Annex SC
(normative)

Stainless and Carbon Steel Mixed Materials Storage Tanks

SC.1 Scope

SC.1.1 This Annex covers materials, design, fabrication, erection, and testing requirements for vertical, cylindrical, aboveground, closed- and open-top, welded, storage tanks constructed with stainless steel and carbon steel. Generally, in this Annex the term stainless steel includes austenitic or duplex unless noted otherwise. Stainless steel and carbon steel may be used in the same tank for shell rings, bottom plates, roof structure and other parts of a tank to provide product storage for conditions that require only certain portions of the tanks to provide added corrosion resistance. These tanks are mixed material tanks. Stainless steel and carbon steel plates may be mixed in the bottom, roof or within any shell course. This Annex does not cover stainless steel clad plate or strip lined construction.

SC.1.2 This Annex applies to tanks in non-refrigerated services with a maximum design temperature not exceeding 260 °C (500 °F). For the purposes of this Annex, the design temperature shall be the maximum design temperature as specified by the Purchaser. It is cautioned that exothermic reactions occurring inside unheated storage tanks can produce temperatures exceeding 40 °C (100 °F).

SC.1.3 This Annex states only the requirements that differ from the basic rules in this standard. For requirements not stated, the basic rules must be followed including Annex S and Annex X as applicable. References to paragraphs in this Annex shall be to the basic document unless stipulated otherwise.

SC.1.4 For limitations due to thermal effects see S.3.6 and X.3.7.

SC.1.5 The nameplate of the tank shall indicate that the tank is in accordance with this Annex by the addition of Annex SC to the information required by 10.1.1. In addition, the nameplate shall be marked with the maximum design temperature in the space indicated in Figure 10.1.

SC.2 Materials

SC.2.1 Materials shall be in accordance with Section 4, Annex S, and Annex X.

• **SC.2.2** Selection of the type/grade of stainless steel and carbon steel for mixed material tanks depends on the service and environment to which it will be exposed and the effects of fabrication processes. (S.4.3.2, S.4.4.3, and X.2.1.1) The Purchaser shall select the type/grade. The Purchaser shall also specify which components shall be stainless steel.

SC.2.3 Components of a tank including shell, roof, bottom or bottom openings and their reinforcement may be carbon steels meeting the requirements of Section 4, provided they are protected from corrosion and the design and details consider the dissimilar properties of the materials used. Carbon steel attachments (e.g., clips for scaffolding) shall not be welded directly to any internal stainless steel tank surface.

SC.2.4 Impact tests are not required for austenitic stainless steel base metals. See X.2.3.2 for impact testing requirements for duplex stainless steel. Carbon steels in a mixed material tank shall require impact testing in accordance with the basic document.

SC.2.5 Welding of stainless steel to carbon steel shall use stainless steel electrodes appropriate for the type/grade of stainless steel used and the welding process employed.

SC.3 Design

A structural analysis of the entire tank structure is required to adequately predict stresses due to differential movements if item a and either items b or c also apply:

a) austenitic stainless steel is joined to either carbon steel or duplex stainless steel components such as bottom to first shell course, adjacent shell courses, and roof to top shell course;

b) the design temperature exceeds 40 °C (100 °F) and the diameter exceeds 30 m (100 ft); or

c) the design temperature exceeds 93 °C (200 °F).

The structural analysis required above shall include all material properties that affect differential component expansion and necessary for adequate stress prediction.

The material combination of this paragraph applies to all other sub-paragraphs in Section SC.3. No analysis of stresses from differential movements is required for duplex stainless steel joined to carbon steel.

SC.3.1 Bottom

SC.3.1.1 When the bottom plate and first shell course are of different materials, the design shall account for differential component expansion.

SC.3.1.2 When the annular plate and first shell course are of different materials and the design temperature is greater than 40 °C (100 °F), the design shall account for differential shell component expansion. When the first shell course is carbon steel and the annular plate is stainless steel, the requirements of 5.5.1 shall apply.

SC.3.2 Shell Design

SC.3.2.1 The variable point design method shall not be used for design of mixed material tank shells.

SC.3.2.2 Austenitic stainless steel insert plates or thickened insert plates shall not be used in carbon steel or duplex stainless steel plates and carbon steel or duplex stainless steel insert plates or thickened insert plates shall not be used in austenitic stainless steel plates except when an evaluation for differential movement due to temperature is performed.

SC.3.2.3 Where adjacent shell courses are of different materials and the design temperature is greater than 40 °C (100 °F), the design shall account for differential shell course expansion with regard to out of plane bending in the carbon steel plates. Use of stiffeners or thicker carbon steel plates may be required.

SC.3.2.4 The required nominal shell thickness shall not be less than the greatest of the design shell thickness plus corrosion allowance, hydrostatic test shell thickness, or the nominal plate thickness listed in 5.6.1.1 (note 4 does not apply to the first shell courses made of stainless steel material).

SC.3.3 When the roof and shell are of different materials and the operating temperature is greater than 40 °C (100 °F), the design shall account for differential component expansion. Use of stiffeners or thicker component members may be required.

SC.3.4 Nozzles and Manways

SC.3.4.1 Reinforcement requirements of 5.7 must be maintained except insert plates and thickened insert plates shall comply with SC.3.2.2.

- **SC.3.4.2** Nozzles and manways shall be of the same material as the shell course unless otherwise specified by the Purchaser.

SC.3.4.3 Reinforcing plates for shell penetrations shall be carbon steel to carbon steel and stainless steel to stainless steel even if the nozzle material differs from the shell material.

SC.4 Miscellaneous Requirements

SC.4.1 Chemical cleaners and pickling solutions used shall not have a detrimental effect on the stainless steel or carbon steel in mixed material tanks and their welded joints. Chemical cleaners and pickling solutions shall be disposed of in accordance with laws and regulations governing the disposal of such chemicals. The use of chemical cleaners shall always be followed by thorough rinsing with potable water and drying (see S.4.9 and X.4.5).

SC.4.2 Impact tests are not required for austenitic stainless steel weld metals and heat-affected zones. Impact tests of the carbon steel or duplex stainless steel heat affected zone shall be performed when required by the basic document or Annex X.

- **SC.4.3** Postweld heat treatment of austenitic stainless steel and duplex stainless steel materials need not be performed unless specified by the Purchaser. PWHT of carbon steel components shall be performed when required by the basic document. For mixed material nozzle assemblies, the PWHT requirements of 5.7.4 are not mandatory except when specified by the Purchaser. The Purchaser is cautioned that mixed material nozzles with duplex stainless steel should not be PWHT due to the potential damaging effects of high temperature on the duplex material. The Purchaser is advised to discuss with a materials consultant or mill representative to determine what PWHT can be done for the specific material/chemistry/configuration.

SC.4.4 Surfaces of carbon steel plates shall be free of rust and scale prior to welding to stainless steel plates.

SC.4.5 At butt welds between stainless and carbon steel, at least one side of the joint shall be beveled with land not to exceed $t/3$ in order to prevent excessive weld metal dilution.

SC.4.6 Internal galvanic corrosion will occur by using mixed material construction and additional mitigation such as appropriate localized coatings should be considered.

SC.4.7 Where substantial quantities of uncoated stainless steel are welded to coated carbon steel, accelerated corrosion rates are possible at holidays in the carbon steel coating.