Correction Gauge Tables For Incrustation

API RECOMMENDED PRACTICE 2556
SECOND EDITION, AUGUST 1993

REAFFIRMED, NOVEMBER 2013

AMERICAN PETROLEUM INSTITUTE

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Measurement Coordination

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FOREWORD

Incrustation is defined as any material that adheres to the internal vertical sidewall surfaces of a tank when the tank is otherwise empty. The purpose of this recommended practice is to give some procedures for measuring and correcting volumetric errors caused by incrustration in tanks.

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SECTION 1—GENERAL

1.1 Scope

Incrustation is defined, for the purpose of this recommended practice, as any material that adheres to the internal vertical sidewall surfaces of a tank when the tank is otherwise empty.

Incrustation has the same effect on tank capacity as deadwood (anything that displaces liquid inside a tank) and should be treated as such as long as it remains in the tank. The problem of deducting the volume of liquid displaced by incrustation is complicated by two of incrustation's basic and typical characteristics: First, incrustation is difficult to measure, and second, its thickness is usually variable.

Some oils present no incrustation problem, but many others do, usually on a field-wide basis. The error in measurement from any one tank may be slight, but the accumulated error from an entire field or from any one tank over a period of time could be substantial. The error always has the effect of indicating too large a tank capacity; therefore, a receiving carrier cannot be expected to continually absorb the effect of these errors. The method selected to correct the error should depend upon the desired approach to accuracy of measurement.

The tables given in this recommended practice (see Section 4) show the percent of error of measurement caused by varying thicknesses of uniform incrustation in tanks of various sizes. These tables may be used as a guide by the tank owner and the carrier to negotiate an allowance for incrustation. If it is established that incrustation is causing a substantial loss to a carrier or to any other receiver using affected tank gauges as the basis for custody transfer measurement, it is the responsibility of the tank owner to provide a tank that will permit an accurate measurement or to agree to a reasonable adjustment.

1.2 Referenced Publications

The following standard is cited in this recommended practice:

API

Manual of Petroleum Measurement Standards
Chapter 4, "Proving Systems"

SECTION 2—TYPICAL CONDITIONS

2.1 Paraffin or Asphalt

For paraffin or asphalt, successive layers of incrustation continue to attach to the internal wall surfaces of a tank until some areas become overburdened and *slough off* or until a temperature change causes a cleaning of all surfaces or portions thereof.

2.2 Corrosion

Some adhesions are porous whereas others are impervious. Porous incrustations usually are a combination of metal corrosion products and the heavy ends of crude oil. Porous incrustation fills and drains with each filling and emptying of a tank; therefore, even the most accurate linear measurement cannot result in accurate deadwood deductions.

2.3 Temperature

Some incrustations are a direct result of the tank shell temperature being lower than the pour point of the oil. The amount of adhesion increases as the temperature of the tank shell decreases.

SECTION 3—TYPICAL REMEDIES

Some of the procedures that are satisfactory in correcting for the effects of incrustation are given below; however, this recommended practice is not intended to preclude other procedures. No single procedure can be recommended for all cases.

3.1 Lease Automatic Custody Transfer (LACT)

A properly designed, installed, and operated lease automatic custody transfer (LACT) unit or truck loading meter-

ing system will normally solve the problem caused by incrustation; however, compromise is in order if the cost of the most accurate procedure cannot be justified by the loss incurred by the carrier or others concerned.

3.2 Meters

The amount of incrustation may be measured by comparing the quantities as determined by an accurately calibrated and properly installed meter against a conventional run ticket covering the same movement; however, special care should be taken when tanks are calibrated by meter. Meters that are used for measurement should be proven according to Chapter 4 of the API *Manual of Petroleum Measurement Standards*.

3.3 Heat

If the incrustation is caused by a product that contains wax or gum, the most practical and accurate solution is to ensure that the liquid and the shell temperatures remain at a level above the pour point of such product throughout the delivery cycle. Insulating the tank or the application of heat may be accomplished by any safe and practical means, such as steam coils or heating systems, *but direct fire is specifically not recommended*.

3.4 Cleaning

The tank owner may choose to keep tanks sufficiently clean to satisfy the carrier or other affected parties. This may be accomplished in any practical way, such as by manual, steam or solvent cleaning; or by the application of a suitable coating to the interior surfaces of the tanks.

3.5 Linear Measurement

Where the buildup of incrustation is slow and tank runs are infrequent, the most practical solution to correct for incrustation is probably the use of linear measurements. This type of correction is not recommended for tanks with nominal capacities in excess of 65 barrels per foot (35 cubic meters per meter). If the incrustation is a type that is impervious and remains fairly constant, then the amount of deadwood for full tank runs can be determined by measuring the thickness of the incrustation at a sufficient number of points within the tank to determine an average. An average deduction should be calculated from no less than three measurements taken over the span of the tank height being transferred. If the incrustation does not remain fairly constant for any reason, such as changes resulting from seasonal thermal effects, it may be necessary to repeat these linear measurements to determine if the deduction is still within a reasonable tolerance. If less than full tank runs are to be encountered normally, the incrustation should be similarly determined by linear measurements over the span of the tank's operating height; however, properly measured varying thickness dimensions should be assigned at successive levels upward on the vertical walls of the tank.

