# DEGRADING ACTION OF ENVIRONMENTAL FACTORS ON MATERIALS INCORPORATION OF WORKS OF ARTS

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***Abstract:** This paper presents the issues of environmental factors on the materials constituting the objects of art. Processes are treated in the degradation of physical-chemical factors of environment on the construction elements of stone and metal objects of heritage manifested through incrustation, corrosion and gipsare. Monitoring and control of such processes makes it possible destructive objects safeguarding heritage through the preventiveconservation and restoration*

**Introduction.**

The development of the industry increased in recent decades, has demonstrated close relationship between growth and changes that happen in the environment. Degradation of cultural goods is the effect of spontaneous processes with uncontrolled development, the result of a series of physical and chemical processes that gradually alter, the appearance, form and nature of material objects that are made, their resistance until the stage that makes it impossible to use as testimony of history and human civilization. If you take into account that many goods are either rare or unique, it is easy to predict what irreparable loss of cultural supports. Monitoring and control of such processes makes it possible destructive objects safeguarding heritage through preventive conservation and restoration. Presence in the atmosphere of corrosive gases (pollutants) such as CO2, SO2, NO2, X2 (halogen), caused by industrial and urban activities (from thermal fallout, exhaust gases, the discharge of waste gases from chemical, metal) creates problems of historical monuments and heritage of all goods-based organic material, in particular, stored in various sites, afectându them their conservation and their sustainability. Elements of air pollution are dust, smoke, reactive gases (SO2, (NO) x), ammonia, formaldehyde, ozone, and the results of industrial

processes and to some extent and sources of natural and organic. The sources of pollution acting directly on objects of art by origin are: internal and external. Internal pollution is a conventional means context (objects and auxiliary materials used for display or decorative purposes), which emits more or less local, some chemicals that can change the status of objects. The problem internal sources of pollution is newer and therefore less researched. External sources of pollution: air, light, the results of industrial processes and to some extent and sources of natural and organic. For the choice of measures to fight air pollution with harmful industrial gases, known to be the main processes generating pollutants. They create problems of historical monuments and heritage of all goods.

**2. Study the physico-chemical factors on the material**

One of the basic preventive conservation is the degradation which is the direct result of factors, given the role of preservation solutions on countering these threats [1]. Degradation factors are grouped into three classes, taking as a criterion specific ways in which the act of cultural goods: physico-chemical factors of the environment ,biological factors, other factors. Physico-chemical factors of environment are grouped by their function in the processes of degradation in two categories - reactive factors - factors of activation. Factors reagents or reaction are: moisture, oxygen, reactive gases: sulfur dioxide (SO2), ozone (O3), nitrogen oxides (NO) X, ammonia (NH3), formaldehyde and others. Important is that only the presence of these factors in the environment of cultural goods, make possible the chemical and physical processes that induce their degradation.
Activation factors are temperature and radiation, visible and invisible spectrum, lighting sources, which by their specificity, provide energy necessary chemical reactions.

**2.1. Stone degradation**

Deggradation stone for the construction of objects of heritage, of calcareous origin, chemical attack of the natural environment lies in the formation of a crust due to acid rain, which by chemical reactions forming deposits in the form of crust that may have protective role in relation conditions of reaction, called patina. For limestone, the phenomenon is growing by reversible reactions seen best through limestone caves stalactitelor and stalagmitelor. The phenomenon of incrustation objects with a structure of calcite occurs as a result of processes in three stages: silicatarea, recristalizarea and gipsarea. Reactions that underlie the destructive action of sculptures in stone, calcite, due to reaction of carbon dioxide and sulfuric acid in air industrial pollution, acid rain on the occasion.

1. The carbon dioxide in aqueous medium, forming carbonic acid, weak acid, which depending on the temperature and strength of calcite rocks attacked under the reaction 1.

$$H2O + CO_2 \leftrightarrow CaCO_3 + Ca(HCO_3)_2 \quad (1)$$

$Ca(HCO_3)_2$, calcium carbonate acid is a soluble product which may involve the migration of silica particulate material ($SiO_2$), forming in the solution concentration increased up to saturation, temperatures higher precipitation ($CaCO_3$) insoluble, by which cementation resulting calcium silicate $CaO.SiO_2$ in an appointed guardian patinarea rocks. This mechanism is demonstrated by the nature of cementation by silicatarea sandy sedimentary rocks. Determining a percentage of 1.13% Si, in both cases shows that silicatarea is a natural phenomenon in nature and important in patinarea rocks, material support of stone sculptures, buildings, cultural heritage assets. In this context, through evaporation and water movement to the left of the chemical equilibrium of reaction (1), forming insoluble products. $CaO.CaSiO_2$ is a saturation of the rock pores and the possible closure of microcellular. The phenomenon of dissolution, crystallization, recristalizare may develop through the same reaction and by the same mechanism based on the conditions and the gaps between microagregate and gradually between particles larger, developing crystalline aggregates on the objects of heritage type stalactitelor and stalagmitelor in limestone caves.

