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ENVIRONMENTALLY FRIENDLY PROTECTION METHODS USED BY THE ARMED FORCES OF THE REPUBLIC OF CROATIA

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SUMMARY

Armed Forces of Republic of Croatia use several methods to protect their equipment. They range from coatings, dry air to the use of vapor corrosion inhibitors (VpCI). Of all these methods the use of VpCI technology was the most successful for the following reasons:

- VpCI is economical
- Effective
- Environmentally friendly
- Protected equipment can easily be reused
- Less people are needed to work on conservation

The results of use of VpCIs in conservation of infantry weapons in the Armed Force of Republic of Croatia are shown in this paper. After being equipped with VpCI polyethylene film weapons were ready for storage at different locations in regard of different climates.

One location was in the area of mild, Mediterranean climate, the other in cold, mountain climate and third in dry continental climate.

10% of all stored weapons were removed periodically for inspection to verify the effectiveness of corrosion protection.

The results of the inspection procedure in this paper show the advantages of using VpCIs to protect weapons and military equipment when compared to other methods.

KEY WORDS:

- Conservation: corrosion protection
- Infantry weapons: 14,5 mm fire arms
- VpCIs; Vapor Corrosion Inhibitors
- Armed Forces of Republic of Croatia

INTRODUCTION

Unprotected metals, from which the majority of weaponry and military equipment is made of, are subject to corrosive processes in practically all conditions of storage and use. Corrosion significantly affects changes in the projected properties of the equipment, shortens the timeframe of use, and increases the risk of unwanted mechanical and other properties being showcased during the use of unprotected equipment. The National Association of Corrosion Engineers considers that corrosion-related expenses in the United States amount to $300 billion per year, and that as much as 30% of the annual production of black metals in Russia is ruined due to corrosive processes.

CORROSION

Out of the many factors that influence the propagation of corrosion in construction materials and equipment during exposure to atmospheric elements, the most important are:

- Relative air humidity,
- Atmospheric composition (gases, acid fumes, salt particles, dust),
- Air temperature.

From the standpoint of metal corrosion, the concept of critical relative air humidity is especially important. The critical humidity for steel is 60%, and much less in the presence of SO_2. In practice, the relative air humidity should be kept under 50% (between 30% and 50%) to prevent corrosion. Among the agents that influence corrosion, the most important ones are SO_2, H_2S, ammonia, HCl, etc. SO_2 is most important in industrial atmospheric conditions, while chlorides are dominant in coastal areas.
The propagation of corrosion in metallic materials depends on the temperature of the surroundings, increases with rising temperature, and goes on unimpeded at temperatures above 25°C.

CONSERVATION

Conservation is a form of temporary protection that is implemented in the protection of weaponry and military equipment while in short-term or long-term storage. Therefore, conservation can be short-term or long-term. All methods of conservation can in essence be divided into two major categories:

- Protective coatings (coating methods, cocooning, banana film, etc.)
- Non-contact protective materials (Vapor inhibitor methods)

The armed forces of various countries have researched and developed various methods and materials in the fight against corrosion, and those methods and materials have advanced and improved over time. Many tested and applied methods have a long history, where as methods from the protective coating where as category were applied in earlier times, vapor inhibitor-based methods are relatively more recent. Although these methods first appeared, and were used, during World War II, they have been developed in a broad manner in the last 20 years or so.

Coating-based Conservation

In the category of coating-based materials (contact materials), we include conservation oils, solvents and consistent conservatory tools, i.e. greases. They differ according to the character of the protective film, which can be oil-based, soft, or hard. Oil-based film offers long-term protection of up to five years, in a hermetically sealed environment. Soft film offers protection of up to ten years in indoor

environments, and hard film offers protection exceeding ten years. Application technologies are relatively simple, and include submersion, coating, or spraying. The elementary chemical base of coating-based materials is a certain fraction of crude oil, with the addition of appropriate additives.

