ANACONDA METAL HOSE

INTRODUCTION

ANACONDA metal hose is the leader in the flexible hose field since our beginning in 1908. ANACONDA stands for a complete line of flexible products, such as corrugated metal hose, stripwound hose, metal bellows and expansion joints, vibration eliminators, Sealtite electrical wiring conduit, and specially designed flexible connectors for many purposes.

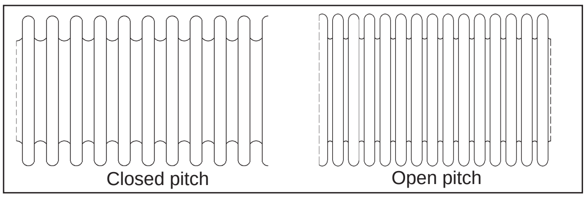
Our leadership in the field was made possible by years of dedication to producing only the highest quality metal hose products available. Strict quality control guidelines, coupled with modern manufacturing practices and an expert team of engineers and research and development personnel, assures you of the best possible products and technical services. Special hose assemblies for unique applications can be designed by our engineering department and manufactured to meet specific customer requirements. Highly-trained sales representatives located in offices all over the world are only part of our dedicated customer service network. Contact the ANAMET representative nearest you for assistance.

ANACONDA products are manufactured by ANAMET Electrical, Inc., Mattoon, Illinois, USA; ANAMET Canada Inc., Colborne, Ontario, Canada and ANAMET EUROPE

CORRUGATED METAL HOSE

What it is..., how it is made..., where it is used...

Fig. A: corrugated metal hose



Open pitch may be used where high flexibility is not essential. Pitch can affect flexibility and it varies from one manufacturer to another. Specifications on open pitch are available by contacting your ANAMET representative.

For higher pressure applications, one or more wire braid coverings are applied to the corrugated hose. Braiding prevents hose elongation under pressure, dampens vibration and provides some mechanical protection for the inner core. Two or more braids are available to increase pressure capabilities of certain corrugated product lines; however, the deformation pressure (a point where corrugation material would yield or plastically deform) governs the maximum working pressure regardless of the number of braid layers.

A corrugated metal hose is defined as a length of tubing made flexible by forming convolutions so that it may be readily bent while remaining liquid- and gas-tight.

ANACONDA corrugated hose is made by thin wall tubing, corrugated into annular profiles. The annular hose profile (Fig. A) is designed so that each convolution is a complete circle or ring in itself.

Corrugated hose is pressure tight and is particularly adapted to continuous flexing or vibration. It is available in closed pitch or open pitch. Closed pitch is standard, unless otherwise specified.

TEMPERATURE CORRECTION FACTORS

Table "T"

TEMP. °C	STEEL	AISI 304	AISI 321	AISI 316L	MONEL	BRONZE
-20/-200	-	1	1	1	1	1
20	1	1	1	1	1	1
50	0,98	0,90	0,93	0,90	0,96	0,95
100	0,90	0,73	0,83	0,73	0,87	0,86
150	0,89	0,66	0,78	0,67	0,83	0,82
200	0,86	0,60	0,74	0,61	0,80	0,75
250	0,82	0,55	0,70	0,58	0,79	-
300	0,76	0,51	0,66	0,53	0,79	-
350	0,73	0,49	0,64	0,51	0,79	-
400	0,70	0,48	0,62	0,50	0,79	-
450	0,41	0,46	0,60	0,49	-	-
500	0,24	0,46	0,59	0,47	-	-
550	-	0,46	0,58	0,47	-	-
600	-	-	0,34	0,25	-	-
650	-	-	0,19	-	-	-

As the service temperature increases, a hose assembly maximum pressure rate decreases. The maximum allowable pressure of the hose assembly shall be the lowest of any method of assembly (mechanical, soldered, welded, silver brazed). By using the factors given in the left chart, the approximate safe working pressure, at elevated temperatures, can be calculated for assemblies with welded or mechanically attached fittings.

Example

Given:	Maximum operating temperature 350°C Maximum operating pressure 30 bar.
Determine:	Is 20 mm BW656-1S (hose AISI 316L with braid AISI 304) with welded steel fittings satisfactory for the given operating conditions?
	From the hose capability chart the working pressure for 20 mm BW656-1S is 70 bar. The largest correction factor at 350°C is now determined, in this case 0,49 for the AISI 304 braid (see table).
Calculation:	70 bar x 0,49 indicates an allowable working pressure of 34,3 bar at 350°C.
Solution:	The hose BW656-1S will meet the required conditions outlined above.

ENGINEERING DATA

QUALITY ASSURANCE

Within ANAMET EUROPE B.V. quality assurance is integrated in the corporate philosophy and adopted by all levels of the company.

The objective of the company's Quality Assurance Programme is to attain a quality level conform to ISO-9001.

In addition to the requirements and specifications of the end-users ANAMET produces in conformity with international regulary standards of independant classification authorities.

Laboratory for special test procedures, materials tests, calibration, etc..

ANAMET EUROPE B.V. is since May 28th, 2002 certified by "Stoomwezen B.V." to produce flexible hoses accordingly to the Pressure Equipment Directive (PED) 97/23/EG, even up to category II.

