

1. Place the verification standard (do not start with water) in the AquaLab for measuring. When a final reading is reached, check it against the value listed above. If it is within  $\pm 0.003$ , place your second solution in the drawer for testing. It should read the value  $\pm 0.003$  listed in the table above. If the readings are within the expected values your verification is complete.

2. If the first solution does not read within  $\pm 0.003$  of the expected value, then you need to adjust the linear offset so that the solution reads correctly. Instructions for this are in your operator's manual. When you are finished measuring both standards the readings should be within  $\pm 0.003$  of the predicted values.

### References

- AOAC, Method 978.18D Preparation of Reference Salt Slushes. 1995. Official Methods of Analysis of AOAC International. 16th Ed. AOAC International, Arlington VA.
- Campbell, G.S. and W.H. Gardner. 1971. Psychrometric measurement of soil water potential: temperature and bulk density effects. Soil Sci. Soc. Am. Proc. 35:8-12.
- Greenspan, L. 1977. Humidity fixed points of binary saturated aqueous solutions. J. Res. National Bureau of Stds. A. Physics and Chem. 81A:89-96.
- Lang, A.R.G. 1967. Osmotic coefficients and water potentials of sodium chloride solutions from 0 to 40 C. Aust. J. Chem. 20:2017-2023.
- Robinson, R.A. and R.H. Stokes. 1965. Electrolyte Solutions. Butterworths, London.

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# AquaLab Verification Standards

Using the AquaLab is easier than ever. Pre-packaged standard salt solutions are immediately available for performance verification, saving you time and money. Validation and documentation for GMP and GLP has also become easier. Operate your instrument with certainty and insure the quality of your food product by using low cost precision salt solutions.

- No need to purchase and store reagent grade salts.
- No additional laboratory equipment necessary.
- Avoid solution handling and mixing errors.
- Save technician time.

The AquaLab should be verified against a known salt standard daily. For high use or batch processing, the instrument should be checked regularly against a known salt standard of similar water activity. Checking the water activity of a standard solution will alert the operator to the possibility of contamination of the unit or shifts in the linear offset from other causes.

Now, you can verify the AquaLab performance with confidence. Performance Verification Standards come in four water activity levels; 0.984, 0.760, 0.500, and 0.250  $a_w$ . The standards are produced under a strict quality assurance regime. The accuracy of the standards is verified by an independent third party and are shelf stable for one year. Order your verification salt standard of similar water activity today.

### Uncertainties Using Saturated Salt Solutions

The water activity values listed in our operator's manual for saturated salts were reprinted from Greenspan (1977). His method for determining water activity was to combine all of the available data from tests by other researchers. He did not set up any experiments of his own. The uncertainty he published is due to variation among the

results from the different methods. There are, therefore, limitations to the accuracy of these values. The instrumentation available for making water activity measurements is much better now than it was in 1977, so improved standards are needed.

Saturated salt solutions can be prepared by several methods. The AOAC method involves starting with salt and adding water in small increments, stirring well with a spatula after each addition, until salt can absorb no more water as evidenced by free liquid (where it will take on the shape of the container but will not easily pour). This method gives the most accurate readings, but only for a short time unless great care is taken to prevent water gain or loss. When a salt standard is prepared so that it consists mostly of liquid with a few crystals in the bottom, it can result in a layer of less than saturated solution at the surface which will produce a higher reading than anticipated. Conversely, solid crystals protruding above the surface of the liquid can lower the readings. To comply with Good Laboratory Practices (GLP), a saturated salt solution must read within reasonable analytical error of the accepted published value for a given temperature.

### Why AquaLab Verification Standards are Superior

Our research indicates that unsaturated salt solutions make much better standards than saturated salts. Robinson and Stokes (1965) give activity coefficient for various salt solutions. These can be used to compute the water potential, or partial specific Gibbs free energy, of the water in the solution using;

$$(1) \quad \Psi = -\phi\gamma cRT$$

where  $\psi$  is the water potential,  $\phi$  is the number of active particles per molecule of solute (i.e., 2 for NaCl),  $\gamma$  is the activity coefficient,  $c$  is the concentration of the solute (mol kg<sup>-1</sup>),  $R$  is the gas constant (8.314 J mol<sup>-1</sup> K<sup>-1</sup>),  $T$  is the Kelvin temperature. Water potential is related to water activity by the equation;

$$(2) \quad a_w = \exp\left(\frac{\Psi M_w}{RT}\right)$$

where  $M_w$  is the molecular weight of water (0.018 kg mol<sup>-1</sup>). When equations 1 and 2 are combined a simplified equation for water activity is obtained;

$$(3) \quad a_w = \exp(-\phi\gamma cM_w)$$

For example, equation 3 gives the  $a_w$  in a 6M NaCl solution, ( $M_w = 0.018$  kg mol<sup>-1</sup>,  $\phi = 2$ , and  $\gamma = 1.271$ ; from tables in Robinson and Stokes, 1965) as;

$$a_w = \exp(-2 \times 1.271 \times 6 \times 0.018) = 0.760$$

It is important to note that equation 3 has no explicit temperature dependence. Available data on temperature dependence of  $\gamma$  indicates that its variation is less than  $\pm 2\%$  over the range 0 to 50°C for NaCl (Lang, 1967) and KCl (Campbell and Gardner, 1971) and no other terms have any temperature dependence.

A further advantage of unsaturated salts is that there is no solid phase present to affect the water activity of the solution. Salt in saturated solutions can exist in different states and result in uncertainty in the water activity values.

### Instructions for Using Decagon's Verification Standards

Simply empty one vial of standard solution into a sample dish and place the dish immediately into the AquaLab for measurement. Be gentle when using the drawer so as not to slosh the solution out of the dish. Each vial will fill a sample dish to just less than half full. If the drawer is pushed or pulled too quickly the solution will spill and contaminate the AquaLab. The following table shows the expected values.

Verification Standard	Water Activity
Distilled H <sub>2</sub> O	1.000 ±0.003
0.5m KCl	0.984 ±0.003
6M NaCl	0.760 ±0.003
8.57M LiCl	0.500 ±0.003
13.41M LiCl	0.250 ±0.003

Verify that the AquaLab is functioning properly with any two of these solutions. We recommend that you choose a standard from the range in which you are measuring and distilled water (or another solution from the table).