



Article: Simplified procedures for reconditioning silica gel

Author(s): Stephen Weintraub

Source: *Objects Specialty Group Postprints, Volume One, 1991*

Pages: 88-91

Compiler: Pamela Hatchfield

© 1992 by The American Institute for Conservation of Historic & Artistic Works, 1156 15th Street NW, Suite 320, Washington, DC 20005. (202) 452-9545

www.conservation-us.org

Under a licensing agreement, individual authors retain copyright to their work and extend publications rights to the American Institute for Conservation.

Objects Specialty Group Postprints is published annually by the Objects Specialty Group (OSG) of the American Institute for Conservation of Historic & Artistic Works (AIC). A membership benefit of the Objects Specialty Group, *Objects Specialty Group Postprints* is mainly comprised of papers presented at OSG sessions at AIC Annual Meetings and is intended to inform and educate conservation-related disciplines.

Papers presented in *Objects Specialty Group Postprints, Volume One, 1991* have been edited for clarity and content but have not undergone a formal process of peer review. This publication is primarily intended for the members of the Objects Specialty Group of the American Institute for Conservation of Historic & Artistic Works. Responsibility for the methods and materials described herein rests solely with the authors, whose articles should not be considered official statements of the OSG or the AIC. The OSG is an approved division of the AIC but does not necessarily represent the AIC policy or opinions.

SIMPLIFIED PROCEDURES FOR RECONDITIONING SILICA GEL
by Steven Weintraub

INTRODUCTION

Control of relative humidity within an exhibition case through the use of silica gel is a technique that has been practiced within the museum community for approximately 30 years. In spite of the proven effectiveness of this system of humidity control, its use is limited, because there is a perceived difficulty involved in maintaining and reconditioning a silica gel system. In reality, reconditioning can be performed simply and economically. A simple reconditioning method is the subject of this paper.

TRADITIONAL CONDITIONING TECHNIQUES

Silica gel is conditioned outside the case to a desired humidity. Typically, the gel is placed in a space or environmental chamber conditioned to the proper RH. Alternatively, the gel is placed in a high RH environment and checked periodically until it has adsorbed the proper amount of water. This process can take a significant amount of time. A single layer of dry silica gel may require two days or more to equilibrate with a 50% RH environment. Each additional layer significantly slows the rate of conditioning. The process can be accelerated both by using a forced air flow across the silica gel bed and by maximizing gel surface area and minimizing depth of gel. Direct addition of water in its liquid phase is not recommended since the high heat of adsorption breaks up the silica gel bead.

Eventually, the conditioned gel may require reconditioning as a result of gaining or losing moisture through case leakage. Traditionally, the total amount of silica gel is removed from the case and reconditioned using the same method described above for dry silica gel. This technique is extremely inconvenient and labor intensive. The case must be designed so that all the silica gel can be removed. A special climate controlled space is required to condition the gel.

Art Preservation Services
539 E. 81st St.
New York, N.Y. 10028

THE IN-SITU METHOD FOR CONDITIONING SILICA GEL

There is a relatively simple method for reconditioning silica gel without removing it from the exhibition case. Moisture content is adjusted by either adding or removing water. The relationship of moisture content and relative humidity is well known for the standard types of silica gel used for humidity control in museums. This information is used to calculate the amount of moisture to be added or subtracted in order to change the silica gel's equilibrium point from one level of RH to another.

In order to demonstrate the concept, the following examples are used in order to adjust relative humidity in a sealed case. The actual Moisture Content/Relative Humidity (MC/RH) ratios used in the example calculations are simplified approximations of values for a "typical" silica gel. Actual ratios should be determined by reference to the MC/RH curves for a specific type of silica gel as supplied by the manufacturer.

MOISTURE ADDITION - Assume that the case is at 40% RH and the goal is to raise the case RH to 50% -

1) Determine the moisture content of silica gel at 40% and at 50% RH. Assume that at 40% RH the silica gel contains 25 grams of water per 100 grams of silica gel by dry weight, and at 50% RH, the gel contains 30 grams of water per 100 grams of silica gel.

40% RH = 25 grams water/ 100 grams dry silica gel
50% RH = 30 grams water/ 100 grams dry silica gel

2) Determine the amount of water necessary to raise the case RH from 40% to 50%. If the silica gel contains 25 grams of water at 40% RH and 30 grams at 50% RH per 100 grams of dry silica gel, it is necessary to add 5 grams of water per 100 grams of dry silica gel to raise the equilibrium moisture content (EMC) of the silica gel from 40% RH to 50% RH. The addition of 5 grams of water per 100 grams of silica gel is the equivalent of adding 5% by weight of water to silica gel.

