Lascaux
the spirit of colours

Theoretical Requirement of ART-SORB® in a given show-case

The following is a simple calculation used to determine the amount of ART-SORB® necessary to keep constant humidity in a showcase given the severest possible conditions of temperature and relative humidity in the outside atmosphere:

$$\text{ART-SORB}^{®}\ \text{Weight (kgs of dry base)} = \frac{(W1 - W0)\ \text{or}\ (W0 - W2)}{M}$$

The larger of the two values for the numerator of the above equation should be used, since it represents a greater amount of moisture ad/desorbed and thus the more severe of the two conditions.

Note Weight in grams /1 m^3
RH in %
Temperature in °C

W0 = water content in air at temperature T0 and RH H0

W1 = water content in air at temperature T1 and RH H1

W2 = water content in air at temperature T2 and RH H2
(Note that T1 > T0 > T2, with T0 being desired RH and temperature)

M = A symbol for M-Value, or the amount of water (in grams) gained or lost by 1 kg of silica gel when RH changes by 1%.

The above equation can be used to calculate the minimum quantity of ART-SORB® necessary to keep a predetermined relative humidity within a 1% deviation range given the severest possible swing in temperature. Note that if a 2% deviation from the predetermined RH is permitted, only half the amount of ART-SORB® calculated by the above equation is necessary.

Example

Conditions: Desired RH is 60% at 25° C. Most severe possible temperatures predicted at 5° C and 35° C.
By looking at the "Weight of Moisture given RH and Temperature" chart (Fig. 1) we determine that:
W0 = 13,5 grams/1 m3 at 25° C, 60% RH
W1 = 22,9 grams/1 m3 at 35° C, 60% RH
W2 = 4,12 grams/1 m3 at 5° C, 60% RH
By looking at the M-Value chart we see that between 50% and 70% RH the average M-Value is 14 (Fig. 2).
Thus
W0 = 13,5 g/1 m3 bei 25° C, 60% RF
W1 = 22,9 g/1 m3 bei 35° C, 60% RF
W2 = 4,12 g/1 m3 bei 5° C, 60% RF
By looking at the M-Value chart we see that between 50% and 70% RH the average M-Value is 14 (Fig. 2).
Thus:

$$\text{ART-SORB}^{®}\ \text{weight (kgs of dry base)} = \frac{(22{,}9 - 13{,}5)}{M}$$

$$= 0{,}67\ \text{kg ART-SORB dry base}^{®}$$

While studying the above calculation, please note that two added factors must be taken into account:
1. The exhibition case must be sealed reasonably well. If it is not sealed well the frequent exchange of air between inside and outside the case will require a larger amount of ART-SORB®.
2. The type of artwork inside the case may affect how much ART-SORB® is necessary. If the material being protected tends to adsorb a lot of moisture, the ART-SORB® will be required to alter the moisture content of both the air inside the case and the moisture contained in the artwork.
Note: The above information was supplied by Dr. Miura of the Tokyo National Research Institute.

Figure 1: Weight of Moisture Given RH and Temperature in a Given Area Moisture

(g/m3)