Stoomwezen
Lloyd's Register

Stoomwezen BV

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VERKLARING VAN TOEZICHT OP DE EINDCONTROLE
VOLGENS MODULE A1

Hiermee wordt verklaard dat Stoomwezen BV als aangemelde instantie (notified body) in de zin van artikel 11 en 12 van Richtlijn 97/23/EG betreffende Drukapparatuur, de relevante procedures heeft toegepast bij de uitvoering van het toezicht op de eindcontrole van de hierna te noemen drukapparatuur en dat de resultaten in overeenstemming zijn met de van toepassing zijnde essentiële veiligheidseisen van de Richtlijn betreffende Drukapparatuur.

Fabrikant	Naam	: Anamet Europe BV
	Adres	: Transformatorweg 30
	Woonplaats	: Amsterdam
	Land	: Nederland
Soort drukapparatuur		: Installatieleiding
Omschrijving drukapparatuur	Benaming en/of typenummer	: Flexible slang, BW650; 850; 950
Geldigheidsgebied	Serie / fabrieksnummer	: n.v.t.

Een overzicht van de uitgevoerde onderzoeken is vastgelegd in het bezoekrapport met het hierna te noemen kenmerk. Deze Verklaring is slechts geldig in combinatie met het betreffende bezoekrapport en blijft geldig tot vervallenverklaring of intrekking.

Datum uitgave: 02-07-2002

Uitgegeven door Stoomwezen BV
Notified body nummer: **0343**

Kenmerk en uitgave van het bezoekrapport, alsmede het kenmerk van deze verklaring:

PED/A1/ 2018575
Uitgave: 0

Namens Stoomwezen BV

Locatiemanager - Rotterdam

Naam: J.P.E. Verschuren

Stoomwezen BV

Anamet Europe b.v. cooperates with the following classification authorities for type approval or acceptance testing of its high quality products.

ENGINEERING DATA

HOSE ASSEMBLY DESIGN CONSIDERATIONS

Flow velocity

Extremely high conveyant velocities in corrugated hose should be avoided as the corrugations could be forced into resonant vibration resulting in premature fatigue failure.
Consult your ANAMET representative for applications involving flow velocities in excess of 35 m/s for braided hose and 6 m/s for unbraided hose.

Temperature

As the temperature of metal hose increases, the pressure capability decreases. The factors shown of tabel “T” should be used to adjust the pressure capabilities at higher temperatures

Pressure

Pressures capabilities shown in the various hose tables are based on constant pressures.
For pulsating or shock pressures consult your ANAMET representative.

Corrosion

Recommended alloy selection to provide satisfactory performance with various media can be found in tabel “M”.

Motion movement

“LENGTH”-The active or exposed length of a hose assembly must be sufficient to meet the conditions of movement. Lengths shorter than suggested can result in premature fatigue failure. Length tolerances as per our Quality Assurance Programme.

“BEND RADIUS”-The bend radius shown in the various hose tables are adequate to meet most industrial flexing requirements. Consideration should be given to those applications involving levels of high frequency or large amounts of travel by increasing the bend radius. Avoid sharp bends except where the installation is permanent and no additional flexing is expected. To prevent overbending of the hose, an overall casing can be used.

“INSTALLATION PRECAUTIONS”-Hose assemblies must be installed so that all motion/movement is in the bending plane. Metal hose when flexed out of its bending plane will be subjected to torsion/twisting which develops a shear stress that can produce early hose failures. Braided hose must not be subjected to axial motion. Extension will result in preloading the braid. Compression will cause braid slack and can result in squirm of the corrugated core.

“ABRASION”-Allow for sufficient clearance so that hose in motion will not come in contact with adjacent objects. Where abrasion cannot be avoided, an overall casing is required to protect the hose from external damage.

Safety factor

We suggest that the maximum working pressures be no more than 25% of the rated burst pressure of the hose assembly after correcting for service temperature. Circumstances may require safety factors greater than 4 :1.

Testing

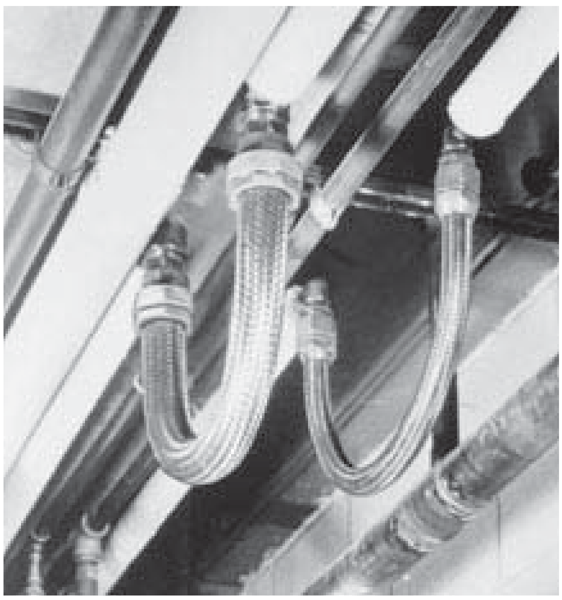
Depending on diameter, length, pressure, type of hose and end fitting design, hose assemblies are tested in various ways. It is ANAMET’s standard practice to test assemblies by using one or more of the following methods: vacuum, hydrostatic, pneumatic or dye penetrant. Test media include: air, nitrogen, helium, water or oil.
If special testing is required, it must be detailed at the time of an inquiry.

Tolerances

The standard tolerances used by ANAMET are found to be acceptable by most users. When tolerance considerations are critical, consult your ANAMET representative.

Cleaning

Depending on the medium being conveyed, special cleaning practices are sometimes necessary. ANAMET has special cleaning procedures where cleaning to standard commercial levels is not acceptable. Where special cleaning is necessary, detailed requirements must be clearly specified.



