Introduction

For over-lubricated and poisoned ethnological materials and objects, new methods of cleaning, degreasing, and decontamination are needed. Previous experiments by Unger (2004) and Tello et al. (2005a and b) with supercritical carbon dioxide (SC-CO2) showed clearly that there is a need for more studies in this field. The concept presented is based on the principles of “Green Chemistry”. Its objective is the use of nontoxic, environmentally compatible solvents that are easy to regenerate, and can be continually recycled. In addition to SC-CO2, liquid carbon dioxide is considered for further experiments.

Carbon Dioxide as a Cleaning Agent

By varying temperature and pressure, carbon dioxide can be turned into a solid, liquid or a supercritical (fluid) form. Solid carbon dioxide has been used to take wax off parquet flooring. At a temperature of 15°C and 50-60 bar CO2 is in its liquid state. It is used as a cleaning agent in closed plants with a circulation process to clean fabrics, metal, glass, rubber and textiles. Metals and electronic components are cleaned of grease, oil and dirt using the UniClean-Procedure at the Union Engineering Company in Fredericia, Denmark. This company's interest in finding new fields of application made it possible to submit objects with unsatisfying old conservation treatments as well as soiled and contaminated materials to the cleaning, degreasing and decontamination process.

Selection of Materials

The materials and objects were selected from different museums and institutions in Germany: part of a panel board with high contamination levels of lindane, PCP, and DDT; a sample of woolen cloth contaminated with DDT and its metabolites, lindane, mercury, and arsenic; part of an epitaph conserved with linseed oil; a piece of gilded leather tapestry lubricated with synthetic fats, montanic wax, and Vaseline; a sample of collagen sausage casing and a sample of seal gut, both lubricated with wax and lipids. These samples were provided for an experimental trial of the UniClean-Procedure by the Union Engineering Company.
Equipment and Procedure

The UniClean-Procedure is based on a washing process with liquid carbon dioxide to degrease and to clean metal components. The system runs with a CO2 storage tank, a washing tank formed as an autoclave, a distillation tank, an oil boiling out unit, and a CO2 compressor. The residues are put into a wire basket, and the washing tank is closed and then flooded with CO2. The CO2 circulates and washes the items inside. The polluted CO2 is pumped out and reconditioned in the oil boiling out unit and the distillation tank for further use.

The washing process itself was carried out at a temperature of 15-20°C and 50-55 bar. The wooden pieces remained in the tank for twenty-four hours; the collagen sausage casing, the seal gut, the sample of the woolen cloth and the piece of the gilded tapestry remained 30 minutes in the liquid CO2.

Conclusion

The DDT rate from the panel board was reduced to 88.9% and the lindane rate to 32.8%. The process was not successful on the epitaph, the crosslinked linseed oil could not be removed. Comparable results have been found in earlier experiments with SC-CO2. The DDT rate from the sample of the woolen cloth was decreased to 91.1% and the arsenic rate to 25%. As expected, the lindane rate was at a low range already and was not changed after the experiment.
Outlook

At this stage the application of liquid CO2 for the cleaning, degreasing, and removing of ageing and decomposition products from wax, oil and grease as well as the decontamination of biocides from cultural heritage seems a promising method further examined. The effect of the cleaning of dirty surfaces formerly treated with greasy substances is enormous. The liquid phase of CO2 in its circulation process contains no residues and uses a low state of energy at the same time. With this technique, “Green Chemistry” has found its way into conservation science. The health hazard for conservators who often have to use solvents while cleaning over-lubricated or contaminated objects should not be neglected. Ongoing assessments have to clarify the best parameters for the already-tested materials, and more groups of materials and objects should be included in further experiments. Finally, it should be tested if liquid CO2 can be used for mass decontamination and if it could replace SC-CO2 plants in certain cases. Colleagues who are interested in taking part in this research are encouraged to provide materials or objects for further studies. For other concerns, please contact one of the authors.

Bibliography


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