	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
40°C	48.6	43.7	38.8	34.0	29.1	24.3	19.4	14.5	9.72	4.86
39°C	46.4	41.7	37.1	32.4	27.8	23.2	18.5	13.9	9.28	4.64
38°C	44.3	39.8	35.4	31.0	26.5	22.1	17.7	13.2	8.86	4.43
37°C	42.2	37.9	33.7	29.5	25.3	21.1	16.8	12.6	8.44	4.22
36°C	40.2	36.1	32.1	28.1	24.1	20.1	16.0	12.0	8.04	4.02
35°C	38.3	34.4	30.6	26.8	22.9	19.1	15.3	11.4	7.66	3.83
34°C	36.4	32.7	29.1	25.4	21.8	18.2	14.5	10.9	7.28	3.64
33°C	34.6	31.1	27.6	24.2	20.7	17.3	13.8	10.3	6.92	3.46
32°C	32.3	29.0	25.8	22.6	19.3	16.1	12.9	9.69	6.46	3.23
31°C	31.2	28.0	24.9	21.8	18.7	15.6	12.4	9.36	6.24	3.12
30°C	29.6	26.6	23.6	20.7	17.7	14.8	11.8	8.88	5.92	2.96
29°C	28.1	25.2	22.4	19.6	16.8	14.0	11.2	8.43	5.62	2.81
28°C	26.6	23.9	21.2	18.6	15.9	13.3	10.6	7.98	5.32	2.66
27°C	25.2	22.6	20.1	17.6	15.1	12.6	10.0	7.56	5.04	2.52
26°C	23.9	21.5	19.1	16.7	14.3	11.9	9.56	7.17	4.78	2.39
25°C	22.6	20.3	18.0	15.8	13.5	11.3	9.04	6.78	4.52	2.26
24°C	21.4	19.2	17.1	14.9	12.8	10.7	8.56	6.42	4.28	2.14
23°C	20.2	18.1	16.1	14.1	12.1	10.1	8.08	6.06	4.04	2.02
22°C	19.1	17.1	15.2	13.3	11.4	9.55	7.64	5.73	3.82	1.91
21°C	18.0	16.2	14.4	12.6	10.8	9.00	7.20	5.40	3.60	1.80
20°C	17.0	15.3	13.6	11.9	10.2	8.50	6.80	5.10	3.40	1.70
19°C	16.0	14.4	12.8	11.2	9.60	8.00	6.40	4.80	3.20	1.60
18°C	15.1	13.5	12.0	10.5	9.06	7.55	6.04	4.53	3.02	1.51
17°C	14.3	12.8	11.4	10.0	8.58	7.15	5.72	4.29	2.86	1.43
16°C	13.5	12.1	10.8	9.45	8.10	6.75	5.40	4.05	2.70	1.35
15°C	12.7	11.4	10.1	8.89	7.62	6.35	5.08	3.81	2.54	1.27
14°C	12.0	10.8	9.60	8.40	7.20	6.00	4.80	3.60	2.40	1.20
13°C	11.3	10.1	9.04	7.91	6.78	5.65	4.52	3.39	2.26	1.13
12°C	10.6	9.54	8.48	7.42	6.36	5.30	4.24	3.18	2.12	1.06
11°C	10.0	9.00	8.00	7.00	6.00	5.00	4.00	3.00	2.00	1.00
10°C	9.40	8.46	7.52	6.58	5.64	4.70	3.76	2.82	1.88	0.94
9°C	8.84	7.95	7.07	6.18	5.30	4.42	3.53	2.65	1.76	0.88
8°C	8.31	7.47	6.64	5.81	4.98	4.15	3.32	2.49	1.66	0.83
7°C	7.81	7.02	6.24	5.46	4.68	3.90	3.12	2.34	1.56	0.78
6°C	7.33	6.59	5.86	5.13	4.39	3.66	2.93	2.19	1.46	0.73
5°C	6.87	6.18	5.49	4.80	4.12	3.43	2.74	2.06	1.37	0.68
4°C	6.43	5.78	5.14	4.50	3.85	3.21	2.57	1.92	1.28	0.64
3°C	6.01	5.40	4.80	4.20	3.60	3.00	2.40	1.80	1.20	0.60
2°C	5.61	5.04	4.48	3.92	3.36	2.80	2.24	1.68	1.12	0.56
1°C	5.23	4.70	4.18	3.66	3.13	2.61	2.09	1.56	1.04	0.52
0°C	4.87	4.38	3.89	3.40	2.92	2.43	1.94	1.46	0.97	0.48
-2°C	4.14	3.72	3.31	2.89	2.48	2.07	1.65	1.24	0.82	0.41
- 4°C	3.55	3.19	2.84	2.48	2.13	1.77	1.42	1.06	0.71	0.35
- 6°C	3.03	2.72	2.42	2.12	1.81	1.51	1.21	0.90	0.60	0.30
- 8°C	2.56	2.30	2.04	1.79	1.53	1.28	1.02	0.76	0.51	0.25
-10°C	2.14	1.92	1.71	1.49	1.28	1.07	0.85	0.64	0.42	0.21

Figure 2: EMC/RH and M-Value of respective Silica Gels

% RF	Reg. Density .		Inter. Density 59		ART-SORB®	
	EMC	M	EMC	M	EMC	M
0	0	7	0	2	0	6, 5
10	7	7	2	1	6, 5	5
20	14	6,5	3	1	11,5	4,5
30	20,5	4,5	4	1	16	4
40	25	3,5	5	1,5	20	6
50	28	2	6,5	1,5	26	8,5
60	30,5	1,5	8	3	34,5	12,5
70	32	1	11	6	47	20,5
80	33	1	17	15,5	67,5	6,5
90	34	1	32,5	61	74	6
100	35		93,5		80	