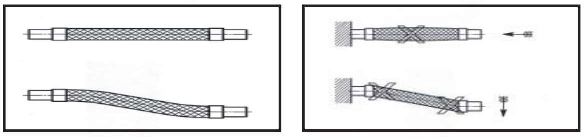
Typical example of axial movement in overhead heating piping absorbed by correct designed corrugated bronze hose assemblies.

ENGINEERING DATA

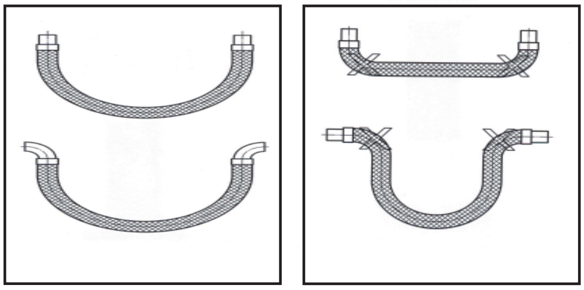
IMPORTANT POINTS WHEN INSTALLING HOSE ASSEMBLIES

RIGHT WRONG

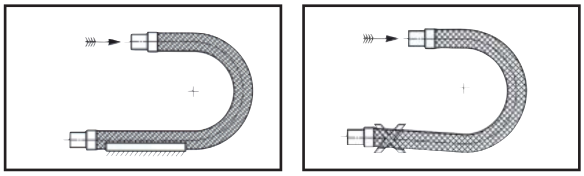
AXIAL LOAD
Axial compression may lead to squirm the corrugated hose. Axial tension lowers the pressure capacity of braided hose.



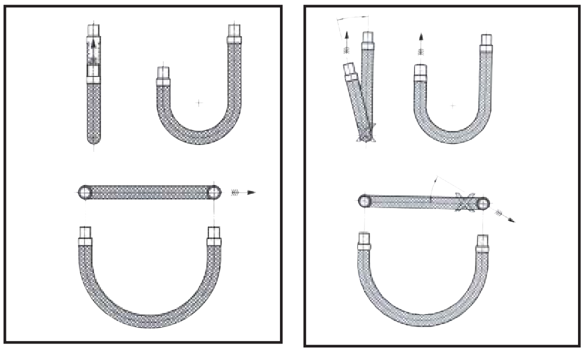
BENDING
Install a hose in its most natural loop. Overbending lowers the pressure capacity and the cycle life



WEIGHT
The weight of the hose and the medium must be supported adequately.



TORSION
Torsion must be avoided. Torsion occurs when the movements are not in the same plane as the fittings.



INSTRUCTIONS FOR SELECTION, INSTALLATION AND MOUNTING

The life time of metal hoses will increase when next instructions are followed:

1. Select the right fittings
   Whenever possible select at least one swivel fitting or a floating flange. This avoids torsion problems during installation.

2. Do not overbend the hose (check technical data)
   Avoid overbending, specially close to the fittings. Install the hose in its most natural position, free of kinks and sharp bends.

3. Do not torque a corrugated metal hose
   Torsion can have dramatic consequences on the life of a corrugated metal hose. Torsion occurs when the movements are not in the same plane as the fittings. Use two keys when fixing swivel nuts.
   Note: Stripwound hose can absorb some torsion.

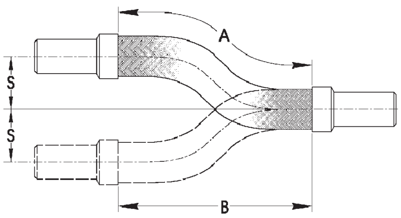
4. Avoid scratching over rough surfaces
   The braiding is the essential part of a hose assembly to withstand the internal pressure. A damaged braid diminishes the pressure capacity of the assembly and is detrimental to its function.

5. Avoid exposure to weld or grinding splatters
   Weld or grind splatters may lead to corrosion of the stainless steel parts. Use a heat proof shield (no plastic!) during welding or grinding in the proximity of metal hoses.

ENGINEERING DATA

DETERMINING MINIMUM OVERALL LENGTH OF HOSE ASSEMBLIES FOR INTERMITTENT FLEXURE

From the “minimum c/l bend radius for flexing bend” column in the hose specifications, obtain the proper bend radius for the type and size of hose chosen. Use the formulas below to calculate the length “A” of the exposed hose required. Determine the overall length of fittings from fitting specification pages and add to the exposed length of hose “A” to arrive at the assembly overall length. Distance between end connections should be such that there is no stress on the hose in the extreme offset position.



FOR INTERMITTENT FLEXURE

Use formulas and table for “K” below to determine the required hose length

Formula

$A = 2{,}8\sqrt{R_h \times 2S}$

$B = K \times A$

* When $S \leqslant 0{,}5R_h$,otherwise another installation is required.

In order to find the overall length, add the length of the fittings to the calculated length “A”.

Example

Hose nominal I.D. 32 mm.
Type BW656-1S, min. c/l bend radius for flexing bend R_h = 230 mm from table. Desired movement S = 80 mm, $0{,}5R_h = 0{,}5 \times 230 = 115 \Rightarrow S(=80) \leqslant 115 \Rightarrow$ is allowed.

Calculation

$A = 2{,}8\sqrt{230 \times 2 \times 80} = 537$ mm

A/S = 537 / 80 = 6,71 K = 0,988 (see table”K”)

B = 0,988 x 537 = 531 mm

FOR NON-MOVING OFFSET INSTALLATIONS

Use formulas and table for “K” below to determine the required hose length “A”.

