FIELD RESULTS: USE OF VOLATILE CORROSION INHIBITING PACKAGING MATERIALS FOR THE PROTECTION AND PRESERVATION OF WEAPONRY

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ABSTRACT

The protection and preservation of weaponry is a problem every army must deal with. This paper presents the results of actual field usage of Volatile Corrosion Inhibiting (VCI) film as used by the Croatian Army. Several types of preservation methods were utilized by the Croatian Army. A comparison of VCI film and conventional preservation methods is made. The factors studied for comparison include effectiveness of the protection, the length of protection offered, labor requirements for protection, labor requirements of reactivation and the effect of temperature on the time required for reactivation. The results show that VCI films are well suited for weaponry preservation and offer many advantages over conventional preservation methods. The results show that for protection terms of up to two years VCI films alone are the best choice. For preservation periods of two to five years the combination of a VCI film and VCI oil proved to be the best. Finally, for long term protection of five to fifteen years a combination of VCI film and a VCI/barrier oil proved to be the best.

Key Words: VCIs, volatile corrosion inhibitors, weaponry conservation, military, small arms preservation, VCI packaging, VCI oils

INTRODUCTION

Armies throughout the world have long struggled with trying to protect its weaponry from corrosion. There are several factors that make weaponry preservation a challenge. Firstly, because many items operate with extremely small tolerances, even minute amounts of corrosion can render a weapon unusable. Secondly, the geometry of many weapons makes them difficult to protect. Lastly, the conditions that the weapons are exposed to are often very severe.

Another consideration for weaponry preservation is the desire to have varying lengths of protection. Some weapons may need to be preserved for periods of fifteen to twenty years, while others may need to be protected for only weeks at a time or less. It is likely that if alternative methods can be employed for shorter terms they would offer advantages in cost as well as application time. In short, it is easier to justify greater expenditures of time and money for long term preservation, but not so for short term protection.

The Croatian Army employed a conventional means of corrosion control. The first step was to coat the weapon with oil. The second step was to place the weapon in a hermetically sealed bag with a desiccant. This method was effective for corrosion control. It was used to provide very long term protection, up to twenty years as well as for short term protection, up to two years.

Despite the effectiveness of this method, there were also several problems inherent to this protection scheme. This method often required a large amount of labor for both the preservation and reactivation steps. These same tedious steps had to be repeated regardless of the length of protection desired. Also, the amount of time required for reactivation in many cases was a function of the temperature making reactivation unreliable. Finally, oftentimes the weapon was not functional immediately.

Therefore, it was desired to determine if a method of preservation could be utilized that would allow for varying lengths of protection and decrease the time involved in preserving and reactivating weaponry.

VCIs offer many advantages over conventional corrosion control methods. The mechanism of VCIs have been previously described (1). VCIs are used in a wide variety of industries, from corrosion protection of electronics (2,3), to marine applications (4,5). For this application VCIs were used in two forms, a polyethylene film and in oil.

EXPERIMENTAL PROCEDURE

This study utilized results from actual field usage. The results of using several methods over a period of several years are evaluated. Infantry armaments were studied to determine the best overall preservation method for a given length of time. No modification was made regarding the usage of these weapons. They were preserved and reactivated as they would normally.

For this study the Croatian Army used two different means of preservation. The first method, a classical method for the protection of armaments, was to first coat the metal surfaces of the gun with an oil. The second step was to place the weapon in a hermetically sealed barrier type bag. A desiccant was also added to the bag. The second method was based upon the used of VCIs. To preserve the weapon using the VCI method it was either placed in the bag alone or with a VCI oil depending upon the length of protection desired. The bag was then sealed. The goal was to compare a conventional protection method (desiccation and oiling) to a modern method of a VCI packaging.

The steps for reactivation are as different as the two methods. For the conventional method the first step is to remove the gun from the bag. Next the oil is removed with the aid of solvents. For the VCI method the weapon is simply removed from the bag and it is ready to use. The bag may be reused if desired.

Three lengths of protection were considered: Two years and under, two to five years and five to fifteen years. The classical method of desiccation and oiling was compared to three different methods utilizing VCIs. For up to two years of protection a VCI film alone was used. For protection terms from two to five years the moving parts were lubricated with a low viscosity VCI oil. A medium viscosity VCI/barrier oil was used for protection from five to fifteen years.

The methods were compared, considering several factors. The basis used to evaluate the labor requirements was the time required for preservation time and reactivation time. The factors used to evaluate the performance of the preservation method were visual inspection for corrosion and dependability of the armament after reactivation. The dependability of the reactivation was evaluated by operational firing of the weapons.

