate	B	NR	NR	A	A	A
Copper ore slurry	A					A
Copper sulfate	B	A	B	A	A	71 (160)
Dairy products	A	A			A	-
Dichloroacetic acid	NR	NR		A	A	NR
Dyes	A	A			A	NR
Fatty acids	A	A	B	A	A	NR
Ferric chloride	NR	B	NR	A	A	A
Ferric sulfate	B	B	NR	A	A	A
Ferrous chloride	NR	B	NR	A	A	A
Ferrous nitrate	NR	B			A	
Ferrous sulfate	NR	B	B	A	A	A
Fluorosilicic acid	NR	NR	A	A	B	A
Formaldehyde	A	B	A	A	A	A
Formic acid (all concentrations)	24 (75)	21 (72)	NR	A	A	NR
Fresca (soft drink)	A	A			A	
Fruit juices	A	NR	B		A	NR
Gin	A	A			A	A
Ginger ale	A	A			A	

...Materials suitability

Material	AISI 316L stainless steel	Hastelloy C	Monel	Tantalum	PTFE	Elastomer (Viton)
Ginger beer	A	A			A	A
Glucose	A	A	A	A	A	A
Glutaric acid		24 (75)			A	NR
Grape juice	A	A			A	
Green liquor (NaOH)	B	A	A	A	A	
Hydrobromic acid	NR	NR	NR	A	A	66 (151)
Hydrochloric acid	NR	NR	NR	A	A	NR
Hydrocyanic acid	NR	NR	NR	A	A	NR
Hydrofluoric acid	NR	NR	B	NR	A	71 (160)
Hydrogen peroxide	B	A	NR	A	A	71 (160)
Hydrogen sulfide	A	A	NR	A	A	A
Iodic acid	NR				A	
Lactic acid 10 to 85 %	NR	NR	B	A	A	A
Lactic acid 5 %	A	38 (100)	NR	A	A	A
Latex	A	A			A	
Lead acetate	B	B	B	A	A	A
Lemon juice	A	A			A	
Lime (calcium hydroxide)	A	A	A	A	A	60 (140)
Machine broke	A	A			A	A
Magnesium carbonate	B	B	A	A	A	
Magnesium chloride	B	A	B	A	A	B
Magnesium hydroxide	B	B	B	A	A	
Magnesium nitrate	B	B	B	A	A	71 (160)
Magnesium sulfate	38 (100)	B	A	A	A	71 (160)
Maleic acid	A	A	A	A	A	A
Malic acid	A	B	B	A	A	A
Mercuric chloride	NR	NR	A	A	A	B
Milk (skimmed or regular)	A	A	B		A	
Molasses (Zuelaluf)	A	A	A	A	A	
Nickel chloride	NR	B	B	A	A	A
Nickel nitrate	B	B	A	A	A	A
Nickel sulfate	B	B	B	A	A	A
Nitric acid (all concentrations)	B	NR	NR	A	A	
Nitric acid 5 %	A	NR	NR	A	A	A
Oxalic acid	NR	NR	B	A	71 (160)	NR
Paper pulp	A	A			A	
phosphate slurry	NR	A			A	A
Phosphoric acid 30 %	B	26 (79)	100 (212)	A	A	71 (160)
Phosphoric acid 80 %	NR	B	100 (212)	A	A	71 (160)
Potassium 5 to 50 %	30 (86)	A			A	66 (151)
Potassium Aluminum sulfate	B	B	B		A	A
Potassium bisulfate	B				A	A
Potassium bromide	B	A	B	A	A	A

Material	AISI 316L stainless steel	Hastelloy C	Monel	Tantalum	PTFE	Elastomer (Viton)
Potassium carbonate	B	B	B	NR	A	
Potassium chlorate	B	B	B	A	A	A
Potassium chloride	B	A	B	A	A	A
Potassium cyanide	NR	B	B	A	A	A
Potassium permanganate	B	B	B	A	A	
Potassium phosphate	B	B	A	A	A	A
Potassium sulfate	NR	B	A	A	A	A
Potassium sulfide	A	NR	B	A	A	A
Root beer	A	A			A	A
Rosin size	A	A	A	A	A	
Rum	A				A	A
Salicylic acid	B	B	A	A	A	NR
Seawater	B	A	A	A	A	A
Sewage	A	B	A	A	A	A
Silver nitrate (all concentrations)	B	NR	NR	A	A	A
Sodium acetate 50 %	B	A	A	A	A	A
Sodium chloride (salt)	B	A	B	A	A	A
Sodium hydroxide	B	B	A	NR	A	A
Sodium hypochlorite	NR	NR	NR	A	A	A
Sodium nitrate	B	B	A	A	A	NR
Sodium phosphate	B	B	A	A	A	A
Sodium sulfate	B	NR	NR	A	A	71 (160)
Sodium sulfide	B	B	A	B	A	71 (160)
Sodium sulfite	B	B	B	A	A	71 (160)
Starch	B				A	A
Sulfuric acid	NR	22 (73)	NR	A	A	A
Sulfurous acid	NR	B	NR	A	A	A
Tab	A	A			A	A
Tartic acid	B		B		A	77(171)
Titanium dioxide	A	A			A	
Tomato juice	A	A			A	A
Urea	B	A	B	A	A	
Vinegar	A	A	A		A	
Water (impure)	A	A			A	A
Whiskey	A	A			A	A
White liquor	A	A	B	A	A	A
Wines	A	A			A	
Zinc chloride (all concentrations)	NR	B	B	A	A	71 (160)
Zinc sulfate	B	B	B	A	A	71 (160)

® Hastelloy is a registered trademark of Haynes International, Inc.
® Monel is a registered trademark of Special Metals Corporation
™ Viton is a DuPont de Nemours trademark

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