Formula

$A = 2\sqrt{R_e \times 2S}$

$B = K \times A$

* When $S \leqslant 1{,}5R_e$,otherwise another installation is required.

In order to find the overall length, add the length of the fittings to the calculated length “A”.

Example

Hose nominal I.D. 50 mm.
Type BW856 -1H, min. c/l bend radius for permanent bend R_e = 140 mm from table. Desired movement S = 120 mm, $1{,}5R_e = 1{,}5 \times 140 = 210 \Rightarrow S(=120) \leqslant 210 \Rightarrow$ is allowed.

Calculation

$A = 2\sqrt{140 \times 2 \times 120} = 366$ mm

A/S = 366 / 120 = 3,05 K = 0,930 (see table “K”)

B = 0,930 x 366 = 340 mm

EXPLANATION OF FORMULA

A = Exposed length of hose
B = Installed length of hose (as illustrated)
S = Lateral movement

K = Factor, see table below
R_h = min. c/l bend radius for flexing bend
R_e = min. c/l bend radius for permanent bend

TABLE FOR K

A/S	2	2,5	3	3,5	4	4,5	5	6	7	8	9	10	11	12	13	⩾ 14
K	0,825	0,897	0,928	0,947	0,960	0,970	0,975	0,985	0,990	0,993	0,994	0,995	0,996	0,997	0,997	0,998

ENGINEERING DATA

VERTICAL LOOP FOR MAXIMUM VERTICAL TRAVEL

The illustration at the right shows the proper method of installing hose in vertical loops.
The formula and the table for “B” will aid in determining the overall length of an assembly.

Formula

Overall length= B + 0,5 π. A + 0,5S

Data
Using 25 mm type BW856-1H hose with fittings attached.

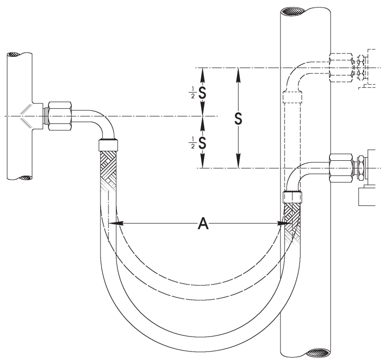
Example

A = 230 x 2 = 460 mm (2x “minimum c/l bend radius for flexing bend”, see table type BW856).

B = 410 mm (from table “B”)
S = 200 mm (desired movement)

Overall length=

410 + 0,5 π . 460 + 100 = 1232,6 mm
or appr. 1235 mm.



VERTICAL LOOP FOR SHORT HORIZONTAL TRAVEL

The formula and the table for “B” will aid in determining the overall length for an assembly when installed as illustrated in the drawing on the right.

Formula

Overall length = B + 0,5 π (A + S)

$$C = \frac{A + B + (0,5\,\pi\,.\,S)}{2}$$

Data
Using 10 mm type BW656-1S, with fittings attached.

Example
A =150 x 2 = 300 mm (2x min. c/l bend radius for flexing bend, see type BW 656).

B =280 mm (from table “B”)

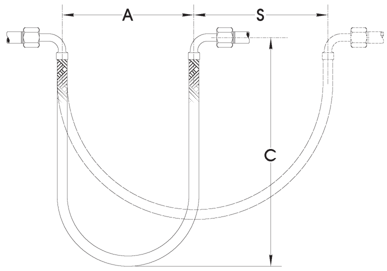
S =250 mm (desired movement)

Overall length =

280 + 0,5 π (300 + 250) = 1143,9 mm or appr. 1145 mm.

$$C = \frac{300 + 280 + (0,5\,\pi\,.\,250)}{2}$$

C = 486,3 mm or appr. 490 mm.



HORIZONTAL LOOP FOR MAXIMUM HORIZONTAL TRAVEL

The illustration on the right is another example of a typical installation of hose in which the movement is horizontal. The purpose of the support is to prevent the hose from sagging and causing failure near the fittings.

Formula
Overall length= B + 0,5 π . A + 0,5S

Data
Using 12 mm type BW856-1H hose with fittings attached.

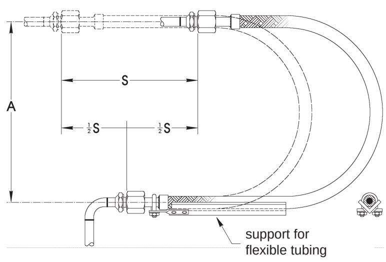
Example
A = 2 x 205= 410 mm (2x “minimum c/l bendradius for flexing bend”, see type BW856)

B =310 (from table “B”)

S =desired movement 550 mm

Overall length=

310+(0,5 π . 410) +(0,5 x 550)=1229 mm
or appr. 1230 mm.



EXPLANATION OF FORMULA

A = Bend diameter (2 x R_h)
B = Factor including the length of fittings and allowance for straight sections beyond each fitting.
S = Movement

C = Required free height
R_h = min. c/l bend radius for flexing bend
R_e = min. c/l bend radius for permanent bend

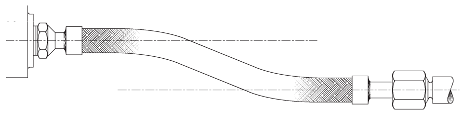
TABLE FOR B

Inside hose Diameter																
	mm	5-8	10	12-15	20	25	32	40	50	65	75	100	125	150	200	250
	inch	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10
B	mm	230	280	310	360	410	460	510	560	610	660	760	840	910	1020	1170

ENGINEERING DATA

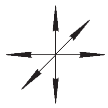
MISALIGNMENT AND OFFSET MOVEMENTS

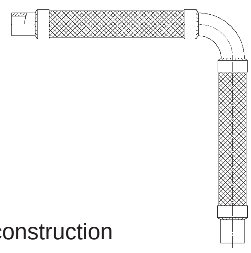
For intermittent offset movement consult offset formula on page 9 and the “minimum c/l bend radius for flexing bend” columns in specifications for each type and size of corrugated hose.
For misalignment and ease of installation where there is no significant movement or vibration, consult offset formula on page 9 and “minimum c/l bend radius for permanent bend” columns in specifications for each type and size of corrugated hose.



