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PROCEEDINGS OF THE US-PACIFIC RIM WORKSHOP ON EMERGING NONMETALLIC MATERIALS FOR THE MARINE ENVIRONMENT "ENVIRONMENTAL ISSUES FOR CANADIAN NAVAL VESSELS"

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ENVIRONMENTAL ISSUES FOR CANADIAN NAVAL VESSELS

THE US-PACIFIC RIM WORKSHOP ON EMERGING NONMETALLIC MATERIALS FOR THE MARINE ENVIRONMENT

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ABSTRACT

To ensure compliance with environmental regulations, Canadian naval vessels are or will be undergoing many changes in ship systems concerned with sewage disposal, waste disposal, oil and water separation technology and other processes that involve environmentally sensitive chemicals or materials. At the same time new, maintenance materials and processes are being introduced to reduce the production of volatile solvents, toxic chemicals, non-degradable products and hazardous waste.

An overview of the current technologies and processes used on ships will be presented. Proposed new technologies and the possible problems in integrating them into ships systems will also be discussed.

INTRODUCTION

Compliance with national (Canadian Shipping Act, Environmental Protection Act and other local regulations) and international (MARPOL 73/78 and local requirements in international ports of call) environmental standards is a priority for Canadian Naval vessels.

The environmental compliance problems can be broken down in to two main areas of concern:

- ship maintenance materials and procedures, and
- ships systems.

Ship maintenance materials and procedures include:

- coatings,
- surface preparation,
- cleaners and other maintenance procedures,
- removal and disposal of ship and shipyard waste.

Areas of concern for ship systems include:

- blackwater collection and treatment systems,
- grey water collection and treatment,
- solid waste collection and disposal - including plastic, foodstuffs, and trash,
- oily/water separation monitoring and disposal, and
- the use and effect of cleaners and other chemicals on other treatment systems.

To comply with the national and international standards for ship systems the Canadian navy initiated the *Maritime Environmental Projection Project (MEPP)* in 1993 at a total estimated cost of $55M to be completed by fiscal 2000/01.

MATERIALS AND MAINTENANCE PROCESSES

A. Coatings

The introduction of new coatings for Canadian naval vessels has been underway for some time. The areas of major concern for environmentally compatible coatings are: volatile solvent content (VOC), toxic pigments (chromates and organotin), chromate surface treatment processes and non-toxic fouling release coatings to replace copper and organotin anti-fouling coatings.

The use of water-borne coatings as a means of reducing solvent content is an approach that has solved some of the problems of VOC, especially for interior coating systems. Water-borne systems are not compatible with the Canadian winter climatic conditions (high humidity and low temperature) at both the east and west coast shipyards and have not been used on exterior surfaces. Below 7-10°C, problems with curing and drying of water-borne systems has resulted in failures and the continued use of solvent based systems. Recent attempts to reformulate the current top-side alkyd coating to meet reduced VOC levels have not produced an acceptable coating.[1] Some commercial coatings are currently being evaluated but gloss retention, re-coatability and cost are some of the obstacles to be overcome. The use of a high solids coatings for cosmetic purposes is also a concern because repeated over-coating (not unknown on naval vessels) will lead to excessive paint build-up that may lead to top-side weight problems.

Reduction in the volume of chromate primers used on ships has been attacked in three ways. For bilge and engine room areas, high solids coatings containing no inhibitors are applied at high film thickness (160-200 μm). On the exterior hull and decks inorganic zinc or zinc rich epoxy primers are used and in interior spaces, water-borne chromate-free primers are being used. For the superstructure, a chromate-free primer and wash primer has been developed for Canadian naval vessels,[2,3] but problems in reducing the VOC have resulted in these coatings not being used on Canadian ships and currently conventional chromate primers are still used. Commercial and in-house research solvent based chromate-free coatings are being considered for possible future use.

In-house research in cooperation with the University of British Columbia has resulted in the development of a zinc phosphate surface treatment that could be used as a possible replacement for chromate wash primer

SHIP SYSTEMS

A. Blackwater Collection and Treatment Systems

Currently most warships are fitted with blackwater vacuum collect, hold and transfer systems. Electrolytic chlorine generation (from sea water) to oxidize and breakdown the solid waste is also used on some ships. Some concerns have been raised over the possible generation of chlorinated organic compounds during this process which poses a disposal problem.[6] Although there is some 'quality control' over what goes into the blackwater tanks; detergents, cleaners and other chemicals may be disposed or washed down the heads, which even after oxidation may pose a problem for effluent quality and subsequent disposal.

There is no reliable on-line monitoring system available to ensure overboard discharge from sewage treatment systems will meet environmental standards, although under ideal conditions and during standard tests the effluent produced by electrolytic chlorination of the sewage meets the required international standards.

Bacteriological systems are also under investigation as possible sewage treatment systems. This will eliminate any concerns over the possibility of organo-chlorine generation but this type of system also poses considerable problems. Strict control of what can be placed in the blackwater system must be maintained to prevent destruction of the bacteriological process. Cleaners and other chemicals could either kill bacteria or reduce their effectiveness due to pH changes etc. and must be strictly controlled.

The biological process will also require a good in-line monitoring system to ensure the effluent meets the various environmental standards for BOD, pH, total solids, etc. Results of standard testing will not be sufficient to ensure the bacteriological process meets the required standards due to the variability inherent in the biological process.

B. Grey Water Collection and Treatment

Although greywater, defined as water collected from bilges and wash down processes etc. but not from sewage or oily processes, is not regulated at the national and international levels, local port regulations usually ban discharge of grey water. The volumes generated are usually large and holding capacity on a ship is limited. This water must be treated and discharged on a routine basis. Although the technology is available to treat this water, space and weigh restrictions on most ships limit the applicability of new technology. Education and operational changes will be the most effective method in reducing this problem.

