

Measuring Water Content in DMSO for Compound Storage Tubes Using the TubeDowser



Water and DMSO Solutions in Storage Tubes

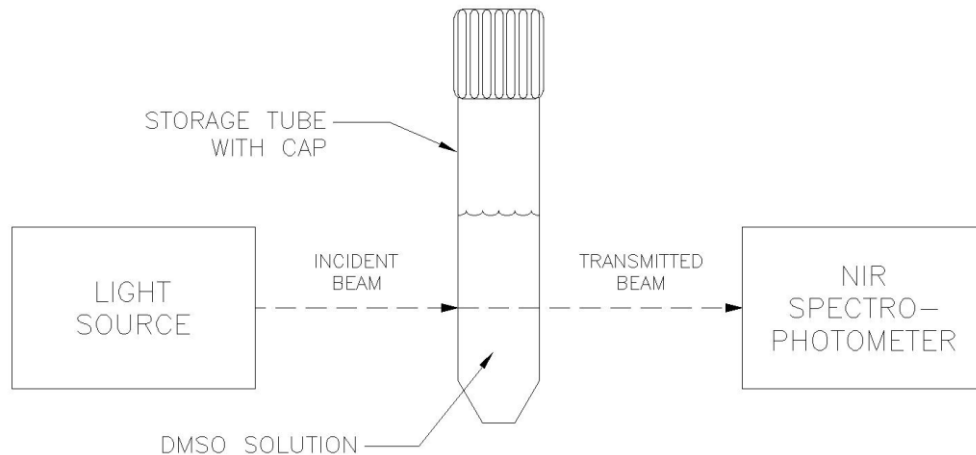
The screening of large numbers of chemical compounds for pharmaceutical, toxicological, genetic or other types of activity is a technique that is widely used by scientists and researchers. For example, in searching for compounds that might have usefulness as new drugs (commonly referred to as "hits"), a researcher may want to determine if a compound shows any sign of binding to or reacting with another biological molecule, so as to decrease or increase the activity of the bio-molecule. To do this, the researcher needs to evaluate how one or more test compounds react with a large number of target compounds. This means that pharmaceutical companies and other research organizations need to maintain very large libraries of target compounds for high throughput screening. The library size can range from hundreds of thousands to tens of millions of chemical compounds. Each of these compounds must be cataloged, stored, sampled, distributed and tracked. Not only are the logistics of tracking a large chemical library challenging, but the quality of the chemical samples in the library must also be monitored. Initially, the individual compounds in the chemical library are usually obtained as solids, films or beads. A master copy of the compound is then prepared as a concentrated solution in an organic solvent, which is usually dimethyl sulfoxide (DMSO), and is stored in a compound storage tube. Replicates (or daughters) of the master copy are prepared and distributed to end

users. The end user may prepare a low volume working copy of the compound by transferring a small volume of the local master to another storage container, such as a polypropylene microtube or microplate. The concentration of the compound in the working copy could be, for example, ten millimolar (10 mM) for small molecule compounds, or 200 mM for fraction libraries. Small volumes of the working copy of the compound are constantly removed from the storage container as the researcher prepares samples for use in an assay. This use exposes the working copy to common laboratory contaminants such as light, water vapor, dust, and oxygen, and gradually causes the quality and concentration of the working copy to change. Water vapor is a major problem for samples stored in DMSO since DMSO is very hygroscopic, and it is not unusual for the concentration of working copies to decrease by as much as 20% or more while being used because of water dilution. Water uptake by DMSO also causes freezing point depression, which can cause quicker degradation and precipitation of samples when being stored at low temperatures. Consequently, it is necessary to periodically check the concentration of water in the working sample.