MUTIPLE MOVEMENTS

To absorb movements in several directions and at several planes, a 90° flexible hose assembly is recommend, made up out of two short flexibles which are connected by a 90° pipe angle. At both ends of the assembly swivel flanges are used for connection to the piping system. This is important in order to avoid tension of the flexible hoses during installation. The necessary length of the hoses is determined by various movements. Torsion on account of these movements will then be absorbed by the two hoses.



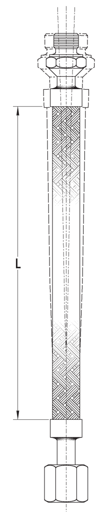


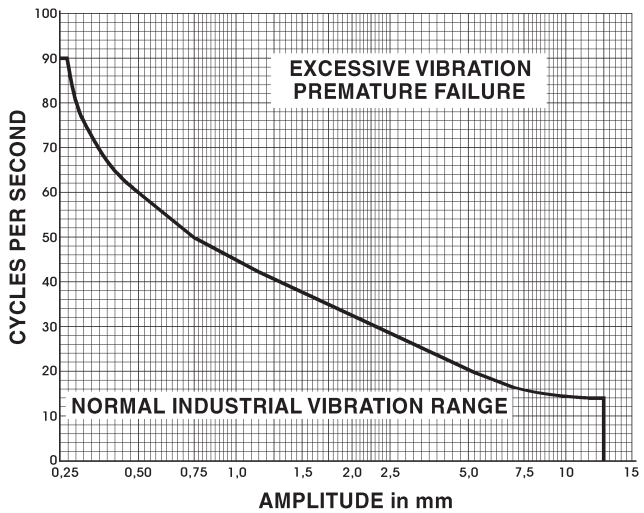
“Dog leg” construction

VIBRATION

Normal vibration encountered in average industrial applications is illustrated in the chart at the right.
Under these conditions the exposed length of hose (Dimension L, drawing at right), should never be shorter than length given in “min. exposed length for normal vibration” in specifications for each type and size of corrugated hose.

Definitions
Amplitude equals lateral displacement from c/l of hose. Double amplitude equals lateral displacement on both sides of hose or 2 times the amplitude.





ENGINEERING DATA

CORROSION RESISTANCE TABLE

The following tables may be used only as a guide in the selection of the most suitable hose and fitting material when conveying a given medium. The listed media are in general considered to be pure, at room temperature and, unless otherwise specified, dry. A change in any one of these conditions may change the rating. No attempt has been made to account for variations in service conditions since these variables are too innumerable and complex.

Additional information on service life, etc. is keyed to the following notes. The numbers appear as superscripts to the upper right of the rating as: Acetaldehyde C[2] (bronze).

"Dry" can also be referred to as "anhydrous".

When there is a question on this reference table or you have unusual service conditions or media, contact us before ordering.

RATING CODE

A - Suitable (normal condition)

B - Limited Service

C - Unsuitable

NOTES

[1] Susceptible to intergranular corrosion

[2] May cause explosive reaction

[3] Susceptible to stress corrosion cracking

[4] Susceptible to pitting type corrosion

[5] Discolors

[6] Concentration over 50% and/or temperature over 95°C, refer to our engineering department.

	BRONZE	MONEL	CARBON STEEL	STAINLESS 304L/321	STAINLESS 316L
Acetaldehyde	C[2]	A	B	A	A
Acetanilide	B[3]	B	B	B	B
Acetic acid	C	B	C	B[1]	A[1]
Acetic anhydride	B	B	C	B	B
Acetone	A	A	C	B	B
Acetophenone	A	A	A	B	B
Acetylene	C[2]	A	A	A	A
Acrylates	B	B	B	B	B
Acrylic acid	B	B	C	B	B
Acrylonitrile	A[4]	A	A	A	A
Alcohols	A[5]	A	A[5]	A	A
Alum	B	B	C	B	B
Alumina	A	A	A	A	A
Aluminum acetate	B	B	C	B	B
Aluminum chloride - dry	B[1]	A	B	A	A
Aluminum chloride - moist	C	B	C[3]	C[3,4]	C[3]
Aluminum fluoride	B	B	B	C	C
Aluminum hydroxide	B	B	B	A	A
Aluminum sulfate	C	B	C	B[1,3]	A[3]
Ammonia - dry	A	A	A	A	A
Ammonia - moist	C[3]	C	C[3]	A	A
Ammonium acetate	C	A	A	A	A
Ammonium bromide	C	B	C	C[4]	C[4]
Ammonium chloride - dry	C[4]	A	B	A	A
Ammonium chloride - moist	C[4]	B	C	C[3,4]	C[3]
Ammonium hydroxide 6	C[3]	A	B	A	A
Ammonium nitrate	C[2]	C[2]	C[3]	A	A
Ammonium sulfate	C	B	C	C[1]	B
Amyl acetate	A	A	A	A	A
Amyl alcohol	A	A	A	A	A
Amyl chloride - dry	A	A	B	A	A
Amyl chloride - moist	C	B	C	C[3,4]	C[3]
Aniline	C[3]	A	C	B	B
Aniline dyes	C[3]	A	C	B	B
Asphalt	A	A	A	A	A
Atmosphere - industrial	A	A	C	B[4]	A[4]
Atmosphere - marine	A	A	C	B[4]	B[4]
Atmosphere - rural	A	A	C	A	A
Barium carbonate	B	B	B	B	B
Barium chloride - dry	B	A	A	A	A
Barium chloride - moist	B	B	B	C[3,4]	C[3]
Barium hydroxide	C	B	B	B	A
Barium sulfate	B	B	B	B	B
Barium sufide	C	C	C	B	B
Beer	A	A	C	A	A
Beet sugar syrups	A	A	B	A	A

