

Stainless steel piping for pulp handling and chemical recovery

ARTHUR H. TUTHILL, RICHARD E. AVERY, AND RONALD D. CROOKS

Stainless steel piping has been the standard construction material for handling pulp for some years. This piping is procured to one of the three ASTM pipe specifications or to TAPPI's "Recommended Specifications for Stainless Steel Piping, Fittings and Accessories for the Pulp and Paper Industry." In this article we review the key differences in these four specifications, especially as they affect the quality of butt welds and surface finish.

Pulp is handled in large-diameter, light-wall welded pipe. Discoloration from carbon steel led to the use of stainless steel after World War II. At that time, ASTM A312 was the principal specification for stainless steel piping;¹ A312 required post-weld heat treatment after the longitudinal weld was made to meet the needs of the chemical industry for corrosion resistance. As the low-carbon grades, 304L and 316L, became widely available, ASTM A778 was developed to meet the needs of the pulp and paper industry for as-welded, low-carbon stainless steel pipe. Concurrently, TAPPI developed a specification for as-welded stainless steel of even lighter wall than schedule 5S covered by ASTM.² TAPPI also included specifications for butt welds which the ASTM pipe specifications do not address. In recent years, surface finish has become increasingly important, especially in the headbox-approach piping.

Chemical-recovery piping is of smaller diameter than pipe for handling pulp. Carbon steel gave reasonably satisfactory service until mills began recycling wash water and more corrosive constituents worked their way into the chemical-recovery section. Increasingly, 304L and 316L have been used to replace carbon steel piping as it fails and for new construction.

Stainless steel piping

Success with stainless steel piping begins with adequate procurement specifications and then proper weld fabrication. Mills can procure stainless steel pipe to one of the four major specifications shown in Table I. Familiarity with these specifications will assist in obtaining the pipe quality needed in the

most economical manner. Key information about each of the four specifications in Table I is reviewed below.

ASTM A312 is the specification developed for, and used by, the chemical industry. Longitudinal welds are autogenous, i.e., no filler metal is added. Solution annealing after the longitudinal weld is made as required.

Purchasers using A312 are cautioned to select the low-carbon "L" grade or a stabilized grade to avoid sensitization after butt welds are made. Both the 0.08% and 0.03% carbon grades are covered in the A312 specification. Warehouses prefer to stock piping to A312 in pipe sizes up to 12 in., as it is the most widely used by other industries. Separate specifications for butt welding are required and must be developed by the paper mill purchasing the piping in order to avoid substandard butt welds.

ASTM A778 is the specification developed for the pulp and paper and other industries using large-diameter as-welded stainless steel piping. The specification covers 3-in. to 48-in. diameters, but is generally used for 8-in. diam. and larger. Because the pipe is delivered as-welded without a final anneal as in A312, only the low-carbon grades are included in A778. Filler metal is optional unless specified by the purchaser. Separate butt-welding specifications must be developed by the mill purchasing the piping in order to avoid substandard butt welds.

ASTM A409 covers spiral-welded pipe of 14-in. and larger diameters.¹ As with A312, users must select the low-carbon "L" grade or a stabilized grade to avoid sensitization after butt welds are made because both the 0.08% and 0.03% carbon grades are covered in A409. Solution annealing is optional. Separate butt-welding specifications must be developed by the mill purchasing the piping in order to avoid substandard butt welds.

The fourth specification, "Recommended Specifications for Stainless Steel Piping, Fittings and Accessories for the Pulp and Paper Industry, Second Edition," was developed by TAPPI primarily for thinner-wall, large-diameter piping for low-pressure service. This specification covers two wall thicknesses of three low-carbon grades—304L, 316L, and 317L—of pipe and fittings. The wall thicknesses in the TAPPI specification are less than schedule 5S. Unlike the ASTM specifications, the

¹ASTM Specifications, A312, A778, and A409 for stainless steel pipe 1993. ASTM, 1916 Race St., Philadelphia, PA 19103.

² *Recommended Specification for Stainless Steel Piping, Fittings and Accessories for the Pulp and Paper Industry*, TAPPI PRESS, Atlanta, 1986.

I. A comparison of stainless steel piping specifications used by the pulp and paper industry

<i>Specification</i>	<i>ASTM A312</i>	<i>ASTM A778</i>	<i>ASTM A409</i>	<i>TAPPI</i>
Coverage	Welded and seamless	Welded	Spiral	Welded
Fittings	ASTM A409	ASTM A774	A403/A774	TAPPI
Sizes (in.)	1/8–30	3–48	14–30	1/8–1.5
Wall thick.	SCH 5S-80	0.062-0.500	SCH 5S, 10S	SCH 5S 3 in.–36 in. 125 lb and 250 lb
Number of alloys	30	5	16	304L, 316L, 317L
Solution anneal	Required	As welded	Optional	As welded
Filler metal	Autogenous	Matching	Optional	Matching
Mechanical tests	Tension face bend	Tension guided bend	Tension guided bend	None
Straightness	Reasonable	0.25 in./10 ft	0.25 in/10 ft	
HydroTest	Required	Optional	Required	None
Oxide removal	Required	Optional	Optional	Required
Surface finish ≥3/16-in.	Not specified	Negotiable	Negotiable	2D to 8 gauge
Butt welds	Not covered	Not covered	Not covered	GTAW, full penetration 1/16-in. max. projection = 2D finish

TAPPI specification includes guideline specifications for butt welds as well as surface finish requirements for butt welds and the pipe.