Water Content Measurement Methods

Several methods for determining the water content (hydration) of DMSO are known in the Industry. An older method is the *Karl Fischer Titration Technique*, which is very time consuming. Newer methods include acoustic methods and optical methods, such as fluorescence techniques and absorption techniques. In particular, an optical approach to determining the water content in DMSO for a corporate compound collection is of special interest. It was described in a technical paper, by Semin et al., "A Novel Approach to Determine Water Content in DMSO for a Compound Collection Repository".*

This approach uses near-infrared (NIR) spectroscopy to analyze the absorption bands of water present in the DMSO. As shown in the following block diagram, a light source projects an incident beam through the center of the tube under test, and the transmitted beam through the tube is measured by a NIR spectrophotometer. The path length for the absorption measurement is defined by the diameter of the storage tube. If water is present in the liquid, part of the IR light energy is absorbed by the water molecules due to the stretching modes of O-H bond. Therefore, using the O-H bands characteristics of water, NIR spectroscopy can be used to measure absorption and water quantitatively in organic solvent such as DMSO. In addition, in the paper, it was also demonstrated that the NIR measurement is insensitive to the presence of compounds at typical storage concentrations.



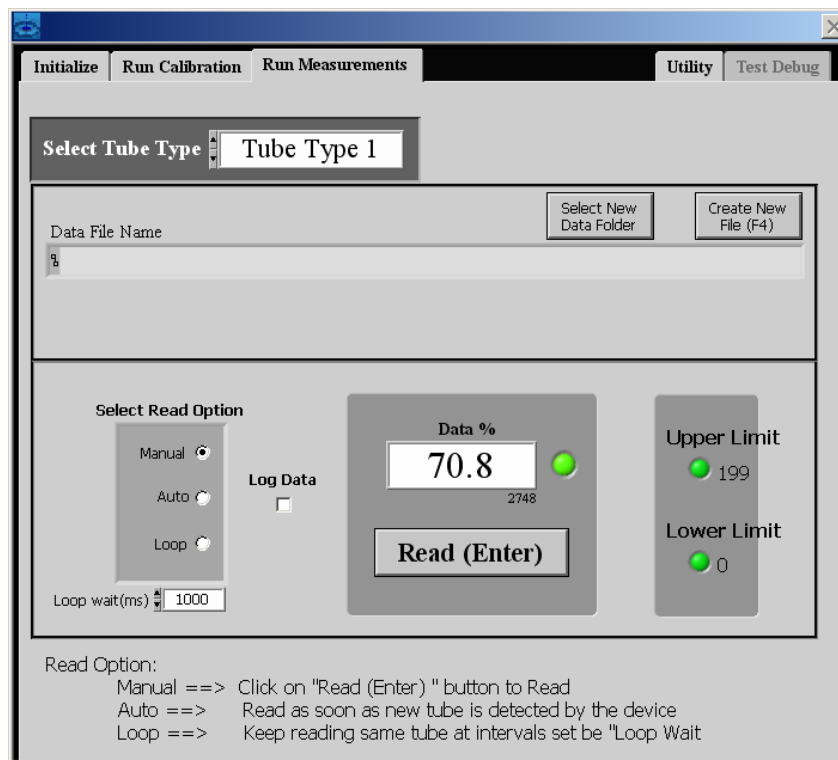
NIR spectroscopy also has a real advantage in that many plastic and glass materials are transparent to NIR radiation at the thickness of storage tubes. It allows the possibility of taking an NIR spectrum of a sample without de-capping the tube, since the reading can be taken directly through the plastic tube or glass vial. This approach is very desirable because it is both accurate and nondestructive. However, the instrumentation typically used in this method, namely the spectrophotometer, means that it is relatively expensive and additional analysis is required to yield water content information. What is needed is a simplified technique for measuring the water content in DMSO solutions that can be used in a lab. More importantly, the measurements must be taken directly in the storage vessel holding the DMSO without destroying or contaminating any of the solution. This is exactly what is accomplished in EDC's TubeDowser: it adopts the measurement technique used in NIR spectroscopy and combines the optics, electronics, and mechanics into a small mobile device. The TubeDowser is powered through a USB cable, it is very simple to use, and measures the hydration level directly in percentage of DMSO without any sample preparation.

