



Designation: D5017 – 24

Standard Test Method for Determination of Linear Low Density Polyethylene (LLDPE) Composition by Carbon-13 Nuclear Magnetic Resonance¹

This standard is issued under the fixed designation D5017; 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 This test method determines the molar composition of copolymers prepared from ethylene (ethene) and a second alkene-1 monomer. This second monomer can include propene, butene-1, hexene-1, octene-1, and 4-methylpentene-1.

1.2 Calculations of this test method are valid for products containing units EEXEE, EXEXE, EXXE, EXXXE, and of course EEE where E equals ethene and X equals alkene-1. Copolymers containing a considerable number of alkene-1 blocks (such as, longer blocks than XXX) are outside the scope of this test method.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* See Section 8 for a specific hazard statement.

NOTE 1—There is no known ISO equivalent to this standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D883 Terminology Relating to Plastics

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E386 Practice for Data Presentation Relating to High-Resolution Nuclear Magnetic Resonance (NMR) Spec-

troscopy (Withdrawn 2015)³

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E2977 Practice for Measuring and Reporting Performance of Fourier-Transform Nuclear Magnetic Resonance (FT-NMR) Spectrometers for Liquid Samples

IEEE/ASTM SI-10 Standard for Use of the International System of Units (SI): The Modern System⁴

3. Terminology

3.1 Some units, symbols, and abbreviations used in this test method are summarized in IEEE/ASTM SI-10 and Practice E386. Other abbreviations are listed as follows:

3.2 Abbreviations:

3.2.1 ¹³C—carbon 13,

3.2.2 LLDPE—linear low-density polyethylene,

3.2.3 T1—relaxation time, and

3.2.4 TR—pulse repetition time.

3.3 Definitions of Terms Specific to This Standard:

3.3.1 With a few modifications, terms used to designate different carbon types were suggested by Carman.⁵ Methine carbons are identified by CH and branch carbons are labeled according to branch type as summarized in Table 1. Branch carbons are numbered starting with the methyl as number one.

3.3.2 Backbone methylene carbons are designated by a pair of Greek letters that specify the location of the nearest methine carbon in each direction. For example, α,α -methylene carbon is between two methine carbons or an α,δ^+ methylene carbon has one immediate methine neighbor and the second methine carbon is located at least four carbons away.

4. Summary of Test Method

4.1 Polymer samples are dispersed in hot solvent and analyzed at high temperatures using Carbon-13 nuclear magnetic resonance (NMR) spectroscopy.

¹ This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.70 on Analytical Methods.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from ASTM International Headquarters, 100 Barr Harbor Drive, C700, West Conshohocken, PA 19428.

⁵ Carman, C. J., Harrington, R. A., and Wilkes, C. E., *Macromolecules* 1977, Vol 10, p. 536.

*A Summary of Changes section appears at the end of this standard