	BRONZE	MONEL	CARBON STEEL	STAINLESS 304L/321	STAINLESS 316L
Benzaldehyde	C	B	C	B	B
Benzene (Benzol)	A	A	A	A	A
Benzoic acid	A	B	C	A	A
Benzylamine	C[3]	B	B	B	B
Benzyl chloride - dry	B	A	B	A	A
Benzyl chloride - moist	B	B	C	C[3,4]	C[3]
Black liquor, sulfate process	C	A	C	B	B
Bleaching powder - dry	B	A	C	A	A
Bleaching powder - moist	B[1]	B	C	C[1,3,4]	C[3,4]
Borax	A	A	B	A	A
Bordeaux mixture	B	A	B	A	A
Boric acid	B	B	C	A	A
Boron trichloride - dry	B	B	A	B	B
Boron trichloride - moist	B	B	B	C[3,4]	C[3]
Boron trifluoride - dry	B	B	A	B	B
Brines	B	B	C	C[3,4]	C[3]
Bromic acid	C	C	C	C	C
Bromine - dry	A	A	C	B	B
Bromine - moist	B	B	C	C	C
Butadiene	A	A	A	A	A
Butane	A	A	A	A	A
Butanol (butyl alcohol)	A	A	A[5]	A	A
Butyl phenols	B	A	B[5]	B	B
Butylamine	C[3]	A	A	A	A
Butyric acid	B	B	C	B	B
Cadmium chloride - moist	B	B	C	C[3,4]	C[3]
Cadmium chloride - dry	B	A	A	A	A
Cadmium sulfate	B	A	B	A	A
Calcium bisulfite	B	B	B	B[1]	B
Calcium bromide	B	B	C	C[3]	C[3]
Calcium chloride - moist	B	B	C	C[3,4]	C[3]
Calcium chloride - dry	B	A	A	A	A
Calcium fluoride	B	B	C	C	C
Calcium hydroxide	B	B	C	B	B

ENGINEERING DATA

CORROSION RESISTANCE TABLE

	BRONZE	MONEL	CARBON STEEL	STAINLESS 304L/321	STAINLESS 316L
Calcium hypochlorite - moist	C	B	C	C[3,4]	C[3,4]
Calcium hypochlorite - dry	B	A	B	A	A
Calcium nitrate	B	B	C[1]	B[1]	B
Calcium oxide	A	A	A	A	A
Cane sugar syrups	A	A	B	A	A
Carbolic acid (phenol)	B	B	C	B	A
Carbon dioxide - dry	A	A	A	A	A
Carbon dioxide - moist	C[4]	A	C	A	A
Carbonated beverages	B	A	C	A	A
Carbonated water	B[4]	A	C	A	A
Carbon disulfide	B	B	B	B	B
Carbon tetrachloride - dry	A	A	B	A	A
Carbon tetrachloride - moist	B	B	C	C[3,4]	C4
Castor oil	A	A	A	A	A
Chlorine - dry	A	A	B	A	A
Chlorine - moist	C	B	C	C[3,4]	C[3]
Chloroacetic acid	C	B	C	C[3,4]	C[3]
Chloric acid	C	C	C	C[3]	C[3]
Chlorine dioxide - dry	B	A	B	A	A
Chlorine dioxide - moist	C	B	C	C[3,4]	C[3]
Chloroform - dry	A	A	A	A	A
Chloroform - moist	B	B	C	C[3,4]	C[3]
Chromic acid	C	B	C[3]	C[1,4]	B
Chromic fluorides	C	B	C	C	C
Chromic hydroxide	B	B	B	B	B
Chromium sulfate	B	B	C	B	B
Cider	A	A	C	A	A
Citric acid	C	B	C	B	B
Coffee	A	A	C	A	A
Copper chloride - dry	A	A	B	A	A
Copper chloride - moist	B	B	C	C[3,4]	C[3]
Copper nitrate	C	C	C	A	A
Copper sulfate	C	B	C	B[1]	B
Corn oil	A	A	A	A	A
Cottonseed oil	A	A	A	A	A
Creosole	B	A	A	A	A
Crude oil	B	A	C	C[1]	B
Cyclohexane	B	B	B	B	B
DDT	B	B[4]	C	A	A
Dichloroethane - dry	A	A	A	A	A
Dichloroethane - moist	C	B	C	C[4]	C[4]
Dichloroethylene - dry	A	A	B	A	A
Dichloroethylene - moist	C	B	C	C[4]	C[4]
Dichlorophenol	B	B	C	B[3]	B[3]
Diisocyanate	B	A	B	A	A
Dimethyl sulfate	B	B	B	B	B
Epichlorohydrin - dry	B[4]	A	C[4]	A	A
Epichlorohydrin - moist	C[4]	B	C[4]	C[3,4]	C[3]
Ethane	A	A	A	A	A
Ethers	A	A	B	A	A
Ethyl acetate	A	B	B	B	B
Ethyl alcohol	A	A	A	A	A
Ethyl benzene	B[5]	B	B	B[3]	B
Ethyl chloride - dry	A	A	A	A	A
Ethyl chloride - moist	B	B	C	C[3,4]	C[3]
Ethylene	A	A	A	A	A
Ethylene chlorohydrin - dry	B	A	B	A	A
Ethylene chlorohydrin - moist	C	B	C	C[4]	C[4]
Ethylene diamine	C[1]	B	B	B	B
Ethylene glycol	A	A	A	A	A

