Instruction **MI 019-042 en**

October 2020

Corrosion and abrasion guide

Supplementary Instructions

CFS300A / CFS400A / CFS600A and CFS700A series of meters

Schneider Electric

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1.1 Introduction

General corrosion guidelines for process vessels, pipework and parts usually refer to the erosion of large amounts of material from comparatively thick walled components and cannot be used for the thin walls of the measuring tubes in Coriolis flowmeters.

The wall thickness of the measuring tubes is usually in the region of 0.2 … 2mm (depending on meter size) and the erosion of even a small amount of material can cause measurement problems and eventual meter failure.

Corrosion effects like pitting or stress corrosion cracking can occur even without corrosion of the overall tube and, if severe enough, can cause meter failure.

For these reasons many fluids will be shown as unsuitable in this guide for use with mass flowmeters when compared to more general corrosion guidelines.

1.2 Material information

Material elements by percentage

Element	% (as specified by manufacturer)		
Stainless Steel	316L	UNS S31803	UNS S32760
C	0.035 max	0.03 max	0.050 max
Mn	2.0 max	2.0 max	1.0 max
P	0.045 max	0.03 max	0.030 max
S	0.03 max	0.02 max	0.010 max
Si	1.0 max	1.0 max	1.00 max
Cr	16.0...18.0	21.0...23.0	24.0...26.0
Ni	10.0...15.0	4.5...6.5	6.0...8.0
Mo	2.0...3.0	2.5...3.5	3.0...4.0
N	-	0.08...0.2	0.2...0.3
Cu	-	-	0.5...1.0
Fe	Remainder	Remainder	Remainder
Hastelloy®	C22	-	-
Cr	20...22.5	-	-
Mo	12.5...14.5	-	-
W	2.5...3.5	-	-
Fe	2.0...6.0	-	-
Co	2.5 max	-	-
Mn	0.5 max	-	-
V	0.35 max	-	-
Ni	Remainder	-	-

Element	% (as specified by manufacturer)		
Titanium	Grade 2	Grade 9	-
Al	-	2.5...3.5	-
V	-	2.0...3.0	-
Fe	0.2 max	0.25 max	-
C	0.08 max	0.08 max	-
O	0.18 max	-	-
N	0.03 max	-	-
H	0.015 max	-	-
Ti	Remainder	Remainder	-
Tantalum	RO5200	RO5255	-
H	0.002 max	0.002 max	-
Si	0.005 max	0.005 max	-
N	0.010 max	0.01 max	-
C	0.010 max	0.01 max	-
Ti	0.010 max	0.01 max	-
Fe	0.010 max	0.01 max	-
Ni	0.010 max	0.01 max	-
O	0.015 max	0.015 max	-
Mo	0.02 max	0.02 max	-
W	0.05 max	9.0...11.0	-
Nb	0.1 max	0.1 max	-
Ta	Remainder	Remainder	-

1.3 Duplex Stainless Steel S31803

Stainless Steel UNS S316L is a 100% austenitic structure steel, with a composition that is: 18% Chrome, 8% Nickel, 2.5% Molybdenum and the balance Iron, UNS S31803 is a 50% austenitic / 50% ferritic structure steel (typically known as "duplex"), with a (typical) composition of: 22% Chrome, 5% Nickel, 3% Molybdenum, with the balance Iron.

UNS S31803 is a low carbon duplex Stainless Steel that has a much higher tensile strength than S316L and is therefore able to cope with the stress caused by thermal expansion. The corrosion resistance of UNS S31803 is the same as S316L, the surface roughness is similar to S316L and it can be polished to <0.5um Ra for hygienic applications.

1.4 NACE information

National Association of Chemical Engineers (NACE standard MR0175-2015) is a material requirements standard relating to the general problems of Sulphide Stress Cracking (SSC) of metals directed towards sour environments.

1.5 Galvanic corrosion with Titanium

Galvanic corrosion can occur when a noble metal is placed in close contact with other metals, for instance in a steel pipeline. If the line is Stainless Steel, Titanium is very close in the galvanic table therefore galvanic corrosion is unlikely to be a problem and no precautions are necessary. If carbon steel lines are used, galvanic corrosion of the carbon steel may occur with certain acids. This corrosion process causes small amounts of hydrogen gas to form at the wetted metal-to-metal contact area and the hydrogen gas can cause the Titanium to become brittle. Such corrosion can be avoided by electrically insulating the meter from the pipeline using insulating gaskets, bolt sleeves and washers.

The use of an alternative tube material e.g. Hastelloy® C-22 will prevent the problem.

1.6 Problem applications

1.6.1 Hydrochloric acid (HCl)

Stainless Steel, Hastelloy® and Titanium meters

Meters with Stainless Steel, Hastelloy® and Titanium measuring tubes are not suitable for measuring Hydrochloric acid, regardless of the concentration or temperature of the acid. Fluoride and chloride impurities in the acid cause stress corrosion cracking that will cause meter failure, even if there is no bulk removal of tube material.

