

ENVIRONMENTAL SIMULATION FOR SAFE PRESERVATION OF WET MUMMIES, THE CASE OF "ÖTZI", THE MAN FROM THE ICE

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BIOGRAPHY

Gianluigi Angelantoni after his scientific studies and engineering background in 1965 joined the father's company as responsible for developing the new emerging business of environmental test systems.

Since 1977 is managing director of the company which expanded up today in three main divisions involving 220 people dealing with environmental simulation, biomedical preservation equipment and industrial refrigeration plants.

He covered several positions, both in business and academic contests, in the regional associations of industries he was vice-president of the Young Entrepreneurs (1980-1984), delegate to the National Council of the Small Enterprises (1986-1994), member of the "Confindustria" Executive Committee (1989-1994) and presently member of "Sitech", the Steering Committee for the Technology Innovation. Very active in the "Quality" field, he was the President of the local Quality Club (1992-1994) and is presently member of the Steering Committee of the Italian Association for the Quality (AICQ).

Constantly contributing to the CEEES activities, he was appointed as CEEES President from 1996 to 1998.

ABSTRACT

The archeological signs of the past are very impressive when discovered but the first arising question is how to preserve them for the future. Particularly in case of organic material, like human bodies, the technical issues relevant to the preservation environment are very critical and the design requirements often fight with the physical laws.

One of the most important discovery in this field was "Ötzi" the man, or better the mummy, found in the Similaun glacier and 5,500 years old. The peculiarity of this mummy is that is "wet" and not "dry" like the Egyptian mummies, to keep this treasure, witnessing of the human evolution, a special thermal safe was conceived, designed, manufactured and presently maintained in the museum of Bolzano, Italy.

These kind of applications require the maximum care and special technical solutions in order to : create in a clean room the proper climatic conditions as -6°C of temperature with nearly 100% relative humidity; ensure the proper lighting avoiding dangerous radiation; provide a very accurate measurement and control system including color and weight of the mummy; provide the maximum reliability of the system by a redundant and fail safe configuration which avoid any possible damage to the mummy. Practically the environmental chamber technology has been taken as the baseline to implement a state of the art preservation system which successfully demonstrate that wet mummies can be preserved and at the same time can be shown to the future generations.

KEYWORDS : environmental simulation, IEC 60068, mummies preservation, environmental chamber performances, high humidity at low temperature,.

INTRODUCTION

One of the most important archaeological discoveries of this century is surely "Ötzi" (from Otztal or 'Pusteria Valley' close to the discovery site) the mummy of the Similaun glacier, almost 5500 years old. For Ötzi a complete museum was arranged in Bolzano (Museo Archeologico dell'Alto Adige) in the former building of Banca d'Italia.

The discovery was accidentally made by two German tourists in September 1991 at 3200 meters in Italian territory at 92 meters from the Austrian border. It is curious to note that the Ötzi's death seems to have happened in the same season, September.

At the beginning the discovery area was considered Austrian territory. So the mummy was given to the Institute of Anatomy of the University of Innsbruck, which returned him to his present home at the beginning of 1998 after careful investigation concerning the Italian right over Ötzi. The importance of the discovery is that the body of an apparently 40 years old man, who lived almost 5500 years ago, has survived to this day, in its entirety, thanks to the protective ice. "Only the strong will survive and improve themselves", this sounds like the message behind the history of Ötzi, the man from the ice who had to fight against the ambient dangers searching always the right solution to the daily problems. Today the meeting between Angelantoni Industrie and the Ötzi's mummy looks like the natural meeting of two identical philosophies of life.



Fig. 1 : Pictorial representation of Ötzi

We can consider Ötzi as an ideal bridge between the past and the future because he was a man who lived free, without frontiers as a modern citizen of the world.



Fig. 2 : Discovering Otzi

THE ENVIRONMENT

His present destiny is also joint to the international project of research in which at least 110 Universities from 30 countries work. The man, frozen to death and whose body survived until today thanks to the ice, had to go back to the kingdom of cold and the kingdom of cold is surely represented by the futuristic equipment for the mummy preservation.



Fig. 3 : The “Mummy”

Angelantoni Industrie understood the real value of the Ötzi's project since the beginning. We wanted to be one of the protagonists of this adventure supporting Syremont, a company of the Montedison group, specialized in the cultural goods restoration and preservation, for the thermal and climatic technology.

We like to call our equipment a “thermal safe” because we know that a treasure is kept inside. For this reason we have designed our chamber at the highest technical and safety levels. The main difficulty to overtake during the chamber design was the environment simulation in which the mummy was kept for over 5000 years.

The climatic conditions to be simulated were -6°C temperature (easily feasible), but with relative humidity close to 100%, the same existing inside the ice.

At the same time, we had to ensure the best precision in measure and control.

This was the only possible way to avoid the mummy dehydration and weight lost.

During his stay in Innsbruck, the mummy was stored completely covered with ice and protected by special curtains against the light. For better safety, the mummy was stored constantly in the dark.

These conditions were not convenient for a museum where the mummy should have been showed to the visitors.