The actual deduction to correct for incrustation should be calculated using Equations 1 and 2 or Equations 3 and 4.

For tanks calibrated in customary units,

$$D = 2.6737\sqrt{B} \tag{1}$$

$$\frac{\Delta B}{B} = \left[\frac{I}{3D}\right]\left[1 - \frac{I}{12D}\right] \tag{2}$$

Where:

B = tank capacity (barrels per foot).
D = tank diameter (feet).
I = average incrustation thickness (inches).
ΔB = change in tank capacity due to incrustation (barrels per foot).

For tanks calibrated in SI units,

$$D = 1.1284\sqrt{B} \tag{3}$$

$$\frac{\Delta B}{B} = \left[\frac{4I}{1000D}\right]\left[1 - \frac{I}{1000D}\right] \tag{4}$$

Where:

B = tank capacity (cubic meters per meter).
D = tank diameter (meters).
I = average incrustation thickness (millimeters).
ΔB = change in tank capacity due to incrustation (cubic meters per meter).

SECTION 4—TABLES

4.1 Gauge Table Notation

Any tank gauge table that has been adjusted to correct for deadwood deductions caused by incrustation should have on its face a note stating the amount of the adjustment and how the amount was determined. For example: “From the true capacity of this tank, 7.31 barrels have been deducted between 1 foot 0 inches and 16 feet 1 inch (1.16 cubic meters have been deducted between 0.30 meters and 4.90 meters) as a result of errors caused by incrustation. The amount was deter-

mined by meter according to recommended procedures described in API MPMS Chapter 4."

4.2 Tables for Uniform Incrustation

Tables 1 and 2 are intended only to be used as a guide in indicating the approximate effect of uniform incrustation on tanks of various sizes. They are not intended for direct use as a basis for actual deductions to correct for incrustation. Actual deductions should be determined individually by using one of the typical remedies suggested in Section 3.

Table 1—Approximate Reduction of Tank Capacity[a] by Uniform Incrustation in Barrels per Foot and Percent Capacity

	Thickness of Uniform Incrustation (in inches)							Tank Size Bbl/ft
	1/64	1/32	1/16	1/8	1/4	3/8	1/2	
Bbl/ft	0.007	0.014	0.028	0.056	0.112	0.168	0.224	13
% by volume	0.054	0.108	0.216	0.432	0.863	1.292	1.721	
Bbl/ft	0.007	0.015	0.029	0.058	0.116	0.174	0.232	14
% by volume	0.052	0.104	0.208	0.416	0.831	1.246	1.659	
Bbl/ft	0.009	0.017	0.035	0.070	0.139	0.209	0.278	20
% by volume	0.044	0.087	0.174	0.348	0.696	1.043	1.389	
Bbl/ft	0.011	0.022	0.045	0.089	0.179	0.268	0.357	33
% by volume	0.034	0.068	0.136	0.271	0.542	0.812	1.082	
Bbl/ft	0.016	0.031	0.063	0.126	0.251	0.376	0.502	65
% by volume	0.024	0.048	0.097	0.193	0.386	0.579	0.772	

Note: Refer to the specific tank gauge table capacity to determine tank size that should be used for a specific case.
[a]Upright cylindrical flat-bottom tank.

Table 2—Approximate Reduction of Tank Capacity[a] by Uniform Incrustation in Cubic Meters per Meter and Percent Capacity

	Thickness of Uniform Incrustation (in millimeters)							Tank Size m^3/m
	0.5	1	2	4	6	8	10	
m^3/m	0.005	0.009	0.019	0.037	0.056	0.075	0.093	7
% by volume	0.067	0.134	0.268	0.535	0.802	1.069	1.335	
m^3/m	0.005	0.010	0.020	0.040	0.060	0.080	0.100	8
% by volume	0.063	0.125	0.251	0.501	0.751	1.000	1.249	
m^3/m	0.006	0.012	0.024	0.047	0.070	0.094	0.117	11
% by volume	0.053	0.107	0.214	0.427	0.640	0.853	1.066	
m^3/m	0.008	0.015	0.030	0.060	0.090	0.120	0.150	18
% by volume	0.042	0.084	0.167	0.334	0.501	0.667	0.834	
m^3/m	0.010	0.021	0.042	0.084	0.126	0.168	0.209	35
% by volume	0.030	0.060	0.120	0.240	0.359	0.479	0.598	

Note: Refer to the specific tank gauge table capacity to determine tank size that should be used for a specific case.
[a]Upright cylindrical flat-bottom tank.

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