Tantalum meters

Meters with Tantalum measuring tubes are suitable for measuring Hydrochloric acid with a maximum concentration of 37% and a maximum temperature of 100°C / 212°F.

1.6.2 Methanol

Pure methanol, or methanol based fluids that contain less than 2% water, strips the protective oxide layer from Titanium and Tantalum measuring tubes and this will cause corrosion. Therefore Titanium and Tantalum cannot be used. Stainless Steel or Hastelloy® C-22 are suitable alternatives for these applications.

Methanol based fluids that contain a minimum of 2% water can be used with all measuring tube materials.

1.6.3 Oxygen rich gasses

Titanium reacts with oxygen rich gasses (> 35% O_2) and the reaction causes heat that can result in an explosion.

An alternative measuring tube material should be used when measuring oxygen rich gasses.

1.6.4 Passivation fluid

Passivation fluid is (normally) a mixture of nitric acid (HNO_3) and hydrofluoric acid (HF) and is used to ‘passivate’ (clean) stainless steel pipework in high purity systems. For example the pharmaceutical industry. Passivation removes weld discolouration, dirt, grease, metal particles, etc.

The nitric acid has very little corrosive effect but hydrofluoric acid is very aggressive even at very low concentration (< 0.5%) for all measuring tube materials. Because of the relatively thin wall of the measuring tube, such corrosion will cause meter failure.

The manufacturer recommends that the meter is removed from the process line and replaced with spool pieces during the passivation process.

2.1 Introduction

The table in this section allows you to identify the wetted part/s material best suited to your application, based on the chemical, concentration and temperature being measured.

Concentration in column three is a percentage by weight (mass)

2.2 Using the compatibility table

- Identify the chemical by name and cross check it with the chemical formula in column two.
- Check the concentration of the chemical to be measured and make sure that the concentration is within the maximum limit shown in column three.
- Read across the table row to identify the most compatible material for the application.

CAUTION!
The advice given in this document is only intended as a guide, based on the manufacturer's experience.

The manufacturer supplies the information in good faith and does not accept responsibility for the suitability of the wetted part/s material chosen. The final choice is made by the customer who accepts full responsibility

2.3 Symbols used in the table

Symbol	Meaning
√	The wetted part/s material is suitable based on a corrosion rate less than 0.5mm (0.002") per year.
x	The wetted part/s material is not suitable
nd	no data is currently available
160 / 71	Temp. data (°F / °C). This shows the maximum chemical temperature at which the wetted part/s material is suitable. ①
①	Footnote. The information is given at the bottom of the table
>	Greater than
<	Less than
...	Range. This will be between two values. For example 0...25

① Always check the relevant technical data for the meter to find out the maximum operating temperature.

2.4 Compatibility table

			Max Temp °F / °C			
Fluid	**Formula**	**Conc.%**	**SS**	**Hast**	**Ti**	**Ta**
Acetaldehyde	CH_3CHO	100	200 / 93	200 / 93	300 / 149	x
Acetate	$CH_3CO_2CH_3$	100	400 / 204	400 / 204	400 / 204	nd
Acetic acid	CH_3COOH	20	400 / 204	300 / 149	260 / 127	400 / 204
		50	160 / 71	210 / 99	260 / 127	400 / 204
		80	160 / 71	210 / 99	260 / 127	400 / 204
		95	x	200 / 93	200 / 93	400 / 204
		100	200 / 93	400 / 204	200 / 93	400 / 204
Acetic anhydride	$(CH_3CO)_2O$	100	x	289 / 143	289 / 143	289 / 143
Acetone	CH_3COCH_3	100	400 / 204	140 / 60	nd	78 /26
Acetonitrile	C_2H_3N	100	140 / 60	nd	nd	140 / 60
Acetyl chloride	CH_3COCl	100	70 / 21	99 / 37	220 / 105	nd
Acetylene	C_2H_2	100	400 / 204	220 / 105	79 / 26	79 / 26
Acrylonitrile	CH_2CHCN	100	188 / 87	219 / 104	188 / 87	266 / 130
Adipic acid	$(CH_2)_4(COOH)_2$	100	212 / 100	200 / 93	428 / 220	nd
Air		√	√	√	√	√
Aluminium chloride	$AlCl_3$	10	x	220 / 105	200 / 93	212 / 100
		40	x	220 / 105	x	212 / 100
		100	x	158 / 70	x	212 / 100
Aluminium Fluoride	$AlCl_3$	20	x	x	x	x
Aluminium fluorosulfate	$AL_2F_4SO_4$	15	x	80 / 27	x	nd
Aluminium nitrate	$AlNO_3$	100	68 / 20	nd	68 / 20	212 / 100
Aluminium sulphate	Al_2SO_4	6.50	x	285 / 140	220 / 105	212 / 100
		40	x	285 / 140	220 / 105	212 / 100
		100	x	nd	200 / 93	212 / 100
Amine		100	212 / 100	212 / 100	212 / 100	212 / 100
Ammonia (anhydrous)	dry NH_3	100	248 / 120	248 / 120	77 / 25	x
Ammonia (aqueous)	NH_3 + water	30	158 / 70	158 / 70	x	x
		50	86 / 30	302 / 150	x	x
Ammonium acetate	NH_4CH_3COO	15	220 / 105	220 / 105	77 / 25	x
		55	170 / 77	nd	nd	nd
Ammonium bicarbonate	NH_4HCO_3	50	68 / 20	nd	212 / 100	nd
Ammonium carbonate	$(NH_4)_2CO_3$	30	200 / 93	176 / 80	200 / 93	200 / 93
		50	200 / 93	x	200 / 93	nd
Ammonium chlorate	$(NH_4)ClO_3$	30	nd	nd	122 / 50	nd

