TECHNICAL DATA

Determining Concentration by Weight and by Volume

Introduction

In the laboratory it is customary practice to determine concentrations of polymer quenchants by weight. However, it the field, it is generally more practical to determine concentration by volume. For instance, if a customer has a quench tank of 5000 gallons, and needs a 10% solution, it is generally easier to fill the quench tank with 4500 gallons of water, and then add 500 gallons of polymer quenchant. It is generally not practical to weigh out a 10% solution in the field.

Chemical concentrations are typically identified in several different methods and are expressed using percent composition by mass, volume percent, mole fraction, molarity or normality. In this short white paper, we will focus on concentration by mass and concentration by volume.

Percent Concentration by Mass (%)

This is the mass of the solute divided by the mass of the solution (mass of the solute plus the mass of the solvent), multiplied by 100 to get percent:

$$M\% = \frac{M_{solute}}{M_{solute} + M_{solvent}} x100$$

Example:

Determine the percent composition by mass of a 100 gram NaCl solution that contains 20 grams of NaCl.

Solution: 20 grams NaCl/100 g solution x 100 = 20% NaCl solution by weight

Volume Percent (%v/v)

Volume percent is most often used when preparing solution of liquids. This is defined as:

$$\frac{v}{v}\% = \frac{V_{solute}}{V_{solute} + V_{solvent}} x100$$

Notice that the volume percent is based on the volume of the solution and not the volume of the solvent. The liquid volumes are not necessarily additive. For instance, in some alcohol solutions in water, the total volume will be less than the sum of the solute and solvent.

Example:

Determine the percent composition by volume of 20 ml of ethanol in 100 ml of solution.

Solution: 20 ml ethanol/100 ml solution (ethanol + water) x 100 = 20% ethanol solution by volume.

The calculation of volume percent is generally accurate for the calculation of liquids provided that the liquids have nearly the same specific gravity (Sp). If the two liquids to be mixed have different specific gravities, then there will be differences in the concentration by volume and the concentration by weight. In this case calculation of volume is modified accordingly:

$$\%Conc = \frac{(V_{solute} * S_{g_{solute}})}{(V_{solute} * S_{g_{solute}}) + (V_{solvent} * S_{g_{solvent}})} x100$$

This equation converts the calculation to a mass concentration, and should match the laboratory concentration assuming that the volumes measured are accurate.

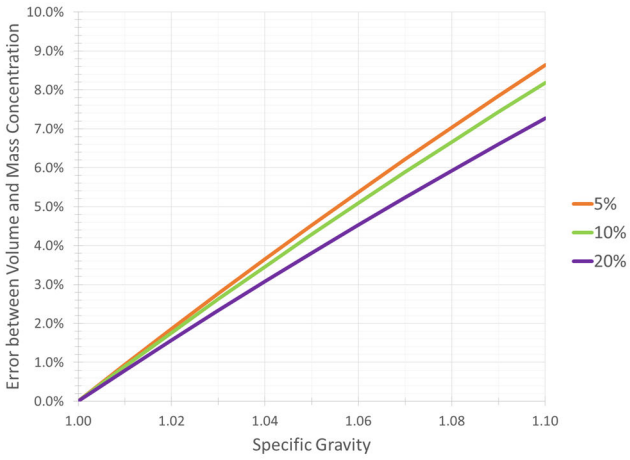
The error between calculation by mass and calculation by volume, as a function of Specific

HOUGHTON™

Houghton International Inc.
Madison and Van Buren Aves.
P. O. Box 930
Valley Forge, PA 19482-0930

Phone: 610-666-4000
Fax: 610-666-0174
info@houghtonintl.com
www.houghtonintl.com

Revised: 19 February 2018 DSM



Product	Specific Gravity	Pounds per Gallon
Aqua-Quench® 110	1.07	8.89
Aqua-Quench® 140	1.06	8.85
Aqua-Quench® 145	1.06	8.85
Aqua-Quench® 245	1.07	8.93
Aqua-Quench® 251	1.07	8.93
Aqua-Quench® 260	1.09	9.10
Aqua-Quench® 364	1.09	9.10
Aqua-Quench® 365	1.07	8.93
Aqua-Quench® 3600	1.03	8.60
Aqua-Quench® 3699	1.02	8.51
Aqua-Quench® C	1.04	8.68
Aqua-Quench® Inhibitor 211	1.28	10.7
Aqua-Quench® Inhibitor 312	1.11	9.26

Application to Polymer Quenchants

Water has a specific gravity (Sp) = 1.0. Polymer quenchants have a specific gravity greater than water. A table of typical specific gravities of commonly used Houghton polymer quenchants are shown in Table 1. Depending on the product, the specific gravity is between 2-9% greater than water. At low concentrations, the errors can be as much as 8%. In other words, if you have a solution of 5% by volume, the concentration measured by the laboratory would be about 5.4% weight percent. At higher concentrations, the error decreases, but because of the higher overall concentration, the difference in the amount of polymer is greater.

For instance, a 20% concentration by volume would be equivalent to 21.3% by weight. Depending on the allowable concentration specification range, this variation may or may not be acceptable. This variation can also explain why there is a difference between Field and Laboratory determined concentrations.

Should you have any questions on this or any other similar topic, please contact your local Houghton Technical Representative.