AMPTIAC
ADVANCED MATERIALS AND PROCESSES TECHNOLOGY
The AMPTIAC Newsletter, Summer, 1999

Air Force Corrosion Prevention and Control Office Turns the Corner on Corrosion Prediction/Assessment

Guest Editorial

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Introduction

The Air Force Corrosion Prevention and Control Office, located at Robins AFB, GA, and operated by the Air Force Research Laboratories' Materials Directorate recently achieved a major milestone in demonstrating an aircraft corrosion prediction program.

The AF Corrosion Prevention and Control Office accomplishes its mission by ensuring Air Force maintenance organizations receive first class training, tools, and material for corrosion prevention / repair of existing USAF aircraft, and by ensuring manufacturers use only the best corrosion resistant materials and processes in construction of new USAF aircraft. The only difficulty with this approach is it leaves the impression every single instance of corrosion attack is found and treated on every aircraft that goes through the maintenance process. As aircraft age, the amount of effort required to achieve this sort of assurance becomes greater and greater. As a result, corrosion maintenance costs on some of the USAF's older aircraft have more than doubled within the past ten years. In addition, structural integrity analysis has to some degree been predicated on the assumption that no corrosion exists within the structure.

The basic tenants of minimizing the impact of corrosion through proper training and ensuring best materials and processes remains sound. However, aging systems have forced a more realistic view that many systems are and will be flying with undetected and untreated corrosion. Therefore, two years ago the corrosion office undertook a multifaceted effort to assess the growth of corrosion in existing aircraft structure and its effects.

Although the program had many important elements, the main technical hurdle to overcome was, "What are the corrosion growth rates in various environments?" If growth rates could be provided, then an engineering assessment of future corrosion could be made. Mr. Richard Kinzie of the corrosion office seized upon a promising new technology (Super-conducting QUantum Interference Device or SQUID) to provide this important element. This technology was previously developed through AFOSR funding as a Non-Destructive Inspection (NDI) method and was

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Spotlight on Technology: Composting – An Innovative Bioremediation Tool

Composting is a well known biological process that has traditionally been used to degrade natural organic materials to form humic substances. This process has been used extensively to reduce the volume of unwanted organic materials, to stabilize easily degraded organic wastes, and to produce soil amendments. More recently, composting has been shown to be effective in degrading a number of hazardous materials, and composting processes have been developed to remediate contaminated soil/sediments and to treat military process waste streams.

Simply defined, composting is a process where dense populations of highly active microorganisms very rapidly break down organic matter. The organics used to fuel the compost typically are easily degraded and supply adequate nutrition for the rapid microbial population growth. The microorganisms are normally naturally occurring, endogenous to the waste materials. The hallmark of an active compost is the spontaneous generation of heat, which results from the very high microbial activity.

Establishing composting conditions is relatively easy. Simply piling up fresh grass clippings will generally create a compost with a noticeable increase in temperature in the interior of the compost within a few hours.

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Volume 3, Number 2

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Corrosion Prediction/ Assessment

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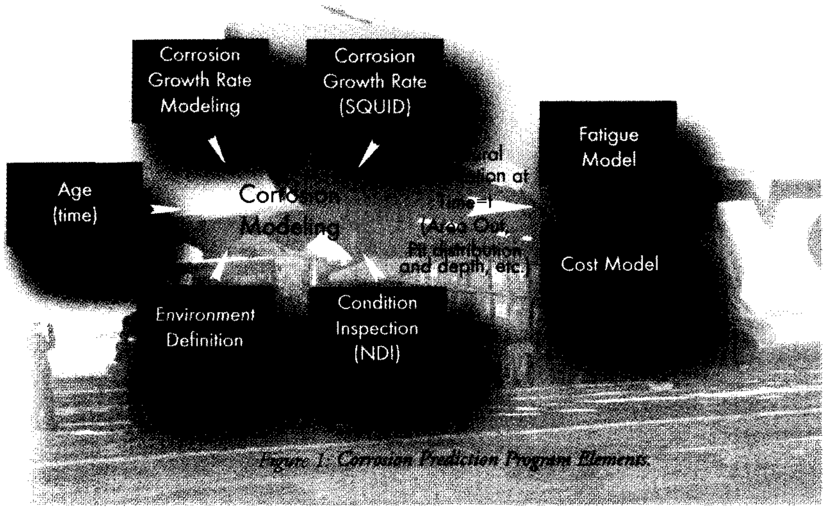

Figure 1. Corrosion Prediction Program Elements.

being advanced by Dr. John Wikswo of Vanderbilt University. Other important elements of the program and how they were brought together are laid-out in Figure 1.

The main goal was to provide the structural maintenance community a decision making tool for minimizing cost while ensuring appropriate inspections for structural integrity. An assessment of the internal corrosion (the demonstration was for a lap joint only) and its severity based on an aircraft's history, location, and usage could be used to determine an inspection schedule. If inspectable, a measurement of the corrosion severity could then be used to determine what action is the most cost effective while maintaining structural integrity. This could involve a number of options from using corrosion abatement technology and continuing to monitor the structure to complete replacement.

