



Technical Bulletin 97-1

North America Committee
Petroleum Subcommittee

API MPMS Chapter 12, Section 1, Part 1 - Calculation of Static Petroleum Quantities Application From The Independent Inspector's Perspective

Introduction:

The purpose of this technical bulletin is to provide information and commentary to IFIA Member Companies and their clients.

In August, 1996 the American Petroleum Institute published Chapter 12, Section 1, Part 1 of its Manual of Petroleum Measurement Standards. This document is titled, "*Calculation of Static Petroleum Quantities - Upright Cylindrical Tanks and Marine Vessels*". While static calculations have been cited in other prior API MPMS documents, this is the first time that they have been compiled into one stand-alone document.

It might be assumed that as there has been little significant change in static petroleum measurement for many years, this document would not have much impact on the industry in general. However, this is not the case. By the introduction of a new correction for the effect of temperature on the steel shell of a tank [CTSh], this standard has introduced a significant change in how shore tank quantities are calculated. While not the only change required by this new standard, it is the only one that involves a significant departure from previous methods of calculation.

The New Correction

Upright cylindrical tanks have capacity tables based upon a specific tank shell temperature. In the U.S.A. this

is usually 60°F. If the actual tank shell temperature differs from the capacity table tank shell temperature, the volumes extracted from that table will need to be corrected, accordingly. There are three items to be considered in making this correction; calculate the temperature of the tank shell, determine the correction and apply the correction.

Note: The new correction is only applicable to upright cylindrical tanks. It does not apply to spherical, horizontal cylindrical, square or rectangular tanks.

Calculate the Temperature of the Tank Shell:

On a non-insulated tank this is done by adding 7/8 [0.875] of the product temperature to 1/8 [0.125] of the ambient air temperature.

For example, what is the tank shell temperature if the temperature of the product in the tank is 135°F and the ambient air temperature is 88°F?

$$\begin{array}{r} 135 \times 0.875 = 118.13 \\ 88 \times 0.125 = 11.00 \\ \hline \text{Tk Shell Temp} = 129.13 \end{array}$$

Rounding to the nearest degree, the tank shell temperature is recorded as 129°F.

The new standard does not provide any instruction or advice on how or where to take the ambient air tem-

perature. IFIA Member Companies recommend if the terminal has a weather station, it should be used. Alternatively, leave a cup-case thermometer in a shady area for at least fifteen minutes or use a portable electronic thermometer that has stabilized to the surrounding air. Ambient air temperatures should not be taken in direct sunlight or enclosed areas.

On insulated tanks, the temperature of the tank shell is considered to be the same temperature as the product in the tank.

Determine the Correction:

For mild steel tanks that were calculated using a tank shell temperature of 60°F, this can be easily achieved by entering the table in Appendix "B1" of the new standard with the temperature of the tank shell. The factor can be read directly from the table. In our example, the correction for a tank shell temperature of 129°F is 1.00086.

The "Appendix B" table of correction factors will apply in most situations; however, tanks that contain heated products often have capacity tables that were calculated using a tank shell temperature other than 60°F. Alternately, tanks containing specialty products such as corrosive chemicals may be constructed from something other than mild steel, such as stainless steel. In this case it will be necessary to use the formula found in section 9.1.3 of the new standard,



to calculate the correction factor. This formula is:

$$CTSh = 1 + 2\alpha\Delta T + \alpha^2\Delta T^2$$

Where:

α = Linear coefficient of expansion of the tank shell material [see note 4]

ΔT = Tank Shell Temperature (T_{Sh}) minus Base Temperature (T_B)

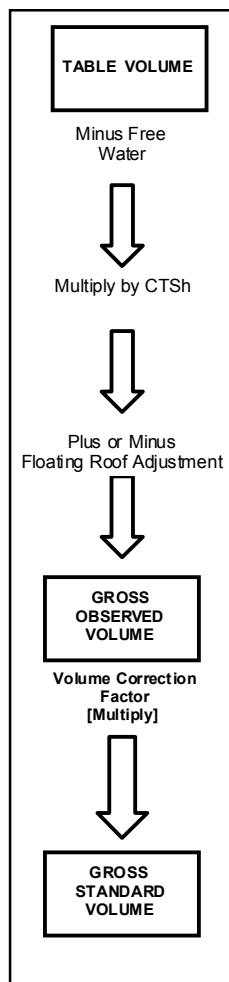
The Base Temperature (T_B) is the tank shell temperature for which the capacity table volumes were calculated to. In the US, this is usually 60°F. The base temperature is usually stated on the capacity table. If this is not the case, contact the company that generated the table. Some capacity tables make reference to an operating product temperature; this should not be confused with the base temperature, which is a tank shell temperature. If the tank capacity tables only reference a product operating temperature, it will be necessary to obtain the actual base tank shell temperature that was used to compute the capacity table volumes. If the tank is insulated, it can be assumed that the base tank shell temperature is the same as the product operating temperature. If the tank is not insulated, the user should contact the company that generated the capacity table to determine what base tank shell temperature was used. Some capacity tables state both the operating product temperature and the ambient air temperature. In this case it is possible to calculate the tank shell temperature; however, caution must be exercised. Prior to the publication of API MPMS Chapter 2.2A, in February 1995, the 7/8ths product and 1/8th ambient temperature rule for calculating tank shell temperatures did not apply. In earlier documents, tank shell temperature was calculated by averaging (50/50) the

