



Material of Construction

All wetted parts are made from SS-316.

Optional:

SS-316L, Hastelloy B/C, Titanium, Monel, Nickel, Inconel, Zirconium, Tantalum, Carbon Steel etc. for different liquids corrosive to SS-316.

Note: Amar offers all the internal & optionally external wetted parts in the same material of construction as that of body & head to give complete corrosion resisting autoclaves.

Most of the above material are available for stirred, non-stirred, fabricated, glass & shaker autoclaves.

Material Selection Guide

AMAR gives recommendation for material selection for particular media, however it does not guarantee 100% corrosion resistance of a particular M.O.C to a particular corrosive media, as it also depends on various parameters like temperature, pressures, concentration etc. of the reactions. Reactors upto 25 ltrs. are machined from rolled / forged bar stock & reactors above 25 ltrs. are normally fabricated from plates. The material listed below may not be available in all possible sizes.

GENERAL CORROSION PROPERTIES OF SOME METALS AND ALLOYS* :

RATINGS

- 0. Unsuitable. Not available in form required or not suitable for fabrication requirements or not suitable for corrosion conditions.
- 1. Poor to fair
- 2. Fair. For mild conditions or when periodic replacement is possible. Restricted use.
- 3. Fair to good
- 4. Good. Suitable when superior alternative are uneconomical
- 5. Good to excellent
- 6. Normally excellent

Small variations in service condition may appreciably affect corrosion. Choice of material is therefore guided wherever possible by a combination of experience and laboratory and site tests.

Materials	Non-oxidizing or reducing media				Liquids			Gases			
	Acid solutions, excluding hydrochloric, Phosphoric, sulfuric, (most condition many organics)	Neutral solutions, e.g. many Non-oxidizing salt solutions, chlorides, sulfates	Alkaline solutions e.g.		Oxidizing Media			Halogen and derivatives			
			Caustic and mild alkalis, excluding ammonium hydroxide	Ammonium hydroxide and amines	Acid solutions, e.g. nitric	Neutral or alkaline Solutions e.g. per sulfates, peroxides, chromates	Pitting media, acid ferric chloride solutions	Halogen		Halide acids, moist, e.g. hydrochloric hydrolysis products of organic halides	Hydrogen halides, dry, e.g., dry, Hydrogen chloride, °C
Stainless Steel, (SS316)	4	5	5	6	5	6	1	0	3		
Hastelloy C 276	5	6	5	6	4	6	5	5	4	4	4<400 3<480
Hastelloy B	6	5	4	4	0	3	0	1	3	5	4<400 3<480
Inconel 600	3	6	6	6	3	6	1	2	5	3	5<220 4<480
Monel 400	5	6	6	1	0	5	1	2	6	3	6<220 3<400 2<480
Nickel 200-commercial	4	5	6	1	0	5	0	2	6	2	6<220 5<400 4<480
Titanium	3	6	2	6	6	6	6	6	0	1	0
Zirconium	3	6	2	6	6	6	2	6	1	6	0



Stainless Steel 316/316L

SS316 & 316L has almost identical corrosion resistance properties, only that 316L is a low carbon stainless steel.

It has excellent corrosion resistance to

- Most organic acid systems like acetic, formic etc.
- Ammonia & most ammonia compounds
- Many salts except chlorides
- Most commercial gases at moderate temperature & pressures.
- Hydrogen chloride, fluoride & chloride in scrupulously anhydrous systems

It has poor resistance to

- Organic halides
- Dilute sulfuric, sulfurous, phosphoric & nitric acids at high temperatures & Pressures.
- Halogen acids at low temperature & in dilute forms
- Caustics, Halogen salts; chlorides

Hastelloy C 276 / C22/ C2000

It is a nickel, chromium, molybdenum alloy that has the widest corrosion resistance & is the most widely used alloy for corrosive media & next most popular after SS316

It has excellent corrosion resistance to

- Variety of chloride compounds & chlorine contaminated material
- Strong oxidizing chloride solutions such as wet chlorine & hydrochloride & sodium hypochlorite solutions
- Concentrated Hydrochloric, Sulfuric & Phosphoric acids

Depending on the application C276, C22 or C2000 can be selected but C276 is the most common & easily available grade.

Hastelloy B3

It is a nickel molybdenum alloy & offers excellent corrosion resistance to solutions of Hydrochloric, Sulfuric & Phosphoric acid in all concentrations & at all temperatures in the absence of oxidizing agents.

Monel 400

It has more better resistance than nickel in reducing environments.

It has excellent corrosion resistance to

- Caustic Solutions
- Chloride salts
- Fluorine & hydrogen fluoride

It has poor resistance to Nitric acid & Ammonia systems.

Inconel 600

It is a nickel alloy & offers excellent resistance to

- Caustic & chlorides at high temperature & pressure when sulfur compounds are present.
- Also suitable for very high temperature applications.
- Reducing - oxidizing environment
- Sulfur free gases

Nickel 200/201

It offers excellent corrosion resistance to

- Handling concentrated alkalis
- Hot caustic environment
- Chlorinated solvents & Phenol

Titanium Gr 2 / Gr 4

It is lighter material & has excellent corrosion resistance to

- Oxidizing agents such as aqua regia & other mixed acids
- Nitric acid at all concentrations except red fuming nitric acid
- Chloride ions, Ferric chloride, cupric chloride & other hot chloride solutions.
- Mild reducing media such as sulfuric & hydrochloric acid
- Titanium burns vigorously in presence of oxygen at high temperatures & pressures.

The material becomes softer above 250°C & hence not advisable above 250°C.

Zirconium

It offers excellent corrosion resistance to

- Reducing environments
- All chlorides except ferric & cupric
- Hydrochloride & Sulfuric acids below 70% concentrations.
- Phosphoric, nitric acids & alkaline solutions.

It has poor resistance to oxidizing agents.

Tantalum

Tantalum is practically inert to many oxidizing & reducing acids. It offers the best & most outstanding resistance to wide variety of corrosive media including hydrochloric, nitric, sulfuric & phosphoric acids. It is attacked by hot alkalis & hydrofluoric acid. The costs are prohibitive however tantalum liner or inner wetted parts of tantalum & others part of Titanium or hastelloy C can be offered. Small sizes such as 50ml - 700ml can be manufactured completely in Tantalum. The max. temp. are restricted upto 250°C only.

Chemical Composition of material of construction of autoclave (Major Elements in %)

Sr. No.	Material	Fe	Ni	Cr	Mo	C	Other
1.	Stainless Steel SS316	60-67	9-12	18-21	2-3	0.08	2.0 Si, 1.5 Mn
2.	Hastelloy-C276	4-7	55-63	14.5-16.5	15-17	0.02	3-4.5W
3.	Hastelloy-B3	2	67-71	1	26-30	0.02	—
4.	Monel - 400	2	65	—	—	0.3	2.3 - 3.1 Al, 0.35-0.85 Ti, 30 Cu
5.	Inconel - 600	6-10	73-80	14-17	—	0.15	—
6.	Nickel - 200	0.4	99.4	—	—	0.15	—
7.	Titanium Gr. 2/Gr. 4	99% Pure Titanium			—	—	—
8.	Zirconium 702	95.5 — Zr, 4.5 HF			—	—	—