So the project was really a technological challenge for Angelantoni Industrie which started the construction of a prototype in Spring 1996. The prototype was tested for several months with a fake mummy inside and in the Summer 1997, the International Commission led by Prof. Platzer, director of the Institute of Anatomy of the University of Innsbruck, gave the authorization to Angelantoni to manufacture the entire climatic system for the Museum. Later the prototype chamber was used for the transport of Ötzi from Innsbruck to Bolzano.



Fig. 4 : The viewing window

THE PRESERVATION SYSTEM

The complete equipment consists of 4 rooms each one with a different function.



Fig. 5 : Preserving the mummy

The first room is installed in correspondence with the laboratory entry and it is used such as a clean room in which the personnel is decontaminated from eventual bacteria, dangerous for the mummy preservation, through ultraviolet ray system with class 10.000 filtered air.

The laboratory room can work in a temperature range down to -6°C according to the personnel requirement and the conditioning

system is equipped with special filters in order to ensure an absolutely “cleaned” ambient in class 1000 with class 10 in the usual working zone.

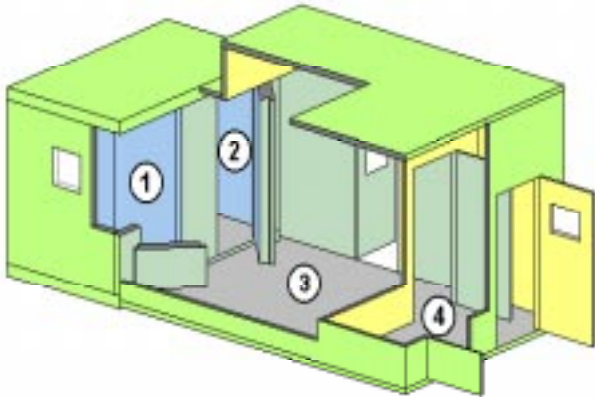


Fig. 6 : Layout of the chamber

Finally the heart of the system is represented by the two mummy rooms, one used as a back up to the other one. The Ötzi chamber is equipped with the highest security devices such as a special bulletproof window for the visitors view and another twin room installed nearby ensuring the mummy preservation against eventual sudden failures of the first room. The chambers air conditioning system was produced according to the highest standard of technology in order to ensure the required performance ($T = -6^{\circ}\text{C}$, R.H. = 98%).

The sleep of Ötzi is protected by a lot of safety systems and alarms, all driven by a special high technology Siemens PLC (the same used for nuclear power station). For instance it is possible to control up to 500 logic signals, used for cooling compressors, automatic valves, pumps, heat exchangers etc. Every 250 milliseconds, 40 measurements are carried out, basically for temperature, humidity and pressure. All the data are obtained and stored in a Data Acquisition System and Alarm Control, including the light status, the doors opening and the weight of the mummy. Ötzi, 16 Kg heavy now, is placed in fact on a very special balance, capable of measuring every change in weight below 1 gr.

The software is working under Windows NT ambient and it is running on two industrial PC, one of complete stand-by, automatically operated in case of failure of the main computer. The images, given by a special camera, are analyzed by a spectrophotometer, digitalized and compared with the original in the PC. The system, developed by the Pavia and Florence Universities, allows to check any alteration of Ötzi’s colours immediately, which could be a spy of dangerous modifications of the preservation state. The data can be checked from remote position through modem too, also using a mobile phone, and they will also be available on Internet for all the International Scientists interested in Ötzi. It will also be possible to visualize the model of the mummy with independent resolution; it means with the possibility of zooming the details, rotating them and seeing them from any angle (CAD Bentley Microstation Software). The applied technology and the experiences acquired with Ötzi allowed us to improve ourselves and become stronger, looking back to our past to better understand our future.

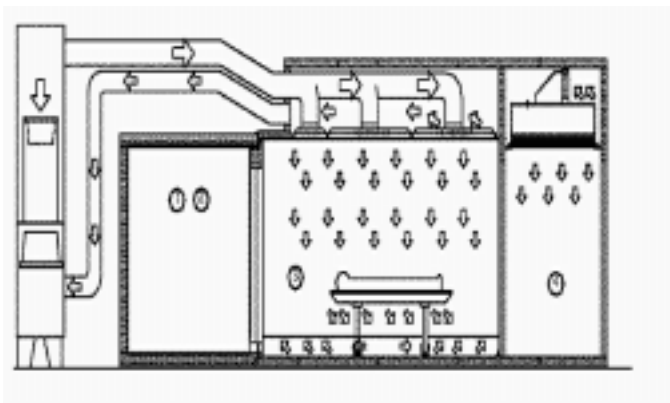


Fig. 7 : Environmental conditioning

For safety reasons, it consists of two totally independent units for each chamber. Each unit works with an indirect cooling system in which the air thermoregulation is performed through air-liquid heat exchangers. The chillers are installed as a “shell” on any wall of the chamber in order to ensure the best temperature and humidity uniformity, without forced ventilation, dangerous for the mummy. The humidity is performed through the ice sublimation and measured through a chilled mirror system integrated with electronic devices, according to the “dewpoint” method. The lighting is based on cold light optical fibers system integrated with filters for ultraviolet and infrared rays in order to avoid deteriorations of the mummy.