C. Solid Waste Collection and Disposal

Solid waste can be broken down into four categories; foodwaste, other biodegradables, plastics, and non-biodegradable (glass and metal). Military studies have shown that a crew of 225 people generate about 2.7 cubic metres of waste per day as shown in the following table:

TABLE 1 - SHIP SOLID WASTE GENERATION

Material	%
Food	7
Paper and Wood Products	45
Plastic	37
Metal and Glass	11

A ships at sea for 30 days would therefore generate over 80 cubic metres of solid waste that must be either processed or stored.

The possible technologies available for handling and reducing the waste stream are as follows:

Food and Biodegradable	Pulper with water press Garberators
Metal and Glass	Compactors Ruggedized Shredder
Plastic	Shredder Plastic Processor Odour Barrier Bag System

Many of these technologies are currently available but integration into a ship system is very important. These processes also require sailor intervention in separating the various forms of solid waste for efficient processing and safety considerations. Also the development of biodegradable containers and a reduction in the volume of packaging material will go a long way in solving problems will disposal of organic materials.

A major concern for all of these processes is that they will have to be carried out in a marine environment where sea water contamination is always a possibility. Any processing equipment used on marine vessels must be suitable for this type of environment where corrosion is inevitable.

Plasma arc pyrolysis is another process that needs further development but it may also be a viable method for disposal of the organic based materials. Plasma arc pyrolysis has been used successfully in land based applications such as the destruction of pesticides and PCBs.

D. Oily Water Monitoring, Treatment and Disposal

Coalescer systems are fitted (or will be retro-fitted) on most ships for processing oily-water waste. These systems are susceptible to the presence of detergents and cleaners, which reduce the separation efficiency, and make effluent quality unreliable. Current shipboard technology for measuring effluent quality is not capable of measuring the low levels (< 5ppm) of oil allowed in the discharge. Evaluation of the currently available monitoring methods has shown none of them to be reliable at the detection level required. Research is currently under way into newer methods (including fluorescence) that will allow real time measurement of the oil contamination level down to the levels required to meet national and international standards.

The use of membrane separators to replace coalescers is the next step in upgrading the oily water treatment system on board ship. The membranes are not affected by detergents but some metal ions contaminants may inhibit or reduce their effectiveness and require increased maintenance procedures. The membrane permeability can be selected to meet whatever effluent quality is required, this must be balanced with processing capacity requirement and the size of the membrane treatment system.

and chromate conversion coatings. Research is ongoing to finalize this process for brush, spray and dip application.[4,5]

Copper and organotin based anti-fouling coatings, that meet the Canadian environmental standards for toxin release, are still being used on many on Canadian Forces (CF) ships. Concerns over future regulations has led to research to develop various coating formulations based on degradable polyurethane, silicon oils and silicone resins that have potential fouling release properties. Concurrent with this research, fouling release coatings from commercial suppliers and coatings developed in other defence laboratories are undergoing evaluation for possible use on CF Ships.

B. Surface Preparation

Air quality regulations have not affected the use of normal grit blasting procedures in Canadian shipyards, although quality controls are in place to control the friability and dust content of the blasting grit used. As well, grit blasting carried out on the deck of a ship while afloat (not in dry-dock) must be contained and no spent grit and paint can be allowed into the ocean. This requires the use of vacu-blast methods or containment of the free blast area and collection of all the blasting grit in non-dry-dock operations.

Disposal of spent grit and paint in land fills is becoming a concern and is restricted depending on the leachable metals content of the spent grit (dilute acid leaching). A reduction in the use of chromate and copper or organotin based anti-fouling coatings would reduce concerns in this area. New methods of surface preparation, such as ultrasonic assisted water blasting, high pressure water blasting, and recoverable and re-usable media, are being investigated as possible methods of reducing the volumes of material sent to landfill sites. Most of these new processes will allow for the separation of the spent paint from the blast media (usually water) and re-use of the media, leaving small volumes of spent paint for disposal.

C. Cleaners And Other Maintenance Procedures

Disposal of used cleaners and other maintenance materials continues to be a concern. Many can be collected at the source and recycled or stored for proper disposal or treatment, but for a ship a sea, storage and disposal of these types of materials is becoming an increasing problem. Many of the currently used cleaners have been examined and many of those found to be non-biodegradable have been removed from use and replaced with other more environmentally friendly materials. Although education of the sailor and ship operators can alleviate many problems, incorrect disposal of cleaners and other chemicals can lead to contamination of sewage systems, oily water separators or other treatment systems on board ship. This can lead to expensive disposal or cleanup problems or malfunctioning of the various treatment systems

D. Removal And Disposal Of Ship and Shipyard Waste

Many processes to support naval vessels such as plating, coating, steam cleaning, battery replacement, degreasing and solvent cleaning, etc. produce large volumes of potentially hazardous waste. As well, fuels and lubricants, munitions and explosives, fire fighting materials and refrigerants carried on board ship must be disposed of or recycled and reused. Procedures are in place to collect, recycle and reuse many of these waste products and materials. If procedures for recycling or reuse are not available then waste collection and storage (including reduction in volume) are in place until more environmentally acceptable materials and procedures are available.

E. The Use And Effect Of Cleaners and Other Chemicals On Other Treatment Systems

With the possible introduction of new treatment systems into ships, including biological treatment, concerns have arisen over the possible contamination of the system for cleaners and other chemicals that routinely find there way into the black water system. Along with educating the sailor and operators on correct husbandry and protocols cleaners will need to be screened to determine whether they will have a negative impact on the biological process.

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