5/10/79

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

SERVED MAY 11 1979

In the Matter of	Docket Nos. 50-400
CAROLINA POWER & LIGHT COMPANY	50-401
	50-402
(Shearon Harris Nuclear Power Plant, Units 1, 2, 3 and 4	50-403

ORDER

The Board is considering the possibility of taking official notice of the fact that the test for viscosity is relatively simple; that industrially, viscosity is measured by observing the time necessary for a fluid to flow from a filled container of specified dimensions through an opening in the bottom of the container. Support for this may be found in the Standard Handbook For Mechanical Engineers, Seventh Edition, (McGraw-Hill), p. 3-49, relevant portions of which are attached hereto.

Any party may object to this procedure or controvert the fact to be noticed within ten days after service of this order.

IT IS SO ORDERED.

FOR THE ATOMIC SAFETY AND
LICENSING BOARD

Ivan W. Smith, Chairman

Attachment:
As stated

Dated at Bethesda, Maryland
this 10th day of May, 1979.

STANDARD HANDBOOK FOR MECHANICAL ENGINEERS

Revised by a Staff of Specialists

THEODORE BAUMEISTER, Editor

Consulting Engineer; Simms Professor Emeritus, Columbia University in the City of New York

LIONEL S. MARKS, Editor, 1916 to 1951

Late Gordon McKay Professor of Mechanical Engineering, Harvard University

Seventh Edition

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specific weight is $w = g\rho$, where g is the acceleration of gravity. The units of density are slug ft^{-3} or lb sec^2 ft^{-4}.

The specific gravity, s.g. or sp gr, is the ratio of the density of a substance to that of water at 39.2 F.

The pressure P is the force exerted by a fluid per unit area and has the units of lb ft^{-2}. Because thermodynamic laws and relations are used in fluid mechanics, P is defined as absolute pressure unless specifically stated otherwise (see also Sec. 4). For convenience, pressures are often expressed in pounds per square inch, inches of water, inches of mercury, or millibars, so caution must be observed when substituting in formulas. When pressure is given with respect to atmospheric pressure, it is called gage pressure. Thus, a pressure of 5.3 lb in.$^{-2}$ gage, or 5.3 psig, when the atmospheric pressure is 15 lb in.$^{-2}$, is equivalent to 20.3 lb in.$^{-2}$, or 2,923 lb ft^{-2}. Standard atmospheric pressure is defined as 2,116 lb ft^{-2}, or 14.7 lb in.$^{-2}$. To avoid confusion, units of pressure are often written as psia, lb in.$^{-2}$ abs, psfa, lb ft^{-2} abs; psig, where abs and a stand for absolute and g stands for gage. The temperature T has units of R, degrees Rankine.

When a fluid flows such that its velocities are free of macroscopic fluctuations, the flow is said to be *laminar*. The flow is *turbulent* when the velocities are subject to macroscopic fluctuations. Smoke rising from a cigarette in still air at first illustrates laminar flow and then turbulent flow when the swirls and eddies appear and continue.

When the flow is laminar, Newton's viscosity law states that the applied shear stress τ is proportional to the rate of deformation or to the velocity gradient normal to the velocity, dV/dy. The constant of proportionality μ is the absolute or dynamic viscosity, $\tau = \mu dV/dy$. A Newtonian fluid has a linear relation between the applied shear stress and the rate of deformation, while for a non-Newtonian fluid the relation is non-linear.

In the cgs system the unit of dynamic viscosity is the *poise*, having dimensions of gr sec^{-1} cm^{-1} or dyne sec cm^{-2}. The customary unit is the *centipoise*, having dimensions of poise $\times 10^{-2}$. The dynamic viscosity of water at 68.4 F and atmospheric pressure is 1.0 centipoise. In the English system the units of dynamic viscosity are slug ft^{-1} sec^{-1} or lb sec ft^{-2}. To convert the dynamic viscosity in centipoise to units of lb sec ft^{-2}, multiply by 2.088×10^{-5}.

The kinematic viscosity ν is the dynamic viscosity divided by the density $\nu = \mu/\rho$. In the cgs system the unit of kinematic viscosity is the *stoke*, having dimensions of cm^2 sec^{-1}. It is customary to use the *centistoke* which is stoke $\times 10^{-2}$. In the English system the dimensions of kinematic viscosity are ft^2 sec^{-1}. To convert kinematic viscosity in centistoke to units of ft^2 sec^{-1}, multiply by 1.076×10^{-5}.

Viscosity can be determined experimentally. A few such experiments are the laminar flow of a fluid in a duct, the damping of a torsional or spherical pendulum, the rate of rise or fall of a spherical body in a fluid, or the torque exerted on a stationary cylinder when a fluid fills the annular space between it and a rotating cylinder. Industrially, viscosity is measured by observing the time necessary for a fluid to flow from a filled container of specified dimensions through an opening in the bottom of the container. Empirical relations exist to convert the efflux time to kinematic viscosity. In the United States the Saybolt Universal viscometer is commonly used for petroleum products and lubricating oils. For heavy oils the Saybolt Furol viscometer is used. Dimensions of these viscometers are prescribed by the ASTM. In England the Redwood viscometer and in Germany the Engler viscometer are used.

The value of the kinematic viscosity in stokes can be obtained from the following approximation equations where t is the efflux time in seconds:

Saybolt Universal, when $32 < t < 100$	$\nu = 0.00226t - 1.95/t$
When $t > 100$	$\nu = 0.00220t - 1.35/t$
Saybolt Furol, when $25 < t < 40$	$\nu = 0.0224t - 1.84/t$
When $t > 40$	$\nu = 0.0216t - 0.60/t$
Redwood No. 1 (English), when $34 < t < 100$	$\nu = 0.00260t - 1.79/t$
When $t > 100$	$\nu = 0.00247t - 0.50/t$
Redwood Admiralty (English)	$\nu = 0.0271t - 29/t$
Engler (German)	$\nu = 0.00147t - 3.74/t$