Designation: D 2890 – 92 (Reapproved 2003)

An American National Standard

# Standard Test Method for Calculation of Liquid Heat Capacity of Petroleum Distillate Fuels[1]

This standard is issued under the fixed designation D 2890; 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 describes the calculation of liquid heat capacity, Btu/lb · °F (kJ/kg · K), at atmospheric pressure, of petroleum fuels for which distillation data may be obtained in accordance with Test Method D 86 without reaching a decomposition point prior to obtaining 90 volume % distilled.

1.2 This test method is not applicable at temperatures less than 0°F (−18°C) and greater than 60°F (16°C) above the volumetric average boiling point of the fuel.

1.3 The values stated in inch-pound units are the preferred units. The values in parentheses are for information only.

1.4 *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:*

D 86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure[2]

D 287 Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)[2]

## 3. Summary of Test Method

3.1 The Watson characterization factor, K, is obtained from a graphical correlation relating determined Test Method D 86 distillation data and K. The liquid heat capacity is obtained, either graphically or mathematically, from correlations relating calculated heat capacity, temperature at which heat capacity is being calculated, determined API gravity, and K.

NOTE 1—Details of the method have been published.[3]

## 4. Significance and Use

4.1 Heat capacities obtained by this method are those at atmospheric pressure. However, because the temperature range is low, the calculated values are similar to saturated liquid heat capacities in the temperature-pressure range required for most engineering design.

## 5. Data Requirements

5.1 Distillation temperatures at (in °F) 10, 30, 50, 70, and 90 volume % distilled obtained in accordance with Test Method D 86.

5.2 API gravity determined in accordance with Test Method D 287 or a method of equivalent accuracy.

## 6. Procedure

6.1 Calculate to the nearest 0.1 unit the slope of the Test Method D 86 distillation curve, °F/volume %, as the difference between the 10 and 90 volume % distilled temperatures divided by 80.

6.2 Calculate to the nearest 1°F the volumetric average boiling point (VABP) as the sum of Test Method D 86 10, 30, 50, 70, and 90 volume % distilled temperatures divided by 5.

6.3 Obtain a temperature correction to the nearest 1°F from Fig. 1, using the slope and VABP calculated in accordance with 6.1 and 6.2. Calculate the mean average boiling point (MeABP) as the VABP plus the correction.

6.4 Obtain to the nearest 0.1 unit the Watson characterization factor, K, from Fig. 2 using the determined API gravity and calculated MeABP.

6.5 Obtain the calculated heat capacity at each specified temperature, either graphically from Fig. 3 or by solving the following equation.

$$C_p = [0.6811 - 0.308\,G + (0.000815 - 0.000306\,G)T](0.055\,K + 0.35) \quad (1)$$

where:

$C_p$ = heat capacity, Btu/lb · °F,
$G$ = specific gravity,
$T$ = temperature, °F, and
$K$ = Watson characterization factor.

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.04 on Hydrocarbon Analysis.

Current edition approved May 10, 2003. Published July 2003. Originally approved in 1970. Last previous edition approved in 1996 as D 2890–92 (1996).

[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] *Technical Data Book-Petroleum Refining,* Chapter 7, American Petroleum Institute, Division of Refining, 1220 L St. NW, Washington, DC 20005.