VCI preservation method was used by whole platoons of soldiers. The factors considered above were evaluated by a cross section of soldiers that were using the weapons. The results are presented as an average of the results reported by the soldiers. Additionally, the results are not distorted by results reported by a small group since the test group was an entire battalion.

RESULTS

The results of the evaluation of the labor requirements is presented as a ratio. This ratio is the amount of the time required to preserve the weaponry using the classical method to the time required for VCI film method. For example a four to one ratio indicates that the classical method requires four times more labor than VCI method for that particular operation.

For preservation of up to two years the labor requirements results are given in Table 1. The reactivation time was evaluated at two different temperatures to determine the effect of temperature on reactivation time. The dramatic increase in time at the lower temperature can be attributed to the increase in the time required to remove the oil at the lower temperature. The reactivation time for weapons stored in VCI film was found to be essentially independent of temperature.

The results of the performance testing for periods of up to two years of protection are given in Table 2. Using only the VCI film only was found to keep the armament free of corrosion for up to two years. The classical method also was found to keep the weaponry corrosion free.

The results for protection periods of two to five years is given in Table 3. There is an increase in the time required for preservation for the VCI packaging material, because for this length of preservation VCI oil is used in conjunction with the VCI film. There is no increase in reactivation time as it is not necessary to remove this oil prior to using the weapon.

The results of the performance testing for two to five years is given in Table 4. These results are similar to those for the shorter protection term. The lack of delay in the operation of the firing pin when VCI oil is used is explained by the fact that the oil is not applied to this portion of the weapon.

The results for the labor requirements for protection periods of five to fifteen years of protection are given in Table 5. These results are similar to those seen for the shorter protection terms. The additional protection afforded by the VCI/barrier oil does not result in an increase in the time to preserve the weapon. Again, the VCI/barrier was applied to areas that did not require its removal prior to using the weapon, therefore there was no increase in the amount of labor required for reactivation.

The results for the performance testing for the preservation of five to fifteen years of protection is given in Table 6. Using the VCI/barrier oil in place of the VCI oil allows the protection period to be extended to fifteen years without corrosion. Once again, the conventional preservation method prevented corrosion.

CONCLUSIONS

Using VCIs for the preservation of weaponry was found to result in significant advantages. Firstly, the preservation method can be customized based upon the length of protection desired. Additionally, the VCI method results in a dramatic decrease in labor requirements. The reactivation with the VCI method was found to be more reliable and was independent of the temperature.

Both methods provided corrosion protection. When the appropriate VCI materials were chosen, based upon the length of protection, the armaments were observed to be free of corrosion. For the classical method, it was found to protect the armaments for periods up to fifteen years. Therefore both methods are able to protect the armaments from corrosion.

In summary, the use of VCI materials for the protection and preservation of weaponry was found to result in significantly lower labor requirements, a more reliable reactivation while keeping the weapon corrosion free.

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Table 1: Labor Requirements, Less than Two Years of Protection

Factor	Time Ratio: Conventional Preservation: VCI Packaging
Preservation	4:1
Reactivating time (20°C)	5:1
Reactivation time (-15°C)	23:1

Table 2: Performance, Less than Two Years of Protection

Factor	Oiling and Desiccation	VCI Packaging
Visual inspection for corrosion	No corrosion	No corrosion
Dependability	Delay in operation of firing pin	No delay

Table 3: Labor Requirements, Two to Five Years of Protection

Factor	Time Ratio Conventional Preservation: VCI Packaging and VCI Oil
Preservation	2:1
Reactivation time (20°C)	5:1
Reactivation time (-15 °C)	23:1

Table 4: Performance, Two to Five Years of Protection

Factor	Oiling and Desiccation	VCI Packaging and VCI Oil
Visual inspection for corrosion	No corrosion	No corrosion
Dependability	Delay in operation of firing pin	No delay

Table 5: Labor Requirements, Five to Fifteen Years of Conservation

Factor	Time Ratio Oiling and Desiccation: VCI Packaging and VCI Oil
Preservation	2:1
Reactivation time ($20^{o}C$)	5:1
Reactivation time ($-15^{o}C$)	23:1

Table 6: Performance, Five to Fifteen Years of Protection

Factor	Oiling and Desiccation	VCI Packaging and VCI Oil
Visual inspection for corrosion	No corrosion	No corrosion
Dependability	Delay in operation of firing pin	No delay