

Application Report

Concentration Determinations using the Rudolph Research Analytical DDM 2911 Density Meter

Introduction

From purely an intuitive approach, it is easy to understand how a density meter can determine concentrations. If you were to measure the density of a pure water sample, you would find its density to be 0.9982 g/cm^3 at 20°C . Now if you were to take 1g of NaCl (salt) and add this to the same pure water to make a 100 g solution, the resulting 1% solution of NaCl would now have a density of 1.0053 g/cm^3 at 20°C . Add yet another gram of NaCl and the 2% solution now will have a density of 1.0125 g/cm^3 at 20°C . If you were to continue this process, you would soon have a complete table of % NaCl vs. density at 20°C . Subsequently, you are now able to find the concentration of an unknown NaCl solution.

The example above only discusses the concentration determination of NaCl. However, this same type of relationship is true for many commonly used solutions and many such tables already exist in the literature. But it is not too difficult to make new tables as required. This type of application is called a “two component” or binary solution; whereas chemical “A” is dissolved into chemical “B”. These chemicals “A” and “B” can be a solid dissolved in a liquid or a liquid dissolved into a second liquid. An example of the latter is the %Toluene in n-Heptane. Using the DDM 2911, this analysis becomes extremely user friendly.

Rudolph Research Analytical DDM 2911 Density Meter

The DDM 2911 most often provides the fastest, most accurate, and easiest means for determining the unknown concentration of a solution. Consider the determination of the Normality of a NaOH solution. The common quantitative chemical analysis practice would be titration against a standardized HCl solution until a pink end point is reached. But, consider all the various sources of error inherent to this titration method. The glass buret is calibrated at 20°C , but the room temperature is 22°C , resulting in error #1. Then a standardized HCl solution must be made; resulting in error #2. The buret is filled to the “zero” line, error #3. Then the titration takes place to the pink end point, error #4. The meniscus is read to determine the volume of the titrant used, error #5. This titration method is very tedious, labor intensive, and time consuming, and often yields results that are not repeatable. This is why it is common practice for all titrations to be done three times and then the average of those 3 measurements is calculated.

Now consider the numerous advantages to doing this same quantitative analysis by using the DDM 2911 density meter instead of titration. There is no need for the HCl standard solution. Nor is there a need for the phenolphthalein indicator solution. Human error in reading the meniscus and stopping at the pink end point is eliminated. The time required for the complete analysis is only 2 to 3 minutes and the results are extremely accurate and repeatable. Operator training is minimal as there are only two possible sources of error; contamination of the DDM 2911 U-tube sample chamber and bubbles in the sample. Both of these possible errors are completely eliminated because of the exclusive features of the DDM 2911.

The DDM 2911 permits the use of a 3 point adjustment calibration. The first calibration point would be done on a completely clean and dry U-tube. Subsequently, even the smallest amount of any contamination in the U-tube would be detected by the density meter. The other two calibration/adjustment points would bracket around the density ranges of the samples to be measured providing the highest possible accuracy. The second source of error, bubbles in the sample, is also completely eliminated by the DDM 2911 exclusive VideoView™, whereas even the smallest of bubbles can be easily detected by the operator ensuring precise, accurate measurements every time.

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Common Applications for the DDM 2911 Density Meter

Density is an important quality control parameter since it is a measure of purity, consistency and also a measure of concentration of most all two component or binary solutions.

Concentrations may be determined in the units of %wt, %vol, Proof, Molarity, Normality, ppm, °Brix, API Gravity, and most any other unit which is required by the user.

The following industries rely heavily upon these measurements:

Breweries

Solubility of incoming malts, °Balling, °Plato, OG, Specific Gravity, Apparent Extract, consistency of final beer, etc., may all be measured quickly and easily using the Rudolph Research Analytical DDM 2911 Automatic Density Meter.

Chemical Plants

Density is used for a large variety of reasons for both the common bulk chemicals and the specialty and proprietary products. Acids, caustics, solvents, polymers, elastomers, resins, slurries, and more are all measured using Rudolph's DDM 2911 Automatic Density Meter. Pure chemicals and solutions are measured. Dilutions and blending operations are monitored and controlled through the use of density. Density may be used to determine various concentrations in units of Normality, Molarity, percent by weight or volume, PPM, API, and many other related density values.

Distilleries

Density is used as an officially recognized method for the determination of alcohol concentration for quality control and to insure proper product labeling for declaration of alcohol content for the payment of tax.

Flavor & Fragrances

Density is used to check the blended and/or diluted oils to the desired concentration and customer specifications. Raw materials are checked as well as alcohol, sugar (°Brix), % solids, and many other parameters. Specific Gravity is always checked on final product as a means of ensuring product consistency.

Petroleum

The DDM 2911 complies with all the requirements of ASTM D4052, D5002, D5931, D1250, DIN 51757 and DIN ISO EN 12185. Density, Specific Gravity, API Numbers are all determined at various temperatures using the DDM 2911 for QC in Refineries and R&D laboratories.

Pharmaceuticals

USP29 <841> Specific Gravity Method II and USP29-NF24 approves the use of the DDM 2911 Automatic Density Meter. Also, the European Pharmacopoeia 5.0 (2005), pp. 27-28; Pharmedropa, Vol. 15, 1, January 2003, pp. 174-175 approves the use of the DDM 2911 Automatic Density Meter. Uses include the checking of incoming raw materials and for final testing of product to be released. The DDM 2911 is compliant with 21CFR Part 11 and all cGMP/GLP requirements.

Soft Drinks

The DDM 2911 is used primarily to measure the sugar (°Brix) of the final product to check for proper blending. It is also used by the syrup plants. Consistency of product is essential to this industry and the measurement of density using the DDM 2911 is the most accurate and easiest means to this end.