			Max Temp °F / °C			
Fluid	Formula	Conc.%	SS	Hast	Ti	Ta
Ammonium chloride	NH_4Cl	40	x	212 / 100	212 / 100	202 / 100
Ammonium fluoride	NH_4F	20	x	170 / 77	x	x
Ammonium hydroxide	NH_4OH	45	x	x	170 / 77	x
Ammonium nitrate	NH_4NO_3	28	248 / 120	80 / 27	212 / 100	212 / 100
Ammonium oxalate	$(NH_4)C_2O_4$	10	x	75 / 24	nd	nd
Ammonium perchlorate	NH_4ClO_4	20	86 / 30 ①	x	185 / 85	nd
Ammonium phosphate	$(NH_4)_3PO_4$	10	140 / 60	140 / 60	248 / 120	212 / 100
		100	x	140 / 60	140 / 60	212 / 100
Ammonium sulphate	$(NH_4)_2SO_4$	10	x	220 / 104	248 / 120	212 / 100
		100	x	x	248 / 120	212 / 100
Ammonium sulphide	$(NH_4)_2S$	100	68 / 20	140 / 60	68 / 20	140 / 60
Amyl chloride	$C_5H_{11}Cl$	100	x	140 / 60	nd	212 / 100
Amylphenol	$C_{11}H_{16}O$	100	nd	392 / 200	nd	212 / 100
Aniline	$C_6H_6NH_2$	100	509 / 265	248 / 120	230 / 110	230 / 110
Aniline hydrochloride	$C_6H_7N . HCl$	5	x	nd	212 /100	nd
		100	x	nd	68 / 20	nd
Aqua regia	HNO_3+3 HCl	75	x	x	x	176 / 80
Argon	Ar	100	√	√	√	√
Asphalt		100	392 / 200	nd	302 / 150	212 / 100
Barium carbonate	$BaCO_3$	100	x	x	77 / 25	nd
Barium chloride	$BaCl_2$	25	x	158 / 70	122 / 50	212 / 100
Barium hydroxide	$Ba(OH)_2$	10	225 / 107	225 / 107	77 / 25	78 / 26
Barium nitrate	$Ba(NO_3)_2$	20	150 / 65	x	77 / 25	nd
Benzene	C_6H_6	100	176 / 80	x	176 / 80	nd
Benzoic acid	C_6H_5COOH	10	nd	180 / 82	180 / 82	212 / 100
		100	nd	nd	180 / 82	212 / 100
Benzyl chloride	C_7H_7Cl	100	x	nd	140 / 60	nd
Boric acid	$B(OH)_3$	10	86 / 30	482 / 250	302 / 150	212 / 100
		100	nd	212 / 100	nd	nd
Bromine liquid	Br	100	x	x	x	212 / 100
Butadiene	C_4H_6	100	140 / 60	248 / 120	nd	nd
Butane	C_4H_{10}	100	√	√	√	√
Butanol	C_4H_9OH	100	√	nd	√	√
Butyl acetate	$CH_3COOC_4H_9$	100	248 / 120	220 / 104	248 / 120	212 / 100
Butyric Acid	$CH_3(CH_2)_2COOH$	100	x	260 / 127	225 / 107	77 / 25

