INVESTIGATIONS INTO NAPHTHALENE MITIGATION ON MUSEUM OBJECTS

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Abstract- Many museum collections have been stored with naphthalene and para-dichlorobenzene mothballs to mitigate insect activity. There is mounting concern about the toxicity and carcinogenicity of these substances. Conservators working with mothball-contaminated collections can experience nausea, headaches, and irritation from the odor, which can be especially strong during humidification or aqueous conservation treatments. Experimental results, presented at NATCC 2005, suggest that the naphthalene vapor above a humidified textile was approximately 50 times more concentrated than a dry textile. While the amount of naphthalene on an artifact has proven difficult to quantify, the question of cost-effectively ridding artifacts of the contamination must be addressed. This presentation discusses a method developed at NMAI and MCI to passively remove/reduce mothball residues from textiles using vapor pressure of the pesticide and rapid air exchange. A Delta storage cabinet was retrofitted with ductwork and connected to a laboratory ceiling rail exhaust system. A particularly smelly, mothball treated textile was placed in the sealed cabinet, and air extracted continuously for 18 hours, after which no perceptible odor was detected. Cabinet design, the role of temperature and RH, and the treatment protocol will be described. This is an efficient, non-invasive, cost-effective method for removing mothball contamination from museum collections.

Título- INVESTIGACIONES SOBRE LA MITIGACIÓN DE NAFTALINA EN OBJETOS DE MUSEO

Resumen- Muchas colecciones de museos se han almacenado con naftalina y esferas de para-diclorobenceno para contrarrestar el ataque de insectos, pero hay una preocupación creciente por el carácter tóxico y cancerígeno de estas sustancias. Los conservadores que trabajan con colecciones contaminadas con naftalina pueden experimentar náuseas, dolores de cabeza e irritación debido al olor, el cual puede ser especialmente fuerte durante la humidificación o durante tratamientos acuosos de conservación. Los resultados experimentales presentados en el NATCC 2005 sugieren que el vapor de naftalina sobre un textil húmedo es aproximadamente 50 veces más concentrado que en un textil seco. Aunque se ha comprobado la dificultad de cuantificar la cantidad de naftalina en un artefacto, debe tomarse en cuenta la rentabilidad de la eliminación de contaminantes de los objetos. Esta presentación discute un método desarrollado en el NMAI y el MCI para remover/reducir pasivamente los residuos de naftalina aprovechando la presión de vapor del pesticida y aplicando un rápido intercambio de aire. Se equipó un gabinete de almacenamiento Delta con ductos y fue conectado a un sistema de tubos de escape de laboratorio. Un textil particularmente oloroso que había sido tratado con naftalina fue colocado en el gabinete sellado y se extrajo aire continuamente durante 18 horas, después de lo cual, no se detectó ningún olor. Se describirá el diseño del gabinete, el rol de la temperatura

y de la HR, así como el protocolo de tratamiento. Este es un método eficiente, no invasivo y rentable, para remover contaminación de naftalina de colecciones de museos.

Titre- UNE ÉTUDE SUR LA RÉDUCTION DES ODEURS DE NAPHTALINE PROVENANT DES OBJETS MUSÉAUX

Résumé- De nombreuses collections muséales ont été entreposées avec des boules à mites contenant de la naphtaline et du paradichlorobenzène pour les protéger des insectes. Une inquiétude croissante existe quant à la toxicité et la cancérogénicité de ces substances. Les restaurateurs travaillant avec des collections contaminées par les boules à mites peuvent souffrir de nausées, de maux de tête et d'irritation causées par leur odeur, qui peut devenir particulièrement forte lors de traitements aqueux ou d'humidification. Des résultats expérimentaux, présentés à NATCC 2005, suggèrent que les vapeurs de naphtaline au-dessus d'un textile humidifié étaient d'environ 50 fois plus concentrées que sur le textile sec. Bien que la quantité de naphtaline sur un objet se soit avérée difficile à quantifier, la question de l'élimination de ces produits sur les artefacts à un coût raisonnable doit être envisagée. Cette présentation porte sur une méthode développée au NMAI et MCI pour éliminer/réduire passivement les résidus de boules à mites des textiles en utilisant la tension de vapeur du pesticide et une extraction d'air. Un meuble de rangement Delta a été adapté et relié au système de ventilation du laboratoire. Un textile particulièrement malodorant traité à la naphtaline a été placé dans le compartiment étanche, à la suite de quoi l'air a été extrait en continu pendant 18 heures. Suite au traitement aucune odeur perceptible n'a été détectée. Le plan de conception du cabinet, le rôle de la température et de l'humidité relative ainsi que le protocole de traitement seront décrits. Il s'agit d'un système efficace, non invasif et peu coûteux pour éliminer la contamination des boules à mites des collections muséales.

1. INTRODUCTION

1.1 MOTHBALLS

Mothballs and moth crystals have been used for more than a century to protect artifacts from attack by moths and other pests. Mothballs are a class of volatile insecticides that includes naphthalene, para-dichlorobenzene (pDCB), and camphor. All are room temperature solids with relatively high vapor pressures. Inexpensive and readily available, mothballs were sold in bulk quantities and replenished seasonally in museum collections and homes alike to impart enduring pest protection.