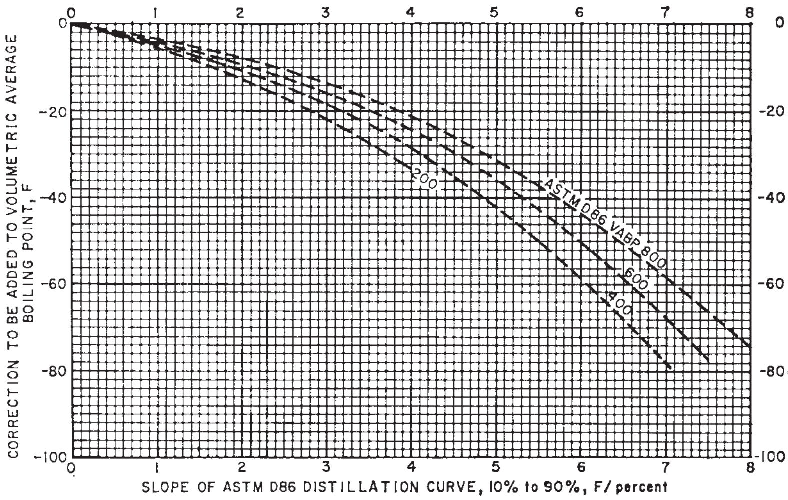


**FIG. 1 Test Method D 86 Distillation Data Correlation**

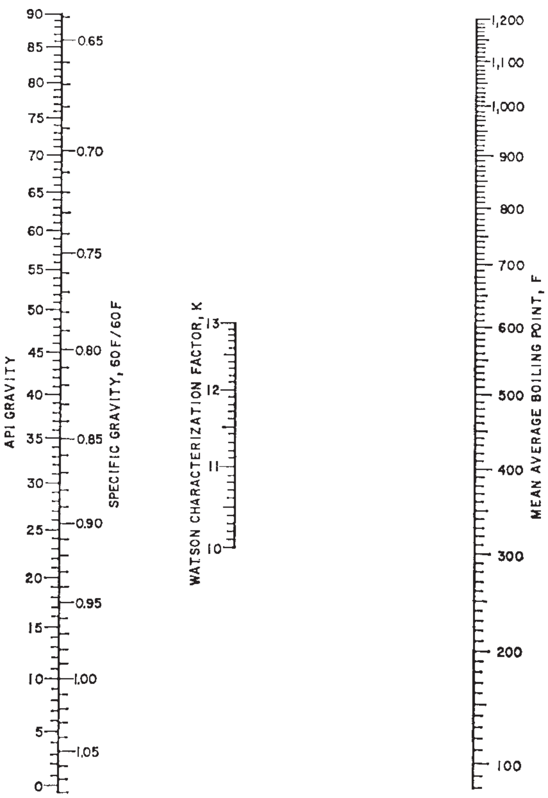


**FIG. 2 Watson Characterization Factor (*K*), API Gravity, and Mean Average Boiling Point**

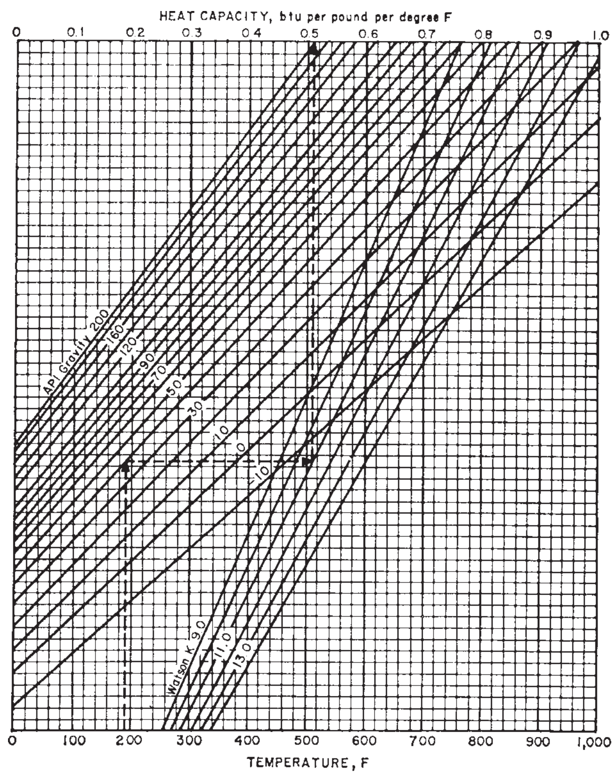


**FIG. 3 Liquid Heat Capacity of Petroleum Distillate Fuels**

NOTE 2—The broken lines in Fig. 3 illustrate the graphical procedure for the following example:
Calculate the heat capacity at atmospheric pressure and 190°F of a petroleum distillate fuel having an API gravity of 40 and Test Method D 86 distillation temperatures of 239, 261, 288, 321, and 367 F at 10, 30, 50, 70, and 90 volume % distilled, respectively. The volumetric average boiling point (VABP) is 295°F, and the slope is 1.60. The temperature correction obtained from Fig. 1 is − 9°F, and the mean average boiling point is 286°F. The value of *K* obtained from Fig. 2 is 11.0. The heat capacity obtained as shown in Fig. 3 is 0.51 Btu/lb · °F.

## 7. Report

7.1 Report the results to the nearest 0.01 Btu/lb · °F.

7.2 The heat capacity, Btu/lb · °F may be converted to the International System of Units (SI) of kilojoule per kilogram kelvin (kJ/kg · K) by multiplying the results obtained in 7.1 by the conversion factor 4.186800 and then rounding to the appropriate number of significant digits.

## 8. Precision and Bias

8.1 The following criteria should be used for judging the acceptability of results (95 % probability).

8.1.1 *Repeatability*—The difference between successive test results, obtained by the same operator with the same apparatus under constant operating conditions on identical test material, would, in the long run, in the normal and correct operation of the test method, exceed the following value only in one case in twenty:

$$0.01 \text{ Btu/lb} \cdot {}^\circ\text{F} \; (0.04 \text{ kJ/kg} \cdot \text{K}) \tag{2}$$

8.1.2 *Reproducibility*—The difference between two, single and independent results, obtained by different operators working in different laboratories on identical test material, would, in the long run, in the normal and correct operation of the test method, exceed the following value only one case in twenty:

$$0.02 \text{ Btu/lb} \cdot {}^\circ\text{F} \; (0.08 \text{ kJ/kg} \cdot \text{K}) \tag{3}$$

NOTE 3—The preceding repeatability and reproducibility were obtained from results submitted by seven laboratories that cooperatively tested four turbine fuels with initial boiling points in the range 320 to 400°F (160 to 204°C), and end points in the range 430 to 535°F (221 to 279°C). Each laboratory determined the required distillation and gravity data in duplicate, and performed the procedures graphically once for each of the two sets of determined data for each sample. Heat capacities of the fuels were not determined during the cooperative program.

8.2 The accuracy of this test method has been reported[3] as within 4 % for straight-run petroleum fractions and approximately 8 % for pure olefins.

8.3 *Bias*—Since there is no accepted reference material suitable for determining bias for this test method, no statement of bias can be made.

## 9. Keywords

9.1 liquid heat capacity; petroleum distillate