

PROGRESS IN PROJECT ON THE FEASIBILITY OF USING MODIFIED ATMOSPHERES FOR MUSEUM PEST ERADICATION: AN OVERVIEW

The Getty Conservation Institute and the J. Paul Getty Museum have been studying the use of low oxygen atmospheres using nitrogen for pest eradication. Earlier work by Nieves Valentin and Frank Preusser found that a 30-hour exposure to an atmosphere of 0.5% oxygen and 99.5% nitrogen killed all life stages of the fruit fly (*Drosophila melanogaster*) [1]. In a collaborative project at the University of California at Riverside, we have proven the mortality of all stages of ten commonly found museum pests at an oxygen concentration of 0.1%, 55% relative humidity and 25.5 °C temperature. The species studied were the webbing clothes moth, furniture carpet beetle, firebrat, cabinet beetle, larder beetle, cigarette beetle, confused flour beetle, cockroach, powderpost beetle and western drywood termite. The time required for 100% kill varied from three hours for the adult firebrat to 192 hours for the eggs of the cigarette beetle. [2,3]

Based on this research we have developed several methods for making nitrogen fumigation practical for museum applications. For small scale fumigations, we designed a method of enclosing the object in heat sealable low oxygen permeable plastic bags and reducing the oxygen concentration to below 0.1%. Two methods were developed: a “dynamic” or continuous nitrogen gas flow system [4], and a “dynamic/static” system which uses nitrogen gas followed by an oxygen scavenger [5]. In both systems pre-humidified nitrogen gas is used to purge the oxygen concentration within the bags to 0.1%. In the dynamic system a continuous low flow rate of nitrogen gas maintains the low oxygen concentration. However, in the “dynamic/static” system, the nitrogen supply is turned off after the initial purge and an oxygen scavenger (Ageless™) [6] is placed inside the bag. The Ageless™ maintains the low oxygen concentration by absorbing any oxygen which permeates the bag. Five pieces of furniture from the collection of the Getty Museum, including a French Neoclassical firescreen (c.1785) and a large Italian Armchair (c.1735), were treated at an oxygen concentration of 0.1% for 14 days. [7] The volume of the bags used to enclose the furniture ranged from 400 - 2500 litres. The oxygen concentration, relative humidity and temperature were monitored during these treatments [4,5].

We know from conservators around the United States that many collections have extensive fumigation problems, involving large numbers of objects, (i.e., textile and natural history collections). The plastic bag technique described above generally involves making individual bags for each object. For the treatment of large numbers of infested objects, the use of a standard bag (such as the one manufactured by Rentokil, which has a volume of 30,000 litres) or a fumigation chamber would be more efficient.¹ Rentokil bubbles were originally designed for toxic gases or carbon dioxide² fumigation, especially in the food and agriculture industry. However we have tested and devised a protocol for maintaining a low oxygen atmosphere of 0.1% in the bubble by repeated purging and vacuuming with nitrogen gas [8]. We are also currently working on the feasibility of converting existing fumigation chambers (designed to use methyl bromide or ethylene oxide) for nitrogen fumigation [9].

The University of California at Riverside study on the feasibility of using modified atmospheres to control insect pests in museums proved the efficacy of using a 0.1% oxygen environment, to kill all life stages of the ten species studied. Although it is possible to maintain a 0.1% oxygen concentration, this may not be easily achievable in all situations with the resources available to museums. To increase the practical application of low oxygen fumigation we are studying insect mortality at oxygen concentrations of 0.3%,

¹ Rentokil is based in England and operates in the United States as B & G Bubble.

0.6%, and 1.0%. This will clarify the correlation between oxygen concentration and the duration of exposure required to achieve 100% mortality. To assess the combined effect of low oxygen and relative humidity on mortality this study will be conducted at 33%,55% and 75% relative humidity.

REFERENCES

1. Valentin, N. and Preusser, F. 'Insect control by inert gases in museums, archives and museum collections', *Restaurator*, 11 (1990).
2. Rust, M. and Kennedy, J. 'The feasibility of using modified atmospheres to control insect pests in museums', Getty Conservation Institute Scientific Program Report, (1992).
3. Rust, M., Kennedy, J., Daniel, V., Drusik, J., and Preusser, F. 'The feasibility of using modified atmospheres to control insect pests in museums'. Submitted to *Studies in Conservation*.
4. Hanlon, G., Daniel, V., Ravenel, N., and Maekawa, S. 'Dynamic System for Nitrogen Anoxia of large museum objects: A pest eradication case study'. *Second International Conference on Biodeterioration of Cultural property, Yokohama, Japan* (1992).
5. Daniel, V., Hanlon, G. and Maekawa, S 'Fumigation of large objects using nitrogen and an oxygen scavenger Ageless™' to be presented at the ICOM Committee for Conservation, 10th Triennial Meeting, Washington D.C. (1993).
6. Lambert, F.L., Daniel, V., and Preusser, F., 'The rate of absorption of oxygen by Ageless™ The utility of an oxygen scavenger in sealed cases', accepted by *Studies in Conservation*.
7. Hanlon, G., Daniel, V., Considine, B., and Maekawa, S. 'Nitrogen Fumigation of Furniture at the J. Paul Getty Museum', to be presented at the ICOM Committee for Conservation, 10th Triennial Meeting, Washington D.C. (1993).
8. Daniel, V. 'Feasibility of using the Rentokil bubble for nitrogen anoxia.' Internal report, Getty Conservation Institute, 4503 Glencoe Avenue, Marina Del Rey, CA 90292.
9. 'Feasibility of converting fumigation chambers for nitrogen use', presently being worked on by Vinod Daniel and Shin Maekawa of the Getty Conservation Institute, 4503 Glencoe Avenue, Marina Del Rey, CA 90292.

² At the recent IIC conference in Madrid, Nieves Valentin presented a paper showing that the Furniture beetle (*Anobium punctatum*) and the Old house borer (*Hylotrupes bajulus*) are not killed by a 60% carbon dioxide environment.

Valentin, N., Algueró, M., and Martin, C., 'Evaluation of Disinfection Techniques for the Conservation of Polychrome Sculpture in Iberian Museums' in *IIC Preprints*, Madrid (1992).

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