Usage and procurement

Chemical recovery section: Types 304L and 316L piping are widely available from warehouse inventories in sizes up to 12 in. Paper mills tend to procure pipe for the chemical-recovery section to ASTM A312 as diameters are smaller than for stock piping. Section H of the TAPPI Piping Specifications can, and should, be used as a basis for procurement of good-quality butt welds.

Stock piping: Schedule 5S and 10S piping may be procured to A312, A778, or A409. For low-pressure service, where wall thicknesses less than Schedule 5S can be used for economy, the TAPPI specification is used. Section H of the TAPPI Piping

Specifications can, and should, be used as a basis for procurement of good-quality butt welds as a supplement to ASTM A312, 778, or 409.

Surface finish: The TAPPI specification requires a 2D finish up to 8 gauge (0.165 in.), which is the upper thickness limit for cold-rolled strip and sheet. For plate gauges 3/16 in. and heavier, a 2D finish is not available as plate is normally hot rolled, not cold rolled. Refer to **Table II** for the standard finishes for plate as given in ASTM A480. The TAPPI specification calls for a No. 1 finish for plate. A No. 1 plate finish may not be smooth enough for stock and headbox piping even after electropolishing; therefore, consideration of other surface options may be necessary.

The following diameter pipes (and larger) require 3/16-in. or heavier plate, and the rougher plate finish must be used to meet wall thickness standards:

Shop Talk

- 14 in. Schedule 10S
- 16 in. TAPPI 250 lb
- 10 in. Schedule 5S
- 30 in. TAPPI 125 lb

In order to obtain the surface finish needed for plate that is to be roll formed into pipe, plate must be further processed before forming into pipe. Polishing may be done at the steel mill and delivered with a No. 4 polished finish to ASTM A480, or the plate may be polished by a shop equipped to polish plate. While cost extras may apply, the critical point is recognition of the change in surface finish when plate rather than sheet or strip must be used to form the pipe.

For butt welds, the TAPPI specification requires a 1/16-in. maximum projection ground to the equivalent of a 2D finish. A hand-held electropolishing tool is of considerable assistance in meeting this requirement. The TAPPI specification also requires welds to pass a final cotton ball or 15-den. nylon stocking rub test with no visible hang up of cotton or nylon.

For headbox-approach piping, the piping may be procured and finished as for stock piping, then electropolished. Surface finish is measured by Ra or RMS. Plate may be ground to 64, 32, or even 8–10 RMS. However, for best results, the ground surface should be electropolished to remove the smeared surface layer left by grinding and polishing. Electropolishing has a further advantage in that it tends to level the high points and reduce roughness.

As a rough guide, expect electropolishing to reduce the RMS or Ra reading by one-half. It is generally necessary to electropolish to achieve an 8–10 RMS or smoother profile. Electropolishing may be done at the pipe shop, at shops specializing in electropolishing, or by plant personnel. Field butt welds made during installation also require grinding and local electropolishing with a hand-held tool. The electropolished surface is less prone to product buildup, easier to clean, and relatively free of most surface defects.

II. Finish for plates ASTM A480

10.1.1	Hot-rolled or cold-rolled and annealed or heat-treated scale not removed for heat-resistant applications
10.1.2	Hot-rolled or cold-rolled and annealed or heat-treated and blast-cleaned or pickled (standard for corrosion-resistant applications [HRAP] designated No. 1 finish)
10.1.3	Hot-rolled or cold-rolled and annealed or heat-treated and surface-cleaned and polished (polish is generally No. 4 finish)
10.1.4	Hot-rolled or cold-rolled and annealed or heat-treated and descaled and temper passed (smoother finish)
10.1.5	Hot-rolled or cold-rolled and annealed or heat-treated and descaled; or cold-rolled and annealed or heat-treated and descaled, and optionally temper passed (smooth finish with greater freedom from surface imperfections than in 10.1.4)

Conclusions

1. Mills have the option of ordering piping to ASTM or to TAPPI specifications. Use of ASTM specifications requires preparation of a separate specification governing the quality of the butt (girth) welds. Section H of the TAPPI specification may be used to specify the quality desired in butt welds.

2. Surface finish for stock and headbox-approach piping is a critical consideration, especially for 3/16-in. and heavier walls. Selective procurement and review of surface-finish options with the pipe producers should result in pipe with an interior finish no rougher than 32 RMS.

3. Electropolishing of both the pipe and butt welds of headbox-approach piping has become common and may be considered standard practice. Electropolished surfaces are smoother, more easily cleaned, and more resistant to corrosion. **□**

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Tuthill, Avery, and Crooks are consultants with, respectively, Tuthill Associates Inc., Blacksburg, VA 24060; Avery Consultant Associates Inc., Londonderry, NH 03053; and Branderis Associates, Inc., Hockessin, DE 19707.