Rathgen-Forschungslabor
Staatliche Museen zu Berlin

How to ensure achievement of anoxia treatments?
The use of target insect species as reference testing material

Bill Landsberger, Rathgen Research Laboratory, National Museums Berlin, Germany
b.landsberger@smb.spk-berlin.de

INTRODUCTION

Under nitrogen-enriched atmospheres, object treatments to eradicate pest infestations are most gentle to all kind of materials. Although, compared to other methods, the procedure is time-consuming, depending on temperature, humidity, oxygen remain and pest species. Generally recommended are 1 to 3 weeks treatment at oxygen concentration less then 0.1 percent (Maekawa and Elert 2003, Strang and Kigawa 2009), what can be expansive to obtain. Often pest insects are not directly visible, but show their activity by occurring frass and debris. Thereby pest identification can be difficult, and the most insusceptible to anoxic conditions are to take into account. To approve success by non-destructive examinations after treatments of museum objects, it is advisable to provide living specimens. Eggs, larvae and pupae of the anobiid drugstore beetle *Stegobium paniceum* (L.) and the cigarette beetle *Lasioderma serricorne* (F.) are fairly tolerant of low oxygen availability (Tab 1).

These species are easily to breed and to cultivate under room climate conditions, and can be hold in stock as reference testing material.

Fig 1. Drugstore beetle colony in PET-bottle

Tab 1. Selected data of environmental conditions to achieve complete pest insect mortality

Reference	Species	O_2 (%)	T (°C)	RH (%)	Time (days)
Gilbert (1989)	*S. paniceum, L. serricorne*	0.4	30	65-70	7
Maekawa and Elert (2003)	*S. paniceum, L. serricorne*	< 0.3	20 / 25	55	22 / 14
Rust and Kennedy (1993)	*S. paniceum, L. serricorne*	< 0.1	25.5	55	8
Rust and Kennedy (1995)	*L. serricorne*	0.3	25.6	33-75	7
Strang and Kigawa (2009)	all pest insects	< 0.1	?	?	7-21
Valentin (1993)	*S. paniceum, L. serricorne*	0.03	30	40	21

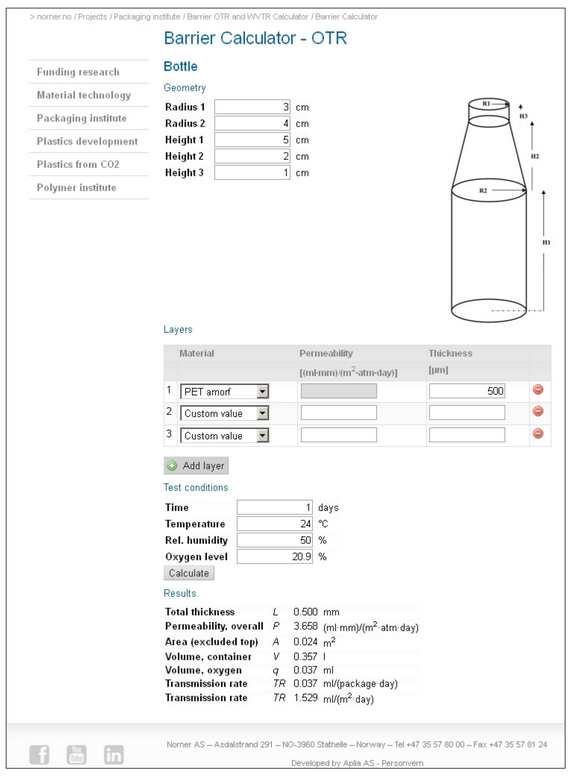

Fig 2. OTR-calculation chart (internet page)

METHODOLOGY

Adult beetles were collected from infested museum storages and reared in laboratory on dry dog food with brewer's yeast. Prior anoxia treatments single colonized dog biscuits were placed each in closed 50 ml-PET-bottles (Fig 1). Depending on dimension and material of used plastic containers, oxygen transmission rate (OTR) was determined by dint of an internet-based calculator (Fig 2).