Characteristics of the application process:

- Enables long-term protection of conserved items.
- Application technologies are relatively simple and do not require specialized equipment.
- Thick layers of coating are formed, which harden during storage, and interfere with the function and the operation of weaponry (automatic weapons).
- Removal of protective coatings is necessary, i.e. de-conservation for use.
- De-conservation is more challenging as the surrounding temperature decreases, and is practically impossible at temperatures below -20°C.
- The use of organic solvents, etc., is necessary for de-conservation.
- During storage of the protective materials, coagulation and separation of fractions occur, as well as increased viscosity.
- The technologies are "dirty", and ecologically unacceptable.

VpCI-based Conservation

The mechanism of protective application is based on inhibiting the corrosive atmosphere through the chemical effects of the active substance evaporated onto the space and condensed on the surface of metallic packaged materials and systems. They additionally act by absorbing the humidity from the packaged space.

They are manufactured and applied in various forms: applied onto polymers, as sprays and powders, in coatings, production materials, tablets, etc.

The properties of the process are:

- Ensures long-term and short-term protection at the same time
- Possibility of re-use of the inhibitor-carrying materials
- Simple application technology
- Possibility of fast and easy insight into the state of the conserved item, as well as immediate intervention
- Minimal investment of human labor into the phases of conservation, de-conservation, and re-conservation
- The independence of the conservation process of the temperature conditions of the surroundings (low and lower temperatures)
- Immediate de-conservation and achievement of readiness for use
- Economic advantages (30-40% lower price compared to solvents and similar coating materials)
- Especially favorable ecological properties
- The necessity for careful handling of the conserved materials due to possible damage to the hermetical packaging is a disadvantage (when sensitive barrier materials are used, such as foil, paper, etc.)

See Fig. 1 for comparison a protection VpCI and coating conservation.

EXPERIMENTAL AREA

Since the very beginning of the recent war, the Armed Forces of the Republic of Croatia have considered various methods of corrosion protection for weaponry and military equipment. In the first years of the armed conflict (1991 to 1995), there was no need for conservation, since all weaponry was in constant use. With the conclusion of military operations, the Croatian Armed Forces started going through several phases of reorganization with demobilization and transferring to reserve forces of a large number of units, and with them their weaponry. This is when the need to protect and conserve a large quantity of weaponry appeared. The Ministry of Defense of the Republic of Croatia has in the meantime adopted the process of conservation of weaponry and military equipment through the application of Vapor Corrosion Inhibitors (VCI), due to the advantages of this method compared to the alternatives. At first, due to urgent needs, the process of conserving infantry weapons was adopted, followed by artillery, Air Force technical equipment, Army spare engines, spare parts, and finally motorized vehicles.

This paper encompasses the testing of conservation efficiency of infantry weaponry in the Armed Forces, since this process has been in place since 1996. The very process of conservation of the said weaponry encompasses a couple of main phases of work: conservation tools and materials preparation, conservation, and control of performed conservation, storage, and safety at work.

The preparation of infantry weaponry for conservation consists of the following actions: cleaning of combustion products, technical examination, examination and (if necessary) removal of corrosion products, degreasing, and examination and preparation of the packaging for storage of the weaponry. This is also the phase when the conservation materials are prepared.

The conservation consists of the following phases: lubrication of weaponry with protective oils, draining of the oils, conservation-placing of the weapon in a protective polyethylene bag with inhibitors, then control of the process of conservation, and finally packaging of conserved items into crates and warehousing.

The expected and ascribed duration of the conservation is three years, with a mandatory inspection upon completion, following which the conservation can be extended for another year.

PROTECTION

Degreased and cleaned unpainted parts of weaponry are coated with a thin layer of protective MIL-P-46002B VCI oil using a brush or a brush soaked in oil. (Fig. 2) After that, the weaponry is mounted onto special holders and left for 10 to 15 minutes, in order for the excessive protective oil to drain off into previously prepared containers. (Fig. 3) Weaponry coated using the described process is placed into protective MIL-B-22020C VCI bags, and the bags are sealed with self-adhesive tape, or are welded shut using specialized equipment. (Fig. 4) Weaponry protected in this manner is laid into prescribed packaging, while making sure not to damage the VCI bags. (Fig. 5) The crates are marked with all necessary elements for unimpeded control of protected weaponry without opening the crates.