2 MEASURING TUBE COMPATIBILITY

			Max Temp °F / °C			
Fluid	**Formula**	**Conc.%**	**SS**	**Hast**	**Ti**	**Ta**
Calcium carbonate	$CaCO_3$	100	√	√	√	√
Calcium chloride	$CaCl_2$	55	x	212 / 100	221 / 105	212 / 100
		100	x	212 / 100	x	212 / 100
Calcium hydroxide	$Ca(OH)_2$	50	x	212 / 100	212 / 100	x
Calcium hypochlorite	$Ca(Ocl)_2$	6	x	212 / 100	212 / 100	212 / 100
		95	x	nd	nd	212 / 100
Calcium sulphate	$CaSO_4$	100	212 / 100	nd	212 / 100	212 / 100
Carbon dioxide	dry	100	248 / 120	248 / 120	248 / 120	248 / 120
	CO_2	100	x	x	248 / 120	248 / 120
Carbon disulfide	CS_2	100	109 / 43	nd	200 / 93	109 / 43
Carbon tetrachloride (anhydrous)	dry CCl_4	100	140 / 60	140 / 60	248 / 120	212 / 100
Carbonic acid	H_2CO_3	Saturated	x	√	nd	212 / 100
Chloric acid	$HClO_3$	10	x	87 / 31	68 / 20	158 / 70
		50	x	x	nd	158 / 70
Chlorine (anhydrous)	dry Cl_2	0...100	x	x	x	212 / 100
Chlorine (aqueous)	Cl_2 + water	0...100	x	x	x	212 / 100
Chloroacetic acid	$CH_2ClCOOH$	85	x	x	221 / 105	212 / 100
Chlorobenzene	C_6H_5Cl	60	x	100 / 38	266 / 130	100 / 38
Chloroform	$CHCl_3$	100	x	x	212 / 100	212 / 100
Chlorosulphonic Acid	$HClSO_3$	100	x	185 / 85	x	nd
Chromic acid	H_8CrO_5	25	x	x	212 / 100	212 / 100
		50	x	x	212 / 100	212 / 100
		100	x	x	nd	nd
Citric acid	C_6H8O_7	25	212 / 100	221 / 105	212 / 100	212 / 100
		50	212 / 100	221 / 105	x	212 / 100
Copper nitrate	$Cu(NO_3)_2$	100	280 / 138	x	280 / 138	68 / 20
Copper sulphate	$CuSO_4$	100	x	221 / 105	221 / 105	212 / 100
Cupric chloride	$CuCl_2$	50	x	x	244 / 118	212 / 100
Cupric cyanide	$Cu(CN)_2$	100	x	x	68 / 20	68 / 20
Cuprous chloride	$CuCl_2$	50	nd	nd	194 / 90	194 / 90
Dichloroacetic acid	$CHCl_2COOH$	100	x	nd	212 / 100	212 / 100
Diethyl phthalate	$C1_2H1_4O_4$	100	221 / 105	nd	221 / 105	nd
Ethyl alcohol (ethanol)	C_2H_5OH	100	221 / 105	nd	221 / 105	212 / 100
Ethylene gas	C_2H_4	100	√	√	√	√

			Max Temp °F / °C			
Fluid	**Formula**	**Conc.%**	**SS**	**Hast**	**Ti**	**Ta**
Ethylene dichloride (anhydrous)	dry $C_2H_2Cl_2$	100	x	221 / 105	221 / 105	212 / 100
Ethylene glycol	$C_2H_6O_2$	100	212 / 100	212 / 100	212 / 100	212 / 100
Ethyl acetate	CH_3 $COOC_2H_5$	100	320 / 160	320 / 160	221 / 105	212 / 100
Ferric chloride	$FeCl_3$	50	x	x	230 / 110	212 / 100
Ferric hydroxide	$Fe(OH)_3$	6	70 / 21	80 /27	68 / 20	68 / 20
		100	70 / 21	80 / 27	nd	nd
Ferric nitrate	$Fe(NO_3)_3$	50	68 / 20	nd	68 / 20	68 / 20
Ferric sulphate	$Fe_2(SO_4)_3$	10	221 / 105	150 / 66	221 / 105	68 / 20
		30	nd	150 / 66	nd	68 / 20
Ferrous chloride	$FeCl_2$	10	x	86 /30	68 / 20	68 / 20
		100	x	x	68 / 20	68 /20
Ferrous sulphate	$FeSO_4$	100	x	nd	68 / 20	68 / 20
Fluoboric acid	HBF_4	30	80 / 27	nd	x	x
Fluorine (anhydrous)	dry F	0...100	x	x	x	x
Fluosilicic acid	H_2SiF_6	0...100	x	x	x	x
Formaldehyde	CH_2O	100	221 / 105	x	221 / 105	68 / 20
Formic acid (aerated)	$HCOO_4$	50	86 / 30	230 / 110	212 / 100	212 / 100
Formic acid (non-aerated)	$HCOO_4$	85	x	221 / 105	x	212 / 100
Heptane	C_6H_{12}	100	221 / 105	221 / 105	221 / 105	212 / 100
Hydrazine	$(NH_2)_2$	100	√	√	nd	nd
Hydrobromic acid	HBr	100	x	nd	x	212 / 100
Hydrochloric acid	HCL + water	0...100	x	x	x	194 / 90
Hydrofluoric Acid	HF + water	0...100	x	x	x	x
Hydrogen gas	H_2	0...100	√	√	√	212 / 100
Hydrogen chloride gas	HCL	0...100	x	x	x	212 / 100
Hydrogen cyanide	NCN	100	88 / 31	88 / 31	88 / 31	nd
Hydrogen fluoride gas	HF	0...100	x	x	x	x
Hydrogen peroxide	H_2O_2	50	104 / 40	194 / 90	x	x
		90	nd	118 / 48	x	x
Iodine gas	I_2	100	x	x	77 / 25	212 / 100
Lactic acid	$CH_3CHOHCOOH$	25	122 / 50	122 / 50	122 / 50	212 / 100
Lithium chloride	LiCl	50	x	212 / 100	212 / 100	212 / 100
Magnesium chloride	$MgCl_2$	40	x	280 / 138	248 / 120	212 / 100
Magnesium hydroxide	$Mg(OH)_2$	100	212 / 100	212 / 100	167 / 75	68 / 20
Magnesium sulphate	$MgSO_4$	50	nd	200 / 93	200 / 93	212 / 100

