EUREKA PROJECT E!2843 - EUROCARE2000 DENEB

1. General description

Project	E! 2843 - EUROCARE2000 DENEB	**Status**	Proposal - 07-APR-2003
Title	**Defence Of Newspapers, Journals And Books**		
Class	Sub-Umbrella	**Technological area**	New Materials
Start date	01-FEB-2002	**End date**	01-FEB-2005
Duration	36 months	**Total cost**	6 Meuro
Partner sought	Yes		

Summary

The Aim Of This Project Is To Develop A Solution To The Problem Of The Physical Degradation Of Newspapers And More Generally Of All Journals And Books. The Proposed Method, I.E. Properly Optimized Envelopes And Atmosphere, Will Ensure Their Long Endurance.

Budget and duration

Phase	Budget(Meuro)	Duration (Months)
Definition phase	2	12
Implementation phase	4	24
Total	**6**	**36**

Member contribution

Member	Contribution	Position	Since
Italy	**60.00%**	**Contact member under Reserve**	**24-APR-2002**

Participants

Company	Country	Type	Role
Icimendue	**Italy**	**SME**	**Main under Reserve**

2. Project outline

Project description

The aim of this project is to develop a solution to the problem of the physical deterioration of newspapers and more generally of all journals which are made of materials 'built' in such a way to last one day only. In fact a dry micro-climate strongly favours the conservation of paper, a per se non-endurable material, since the acid hydrolysis of cellulose shows much slower kinetics in the absence of humidity.
Note that environmental control is subject to high costs.
Thus we plan to develop containers in which it is possible to maintain low humidity. For this purpose we plan to use envelopes, made with composite materials, able to ensure full protection against water vapour and, moreover, to guarantee excellent protection against light, dust, pollution and in part also meteorological accidents. In order to minimise possible degradation reactions, both biological and chemical, which might occur in the confined environment, we will use a controlled atmosphere which should be optimized. The use of a nitrogen-based atmosphere seems mandatory since nitrogen exerts a biostatic action on the growth of biological agents. It must however be remembered that the action of fungi is only retarded by a nitrogen atmosphere, thus with the term 'nitrogen-based atmosphere' we mean an environment free of water, rich in nitrogen and possibly in some other gaseous components such as CO2 or argon. Other gases such as SF6 will also be tested. The sealing of the envelopes, absolutely not trivial, constitutes an important part of this research.
It is important to observe that an environment of this kind can be applied not only to any material important to cultural heritage, but also to all those commercial or industrial products which might require particular protection from humidity and pollution.

Technological development envisaged

1 - The finding of a commercial materials suitable for the preparation of envelopes.
The envelope must be fully impermeable to water in a vapor phase and more generally to all gases. The envelope should be made with materials presumably resistant after many tens of years.
2 - The finding of the best methodology to ensure a perfect seal of the envelope.
The envelope seal is a non-trivial problem and special techniques need to be checked to ensure a perfect seal and a perfect method to measure the sealing procedures.
3 - Selection of a nitrogen based atmosphere in order to minimize oxidation reactions.
This atmosphere must be able to give a sufficient guarantee on regard to the action of bio-degrading agents.
4- The realization of envelopes suitable to be tested as protective containers of newspapers and journals will be done in an Italian industry.
5- The realization of the device (machine) able to put newspaper into a platform, to dry them with a warm flux of the dry nitrogen, to put them into the suitable envelope, to seal this envelope under a suitable pressure of a selected gas mixture.
Istituto Centrale per la Patologia del Libro.
1)Collaboration in the selection of the materials for the envelopes.
2)Supply of the samples to be inserted into the envelopes.
3)Collaboration in the selection of the gases to be used inside the envelopes.
4)Programming and running artificial aging tests.
5)Programming and running of biological tests.
1)Collaboration in the selection of the materials for the envelopes.
Plastic and metallic films are subject to various biological attacks. Many fungi are able to attack some synthetic substrates and to perform de-polymerization actions through specific enzymes. Bacteria and actinomicetes too have a role in causing a loss of mechanical resistance and gas impermeability of plastic films. Moreover some insects can perforate synthetic polymer films and thin metallic foils, as well known in food and seed conservation.
Biodeterioration of the materials used for the envelopes can change the permeability to water vapor which can affect the gases employed to modify the internal atmosphere.
We plan to perform standard protocols on plastic materials that allow a uniform assessment of the quality of the material on respect to biological activity. In particular we will evaluate the resistance of 'selected materials' to the biological action of agents commonly present in archives and libraries , such as fungi of the bio-areosol and of the dust, and insects of the families Anobidae and Dermestidae.
Proposed activity.
Analysis of the resistance of materials used in making envelopes to the attack of biological agents like fungi, bacteria, actinomycetes and insects.