WAREHOUSING

After placing the conserved weaponry into appropriate crates, those crates need to be warehoused in the prescribed manner. Protected infantry weaponry is warehoused and guarded in locked structures built for that specific use. The wooden crates are usually stacked one on top of the other, so that easy access and overview of the conservation control sheets are possible. (Fig 6 and 7)

ENVIRONMENTAL PROTECTION

All liquids and necessary tools must be properly stored after use. Only the necessary tools and quantities for the current task at hand can be stored in the area for conservation and cleaning. During the use of the cleaning, degreasing and conservation tools, utmost attention must be paid to the avoidance of spillage in the conservation area. If such an event should occur, the spilled item must be neutralized, and removed with appropriate tools for removal. After the conservation, the used mops, gloves, and other tools, must be taken care of in an ecologically acceptable manner.

The protected weaponry is stored for safeguarding in three locked warehouses in Croatia (see map of Croatia, Fig. 8), in three different locations: Osijek (280km east of Zagreb, continental climate), Otočac (200km south of Zagreb, rough mountain climate), and Zadar (280km south of Zagreb, a seaport, mild Mediterranean climate-chloride salts present in the air).

An examination of the conserved weaponry was performed in August of 2001.

7.62 mm automatic rifles, from the Otočac warehouse, were conserved on July 15th, 1997, and 2% of the total conserved amount was reviewed. After de-conservation and examination it was determined that all metal parts and barrels were in excellent condition, i.e. there were no traces of corrosion. Furthermore, even though some plastic bags were damaged (around the mouth of the barrel and sights), the weapons from those bags did not exhibit any signs of corrosion either.

Automatic rifles H&K FALL from the Zadar warehouse were conserved on October 17th, 1997, and were examined after de-conservation, but no presence of corrosion was detected. I reiterate that a significant concentration of chloride salts was present in the surrounding atmosphere of this warehouse, due to proximity to the sea.

Machine guns "ERO" 9 mm, from the Osijek warehouse, were conserved on July 1st, 1998, and there were also no traces of corrosion.

CONCLUSION

The Armed Forces of the Republic of Croatia have adopted the method of conserving infantry weaponry through the use of Vapor Corrosion Inhibitors (VCI), in accordance to comparative advantages. The same method has been in active use since 1997. Examinations of the conserved weaponry were carried out due to the expiry of the conservation periods, and the condition the weaponry was found confirmed in their entirety all of the advantages of VCI treatment. All conserved weaponry did not change its condition even after four years, that is, no presence of corrosion or rust could be determined. It should be especially highlighted that no corrosive changes occurred even with respect to the surrounding climate of the locations where the conserved weaponry was kept. The protective effect of the vapor inhibitors is so great that even damaged polyethylene bags provided similar level of corrosion protection to the metallic parts. Finally, the results that were determined by the examination of weaponry have enabled the period of protection by this method to be extended to 4+1+1 years, a total of six years, which will result in significant savings in the area of weaponry conservation.