2. The sulfurous acid and sulfuric acid in rain, produced in hidroatmosferice on calcite, and support for the sculpture, but also as material of construction is under reversible chemical reaction, as a mechanism similar to that of carbonic acid (2):

$$CaCO_3 + SO_3 + 2H_2O = CaSO_4 \cdot 2H_2O + CO_2 \quad (2)$$

Reaction underlying phenomenon gipsare the calcite component of some works of art, historical. Reversible reaction mechanism that takes place at the media calcite, repeated migration solutions, crystallization, recristalizări, cementing and fluctuating temperatures, the expansion of these salts, which is so called efflorescence cause superficial cracks while the material degradându Photo 1, 2. If this mechanism of migration are involved in the form of solution and other aggressive substances, then in addition to possible exfolieri, causing mechanical destabilizing effects for physical and artistic unity will appear and corrosion phenomena Photo 1.

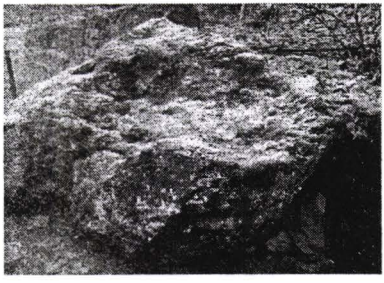

**Photo 1. Evolution items image degradation monument construction.**

**Corrosion.**

Corrosion consists of partial or total destruction of materials, generally metals, in particular, as a result of reactions with chemical agents in the environment.

Corrosion of metals is an inevitable phenomenon. Due to high chemical activity of metals that come into contact with corrosive dry, wet or microbiological destroyed is corodeză. They do not disappear, transform, or in solid compounds, which are deposited or soluble compounds, the corrosive environment.After unfolding mechanism, can distinguish two types of corrosion - chemical corrosion - electrochemical corrosion. Chemical corrosion is the destruction of art objects by metal reactions that take place between them and the environment. Chemical corrosion products may decrease the rate of corrosion, if left on the metal surface. They form a protective layer that isolates the metal from the aggressive. Some metals: Al, Mg, Pb, etc.., Are covered in dry air with a protective layer of oxide, stressed the effect of slowing the rate of corrosion under the same climatic conditions Table 3. Substances that contribute to forming a protective film is called passivation agents. Electrochemical corrosion is explained by the emergence of

local electric currents between different metals or metal and impurities contained therein. The process takes place in the presence of solutions. Works of art in bronze or ferrous alloys exposed outdoors are attacked by oxygen in the presence of water, CO2, SO2 in the atmosphere to form compounds called surface, patina "which are chemical compounds of Corrosion: basic copper carbonate, basic copper sulphate [2] CuCO3 x Cu (OH) 2, CuSO4xCu (OH) 2 or Fe (OH) 2. Acid rain destroyed by corrosion continuous construction materials and goods in precious metals and alloys, depending on geographical areas and the air, and oxygen concentration in the aqueous environment and the types of air pollutants, according to the graph of fig.1 and table 3.

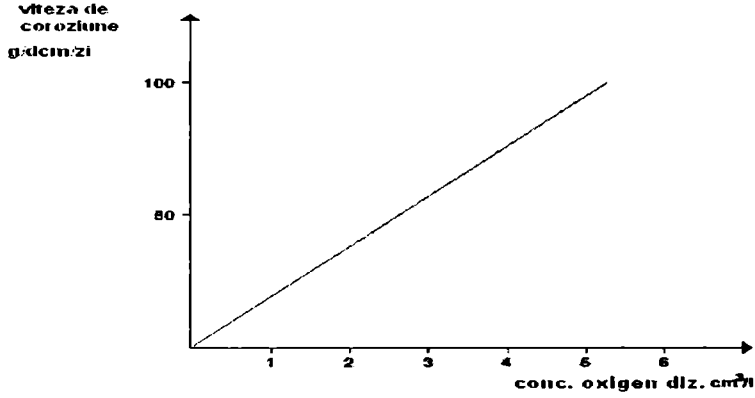


**Fig.1 Graph of corrosion rate depending on the amount of oxygen dissolved in water**

**Table 1. Coefficients of corrosion of metals in terms of geographical area and time of exposure.**

| Metal | Industrial atmosphere | | Marine atmosphere | | Rural atmosphere | |
|---|---|---|---|---|---|---|
| Duration of exposure | 10 years | 20 years | 10 years | 20 years | 10 years | 20 years |
| Aluminum | 0,81 | 0,74 | 0,71 | 0,63 | 0,025 | 0,076 |
| Copper | 1,2 | 1,37 | 1,32 | 1,27 | 0,58 | 0,43 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Lead | 0,43 | 0,38 | 0,41 | 0,53 | 0,48 | 0,33 |
| Zinc | 5,15 | 5,75 | 1,6 | 1,75 | 0,86 | 1,12 |

### 3. Research degradation and restoration measures of bronze objects

Research the degradation, conservation-restoration, has developed in recent decades the growing distance interdisciplinarității, collective complex curator, researchers, conservators, restaurants and investigators: chemists, physicists and biologists, aiming decipher messages and interpreting historical, documentary, artistic , iconography, etc.., that past generations transmit through objects, artistic creations and selecting methods and techniques for optimal conservation and restoration, with a view to the diverse, rich and valuable cultural heritage material to future generations.

