Test Procedures for the Determination of Desiccant Adsorption Capacity

It is not normally necessary to check the desiccant for U.C. (useful capacity, the percentage of water adsorbed by the desiccant on a weight basis). The U.C. is usually determined only as a last resort in special situations after either an exhaustive evaluation of the dryer for electrical or mechanical malfunctions, or if accurate dew point analysis is not available. The usual procedure is to simply change the desiccant without determining its U.C. because if malfunctions or air leaks are not present the desiccant has to be contaminated.

The U.C. is only one of many parameters that are used to design adsorption systems, the particulars of which are not important. What is important is that the drying system produces "dry" air. How "dry" the air is can be readily determined by using a hygrometer to measure the dew point of the air. The dew point will indicated how well the whole drying system is operating, and not just the condition of one component.

Two test methods are for determining U.C. are shown below for informational purposes. Method one is based on the fact that the desiccant gives off heat when it adsorbs water (Heat of adsorption). This test is not 100% accurate because the desiccant does not adsorb liquid water in the same way that it adsorbs gaseous water. A negative result (low temperature rise) does indicate that the desiccant is contaminated, but a positive result (high temperature rise) does not necessarily indicate that the desiccant is okay.

Method two is the test procedure used by some desiccant manufacturers when they test desiccant samples. The normal value is 18% for molecular sieve using a 10% R.H. atmosphere.

Method one

Heat of Adsorption Desiccant Analysis

Apparatus

2	Beakers 250 ml
1	Glass thermometer 50F – 150F
150 ml	Distilled water
1	Graduated cylinder

Place a sample of desiccant in an oven set at 550F. After 3 hours, remove the sample and seal the container to prevent moisture adsorption while the desiccant cools to room temperature (about 24 hours).

Pour 45 ml of water into a beaker and measure the temperature. In a second beaker, pour a quantity of sieve which is about 10% more by volume than the water (50 ml). Dry the thermometer and place it into the sieve. Pour the water into the beaker and observe the increase in temperature of the mixture while stirring with the thermometer. Record the peak temperature which will occur in about 20 seconds. Subtract the water temperature from the peak temperature and record. Run at least 3 tests and determine an average value.

If the temperature difference is 40F or greater, the sieve may be in good condition. If the temperature rise is less than 40 F, the desiccant should be replaced.

If the temperature rise is correct but the dryer still does not produce a low enough dew point, the problem could be that the desiccant beads are physically breaking apart. Look for the presence of powdered or chipped desiccant particles.

Method two

Analytical Procedure for the Determination
of Adsorption Capacity of Silica Gel and Molecular Sieve

Principle

Air saturated at 10-20-40-60 and 80 percent relative humidity is passed over the sample until equilibrium is reached at pressure less that 1" Hg and at some temperature between 76 and 86 deg F. Once the test is started, the temperature must not vary more than + or – 1 deg F throughout the test period.

		Relative Humidity	% H2SO4
A.	Pressure Manometer		
B.	Air Flowmeter	10 percent	64.7
C.	Saturators	20 percent	58.2
D.	Mist Trap	40 percent	47.8
E.	Sample Tube	60 percent	38.4
F.	Bypass	80 percent	26.2

This table of acid strengths by weight percent has been computed from the International Critical Tables. The relative humidity represents values that would be obtained in a closed static system. The actual effluent relative humidities will be below these values, decreasing as the back pressure increases on the system.

The sample containing bottle should be a Nesbitt, Fleming or other standard form adsorption bulb. The test room, the inlet air and the sulfuric acid solutions should be at the same temperature and should not vary more than plus or minus 1.0 deg F during the test period.

Procedure

Refer to drawing SK-912A. The adsorption bulb is tightly packed with about a 1 inch layer of Pyrex glass wool. A two to eight gram sample (2 grams of fine gels and 8 grams on large crystal size) of the desiccant is weighed accurately in the tared adsorption bulb. Extreme care should be exercised to insure exposure of the sample for a minimum amount of time. Connect the adsorption bulb to the apparatus and adjust the air flow to four liters per minute with the by-pass closed. If the manometer indicates the pressure to be greater than 1" of mercury, the bleed-off line should be opened just enough to lower the pressure to less than 1" and that point maintained for the test period. When using the bypass, an occasional check should be made of the amount of air passing through the adsorption bulb by diverting the bypass air form the flowmeter to the atmosphere through the "tee" connection. The flowmeter reading will then indicate the actual air flow through the adsorption bulb. After 5 or 6 hours, the adsorption bulb is removed from the train and weighed. The bulb is then placed back in the adsorption train for two more hours and then it is again weighed. Repeat the two hour weightings until two successive weightings show a weight gain not exceeding five milligrams.

Calculations

Total gain in weight x 100 = water adsorbed % by weight

weight of sample

Sulfuric Acid Solutions for Relative Humidities

Relative Humidity	Deg Be' H2SO4	% H2SO4	Specific Gravity	Temperature Correction 1 deg F	To make 1Liter	
					H2SO4 (ml)	H2O (ml)
1%	60.26	78.12	1.7112	.026 deg Be'	759	241
2%	58.87	74.15	1.6835	.026 deg Be'	747	253
3%	56.60	72.12	1.6303	.027 deg Be'	672	328
5%	54.70	69.20	1.6058	.027 deg Be'	633	367
10%	51.70	64.70	1.5547	.028 deg Be'	574	426
15%	49.21	61.05	1.5137	.028 deg Be'	525	475
20%	47.22	58.20	1.4829	.028 deg Be'	494	506
30%	43.76	52.80	1.4227	.030 deg Be'	430	570
40%	39.80	47.80	1.3784	.031 deg Be'	379	621
50%	36.36	43.12	1.3347	.033 deg Be'	327	673
60%	32.86	38.40	1.2930	.034 deg Be'	282	718
70%	28.73	32.93	1.2471	.035 deg Be'	233	767
80%	23.47	26.40	1.1931	.035 deg Be'	182	818
90%	16.82	18.50	1.1312	.033 deg Be'	119	881

A x B = C
D x E = F
C x 1000 = ml. C.P. H2SO4 required to make 1 liter of R.H. required solution

Where   A = % H2SO4 solution required
B = specific gravity of solution required
C = grams H2SO4 per ml. of solution required
D = % H2SO4 of C.P. H2SO4
E = specific gravity of C.P. H2SO4
F = grams H2SO4 per ml. C.P. H2SO4