



Designation: E 1928 – 99

Standard Practice for Estimating the Approximate Residual Circumferential Stress in Straight Thin-walled Tubing¹

This standard is issued under the fixed designation E 1928; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 A qualitative estimate of the residual circumferential stress in thin-walled tubing may be calculated from the change in outside diameter that occurs upon splitting a length of the tubing. The Hatfield and Thirkell formula, as later modified by Sachs and Espy,² provides a simple method for calculating the approximate circumferential stress from the change in diameter of straight, thin-walled, metal tubing.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

E 6 Terminology Relating to Methods of Mechanical Testing³

3. Terminology

3.1 The definitions in this practice are in accordance with Terminology E 6.

4. Significance and Use

4.1 Residual stresses in tubing may be detrimental to the future performance of the tubing. Such stresses may, for example, influence the susceptibility of a tube to stress corrosion cracking when the tube is exposed to certain environments.

4.2 Residual stresses in new thin-walled tubing are very sensitive to the parameters of the fabrication process, and small variations in these parameters can produce significant changes in the residual stresses. See, for example, Table 1, which shows the residual stresses measured by this practice in samples from successive heats of a ferritic Cr-Mo-Ni stainless steel tube and

TABLE 1 Residual Stresses in Successive Heats of Tubing

Heat No.	Ferritic Cr-Mo-Ni Stainless Steel		Titanium	
	kPa	psi	kPa	psi
1	234000	34000	37000	5400
2	272000	39400	52000	7600
3	217000	31500	30000	4300
4	183000	26500	52000	7500
5	241000	34900	59000	8600
6			30000	4300
7			59000	8600
8			30000	4300
9			52000	7500
10			37000	5400

a titanium condenser tube. This practice provides a means for estimating the residual stresses in samples from each and every heat.

4.2.1 This practice may also be used to estimate the residual stresses that remain in tubes after removal from service in different environments and operating conditions.

4.3 This practice assumes a linear stress distribution through the wall thickness. This assumption is usually reasonable for thin-walled tubes, that is, for tubes in which the wall thickness does not exceed one tenth of the outside diameter. Even in cases where the assumption is not strictly justified, experience has shown that the approximate stresses estimated by this practice frequently serve as useful indicators of the susceptibility to stress corrosion cracking of the tubing of certain metal alloys when exposed to specific environments.

4.3.1 Because of this questionable assumption regarding the stress distribution in the tubing, the user is cautioned against using the results of this practice for design, manufacturing control, or other purposes without supplementary information that supports the application.

4.4 This practice has primarily been used to estimate residual fabrication stresses in new thin-walled tubing between 19-mm (0.75-in.) and 25-mm (1-in.) outside diameter and 1.3-mm (0.05-in.) or less wall thickness. While measurement difficulties may be encountered with smaller or larger tubes, there does not appear to be any theoretical size limitation on the applicability of this practice.

5. Procedure

5.1 On new material, the stress determination shall be made on at least one representative sample obtained from each lot or

¹ This practice is under the jurisdiction of ASTM Committee E-28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.13 on Residual Stress Measurement.

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² Sachs, G. and Espy, G., "A New Method for Determination of Stress Distribution in Thin-walled Tubing," *Transactions of the AIME*, Vol 147, 1942.

³ *Annual Book of ASTM Standards*, Vol 03.01.