For reasoning, we present a possible model for the interdisciplinary approach of the five archaeological pieces that are part of the collections of the Museum of History near the National Museum in Sibiu Brukenthal [3].

Analysis arheometrice have cost the macro and microscopic examinations, including electronic scan microscope, XRD (X-ray diffraction), X-rays and photographs macroscopic RX, RX digital X-rays, XRF - to determine the mineralogical composition of the skates, metallography - technique for specifying Work and analysis microchimice. qualitative and quantitative analysis were performed to scan electronic microscope coupled with an EDX analyzer interface 6 to skate / metal section tranversală.

Conclusions resulting from carrying out these tests.

1.Materialul metal alloy is a binary bronze Cu - Sn.

2.Raportul Cu / Sn is greater in the layer compared to the substrate patina bronze, Sn is more concentrated than in the matrix skate bronze.

3.Culoarea skates and a rank structure in the type I. This type of patina is characterized by the existence of two layers of products. The corrosion is due to a phase pasivizantă internal oxidation and selective dissolution of copper, a process also known as decuprificare.

4.Prin presence of oxygen rich layer on top of the skates can appreciate that it has a thickness of about 50 Hm.

5.Celelalte elements as oxygen, chloride, sulfur, silicon and aluminum are

exogenous and originate from contamination with soil during training skate.

6.Prezența phosphorus surface parts may be due to repeated human handling, which helps to authenticate the age song.

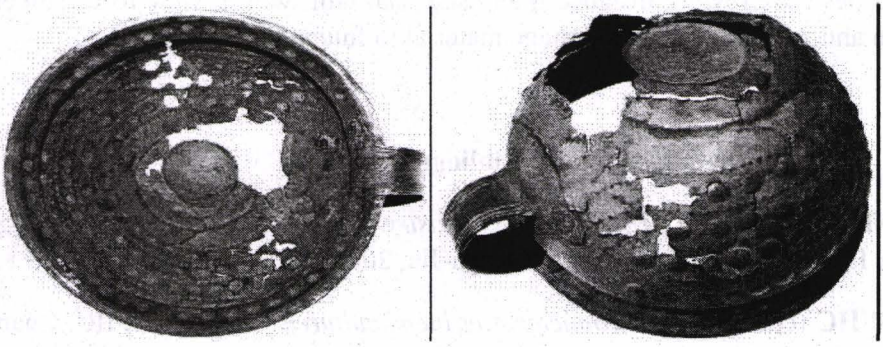

**Photo 2.Coroziunea some metal objects. Cup hook bronze A-4671.**

**Hallstatt B3.**

The pieces present a nice layer of patina noble, but variable as color and composition. In one of the fragments of cup was identified point of an attack by chloride corrosion of copper. In cup with handle, brown patina of color can come from a possible firing. The 4 fragments and cup with handle are strongly degraded by mechanical multiple cracks, breaks, missing parts. On X-rays, under the patina layer, there is a real "network" of microfisuri which indicates a strong fragilizare a metallic material.

Analyzing data obtained from examinations and tests performed, required seven steps, methods and techniques of restoration. 1. Degreasing with organic solvents. 2. Cleanup mechanical, chemical and possibly local. 3. Cleanup mechanical points with chloride. 4. Pasivizare by the vacuum impregnation with an alcoholic solution of BTA, 30% concentration. 5. Structural reinforcement by applying a layer of epoxy resin Araldyte 2020 pieces on the inside. 6. Putting areas and supplement missing. 7. Peliculizare general protective silicone oil. Finally emphasize this possible model interdisciplinary approach, which reminded early work should be applied in all cases of restoration / conservation.

## Conclusion

One of the basic preventive conservation is the degradation which is the direct result of environmental factors. Stones and metals (alloys) as a structural element or statuesque phenomena are subjected to physical and chemical degradation, manifested by incrustation (silicatarea, recristalizarea and gipsarea), corrosion

(patina). Degradation of cultural gradually alter, the appearance, form and nature of the material, physical and artistic unity.

Research the degradation, conservation-restoration, has developed in recent decades the growing distance interdisciplinarității, with a view to the diverse, rich and valuable cultural heritage material to future generations.

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