Model Development: *Condition*

The condition of the corroded part is established by inspection. In developing our prediction model, an eddy-current technique was used to establish the current condition. The technique was able to image the corrosion damage at the interface between two lap joints and show corrosion damage to a tolerance of 0.005 in. The eddy current scans for each of our corrosion specimens (which had a wide range of corrosion damage from almost no damage to very severely damaged) was obtained and examined. These scans were put through the analysis software and a Weibull plot of the damage distribution was obtained. These scans now serve as examples of corrosion damage, and they can be compared to actual aircraft damage to define the "initial condition" of any aircraft lap joint for which NDI data is available.

Environment

In the mid-90's, it became apparent that the base level corrosive environments that had been established in the mid-70's were no longer sufficient. The qualitative ratings from an earlier time had been sufficient to establish base-level maintenance actions; however, they were inadequate for the current needs. What was needed was a quantitative environmental severity rating that would establish differences between base level environments. This would allow engineering managers to use the severity ratings as an aid in determining the probable corrosion damage that could be expected at the next depot visit for an aircraft stationed at a particular base. In 1997, the Air Force Corrosion Program Office set out to accomplish this for all Active, National Guard, and Reserve bases both within the United States and overseas.

The effort was greatly aided by the results of the National

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The AMPTIAC Newsletter is published quarterly by the Advanced Materials and Processes Information Analysis Center (AMPTIAC). AMPTIAC is a DoD sponsored Information Analysis Center, administratively managed by the Defense Information Systems Agency (DISA), Defense Technical Information Center (DTIC). The AMPTIAC Newsletter is distributed to over 20,000 materials professionals around the world.

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However, the overall activity and temperature of the compost can be controlled by adjusting parameters that influence microbial growth, such as moisture level, pH, level of aeration, and nutrient sources. Over the last 16 years significant research efforts have been invested in developing composting technologies that are effective in treating military wastes.

The U.S. Army Environmental Center (USAEC) has taken the lead role in developing compost methodologies for waste cleanup. Initial efforts and much of the subsequent research has focused on the bioremediation of soil contaminated with explosives. Remediation of explosives in soil is a significant concern for the DoD. Forty Army installations require cleanup of explosives contaminated soil, with an estimated 1.2 million tons of contaminated soil. Additional Navy and Air Force, as well as DOE sites will require similar cleanup. Incineration has been the treatment of choice in the past. However, environmentally benign bioremediation technologies have advantages over incineration. Composting is viewed more favorably by the public as a natural process without potentially hazardous emissions or residues. Large quantities of soil can be treated, and depending on the type of explosives in the soil, decontamination down to very low levels is completed in a matter of weeks. Composted soil can then be returned directly to the land as an organic enriched soil.

The USAEC has conducted a variety of studies to develop composting methods that are easily controlled, environmentally acceptable, low cost, and highly effective in destroying explosives. Variables that were examined include loading rates for the soil, different types of organic materials to be used for fuel, and different composting methods such as static piles, windrows, and in-vessel composts. Research efforts have yielded highly successful results.

Windrow composting is one of only two bioremediation methods that has been validated in field tests for treatment of explosives contaminated soil, and is the only bioremediation treatment approved by regulating agencies. Windrow composts have only moderate equipment investments and monitoring requirements. Readily degradable, low/no cost organic wastes, such as manure, are mixed with contaminated soil and a bulking agent, such as wood chips or straw. The bulking agent is used to increase porosity, allowing air to move through the compost. The mixed compost is laid out in long rows (windrows) to facilitate aeration and handling. The rows are periodically turned and mixed with commercially available equipment. Oxygen levels, moisture, and temperature are monitored to maintain high microbial activity and speed the destruction of the explosives.

Windrow composting has been used at a Superfund site at Umatilla Army Depot to cleanup a mixture of explosives in soil. The cleanup was fully successful, finishing a year ahead of schedule. TNT, RDX, and HMX contaminants were reduced 99.7%, 99.8%, and 96.8%, respectively. Overall reduction of explosives was greater than 99%, with a 90-98% drop in the toxicity in the soil. Results from this work demonstrated that the economics of composting compare very favorably to incineration. In assessing the cleanup of 10,000 cubic yards of contaminated soil (13,000 tons) composting costs ranged from $250 to $299/ton, less than half the cost of incineration at $740/ton. Composting costs vary somewhat depending on the sources and trucking costs of the organic materials used at any given site.

In addition to soil remediation, composting techniques have been investigated to treat nitrocellulose fines from munitions manufacturing processes. Disposal of nitrocellulose fines is an increasingly difficult problem. Open burning is no longer permitted in some states and may be banned throughout the US in the near future. Studies with composting have demonstrated it to be an effective means of destroying nitrocellulose. However, costs of composting are projected to be higher than other potential means of disposal. Studies are continuing to evaluate composting and other potential treatment technologies.

In summary, composting promises to be a major tool for the DoD in dealing with explosive contamination problems. As a natural process composting is generally accepted by the general public. When properly used it does not create any secondary waste streams that require further treatment. It is low tech, and thus is easy to operate with minimal labor and relatively low equipment costs. Composting is an old process whose time has come of age.

For more information on composting as a bioremediation tool, contact Rich Doyle, IITRI, 301-918-1576, rdoyle@iitri.org. ■

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