-Evaluation of the resistance to microbial agents.
a)Inoculation of assembled materials with fungi and bacteria commonly used in biodeterioration tests (reference protocols:ASTM,UNI) or isolated in the environment and selected in our lab.
b)Evaluation of the resistance to biological activity will be carried out by observing the samples by means of a stereo microscope (a collaboration with a laboratory with expertise in scanning electron microscopy would be useful)
Evaluation of the resistance to the perforation by insects.
Assembled materials and samples containing paper and organic materials will be exposed to population of insects of the families Dermestidae and Anobidae (the species will be selected according to the availability of selected strains).
Check of the resistance to perforation by stereomicroscopy and eventually permeability to vapor.
3)Collaboration in the selection of the gases (gas mixtures) to be used inside the envelopes.
Microbiological tests. The effect of the lack of oxygen on fungi has been to date only scantily studied. The information on the metabolic and physiological consequences of the exposures of the spores and the mycelium to controlled atmospheres are limited to few species. In many papers a fungistatic effect has been reported, mostly when more than one limiting factor were present, such as low relative humidity and oligotrophic substrate.
According to experimental data from the biology labs of ICPL, different species of fungi , active in the biodeterioration of paper and books, react in a very different way to anoxia.
Since fungal physiology can react to adverse conditions by activating alternative metabolic paths and resistance and survival processes, it is necessary to study the behavior of selected strains of fungi , active in the biological aging of paper, under the actual conditions present inside the envelopes, i.e. lack of oxygen and water vapor in the presence of different gas mixtures N2, CO2, Argon, ..
In fact the residual percentage of oxygen, vapor, and the presence of the modified atmosphere can affect the fungal metabolism and cause different results as far as paper conservation is concerned.
Proposed activity. Comparative study of the physiologic effect and of the fungistatic action of gas mixtures deprived of oxygen (oxygen content less than .1*%) and of vapor (vapor content less than 100ppm), on selected strains of filamentous fungi and on some species of actinomicetes and bacteria active in biodeterioration. Specific gas mixtures will be included in this study for a better understanding of their physiological effect on biological growth, this refers particularly to CO2 which is a metabolite of aerobes.
Fungal and bacterial strains will be selected by the biology department of ICPL among species active in paper deterioration. Pure gases and their mixtures will be tested on mycelia and colonies grown on substrates having different composition in order to evaluate any possible factor having a possible fungistatic and bacteriostatic action. See section 6 of this project.
3)Collaboration in the selection of the gases to be used inside the envelopes.
As well known the deterioration of paper is mostly due to the presence of water in the atmosphere and to the presence of polluting and oxidizing gaseous agents (nitrogen and sulfur derivatives, ozone, oxygen..)
Humidity is a strong agent of degradation because it reacts with the air pollution forming acid compounds. These in turn cause the hydrolitic clivage of cellulose. Moreover the presence of aqueous vapor favors the existence of biological deteriorating agents.
The main purpose of the envelope is the insulation of the paper , as long as possible, from degradation agents present in the atmosphere. Preliminary studies at ICPL have shown that the permeability of the sealed envelopes toward atmospheric humidity depends strongly on the sealing procedures. Note that in composite material the presence of a thin aluminum foil gives a lower permeability of the wall on respect to the seal, meaning that special care is required about sealing procedures in aluminated material.
Proposed activity
Evaluation of the sealing techniques by means of biological tests .
Evaluation of the sealing techniques by submitting the envelopes containing paper to aging cycles in a controlled climate room.
Programming and running artificial aging tests.
Artificial aging tests will be carried out in a controlled climate room by programming either aging cycles at a given temperature (as high as the properties of the material selected for the envelope will allow) and humidity (as high as possible), or by running variable cycles to monitor the effect of sudden jumps in temperature and humidity. Paper samples in different conservation state will be sealed inside a second series of commercial envelopes in order to study the protecting action of the special envelopes. Comparison will be performed with identical samples contained in the two sets of envelopes
5)Programming and running biological tests.
In the field of the preservation of cultural heritage and particularly of books, activity tests of biological agents must be studied and adjusted to get physiological .

Markets application and exploitation

The main goal of the DENEB project is to create a machinery and envelopes able to ensure full protection to newspapers, journals and books. The same machinery and containers will be suitable of extension to any material needing a dry atmosphere.state archives and libraries will be the first beneficiares, but also all industries willing to solve durability problems and long term stability of humidity sensitive products. Our effort will offer a new answer to the rapidly expanding market of delicate electronic devices. New added value to deperible products will be reached. The innovation of the project is such that all the items will be patented.

Project codes

BSI

NACE

3. Main participant

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Contact	**Dr. Mario Mensitieri** General Manager Tel Fax mario.mensitieri@mensitieri.com
Organisation type	SME
Participant role	Main under Reserve

Contribution to project

- Design of the multi-layer structure of the flexible packaging film consisting of appropriate selections of material for each layer and the eventual coatings and additives (each layer will provide a specific functional property), definition of layers sequence and thickness, definition of protocol for lamination process and selection of proper adhesives. Constitutive layers will be plastic film of several types and aluminium foil. - Pre-treatment of films by lacquering and/or varnishing and/or inorganic coating and/or metallization by roll-to-roll aluminium deposition under high vacuum. - Preparation of multi-layer film webs by lamination process. An industrial laminator will be used, able to process both polymeric materials and aluminium foil. - Assessment of functional properties of multi-layer films produced with particular reference to sealability and permeability to water vapour. - Design of whole package and sealing geometry. - Optimisation of sealing conditions able to guarantee the best performances in terms of long-term reliability. - Acquisition and optimisation of packaging machinery for package of newspapers and journals under modified atmosphere. - Realisation of package prototypes containing newspapers and journals under modified atmosphere. - Assessment of preservation capabilities of package prototypes by accelerated testing.

Expertise

Manufacturing of multilayer flexible packaging through several types of lamination processes of polymer films and aluminium foils. Rotogravure printing of single and multilayer plastic films. Roll-to-roll metallization of plastic films by deposition of aluminium layers under vacuum. Lacquering, varnishing and primering of plastic films and substrates. Research and development of new flexible packaging structures. Chemical-physical analysis of flexible packaging materials. Analysis of mechanical resistance of hot and cold plastic film sealings. Analysis of permeability properties of plastic films in relation to water vapour. Gas chromatographic analysis of low molecular weight substances released by the package.