Technical Data Book: Chapter 3—Petroleum Fraction Distillation Interconversions

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Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue NW, Suite 1100, Washington, DC 20001, standards@api.org.

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Preface

The subject of distillation has been of continuing concern in the design and operation of petroleum refineries and related industries. Most of the procedures for interconversion of various distillation data in the previous editions had been developed in the 1940s and 1950s.Over the years, continued interest has led to the development of new analytical correlations for conversion of various distillation data. Detailed results of the methods tested and developed in the course of this work, together with the rationale for inclusion of the procedures in this chapter are available in Documentation Report No. 3-93 available from University Microfilms, Inc., Ann Arbor, Michigan.

Chapter 3 was updated and converted to a Technical Report in 2025. Procedure 3B1.1 was added which covers the interconversion of weight basis to volume basis distillation composition data. The chapter was also revised to update Procedure 3A3.1 (simulated distillation to TBP) with the industry practice of using simulated distillation data directly as TBP data. The 1994 Procedure 3A3.1 is now retired and can be found in Annex A for historical reference. The 2025 Procedure 3A3.1 is now recommended.

SCOPE

Technical Report TDB-3 provides the reader a means to convert distillation curves generated at some reference to a different reference. The technical report discusses the difference between physical and simulated distillation methods. Physical methods are continuously being replaced by simulated methods, with the exception of D2892, which is mainly used for characterizing the distillation for a crude assay. The report ends with a section pertaining to the conversion of a weight basis distillation curve to a volume basis. Converting from weight to volume is important for many refining applications. For example, the conversion is needed to convert the distillation curves for all the products from a fractionation tower to a consistent basis so that a back-blended feed distillation curve can be generated. This permits fractionation key parameters such as cutpoint and yields to be estimated.

Any references to other chapters within this document refer to the corresponding Technical Data Book chapter, which is published as API Technical Report TDB-x, where x is the chapter number.

3-0 Introduction

ASTM and true boiling point (TBP) analytical distillations are used to define the volatility characteristics of petroleum fractions and other complex mixtures. Both are batch distillations which differ mainly in the degree of fractionation obtained during the distillation.

ASTM D86 and D1160 distillations are run in an Engler flask. No packing is employed and reflux results only from heat losses through the neck of the flask. ASTM distillations are more widely used than TBP distillations because the former are simpler, less expensive, require less sample and require only approximately one-tenth as much time. ASTM distillations are standardized. TBP distillations vary appreciably in procedure and apparatus. ASTM distillation methods in use today are:

ASTM Method D86: This method is used for the distillation of motor gasolines, aviation gasolines, aviation turbine fuels, naphthas, kerosenes, gas oils, distillate fuel oils and similar petroleum products. It is carried out at atmospheric pressure. An exposed thermometer is used, and temperatures are reported without stem corrections. ASTM D86 distillations are reported in volume percent.

ASTM Method D1160: This method is used for heavy petroleum products, which can be vaporized partially or completely at a maximum liquid temperature of 750 °F at absolute pressures down to 1 mm Hg and condensed at the pressures of the test. It is carried out at pressures between 1 mm Hg and 50 mm Hg, absolute. Temperatures are measured with a thermocouple. ASTM D1160 distillations are reported in volume percent.

ASTM Method D2887: Simulated distillation (SD) by gas chromatography appears to be the most simple, reproducible and consistent method to describe the boiling range of a hydrocarbon fraction unambiguously. This method is applicable to all petroleum fractions with a final boiling point of 1000 °F or less at atmospheric pressure. The method is also limited to samples having an initial boiling point of at least 100 °F. Figure 3-0.1 shows a typical relation between ASTM D86 and ASTM D2887 distillations for a petroleum fraction. Simulated distillations are reported in percent off which is normally assumed to be weight percent.

ASTM Method D2892: This method is used for distillation of stabilized crude petroleum defined as having a Reid vapor pressure less than 12 psi. It employs a fractionating column of 14-18 theoretical stages operated at a reflux ratio of 5. The method is a form of true boiling point distillation for any petroleum mixture boiling above light naphthas and mixtures with final boiling points below 750 °F.