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Guide to the use of stainless steel pipe specifications

1. Scope

This document is to be used as a general reference for guidance in selecting the appropriate stainless steel piping specification for Pulp Mill service. It also identifies additional quality requirements that may be considered extensions of these basic specifications.

2. Safety precautions

No procedures or practices are contained within this document which warrant safety precautions. As stated elsewhere in this TIP, a general consideration of safety should be part of the pipe specification selection process.

3. General service considerations

3.1 The service expected for the pipe system can have an impact on the choice of alloy, dimensional criteria, method of manufacture, and testing requirements. These issues can be divided into those which affect the functionality of the system, those pertaining to safety and those which have a bearing on operational costs.

3.2 Functional- Characteristics of piping materials which can affect the utility and suitability of the piping system for the intended application.

3.2.1 *Corrosion Resistance*- Corrosion resistance of stainless alloys can be affected by the alloy, the type of welding performed, the exposure time to temperatures in the sensitization range and the nature of the annealing treatment, if any. Corrosion resistance may be improved by obtaining smoother finishes and eliminating crevices, cold working prior to annealing, annealing followed by rapid cooling below the sensitization range, complete descaling after annealing and, removal of heat tint after welding.

3.2.2 *Mechanical Loading*- Mechanical loading concerns relate to either the presence of imperfections within the pipe itself or problems associated with fit-up and fabrication that may result due to the basic pipe product. Specifying tighter tolerance product or increasing the amount and variety of non-destructive testing may be beneficial.

3.2.3 *Internal Pressure*- Pressure piping systems may need added assurance that the product is sound. Increasing the sensitivity or using additional methods of non-destructive testing can increase the certainty of imperfection free materials. Seamless, welded and cast stainless steel piping products are accepted by various pressure service standards provided they are accompanied by the appropriate nondestructive inspection.

3.2.4 *Surface finish*- Surface finish may have an impact on corrosion resistance or affect the tendency for deposits on the surface. Surface finishes are generally better with cold worked products.

3.2.5 *Dimensional*- Cold finished products typically have tighter dimensional tolerances which can facilitate the fabrication of piping systems. More tightly controlled tolerances can improve joint alignment and enhance overall butt-welded joint quality. This improved alignment can also provide a more uniform internal surface which is less likely to cause turbulence or suffer from erosion.

3.3 Safety- The overall integrity of the piping system can be influenced by ordering specifications. More stringent testing requirements may influence manufacturing methods

3.3.1 *High human safety or environmental concerns*- Liquid penetrant, eddy currents, ultrasonic or radiographic tests in addition to a hydrostatic pressure test may be warranted.

3.3.2 *The basic pipe specifications* require only a hydrostatic pressure test which is capable of detecting only through wall leaks exhibiting appreciable leakage. Liquid penetrant tests are capable of detecting only those indications which are exposed to the surface.

3.3.3 *Eddy current, ultrasonic and radiographic tests* are capable of detecting small imperfections located within the wall thickness of the pipe. However, the sensitivity of any of these tests is affected by the type of imperfection and its orientation.

3.4 Cost considerations- Requirements beyond industry standards levels will generally increase costs and should be considered in terms of the potential benefits they return.

3.4.1 *High cost associated with lost production*- Higher costs associated with additional nondestructive examination(s) may be justified to offset the potential risk of lost production.

3.4.2 *Significant cost for routine maintenance*- This condition would indicate a problem inherent to the installed system such as poor alloy choice, poor pipe manufacture with insufficient inspection, or improper installation. Consideration of alternative manufacturing methods or inspections may be warranted.

3.4.3 *Tolerable costs for maintenance with low risk*- Most likely, pipe purchased to one of the basic specifications will be adequate. Use of standard industry specifications usually translates to lower capital costs and increased availability of product.

4. Available specifications

4.1 There are fourteen ASTM Specifications governing stainless pipe products. Most of these specifications have been developed to cover very broad ranges of application and define basic product requirements for general usage.

4.2 Table I lists specifications A451, and A872, which provide centrifugally cast pipe products, and A943 and A949 which provide for spray-formed products.

4.3 Table II lists specifications A312, A376, , and A790 which provide for seamless products.

4.4 Table III lists specifications A312, A358, A409, A778, A790, A813, A814 and A928 which provide for welded pipe products.

NOTE 1: Specifications A312 and A790 provide for both seamless and welded products, and indicate that the desired process is to be specified at the time of order placement. Failure to specify either seamless or welded will leave the decision to the producer or supplier.

5. Method of manufacture

5.1 The specifications in Tables I – III are grouped, in part, based on the method used to manufacture the pipe. The three basic techniques are hot extrusion (seamless), welding, and centrifugal cast. The products, once formed into tubular shapes, may be further shaped or sized by a cold working process such as drawing, pilgering, swaging, or rolling. After hot working, cold working or welding the product may also be annealed to relieve the bulk of the residual stresses, dissolve any secondary metallurgical phases and produce a more homogenous microstructure.

5.2 Centrifugal cast- Produced by centrifugally casting molten steel into a mold and subsequently matching both the inner and outer diameters. The material may be cold worked subsequent to machining. The product is supplied either annealed, or cold worked and annealed.

5.3 Spray-formed – Produced by depositing a gas atomized liquid metal or alloy spray, consisting of droplets, solid particles and partially solid particles, onto a thin-walled collector tube. The solidified product is essentially free of porosity and the inside and outside diameter surfaces are machined. The product may be cold worked prior to final annealing.

5.4 Seamless – Hot work extrusion process producing a hollow defined as having a continuous periphery from start to finish. The product requires somewhat broader dimensional tolerances than welded products, and may exhibit wall thickness variations (eccentricity) of 20%. The product may be furnished either hot worked and annealed or cold worked and annealed. For cold worked product the surface finish is typically smoother and OD tolerances are tighter. The extrusion process is well suited for heavy wall product.