The TubeDowser has the following key features:

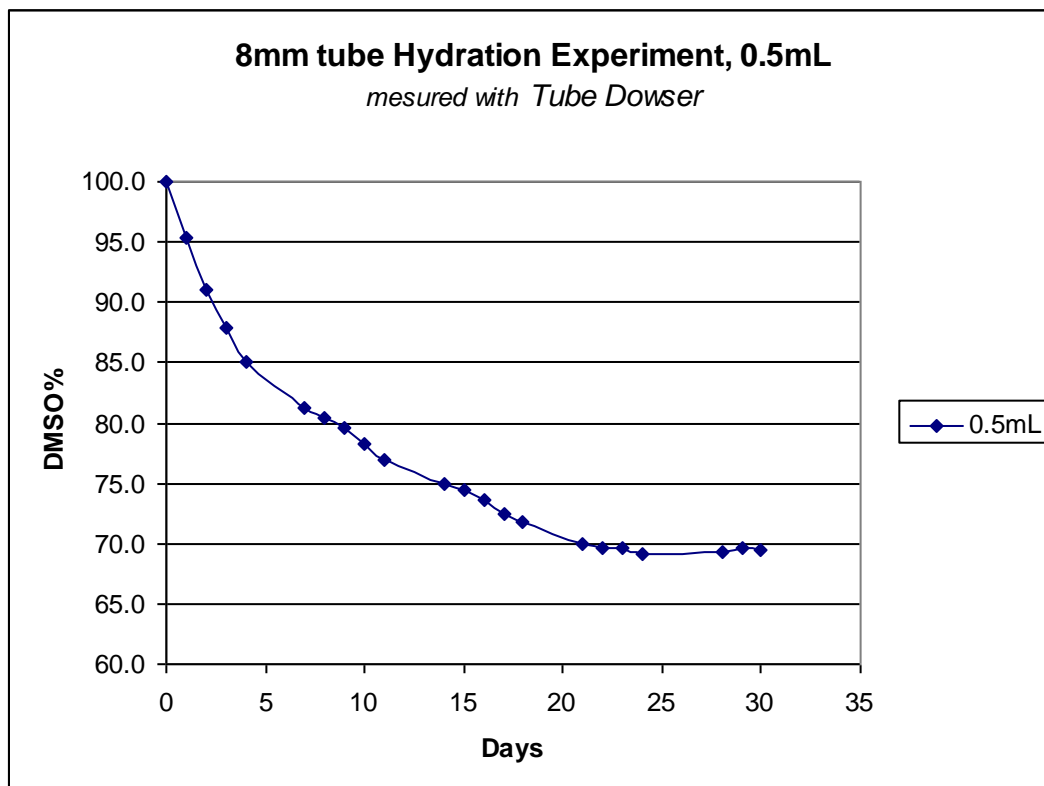
- Completely non-invasive
- Accurate to within 2% of hydration level of DMSO
- Measures a variety of tube styles
- De-capping not required
- Single channel tube reading
- Easily adaptable to existing tube holding systems

Hydration Experiment

As a demonstration of the TubeDowser, an experiment was conducted to measure the hydration in a typical storage tube using the TubeDowser as the measurement instrument. An 8mm Matrix tube was first filled with 0.5mL of DMSO. Afterwards, the tube was purposely left uncapped and placed in a lab under typical room environment (temperature: 22-25 degrees Celsius, RH: 25-35%). The DMSO concentration of the solution was measured periodically with the TubeDowser. To take a DMSO measurement, the tube is simply inserted into the tube holder of the TubeDowser and the reading is taken by pressing the 'Read' button on the measurement screen (see screenshot below).



The data was taken over a period of 30 days. Initially, there is a faster change in hydration during the first 4 days as the DMSO concentration drops to 85%. The hydration rate slows down considerably for the next 15-16 days until it reaches the final level of around 70% DMSO. The result is plotted below.



In conclusion, the TubeDowser provides a simple means to measure the water content of DMSO solutions accurately in storage tubes. The measurement can be taken optically and non-invasive, without decapping the tube. It greatly simplifies the task of monitoring the quality of DMSO solutions in labs and compound storage facilities.

* Reference: "A Novel Approach to Determine Water Content in DMSO for a Compound Collection Repository", *Journal of Biomolecular Screening*, 10(6), pp.568-572 (2005)

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