EuroDrying'2017 – 6th European Drying Conference
Liège, Belgium, 19-21 June 2017
Book of Abstracts, pp. 79-80

ON THE USE OF FREEZE-DRYING TO RECOVER FLOODED ARCHIVAL MATERIALS

A. A. Barresi[1], D. Fissore[1], R. Pisano[1], H. Pittino[2]

[1] *Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino, Torino, Italia.*
[2] *Prodoc s.r.l., Udine, Italia*
E-mail of the corresponding author: antonello.barresi@polito.it

Abstract: Freeze-drying is a low temperature and low pressure drying process, where the liquid water is firstly frozen and, then, the ice is removed through sublimation: by this way the water is removed moving from the liquid to the vapour phase, and this allows avoiding further damages to the material being dried. This paper is focused on the freeze-drying of flooded archival materials, aiming to show the effectiveness of the process for water removal, and the effect on the characteristics of the materials. Various guidelines are provided for the management of various stages of the archiving of paper/archival materials, and of the emergency due to flooding, as well as for carrying out the freeze-drying process.

Keywords: freeze-drying, paper material, parchments, product quality, process design.

Introduction

Today there is a growing interest in finding an effective method for the recovery of soaked archival and librarian materials. Various damages are caused by water, namely swelling, cockling, adhesion of leaves, migration of inks and dyes, distortion, and also microbiological infections. Despite manual recovery can result in a high quality product, the high costs and the slow kinetics of the process motivated the investigation of different drying methods as vacuum drying, freeze-drying, microwave drying [1-5]. In this framework freeze-drying appears to be a particularly efficient and effective technology as it is a low temperature and low pressure drying process, where the liquid water is firstly frozen and, then, the ice is removed through sublimation. Water is thus removed moving from the liquid to the vapour phase, and this allows avoiding further damages to the material being dried. Also mechanical resistance of the dried material appears to be not affected by the freeze-drying process [6].

This paper deals with the freeze-drying of various flooded archival materials (paper, parchments, …), aiming to show the effectiveness of the process for water removal, and the effect on the qualitative characteristics of the materials. Various guidelines are provided for the management of various stages of the archiving of paper/archival materials, and of the emergency due to flooding, as well as for carrying out the freeze-drying process.

Materials and Methods

Experimental investigation was carried out in two different freeze-dryers:

i. an industrial-scale freeze-dryer (UEL 1100 Ing. Brizio Basi & C s.a.s., Milano, Italy), with a total shelf area of about 15 m^2. Pressure in the drying chamber and in the condenser was measured through thermo-conductive gauges (Pirani type). Product temperature was measured by means of PT100 thermoprobes and T-type thermocouples.
ii. a pilot-scale freeze-dryer (LyoBeta 25 Telstar, Terrassa, Spain) with a total shelf area of 0.5 m^2. Both a capacitance (Baratron type 626A, MKS Instruments, Andover, USA) and a thermal conductivity (Pirani type PSG-101-S, Inficon, Bad Ragaz, Switzerland) gauge

were used to measure chamber pressure. Product temperature was measured by means of T-type thermocouples.

Different types of flooded paper/archival materials were considered in this study, aiming to provide a comprehensive overview of the performance of the process. Weight loss in each sample was measured at the end of the freeze-drying process, as well as the variation in the sample sizes. A simple model was proposed to track the dynamics of the process and for the off-line optimization of the freeze-drying cycle.

Results and discussion

The experimental investigation allowed pointing out the effectiveness of the freeze-drying process for the recovery of various types of flooded paper/archival materials. An example of the temperature profiles and of the Pirani/Baratron pressure ratio (used to detect the ending point of the primary drying stage) is shown in Figure 1.

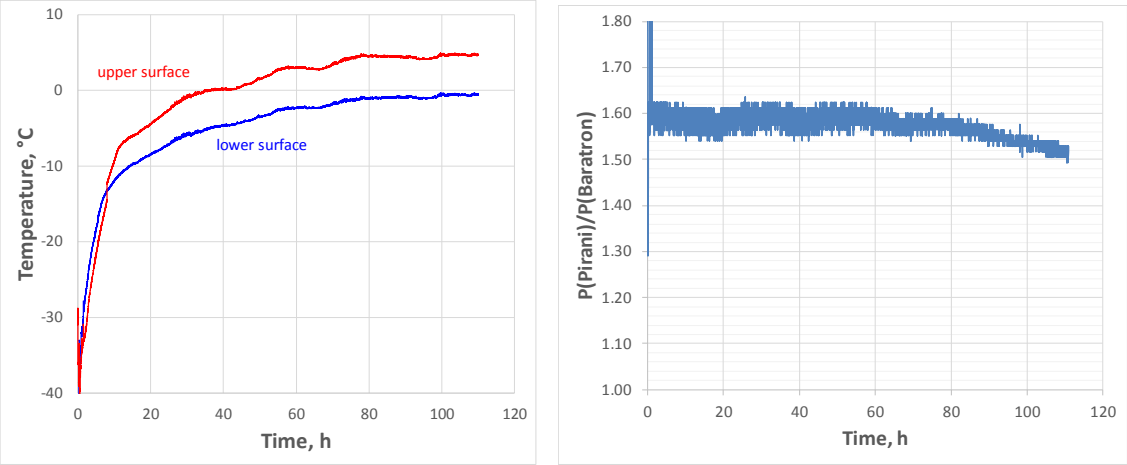

Fig. 1. L.H.S. Product temperature at the supper and lower surface in a sample during the freeze-drying process (@ 0.1mbar and -10°C). R.H.S. Pirani/Baratron pressure ratio measured in the same cycle.

Conclusions

The experimental investigation allowed formulating various guidelines for the management of various stages of the archiving of paper/archival materials, and of the emergency due to flooding, as well as for carrying out the freeze-drying process.

References

[1] Flink, J. M. Hoyer, H. *The conservation of water damaged written documents by freeze drying*, Nature, **234** (1971), 420.

[2] Waters P., *Procedures for salvage of water damaged library materials*, Library of Congress, Washington (1983).

[3] Sugarman J. E., Vitale T. J. *Observations on the drying of paper: five drying methods and the drying process*, J. Am. Inst. Conserv., **31** (1992), 175-197.

[4] Carapelle A., Henrist M., Rabecki, F. *A study of vacuum freeze-drying of frozen wet papers*, Drying Technol., **19** (2001), 1113-1124

[5] Crespi, E., Capolongo A., Fissore, D., Barresi, A. A. *Experimental investigation of the recovery of soaked paper using evaporative freeze drying*, Drying Technol., **26** (2008), 349-356.

[6] Carlsen S. *Effects of freeze-drying on paper*, in Proceedings of 9th International Congress of IADA, Copenhagen, August 15-21 1999, 115-120.