$30\% \text{ MC (EMC at 50\% RH)} - 25\% \text{ MC (EMC at 40\% RH)} = 5\% \text{ MC.}$

3) Calculate the total amount of water that must be added to a case by multiplying the amount of silica gel in the case by the percent of water that must be added. If the case contains 10 kilograms of silica gel (by dry weight), 5% of 10 kilograms is 500 grams. Therefore, it is necessary to add 500 grams of water to the case.

10,000 grams silica gel x 5% MC = 500 grams water to be added.

MOISTURE SUBTRACTION - Assume that the case is at 50% RH and the goal is to reduce the case to 40% RH -

Repeat steps 1) through 3) above, but in this instance, the goal is to remove 500 grams of water. In order to remove water, dry silica gel is added to the case. It is necessary to determine how much dry gel to add such that the entire bulk of gel, including the new addition, comes into equilibrium with the new RH set point of 40%.

Each 100 grams of dry silica gel can adsorb 25 grams of moisture (25% EMC) in order to be in equilibrium at 40% RH. Dividing the total 500 grams of water to be removed by 25% EMC equals 20. 20 represents the number of units (100 grams) of new dry gel that must be added to the case. Therefore, 20 x 100 grams of silica gel equals 2,000 grams of dry silica gel that must be added to the case.

500 grams water/ 25% (EMC at 40% RH) = 20 units of 100 grams of dry gel required.

20 x 100 grams dry silica gel = 2,000 grams dry silica gel to be added.

Therefore, according to the first example, 500 grams of water must be added to the case to bring 10 kilograms of silica gel up from 40% to 50% RH. Two thousand grams of dry silica gel must be added to bring 10 kilograms of silica gel down from 50% to 40% RH. By adding the appropriate amount of water or dry silica gel, the original load of 10 kilograms of silica gel never requires removal, and the entire reconditioning process takes place directly in the exhibition case.

APPLICATION NOTES

1) The bulk conditioning silica gel should be properly distributed within the case. Since the reactivity of the silica gel slows down significantly with depth, it is best to ensure that the silica gel is not deeper than 3/4 to 1 inch. Since the bulk density of most silica gels averages 45 pounds/cubic foot, approximately one square foot of silica gel should contain about 2 1/2 to 3 1/2 pounds of silica gel.

2) If the silica gel is properly distributed, the RH within the case should be dominated by the surface of all organic materials and the top layer of silica gel within the case. As the reconditioning water evaporates or the dry gel adsorbs excess moisture, the case RH will not change abruptly because of the dominating presence of these other buffering materials. In fact, the gradual reconditioning that occurs in-situ is safer than the quick adjustment that occurs when the bulk gel is removed, reconditioned externally and then added in mass to the case.

- 3) The process of reconditioning can be accelerated or slowed down by controlling the surface area of the reconditioning water or dry silica gel.
- 4) Silica gel is a moisture buffer which is used to slow down the RH exchange between the case and the room and has a finite buffering capacity. At a certain point, if the case has an excessively large amount of leakage, no silica gel system will be able to stabilize case RH for any reasonable length of time. Therefore, the case should be as well sealed as possible.
- 5) If the case has excessive leakage, it is possible to overcompensate by adding excess water or dry gel with an appropriately large surface area. While there is a risk of creating excessive and rapid changes in RH by the uncontrolled addition of dry gel or water, the presence of a large quantity of bulk silica gel will buffer against such extreme shifts in RH.
- 6) The proper amount of bulk conditioning silica gel should be used in an exhibition case. Various formulas have been suggested in the literature. In all instances, these formulas make certain assumptions about case leakage, moisture content/relative humidity ratios, acceptable length of time between periods of reconditioning, etc. Given normal conditions of use for high performance silica gels such as Arten Gel or Art Sorb, 5 to 10 pounds of silica gel per cubic yard provides a reasonable measure of protection. It is better to use the larger quantity of silica gel if very stable conditions are required, or if long periods between condition is preferred, or if there is significant case leakage or a large differential between case and room RH.
- 7) Because of leakage and the presence of other moisture sensitive materials, RH adjustment as calculated above will always tend to undershoot the RH goal, since these factors are not taken into account. There is no harm in undershooting since additional water or dry gel can be added. If, by experience, the case humidity is adjusted only half way, approximately twice the amount can be added subsequently to take these other factors into account.
- 8) Sufficient air exchange should be permitted between the silica gel storage area and the display zone which contains the artifact. Additional research will be necessary to provide specific recommendations on minimally acceptable spacing for such air/RH exchange slots or holes.