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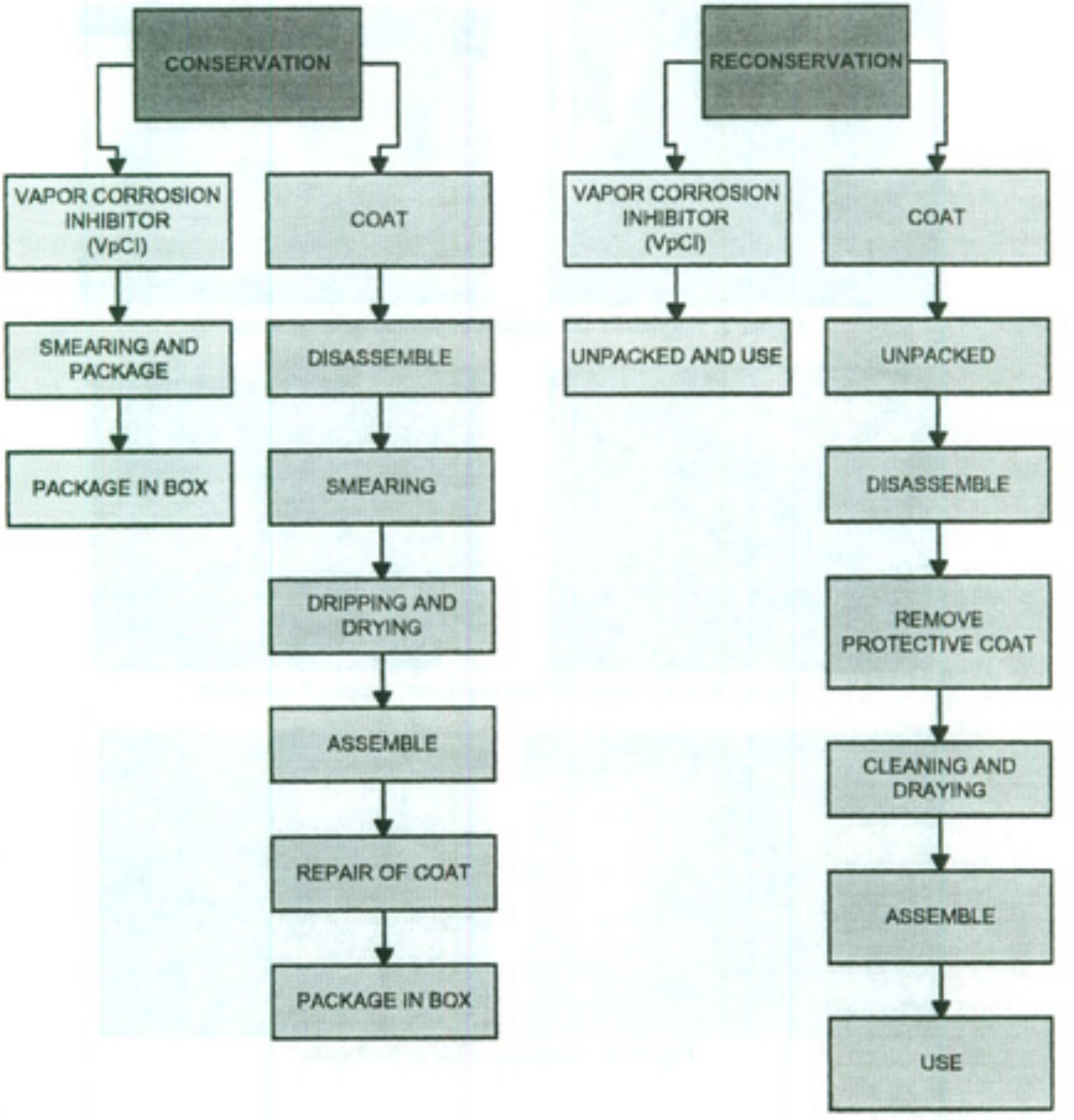