	BRONZE	MONEL	CARBON STEEL	STAINLESS 304L/321	STAINLESS 316L
Ethylene oxide	C[2]	B	B	A	A
Fatty acids	C	B	C	B[1,4]	A
Ferric chloride - dry	B	A	B	A	A
Ferric chloride - moist	C	B	C	C[1,3,4]	C[3,4]
Ferric nitrate	C	C	C	B	B
Ferric sulfate	C	C	C	B[1]	A
Ferrous chloride - dry	B	A	B	A	A
Ferrous chloride - moist	C	B	C	C[3,4]	C[3]
Ferrous sulfate	B	A	C	B[4]	B
Fluorine - dry	B	A	A	A	A
Fluorine - moist	C	B	C	C	C
Formaldehyde	A[5]	A[5]	B[5]	B	B
Formic acid	B	B	C	B[1]	A
Freon	A	A	A	A	A
Fruitjuices	C	A	C	A	A
Fuel oil	B	A	C	A	A
Furfural	A	A	B	A	A
Gasoline	A	A	B	A	A
Gelatine	A	A	C	A	A
Glucose	A	A	B	A	A
Glue	B	A	C	A	A
Glutamic acid	C[4,5]	E[3]	C	B[3,4]	B[3,4]
Glycerin (glycerol)	A	A	B[5]	A	A
Heptane	A	A	A	A	A
Hexachloroethane - dry	B	A	B	A	A
Hexachloroethane - moist	C	B	C	C[4]	C[4]
Hydrazine	C[3]	C	C	A	A
Hydrobromic acid	C	C	C	C[4]	C
Hydrocarbons, pure	A	A	A	A	A
Hydrochloric acid	C	B	C	C[4]	C[4]
Hydrocyanic acid	C	B	C[3]	C[1,3]	C[3]
Hydrofluoric acid	C	B	C	C[1,3]	C
Hydrofluorsilicic acid	C	B	C	C	C
Hydrogen	A	A	A	A	A
Hydrogen chloride - dry	A	A	B	A	A
Hydrogen chloride - moist	C	B	C	C[4]	C[4]
Hydrogen peroxide	C	C	C	B	B
Hydrogen sulfide - dry	A[5]	A	B	A	A
Hydrogen sulfide - moist	C[4,5]	E[3]	C[3]	B[4]	A
Hydroquinone	B	B	B[5]	B	B
Kerosine (kerosene)	A	A	B	A	A
Lacquers	A	A	A	A	A
Lacquer solvents	A	A	A	A	A
Lactic acid	B	B	C	B[1,4]	B[1]
Lime	A	A	B	A	A
Lime - sulfur	C	B	C	B	B
Linseed oil	A	A	B	A	A
Lithium chloride - dry	B	A	B	A	A
Lithium chloride - moist	B	B	B	C[3,4]	C[3]
Lithium hydroxide	C	B	B	B	B
Magnesium chloride - dry	B	A	B	A	A
Magnesium chloride - moist	B	B	C	C[3,4]	C[3]
Magnesium hydroxide	A	A	A	A	A
Magnesium sulfate	A	A	B	B	A
Maleic acid	C	B	B	B[1]	B
Mercuric chloride - dry	B	A	B	A	A
Mercuric chloride - moist	C	B	C	C[3,4]	C[3]
Mercurous nitrate	C[3]	B[3]	B	B	B
Mercury	C	B[3]	B	B	B
Methyl alcohol	A	A	A	A	A