			Max Temp °F / °C			
Fluid	**Formula**	**Conc.%**	**SS**	**Hast**	**Ti**	**Ta**
Maleic acid	$CH_2(COOH)_2$	50	176 / 80	176 / 80	212 / 100	212 / 100
Manganese chloride	$MnCl_2$	45	x	nd	212 / 100	212 / 100
Manganese sulphate	$MnSO_4$	100	68 / 20	nd	68 / 20	nd
Mercuric chloride	$HgCl_2$	100	x	x	212 / 100	212 / 100
Mercuric cyanide	$Hg(CN)_2$	5	95 / 35	x	95 / 35	212 / 100
		100	nd	x	68 / 20	212 / 100
Methane	CH_4	100	√	√	√	√
Methanol + > 2% H2O	CH_3OH	98	149 / 65	149 / 65	149 / 65	②
Methanol + > 50ppm H20	CH_3OH	99.99	149 / 65	149 / 65	x	②
Methanol (pure)	CH_3OH	100	149 / 65	149 / 65	x	②
Methyl chloride	CH_3Cl	100	x	113 / 45	68 / 20	212 / 100
Methyl ethyl ketone	$CH_3CH_2COCH_3$	100	200 / 93	200 / 93	200 / 93	200 / 93
Methyl methacrylate	$C_5H_8O_2$	100	√	√	nd	√
Methylene chloride	CH_2Cl_2	100	x	x	239 / 115	212 / 100
Monosodium orthophosphate in water	$NaPO_3$	(200 mM)	nd	nd	86 / 30	nd
Monochloacetic acid	$CH_2ClCOOH$	80	86 / 30	nd	176 / 80	212 / 100
		100	x	nd	nd	212 / 100
Naphtha			√	√	√	212 / 100
Naphthalene	$C_{10}H_8$	100	212 / 100	x	212 / 100	212 / 100
Nickel chloride	$NiCl_2$	20	x	194 / 90	212 / 100	212 / 100
		80	x	x	nd	nd
Nickel nitrate	$Ni(NO_3)_2$	50	x	x	77 / 25	77 / 25
Nickel sulphamate	$Ni(SO_3NH_2)_2$	50			212 / 100	nd
Nickel sulphate	$NiSO_4$	100	212 / 100	x	212 / 100	68 / 20
Nitric acid	Fuming	100	x	x	x	212 / 100
	HNO_3	98	x	x	95 / 35	212 / 100
		70	75 / 24	nd	140 / 60	212 / 100
		50	100 / 38	nd	140 / 60	212 / 100
		40	125 / 52	nd	140 / 60	212 / 100
		30	130 / 66	nd	140 / 60	212 / 100
		20	176 / 80	nd	140 / 60	212 / 100
Oleum	see sulphuric acid					
Oxalic acid	$(COOH)_2$	10	122 / 50	122 / 50	x	212 / 100
		100	x	x	x	200 / 93
Oxygen rich gas mixture	O_2	>35	√	√	x	√

			Max Temp °F / °C			
Fluid	**Formula**	**Conc.%**	**SS**	**Hast**	**Ti**	**Ta**
Passivation fluid	HNO_3 + HF	0...100	x	x	x	x
Pentane	C_5H_{12}	100	√	√	√	√
Perchloric acid	$HClO_4$	10	x	212 / 100	68 / 20	212 / 100
		100	x	x	x	212 / 100
Phenol	C_6H_5OH	95	131 / 55	131 / 55	x	77 / 25
Phosphoric acid	H_3PO_4	85	68 / 20	77 / 25	x	212 / 100
		20	176 / 80	77 / 25	22 / 25	212 / 100
		5	212 / 100	150 / 66	95 / 35	212 / 100
Potassium bromide	KBr	100	x	x	68 / 20	68 / 20
		75	x	180 / 82	68 / 20	68 / 20
Potassium chloride	KCl	99	x	230 / 110	140 / 60	212 / 100
Potassium hydroxide	KOH	25	212 / 100	nd	122 / 50	x
		50	68 /20	nd	68 / 20	x
Potassium iodide	KI	75	x	212 / 100	212 / 100	68 / 20
Potassium nitrate	KNO_3	100	212 / 100	122 / 50	240 / 115	212 / 100
Potassium permanganate	$KMnO_4$	10	212 / 100	75 / 24	212 / 100	212 / 100
		100	x	x	68 / 20	212 / 100
Potassium sulphate	K_2SO_4	100	212 / 100	x	240 / 115	212 / 100
Propane	C_3H_8	100	212 / 100	212 / 100	212 / 100	212 / 100
Propanol (propyl alcohol)	C_3H_6OH	100	212 / 100	212 / 100	212 / 100	212 / 100
Salicylic acid	$C_6H_4(OH)COOH$	20	212 / 100	212 / 100	212 / 100	212 / 100
Seawater (brine)		100	x	212 / 100	212 / 100	212 / 100
Silicone			√	√	√	√
Silicone oil			√	√	√	√
Silver nitrate	$AgNO_3$	70	212 / 100	nd	212 / 100	68 / 20
Sodium bisulphate	$NaHSO_4$	20	x	149 / 65	x	212 / 100
Sodium carbonate	Na_2CO_3	25	212 / 100	nd	212 / 100	212 / 100
		100	212 / 100	nd	212 / 100	68 / 20
Sodium chlorate	$NaClO_3$	100	x	240 / 116	68 / 20	68 / 20
Sodium chloride	NaCl	100	x	212 / 100	212 / 100	212 / 100
Sodium cyanide	NaCN	10	77 / 25	nd	212 / 100	68 / 20
		100	x	nd	212 / 100	68 / 20
Sodium dichromate	Na_2Cr	100	122 / 50	nd	122 / 50	68 / 20
Sodium hydroxide	NaOH	40	140 / 60	140 / 60	140 / 60	x
		73	x	nd	194 / 90	x

