University of Split, The Arts Academy, Split (Croatia)
Intergrated Undergraduate/Graduate Program in Conservation-Restauration
Conservation-restauration of metals

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Sometimes the cause of corrosion of metalwork is the composite nature of the object itself. This can be particularly true of objects composed of metal and organic materials which release various chemical compounds. An example of such composite objects are firelocks (pistols) that are usually made of metal in combination with wood (which emits volatile organic acids) and leather (which emits non volatile organic acids). Therefore, we decided to carry out a test that would show how much the mentioned organic materials contribute to the corrosion of the metals typically used in the production of firelocks, in the conditions of selected RH values.

Aim

The aim of the test was to find out to what extent, at the selected RH levels, the close proximity of wood and leather contribute to corrosion of the selected metals.

Hypothesis

Substances released by wood (volatile organic acids) and leather (non volatile organic acids) cause higher rates of metal corrosion in conditions of high RH.

INFLUENCE OF ORGANIC MATERIALS ON THE CORROSION OF METALS

Samples

The research was carried out on samples of materials commonly found in firelocks. The most common metals used in manufacturing of firelocks were **copper**, **brass**, **silver** and **wrought iron**, while their gunstocks were usually made of very acidic **walnut wood**. Cartridge pouches for ammunition were made of **leather**.

Relative Humidity

The test was conducted at three different RH values: **33%, 75%**, and **97%**. The selected RH values were maintained with water solutions of three different soluble salts in precisely determined concentrations, each used to maintain a specific RH value.[1]

Salt	Water	RH
30g $MgCl_2$	3 ml	33%
20g NaCl	10 ml	75%
30g K_2SO_4	10 ml	97%

Table 1 Composition of used soluble salt solutions

Microclimate boxes

Nine microclimate boxes were made, using eighteen polypropylene containers. The containers were made in two sizes, with matching lids. Each microclimate box was made of two containers by placing the smaller container into the bigger one. Two containers were required because the lid of the smaller container had to be pierced so that samples could be suspended, which compromised air tightness which was necessary for the desired RH levels to be maintained. Air tightness of microclimate boxes was insured by closing the smaller container in the bigger one, with a lid that retained its full functionality.

Test preparations

Since the aim of the research was to measure the individual influence of two organic materials on the corrosion of metals at three different RH values, six microclimate boxes were made. In order to assess the final results of the research, three additional microclimate boxes, one for each RH, containing only metal samples, were made. Metal samples in the latter three boxes were control samples. The samples were kept in microclimate boxes for 28 days.

CONTROL SAMPLES		
1 RH 33% COPPER BRASS WROUGHT IRON SILVER	2 RH 75% COPPER BRASS WROUGHT IRON SILVER	3 RH 97% COPPER BRASS WROUGHT IRON SILVER
TEST SAMPLES		
4 RH 33% COPPER BRASS WROUGHT IRON SILVER **LEATHER**	5 RH 75% COPPER BRASS WROUGHT IRON SILVER **LEATHER**	6 RH 97% COPPER BRASS WROUGHT IRON SILVER **LEATHER**
7 RH 33% COPPER BRASS WROUGHT IRON SILVER **WOOD**	8 RH 75% COPPER BRASS WROUGHT IRON SILVER **WOOD**	9 RH 97% COPPER BRASS WROUGHT IRON SILVER **WOOD**

Table 2 Layout of samples ordered within microclimate boxes

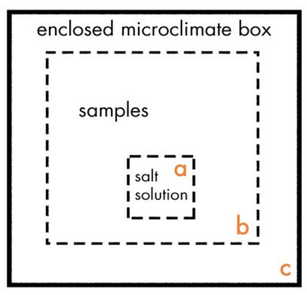

Diagram 1 Microclimate box a) opened container with soluble salt solution b) smaller container c) bigger container

Preparation of samples
Samples were pierced so that polymeric thred could be pulled through.

Preparation of soluble salt solutions
Soluble salt solutions were prepared in separated (third) smallest containers.

Preparation of microclimate boxes
Open containers with soluble salt solutions were placed into smaller containers. Samples were suspended on the lid of the smaller container. The smaller container was put into the bigger container, and sealed with a lid.

Conclusion

Since samples from the control group showed lower corrosion rates than the tested samples from the microclimate boxes with the same RH levels, it has been concluded that the tested organic materials really cause higher rates of corrosion in the selected metals.

Results

Significant changes occurred on iron samples placed into control microclimate boxes 2 (75% RH) and 3 (97% RH), copper, brass and iron samples placed into box 6 (97% RH), and copper, brass, silver and iron samples placed into box 9 (97% RH).

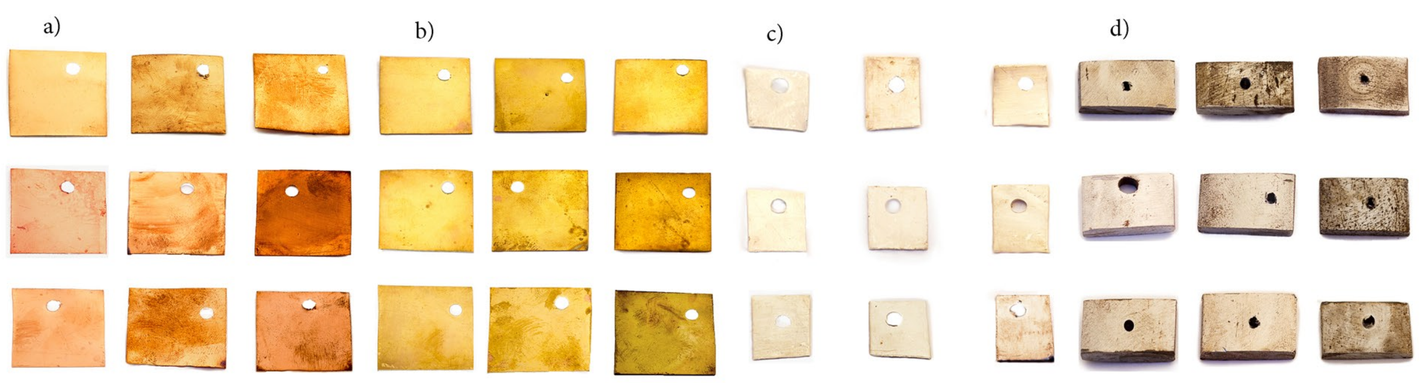

Figure 1 Samples after the test a) copper b) brass c) silver d) wrought iron

[1] G. Quincot, M. Azenha, J. Barros, R. Faria, Use of salt solutions for assuring constantrelative humidity conditions in contained environments, Project Report - PTDC/ECM/099250/2008,2011., https://paginas.fe.up.pt/~selco/wp-content/uploads/2014/02/Relatorio_2.pdf , accessed 20 March 2019