Unlike gaseous pesticides, such as methyl bromide and sulfuryl fluoride, mothball compounds hover between solid and gas phase under normal atmospheric conditions. In an open space, the solid compound will sublime continuously until it has evaporated into the surrounding air. In a closed cabinet, mothballs emit vapor up to an equilibrium concentration that is sufficient to mitigate insect activity, and dependent on the temperature, humidity, and atmospheric pressure. These compounds can also volatilize and re-crystallize on museum collections.

The National Museum of the American Indian (NMAI) purchased thousands of pounds of naphthalene from 1917-1975. Artifacts were often packed in naphthalene flakes until 1987, when the remaining drums of naphthalene were disposed of as toxic waste (Pool 2001). For museum staff working with these artifacts, strong residual naphthalene odors have caused eye and nose irritation, headaches, and nausea. There is also concern about the health risks posed by naphthalene-contaminated regalia repatriated to Native communities that may be worn – danced and sweated in - for ceremonies.

Naphthalene and pDCB both are classified as possible human carcinogens (NTP 2005). While there are no indoor standards for human exposure to naphthalene, the current permissible occupational exposure limit (PEL) is 10 ppm (52 µg/m^3) and may be reduced substantially to sub-ppm levels in light of clinical findings that associate naphthalene with cancer (Chunrong and Stewart 2010). Given the known history of use, reported illness among museum staff, and ongoing risk assessment review, mitigation strategies for the removal of naphthalene and other volatile pesticides from collections must be addressed.

1.2 DETECTION

Mothball vapor has been detected successfully in the museum context by solid phase microextraction (SPME) GC-MS (Ormsby et al 2006). Naphthalene vapor also is detectable by surface enhanced Raman and gas cell FTIR spectroscopies (Madden 2010).

It has been observed that mothball vapor concentrations increase drastically during humidifying and washing treatments. A study by NMAI and NARA suggested that the concentration of pDCB vapor above a humidified textile was approximately 50 times higher than a dry textile (Heald et al 2005).

1.3 MITIGATION

Little has been published about removing mothball residues from museum collections. The National Museum of Ethnography in Stockholm Sweden experimented with infrasound (low frequency sound waves) to reduce pDCB contamination on the textile and garment collection after the conservator suffered impaired breathing from working with these collections (Gustafsson 1990). Contaminated artifacts were placed in a custom-built chamber and exposed to low frequency sound waves and constant air flow, which volatilized and carried away >90% of pDCB contamination (Gustaffson 1993).

2. CURRENT STUDY

A Mexican Saltillo serape (19/0924) exhibited a strong mothball odor during routine photography, and the photographer developed a headache. This prompted NMAI and MCI to reduce the contamination before any conservation treatment proceeded.

Fig.1: Ductwork connection from cabinet to rail exhaust system

The authors developed a non-invasive method to remove the mothball residue by exploiting the vapor pressure of the pesticide and rapid air exchange. In essence, the textile is vented continually for a period of time, and contaminated air is removed to the building exterior. Ongoing experiments are exploring the role of temperature and humidity on the removal rate. A shelf-less powder-coated steel Delta museum storage cabinet was retrofitted with a 6" sheet metal duct attached to the top of the cabinet. The ductwork was connected to the laboratory rail exhaust system (fig.1). A low voltage electric blanket draped over two PVC pipes spanning the interior width provided warmth. Deionized water and 2.5 Kg silica gel placed in a flat polypropylene tray provided humidity. The textile was supported on the electric blanket with a separating layer of undyed cotton fabric (fig. 2). A commercially available naphthalene monitor was placed in the airspace above the blanket.

Figure 2. Cabinet interior with serape in position

The cabinet was left sealed for approximately 4 hours at 23.8 – 24.5 C and 49-79% RH. The naphthalene monitor was removed and bagged for off-site analysis. Though the textile smelled of mothballs, the odor was not as strong as some textiles treated at NMAI. The ductwork was opened to the extraction system and the cabinet exhausted overnight for 18 hrs. When the cabinet was opened the next morning, no perceptible odor was detected on the textile.

The next day the humidification process was repeated with a new naphthalene monitor. When the second monitor was removed and bagged at the four hour mark, mothball odor was perceptible in the cabinet, but less strong than before. The cabinet was exhausted for another 18 hours. No odor was perceived the following day. Naphthalene concentrations reported by the monitoring laboratory indicated were < 0.1 ppm (520 µg/m^3). It was obvious by smell that the naphthalene concentration had been reduced by venting, so it is assumed that either the levels were below the monitor's lower detection limit, or the monitor was improperly exposed.

3. CONCLUSIONS

This initial experiment demonstrated that naphthalene residue is reduced significantly with rapid air exchange. This relatively simple, low cost, and passive treatment can be implemented in any laboratory with an air extraction system. Determining the amount of naphthalene on an artifact and in the surrounding airspace is challenging. A successful detection method will be chemical-specific, sensitive below 1 ppm, and report data in real time.

The prototype cabinet has shown that better systems are needed for opening and closing the duct, as well as controlling humidity and temperature. Future iterations may investigate powered misters and pre-warmed air drawn into the cabinet.

ACKNOWLDGMENTS

Thanks to mechanic William Wallish, Smithsonian Office of Facilities, Engineering & Operations for helping retrofit the cabinet.

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