



# Basic Material

## A) Carbon Steel

- General: Using within min. -29 °C to max. 425 °C
- The Carbon Equivalent (CE) for carbon steel intended for welding shall not exceed 0.43% based on the long formula:  $CE = C + Mn / 6 + (Cr + Mo + V) / 5 + (Cu + Ni) / 15$
- Applications:
  - Service: Non-corrosive piping system ( fresh water, plant air, nitrogen, fuel gas, etc.)
  - Pipes: ASTM A106 Gr.B, API 5L Gr.B
  - Fittings: ASTM A234 Gr.WPB
  - Forgings: ASTM A105

## B) Low Temp Carbon Steel

- General: Using if the minimum service temperature is below -29 °C
- Applications:
  - Service: Low temperature non-corrosive piping system ( flare system )
  - Pipes: ASTM A333 Gr.6
  - Fittings: ASTM A420 Gr.WPL6
  - Forgings: ASTM A350 Gr.LF2

## C) Austenitic Stainless Steel

- General:
  - The use of austenitic stainless steel in offshore is limited to a maximum service temperature of 60 °C
  - Using when the corrosion rate is too high to use carbon steel ( typical more than 3mm or 6mm max. corrosion allowance for the design life )
  - Any hydrostatic testing of austenitic stainless steel shall be conducted with water containing less than 2 mg/kg chlorides, and any open ends sealed after drying to ensure no moisture ingress.
- Application:
  - Service: Fuel gas, chemical injection, instrument air, wet hydrocarbon ( corrosive ).
  - Pipes: ASTM A312 Gr.TP304/304L, ASTM A312 Gr.TP316/316L
  - Fittings: ASTM 403 Gr.WP304/304L, ASTM 403 Gr.WP316/316L
  - Forgings: ASTM A182 Gr.F304/304L, ASTM A 182 Gr.F316/316L

## D) Duplex Stainless Steel

- General: Using when the design condition is exceed the limit do SS316
- Any hydrostatic testing of austenitic stainless steel shall be conducted with water containing less than 2 mg/kg chlorides, and any open ends sealed after drying to ensure no moisture ingress.
- Application:
  - Service:
    - Pipes: ASTM A790 UNS S31803
  - Fittings: ASTM A815 UNS S31803
  - Forgings: ASTM A182 Gr.F51

## E) Alloy Steel

- Elevated Temperature Services:
  - General:
    - Cr-Mo heat resistant steel contain 0.5–9% Cr and 0.5–1.0% Mo. Carbon content max 0.20%
    - Supplied in normalized and tempered, quenched and tempered or annealed condition
    - These Alloy Steels are used up to max temperature about 650 °C
  - Application:
    - Pipes: ASTM A 335 Gr.P11, A335 Gr.P22
    - Fittings: ASTM A234 Gr.WP11, A234 Gr.WP22
    - Forgings: ASTM A182 Gr.F11, A182 Gr.F22
- Low Temperature Services:
  - General: Application with temperature from 0 °C to -195°C. Nickel steels is typically used
  - Application:
    - Pipes: ASTM A 333 Gr.3
    - Fittings: ASTM A420 Gr.WPL3
    - Forgings: ASTM A350 Gr.LF3

## I) Elastomeric

- Natural Rubber->NR
- Styrene Butadiene Rubber->SBR
- Neoprene Rubber->CR
- Butyl Rubber->IIR
- Chlorosulphonated polyethylene->CSM
- Nitrile Butadiene Rubber->NBR, HNBR
- Ethylene Propylene Rubber->EPDM
- Fluoroelastomers->FKM
- Perfluoro Polymer->FFKM
- Fluor-Silicone Rubbers->VMQ, PMQ, FMQ
- Polyurethane Rubbers->AU,EU

## H) Non-Metallic

- Glassfibre Reinforced Epoxy->GRE
- Glassfibre Reinforced Vinylster->GRV
- Using:
  - No use in hydrocarbon and methanol system
  - Maxintemal design temperature 20 bargs
  - Design temperature range for -40 °C up to 95°C for epoxy and up to 80 °C for vinylster
  - Commonly used for the sea water system in offshore
- Glassfibre Rainforced Plastic->GRP

## G) Thermoplastic

- Plasticised Polyvinyl chloride->PVC
- Unplasticised PVC->UPVC
- Polyethylene->PE
- Polyamide->PA
- Polypropylene->PP
- Fluoropolymers:
  - PolyTetraFluoroEthylene->PTFE
  - Polychlorotrifluoroethylen->PCTFE
  - Perfluoroalkoxy->PFE
  - Fluorinated ethylene propylene->FEP
  - Polyvinylidene fluoride->PVDF
- Polyphenylenesulphone->PPS
- Cross-linked Polyethylene->PEX
- Polyketone->PK
- Polyetheretherketone->PEEK

## F) Non-Ferrous Alloy

- Nickel Alloys:
  - Including Inconel and incoloy
  - Commonly used because of the high ppm
- Monel:
  - Monel is a nickel-copper alloy, 10%–90% commonly used
  - Service: sea water
- Copper-Nickel:
  - Cu-Ni 90/10, Cu-Ni 70/30
  - Services: sea water piping system
- Titanium:
  - Non-Alloyed grade: Good corrosion resistance, especially chlorite induced pitting and stress-corrosion cracking
  - Alloyed grade: Good resistance to oxidizing media, e.g. nitric acid
  - Resistance to reducing media superior to non-alloyed titanium