			Max Temp °F / °C			
Fluid	**Formula**	**Conc.%**	**SS**	**Hast**	**Ti**	**Ta**
Sodium hypochlorite	NaOCl	5	x	68 / 20	212 / 100	68 / 20
		12.5	x	x	212 / 100	x
Sodium nitrate	$NaNO_3$	100	212 / 100	x	212 / 100	68 / 20
	$NaNO_2$	100	212 / 100	nd	212 / 100	68 / 20
Sodium peroxide	$(Na)_2O_2$	10	212 / 100	x	x	x
Sodium phosphate	$NaPO_4$	100	x	212 / 100	212 / 100	68 / 20
Sodium silicate	Na_2SiO_3	100	212 / 100	212 / 100	212 / 100	212 / 100
Sodium sulphate	Na_2SO_4	20	212 / 100	212 / 100	212 / 100	212 / 100
	Na_2S	50	x	212 / 100	212 / 100	68 / 20
	$NaSO_3$	20	212 / 100	150 / 66	212 / 100	212 / 100
		50	212 / 100	nd	212 / 100	212 / 100
		100	nd	nd	212 / 100	212 / 100
Soy oil			√	√	√	√
Soy sauce			x	√	√	√
Stannic chloride	$SnCl_4$	24	x	x	212 / 100	212 / 100
Stannous chloride	$SnCl_2$	100	x	nd	nd	68 / 20
Stearic acid	$CH_2(CH_2)_{16}COOH$	100	nd	200 / 93	212 / 100	200 / 93
Succinic acid	$(CH_2\ COOH)_2$	50	nd	nd	212 / 100	nd
Sulphamic acid	S	5	122 / 50	nd	x	nd
Sulphur (molten)	S	100	302 / 150	248 / 120	302 / 150	212 / 100
Sulphur dioxide	SO_2	100	x	68 / 20	68/ 20	68 / 20
Sulphur trioxide	SO_3	100	nd	100 / 38	x	x
Sulphuric acid	H_2SO_4	10 ③	104 / 40	104 / 40	x	212 / 100
		25 ③	x	140 / 60	x	212 / 100
		55 ③	x	68 / 20	x	212 / 100
		98 ③	x	x	x	212 / 100
		④	x	x	x	x
Sulphurous acid	H_2SO_3	100	x	x	175 / 80	212 / 100
Tannic acid	$C_{76}H_{52}O_{46}$	50	212 / 100	x	212 / 100	212 / 100
Tartaric acid	$C_2H_2(OH)_2(COOH)_2$	50	194 / 90	x	122 / 50	212 / 100
Terephthalic acid	$C_8H_6O_4$	77	212 / 100	212 / 100	302 / 150	212 / 100
Tetrachlorethane	$C_2H_2Cl_4$	100	x	160 / 71	160 / 71	212 / 100
Tetrachlorethylene (perchloroethylene)	C_2Cl_4	100	x	nd	212 / 100	nd
Thionyl chloride	$SOCl_2$	100	x	nd	104 / 40	212 / 100
Titanium tetrachloride	$TiCl_4$	100	x	nd	nd	68 / 20

			Max Temp °F / °C			
Fluid	**Formula**	**Conc.%**	**SS**	**Hast**	**Ti**	**Ta**
Toluene	$C_6H_5CH_3$	100	212 / 100	212 / 100	212 / 100	nd
Trichlorethane	$C_2H_3Cl_3$	100	x	x	77 / 25	77 / 25
Trichlorethylene	C_2HCl_3	100	x	212 / 100	212 / 100	nd
Tricloroacetic acid	CCl_3COOH	50	x	212 / 100	x	nd
Trisodium phosphate	$(Na)_3PO_4$	90	x	212 / 100	x	212 / 100
Urea	$(NH_2)_2CO$	100	194 / 90	x	194 / 90	194 / 90
Zinc chloride	$ZnCL_2$	75	x	212 / 100	212 / 100	68 / 20
		100	x	nd	x	68 / 20
Zinc sulphate	$ZnSO_4$	25	212 / 100	212 / 100	212 / 100	212 / 100
		100	nd	x	68 / 20	68 / 20

① If chlorides are present, there is a risk of pitting and stress corrosion cracking in Stainless Steel.
② Please refer to the section on problem applications.
③ velocity <3 m/s
④ Fuming (Oleum)

3.1 Introduction

The table in this section allows you to identify the meter best suited to your application, based on the compatibility of wetted parts.

