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NATIONAL BUREAU OF STANDARDS
Pressure Measurements Section

SUPPLEMENT FOR REPORTS ON DEAD WEIGHT PISTON GAGES

1.0 Reduction of Observations on Dead Weight Piston Gages

- 1.1 Pressure Equation
- 1.2 Load Correction
- 1.3 Fluid Head
- 1.4 Mass and Buoyancy
- 1.5 Gravity
- 1.6 Elastic Distortion
- 1.7 Calibration

2.0 Factors Affecting Performance of Dead Weight Piston Gages

- 2.1 Eccentric Load Error
- 2.2 Corkscrewing
- 2.3 Liquid Buoyancy
- 2.4 Drive Error
- 2.5 Weights
- 2.6 Friction
- 2.7 Leak Rate
- 2.8 Aging Effects
- 2.9 Fluid Viscosity
- 2.10 Leaks
- 2.11 Line Restriction

1.0 REDUCTION OF OBSERVATIONS ON DEAD WEIGHT PISTON GAGES

Measurements of pressures to an accuracy of a part in 10,000 or better can be made with a dead weight piston gage in good working order. To do so one must take into account a number of parameters of the instrument and its environment. The principal instrumental parameters are determined in the calibration. The user must determine those of the environment.

1.1 Pressure Equation. The pressure developed by a dead weight piston gage at its reference level is given by the formula:

$$p_p = \frac{\frac{M_m}{A_o}\left(1 - \frac{\rho_a}{\rho_m}\right) kg_L + \frac{V(\rho_{fa} - \rho_a)}{A_o} kg_L + \frac{\gamma C}{A_o}}{[1+a(t-t_s)]\,(1+bp_p)\,[1+d(p_{zo} + S_z p_p - p_j)]} \qquad (1)$$

where,

p_p Pressure at the reference level in pounds per square inch,

M_m Mass of the weights, including the piston assembly, in lbs,

A_o Effective area (mean area of the piston and cylinder) in square inches, at atmospheric pressure, temperature t_s, and jacket pressure p_{zo},

ρ_a Mean density of the air displaced by the load in lbs per cu. in.,

ρ_m Density of the weights in lbs per cubic inch,

$k = \frac{1}{980.665}$,

g_L Local acceleration due to gravity in cm/sec^2,

V Volume of oil in cubic inches contributing to the load on the piston, (see Footnote 1).

ρ_{fa} Density of the pressure fluid at atmospheric pressure, in lbs per cubic inch,

γ Surface tension of the pressure fluid in lbs force per inch,

C Circumference of the piston assembly in inches at the surface of the pressure fluid,

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Footnote 1. The quantity, V, used herein, is equal to the quantity $A_e y_{fa} - V_{fa}$ used in Monograph #65.

Therefore, $V\rho_{fa} = (A_e y_{fa} - V_{fa})\rho_{fa} = M_{fa}$ (2)