Samples were treated along with concerned objects, additionally kept aside as untreated control and finally probed (Fig 3 and 4). Measuring concentration of oxygen during anoxia application was performed with an oxygen analyzer. Sensors can important vary and must be calibrated regularly (Fig 5).

Fig 3. Inspected reference sample after treatment

COMMENTARY

Concomitant factors as desiccation, high or low temperature, detrimental and handling stress can affect test organisms during anoxic disinfestations and result in higher mortality rates. Under hypoxia, metabolic energy and water production are depleted due to the lack of oxygen. Insects tent to wider tracheae for compensative gas exchange, respectively response through compression and expansion with alternating open or closed spiracles. This reaction increases consumptive water deprivation, whereas pest individuals deep down a large object are sheltered. The described procedure is proposed as standard in any anoxia treatment instead of other testing setups like gauze cages or open end tubes, to minimize deviation from the real.

MATERIALS

- Oxygen analyzer: CheckPoint (Dansensor GmbH)
- PET-bottle: Rotilabo® (Carl Roth KG)

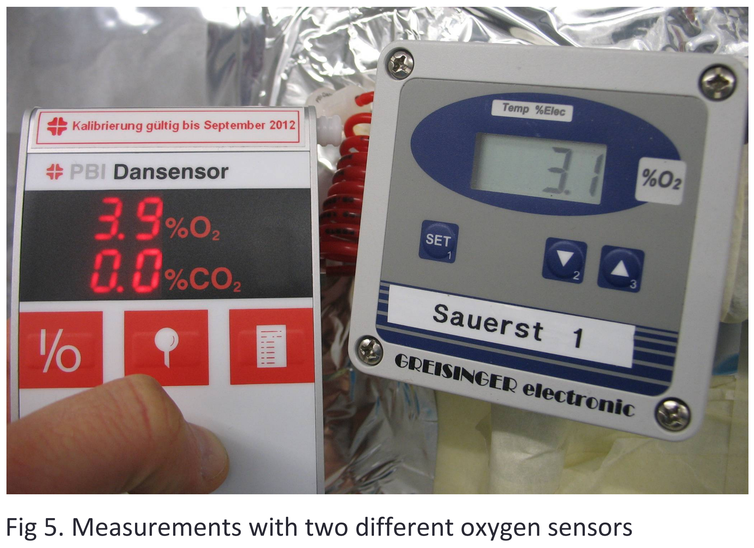

Fig 5. Measurements with two different oxygen sensors

Fig 4. Examination of treated reference material

REFERENCES

- Gilberg, M. 1989. Inert atmosphere fumigation of museum objects. Studies in Conservation 34:80-84.
- Maekawa, S. and C. Selwitz. 1998. Inert Gases in the Control of Museum Insect Pests. Los Angeles: The Getty Conservation Institute.
- Maekawa, E. and K. Elert. 2003. The Use of Oxygen-Free Environments in the Control of Museum Insect Pests. Los Angeles: The Getty Conservation Institute.
- Rust, M.K. and J.M. Kennedy. 1993. The Feasibility of Using Modified Atmospheres to Control Insect Pests in Museums. Getty Conservation Institute Scientific Program Report. Marina del Rey: The Getty Conservation Institute.
- Rust, M.K. and J.M. Kennedy. 1995. Enhancing the Effectiveness of Modified Atmospheres to Control Insect Pests in Museums. Getty Conservation Institute Scientific Program Report. Marina del Rey: The Getty Conservation Institute.
- Strang, T. and R. Kigawa. 2009. Combatting Pests of Cultural Property. CCI Technical Bulletin No. 29, Ottawa: Canadian Conservation Institute.
- Valentin, N. 1993. Comparative Analysis of Insect Control by Nitrogen, Argon and Carbon Dioxide in Museum, Archive and Herbarium Collections. International Biodeterioration and Biodegradation 32: 263-278.
- http://www.norner.no/bcalc/model/otr/

MuseumPests 2014: Integrated Pest Management for Museums, Libraries, Archives and Historic Sites, 27-28 March 2014, Williamsburg, VA