3.2 Material / meter guide table

Material	SAE grade	Wetted parts	CFS300A	CFS400A	CFS600A	CFS700A
Stainless Steel	316L	Measuring tube				
		Flange / connection				
		Spigot			√	
	316 / 316L	Measuring tube			√	
		Flange	√	√	√	
		Spigot	√			
	Duplex (S31803)	Measuring tube	√	√	√	√
		Flange		O	√	
		Raised face				√
		Spigot		√	√	
	Super duplex (S32760)	Measuring tube		O		
		Flange / connection		O		
		Spigot		O		
Titanium	Grade 9	Measuring tube				√
	Grade 2	Raised face				√
Hastelloy® C-22		Measuring tube			√	√
		Process connection				
		Raised face			√	√
Tantalum		Measuring tube				√
		Raised face				√
			√	Standard		
			O	Optional		

Hygienic connections

If the meter is fitted with hygienic connections, please contact the manufacturer for advice.

4.1 Introduction

For the measurement of abrasive fluids such as mineral and metal mining slurries, or sand and water mixtures, a meter with a single straight measuring tube will be less likely to fail than a meter with bent, or multiple measuring tubes. Meters with bent measuring tubes will suffer tube erosion on the bends and multiple tube meters can suffer erosion on the flow splitter.

However, even on a meter with a single straight measuring tube simple precautions must be taken to prevent erosion.

A specific problem with abrasive fluids is their tendency to separate out, with the heavier particles falling to the bottom of the pipeline and the carrier fluid flowing above in a stratified flow.

The purpose of this application guidance is to highlight potential problems so that precautions can be taken during the planning and installation of the meter.

4.2 Transition pieces

The diameter of the measuring tube will normally be smaller than the process pipework and the difference causes a step change where the flanges are connected. The edge of the step change is a very obvious erosion point and after a period of time the weld between the flange raised face and the measuring tube can fail.

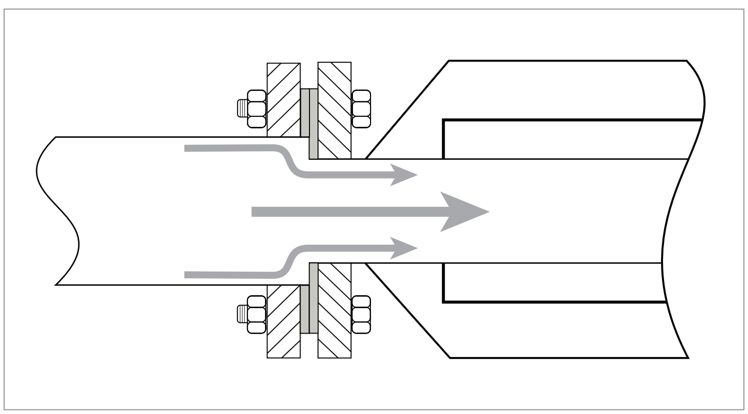

Figure 4-1: The step change between the process pipework flange and the meter flange can cause serious erosion.

The use of transition pieces sandwiched between the two flanges, protects the measuring tube weld and therefore prevents erosion. The transition piece is secured by through bolts and centred by rubber sleeves around the bolts.

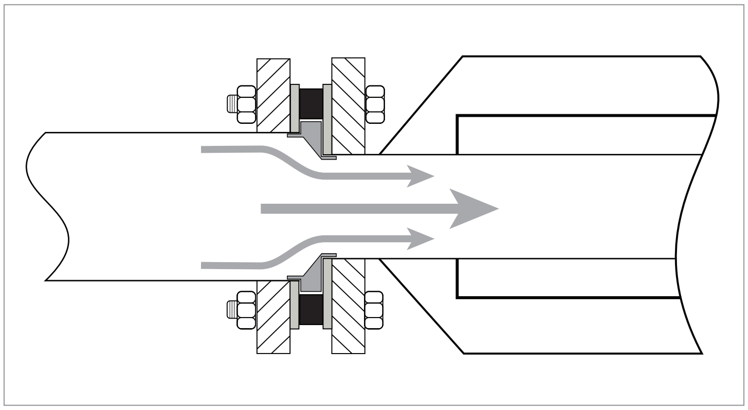

Figure 4-2: The transition piece has a taper on the internal diameter that provides a gradual transition for the abrasive fluid into the meter.

Transition pieces must be regarded as sacrificial wear parts that require regular inspection and should be replaced when necessary. They are available in a variety of materials. For more information, please contact the manufacturer.