product temperature and the ambient air temperature. If this sounds confusing, it is because it is confusing; and, for this reason we recommend contacting the company that produced the capacity table, just to be on the safe side.

When calculating ΔT it is important to maintain the arithmetic sign as this value can be positive or negative and must be applied as such in the CTSh formula. Table B2 in Appendix B lists linear expansion coefficients of various metals.

How to apply the factor

The correction must be applied to the table volume after it has been corrected for free water; and, before any correction is made for the floating roof, if applicable. The floating roof correction is a function of the weight of the roof and the observed density [API Gravity] of the liquid it floats in; therefore, it is essential that the CTSh is applied before the floating roof correction. This gives the gross observed volume [GOV] which is corrected to gross standard volume [GSV] in the usual manner, by applying the VCF.



History

As previously mentioned, API MPMS Chapter 12, Section 1, Part 1 was published in August 1996 and became effective when it was published. The introduction of the new correction factor caused both confusion and consternation within the industry and its implementation by oil companies and terminals has been extremely varied. Some facilities implemented it as soon as they could reprogram their computers while others have yet to implement it.

The position of IFIA Member Companies to this new API standard was the same as that of any API standard, which is to implement it fully, unless another procedure is agreed to by all parties. It must be borne in mind, however, that the U.S. Customs may be one of those parties. When conducting an inspection that falls under the jurisdiction of the U.S. Customs [this includes all imports and both foreign and domestic merchandise entering and exiting foreign trade zones, bonded warehouses and bonded tank farms] independent inspection companies are required to carry out their inspection activities according to the latest API standards, as specified in 19CFR151.13(g)(2). According to "Houston Service Port Trade Bulletin 97-15" issued by the U.S. Customs Service on April 8th, 1997, the Customs will begin mandating the requirements of API MPMS Chapter 12.1.1 on June 1st, 1997.

No sooner had the industry gotten used to the idea of a new calculation standard, than it was discovered that there were a number of errors in it. Most of these were typographical in nature or situations where a formula had been modified but the associated



text had not. However, the equation that was used to calculate the tank shell correction was taken from API MPMS Chapter 2.2A and this was subsequently found to be incorrect. This also impacted most of the data in "Appendix B" including Table B1. On April 24th, 1997 an errata to API MPMS Chapter 12.1.1 was issued. Any references made herein to the standard include any changes incorporated in the errata.

When working cargoes that are not subject to Customs jurisdiction, the application of this standard is a commercial issue and may be used or not, subject to the agreement of the parties concerned.

Other Requirements

There are additional changes that this standard imposes, which while not as significant as the tank shell temperature correction, are nevertheless important.

One of the aims of API MPMS Chapter 12.1.1 was to produce a strict performance standard whereby different individuals with the same base data would arrive at exactly the same number. While coming most of the way to achieving this aim, it falls a little short in the area of Volume Correction Factors [VCF], also referred to as the Correction for the Temperature of the Liquid [CTL].

Table 1 of API MPMS Chapter 12.1.1, which details the number of significant digits (i.e. decimal places) to use with various measurement units, shows four decimal places for the volume correction factor or CTL. There is also a notation attached which states that the standard for producing volume correction factors is the computer subroutine implemen-

tation procedures of API MPMS Chapter 11.1, Volume X; which, when fully implemented generates a factor of five significant places. The use of the printed table is acknowledged as a matter of practical necessity but the notation goes on to state that this only produces volume correction factors with four decimal places, in addition to limiting table entry discrimination levels. It further states that in the event of a dispute, the computer generated volume correction factor should take preference.

The procedure for calculating Net Standard Volume [NSV] from Gross Standard Volume [GSV] requires the sediment and water percentage [S&W] to be converted into a correction factor which is applied to the GSV. If the volumetric value of the S&W is required, the NSV is subtracted from the GSV.

There are many other requirements of API MPMS Chapter 12.1.1 which are not referenced in this technical bulletin and it is in no way intended for this to be a substitute for the standard. The Manual of Petroleum Measurement Standards, of which Chapter 12.1.1 is a part, is published by the American Petroleum Institute, 1220 L Street Northwest, Washington D.C. 20005-4070. Copies of the standard are available from API Publications and Distribution (202) 682-8000, Order No. H12011.

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