Figure 1. Comparison a protection VpCI and Coating conservation

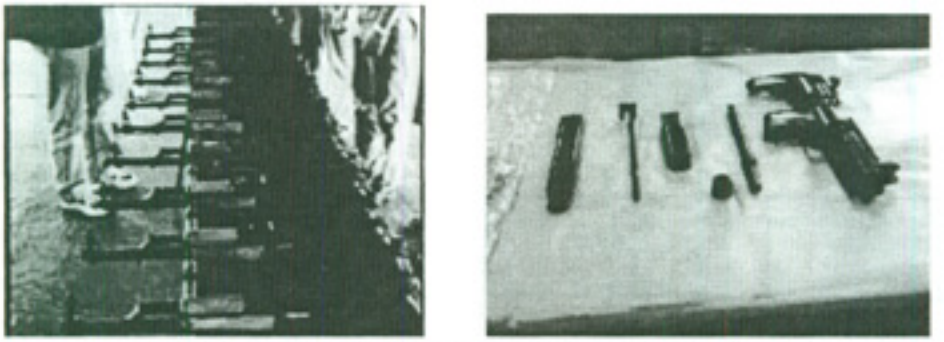

Figure 2. Degreased and cleaned unpainted parts of weaponry

Figure 3. Oil to drain off into previously prepared containers

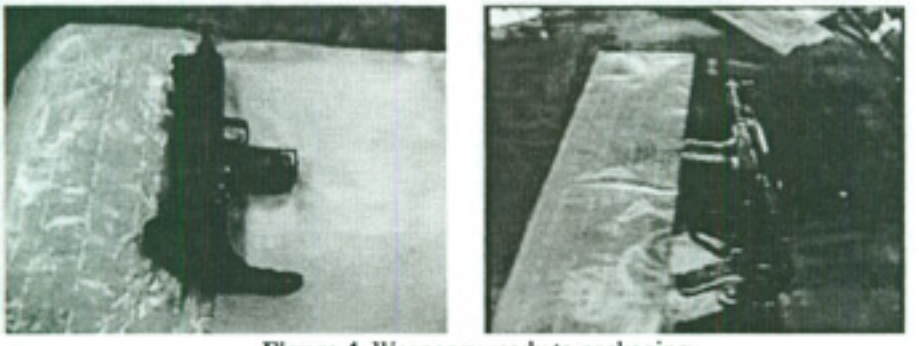

Figure 4. Weaponry ready to packaging

Figure 5. Weaponry packaging, while making sure not to damage the VCI bags and ready for boxes

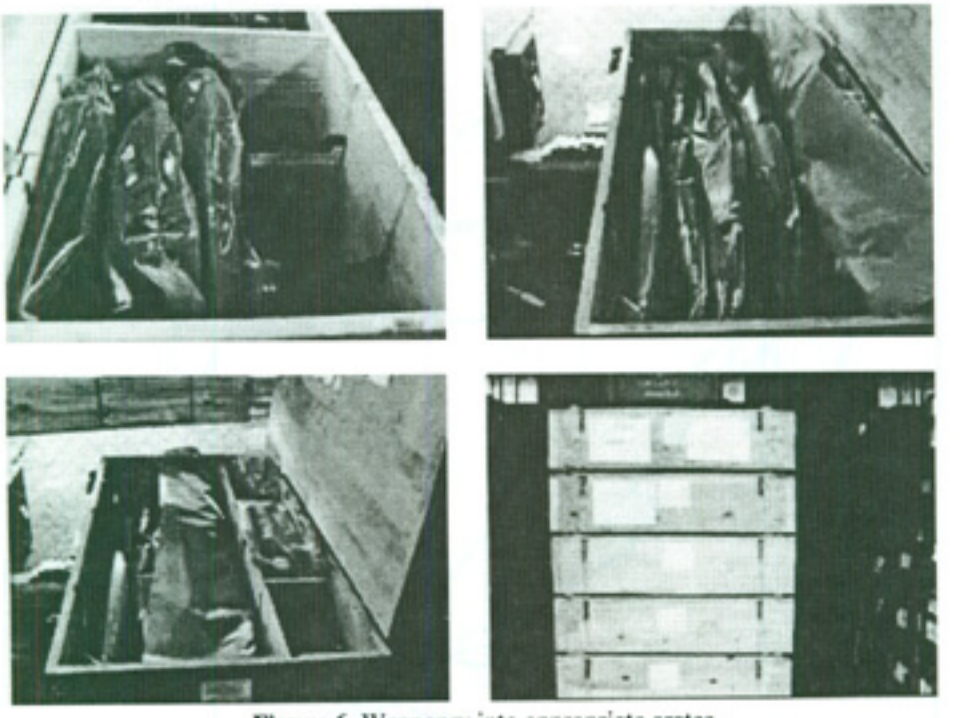

Figure 6. Weaponry into appropriate crates

Figure 7. Stickers for identification on the boxes of weaponry

Figure 8. Map of Croatia