4.3 Fluid velocity

Controlling velocity will help to prevent erosion and at the same time it will prevent fluids from separating out.

Minimum velocity

To overcome the tendency of abrasive fluids to separate out, the velocity should never be less than 1m/sec / 3ft/sec

Maximum velocity

To prevent high levels of erosion the maximum velocity should never be more than 4m/sec / 12ft/sec.

Sizing software

The FlowExpertPro sizing software will help you to calculate the minimum and maximum velocities. For abrasive fluids / slurries always size the meter according to the velocity limits shown above and not the lowest measuring error which always leans towards a smaller meter size and therefore a higher velocity.

4.4 Tube dimensions

The table below shows measuring tube dimensions in terms of tube diameter and wall thickness.

The advantage of using Titanium

Because Titanium is more resistant to abrasion, the manufacturer recommends the use of meters with a Titanium measuring tube for measuring abrasive fluids and slurries.

		Tube diameter (mm / inches)		Thickness (mm / inches)
Meter size	Material	Outer	Inner	Wall
single straight tube meter				
06	T	6.35 / 0.250	5.54 / 0.2148	0.41 / 0.218
	S	6.35 / 0.250	5.54 / 0.2148	0.41 / 0.218
10	T	9.52 / 0.375	8.56 / 0.0220	0.48 / 0.0189
	H	9.52 / 0.375	8.40 / 0.331	0.56 / 0.0220
	S	9.52 / 0.375	8.40 / 0.331	0.56 / 0.0220
	A	9.52 / 0.375	8.72 / 0.343	0.40 / 0.0157
15	T	16.00 / 0.630	14.80 / 0.583	0.60 / 0.0236
	H	15.88 / 0.625	14.96 / 0.589	0.46 / 0.0181
	S	15.88 / 0.625	14.96 / 0.589	0.46 / 0.0181
	A	15.88 / 0.625	14.96 / 0.589	0.46 / 0.0181
25	T	25.40 / 1.000	23.98 / 0.944	0.71 / 0.0280
	H	25.40 / 1.000	24.28 / 0.956	0.56 / 0.0220
	S	25.40 / 1.000	24.28 / 0.956	0.56 / 0.0220
	A	25.40 / 1.000	24.28 / 0.956	0.56 / 0.0220
40	T	38.10 / 1.500	36.28 / 1.428	0.91 / 0.0358
	H	38.10 / 1.500	36.68 / 1.444	0.71 / 0.0280
	S	38.10 / 1.500	36.68 / 1.444	0.71 / 0.0280
	A	38.10 / 1.500	36.68 / 1.444	0.71 / 0.0280
50	T	50.80 / 2.000	48.32 / 1.902	1.24 / 0.0488
	H	50.80 / 2.000	48.80 / 0.921	1.00 / 0394
	S	48.26 / 1.900	46.26 / 1.821	1.00 / 0394
	A	50.80 / 2.000	48.80 / 0.921	1.00 / 0394
80	T	73.03 / 2.875	68.83 / 2.710	2.10 / 0.0827
	H	73.03 / 2.875	70.23 / 2.765	1.40 / 0.0551

		Tube diameter (mm / inches)		Thickness (mm / inches)
Meter size	Material	Outer	Inner	Wall
Multiple straight tube meter				
15	S	9.52 / 0.375	8.70 / 0.343	0.41 / 0.218
25	S	15.88 / 0.625	14.96 / 0.589	0.46 / 0.0181
40	S	25.40 / 1.000	24.28 / 0.956	0.56 / 0.0220
50	S	38.10 / 1.500	36.68 / 1.444	0.71 / 0.0280
100	S	48.26 / 1.900	45.66 / 1.798	1.30 / 0.0512
150	S	73.03 / 2.875	68.81 / 2.709	2.11 / 0.0831
250	S	114.30 / 4.500	108.20 / 4.260	3.05 / 0.1201
400	S	114.30 / 4.500	108.20 / 4.260	3.05 / 0.1201

4.5 Flow profile conditioning

Under normal conditions, Coriolis meters do not require flow profiling in order to measure mass / density.

However, when an abrasive fluid is being measured profile conditioning is required to make the abrasive particles run parallel to the measuring tube walls.

If the abrasive particles are swirling as they enter the meter erosion can occur at the point where they hit the tube wall.

Swirling is caused where there is a bend or elbow in the pipework close to the meter inlet.

To prevent swirling, the process flow can be conditioned by installing a straight length of pipe on the inlet side of the meter. The straight pipe should be twenty times the internal diameter of the process pipe, and no less than ten times the internal diameter.

4.6 Preventing separation

To prevent heavy abrasive particles separating from the carrier fluid, install the meter vertically, with the flow uphill.

4.7 Entrained gas

High density fluids (mineral and metal mining slurries etc.) usually require more energy to drive (vibrate) the measuring tubes. Entrained gas (or air) will further increase the drive energy required. The more gas (air) is entrained in the process fluid, the more energy is required and the higher the risk of measuring errors.

For this reason, the process line should be designed to prevent the inclusion of gas (air) in the process fluid.

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