ENGINEERING DATA

CORROSION RESISTANCE TABLE

	BRONZE	MONEL	CARBON STEEL	STAINLESS 304L/321	STAINLESS 316L
Methane	A	A	A	A	A
Methyl chloride - dry	A	A	A	A	A
Methyl chloride - moist	B	B	C	C[3,4]	C[3]
Methyl ethyl ketone	B	B	B	B	B
Milk	B	A	C	A	A
Mine water	C	B	C	B	B
Napthalene	B	B	A	A	A
Natural gas	A	A	A	A	A
Nickel chloride - dry	B	A	B	A	A
Nickel chloride - moist	C	B	C	C[3,4]	C[3]
Nitric acid	C	C	C	A	A
Nitrotoluene	B	B	B	B	B
Nitrogen	A	A	A	A	A
Oleic acid	B[5]	A	C	B[4]	B
Oleum (fuming H2S04)	C	C	B[3]	B	B
Axalic acid	B	B	C	C[1]	B[1]
Oxygen	A	A	C	A	A
Palmitic acid	B	A	C	A	A
Parafin	A	A	B	A	A
Pentane	B	B	B	B	B
Phenol (carbolic acid)	B	B	C	B	A
Phosphoric acid	C	B	C	C[1]	B[1]
Phthalic acid	B	B	C	B[1]	B
Pitric acid	C	C	C	B	B
Potassium bromide	B	B	C	C	C
Potassium carbonate	B	A	B	A	A
Potassium chloride - dry	A	A	A	A	A
Potassium chloride - moist	B[3]	B	C	C[3,4]	C[3]
Potassium chromate	B	B	C	B	B
Potassium cyanide	C[4]	A	B	B	B
Potassium dichromate	C	A	C	A	A
Potassium fluoride	B	B	C	C	C
Potassium hydroxide	C[5]	A[3]	B[3]	B[3]	A
Potassium nitrate	B	B	B	B	A
Potassium permanganate	B	B	B	B	B
Potassium sulfate	B	B	C	B	B
Propane	A	A	A	A	A
Propylene	A	A	A	A	A
Propylene oxide	C	C	C	A	A
Propylene dichloride - dry	B	A	B	A	A
Propylene dichloride - moist	C	B	C	C[4]	C[4]
Pyridine	B[5]	B	B[5]	B	B
Pyrrolidine	C[3]	B	B	B	A
Quinine	B	B	C	B	B
Rosin	A[5]	A	C[5]	A	A
Sea water	B	B	C	C[3,4]	C[3]
Sewage	A	A	B	A	A
Silver salts	C	A	C	B	B
Silver nitrate	C	C	C[3]	B	A
Soap solutions	A	A	B	A	A
Sodium	C	A	A	A	A
Sodium acetate	B	B	B	B[4]	B
Sodium bicarbonate	B	A	C	A	A
Sodium bisulfate	B	B	C	B[1,4]	A
Sodium bisulfite	C[4]	B[4]	C	B	B
Sodium bromide	B	B	B	C	C
Sodium carbonate	B	A	B	A	A
Sodium chlorate - dry	B	A	A	A	A
Sodium chlorate - moist	B	B	C	C[3,4]	C[3]
Sodium chloride - dry	B	A	B	A	A

	BRONZE	MONEL	CARBON STEEL	STAINLESS 304L/321	STAINLESS 316L
Sodium chloride - moist	B	B	C	C[3,4]	C[3]
Sodium chromate	A	A	B	A	A
Sodium citrate	C	B	B	B	B
Sodium cyanide	C[4]	B	B	B	B
Sodium dichromate	C	B	C	A	A
Sodium fluoride	B	A	B	C[4]	C
Sodium hydroxide 6	B[4]	A	B[3]	B[3]	B[3]
Sodium hypochlorite - dry	B	A	B	A	A
Sodium hypochlorite - moist	C	B	C	C[1,4]	C[4]
Sodium metasilicate	B	A	B	A	A
Sodium nitrate	B	A	B[3]	A	A
Sodium nitrite	B	B	B	B	B
Sodium peroxide	C	B	C	A	A
Sodium phosphate	B	A	C	A	A
Sodium silicate	A	A	B	A	A
Sodium sulfate	A	A	B	B[3]	B
Soldium sulfide	C	A	C	B[4]	B
Sodium sulfite	B	A	C	B	B
Sodium thiosulfate	C	A	C	B	B
Stannic chloride - dry	B	A	B	A	A
Stannic chloride - moist	C	B	C	C[3,4]	C[3]
Stannous chloride - dry	B	A	B	A	A
Stannous chloride - moist	C	B	C	C[3,4]	C[3]
Steam	A	A[3]	C	A	A
Stearic acid	B	B	C[5]	B	B
Strontium nitrate	B	B	C	B	B
Sulfate black liquor	C	B	B	B	B
Sulfate green liquor	C	B	B	B[3]	B
Sugar solutions	A	A	B	A	A
Sulfur - dry	C	A	B	A	A
Sulfur - molten	C	C	C	C	B
Sulfur chloride - dry	B	A	C	A	A
Sulfur chloride - moist	C	B	C	C[3,4]	C[3]
Sulfur dioxide - dry	B	B	C	C[1]	B
Sulfur dioxide - moist	C[4]	C	C	C[1]	B
Sulfur trioxide - dry	A	A	C	A	A
Sulfuric acid, 95-100%	B	B	B	A	A
Sulfuric acid, 80- 95%	B	B	C	B	B
Sulfuric acid, 40- 80%	C	C	C	C[1]	C[1]
Sulfuric acid, 40%	C	C	C	C[1]	C[1]
Sulfurous acid	B	B	C	C[1,4]	C[1,4]
Tail oil	C	B	B	B	B
Tannic acid	B	B	C[5]	B	B
Tar	A	A	B	A	A
Tartaric acid	C	B	C	B	B
Tetraphosphoric acid	C	C	C	B	B
Toluene	A	A	A	A	A
Trichloroacetic acid	C	B	C	C[3,4]	C[4]
Trichloroethane - dry	A	A	A	A	A
Trichloroethane - moist	C	B	C	C[4]	C[4]
Trichloroethylene - dry	A	A	A	A	A
Trichloroethylene - moist	C	B	C	C[4]	C[4]
Turpentine	A	A	B	A	A
Varnish	A	A	B	A	A
Vinegar	B	B	C	A	A
Water, potable	A	A	C	A	A
Xylene	B	A	B	A	A
Zinc chloride - dry	B	A	A	A	A
Zinc chloride - moist	C[4]	B	C	C[3,4]	C[3]
Zinc sulfate	B	B	C	B	A