Life Cycle Costing (LCC) and Life Cycle Assessment (LCA): A Computer Model for Shipyard Blasting and Painting

Principal Investigator Contact Information:

Bhaskar Kura, Ph.D., P.E.,
Associate Professor of Civil & Environmental Engineering
Associate Director of Maritime Environmental Resources & Information Center (MERIC)
University of New Orleans
Engineering Building, Room 828
New Orleans, LA 70148, USA
Ph.: (504)280-6572; Fax: (504)280-5586
bkura@uno.edu

Project Status: Completed

Project Summary

Dry abrasive blasting and painting are the two major processes in ship/boat building and repair yards. Both processes are attributable to 70-90% of the wastes generated by the yards. Dry abrasive blasting results in generation of industrial solid wastes (sometimes these may be considered as hazardous depending on the contamination of leachable metals) as well as air pollutants. Painting operations result in generation of solid wastes, hazardous wastes, and volatile organic compounds (VOC) most of which are hazardous air pollutants (HAP).

Solid/hazardous wastes and air pollutants generated from dry abrasive blasting depend on various important parameters, which include: (a) type of dry abrasive (sand, coal slag, copper slag, garnet, hematite, and others), (b) size/grade of abrasives (coarse, medium, and fine), (c) blast pressures, (d) feed rate, and (e) nozzle size. In addition to buying the abrasives from local suppliers, shipyards also have to pay to dispose of the solid/hazardous wastes generated as well as an environmental fee based on the air emissions they generate in the process. The pollution generated also has a bearing on the societal costs (increased health costs to the community and the government as well as equivalent dollars of environmental impact).

In most cases, the paint to be applied in shipyards is determined by the vessel owner and shipyards do not have any control. However, shipyards do have control over paint application methods, which influence the quantities of hazardous wastes generated and VOC/HAP emitted. The paint application methods vary in performance, which is measured in terms of paint transfer rate, which is defined as the ratio of the mass of paint transferred to the object to the mass of paint consumed. Paint systems with high transfer rates result in minimum hazardous wastes and...
minimum VOC/HAP for the unit area painted. Different paint systems offer different life cycle costs.

Results generated through a field study conducted with support from the National Shipbuilding Research Program (NSRP) were used in developing the following relationships between blasting process parameters, which have a bearing on shipyard’s direct and indirect costs:

- Productivity (ft²/hr) vs. feed rate (lb/hr) keeping the type of abrasive, blast pressure, nozzle and others constant
- Abrasive consumption rate (lb/ft²) vs. feed rate (lb/hr) keeping the type of abrasive, blast pressure, nozzle and others constant

It is desirable to have higher productivity and lower abrasive consumption; however, they might not occur at the same feed rate for a given abrasive for a given blast pressure. NSRP data is available for two blast pressures (80 and 122 psi) and five abrasives with medium size grade (coal slag, copper slag, garnet, sand, and hematite) which was incorporated into the computer model. Unfortunately, previous literature does not have the similar information. In case of painting, performance data available from equipment vendors was used.

This computer model assists shipyards in minimizing their direct and indirect costs as well as societal costs. Based on this approach, the life cycle costs for painting and blasting operations are categorized into three types, (1) shipyard direct costs (material costs, equipment costs, energy costs, and labor costs) borne by shipyards, (2) shipyard indirect costs (waste disposal costs, environmental fee, compliance costs, worker health care, and costs associated with environmental operations), (3) societal costs borne by the public and the government.

This computer software application was developed integrating the above life cycle costing and assessment approach along with the available information on abrasive blasting and paint application processes. The computer application was prepared using Visual Basic 6.0 as the front-end and Access as the back-end and offers user-friendly features. The user can identify alternatives that will minimize the user’s direct and indirect costs while minimizing the environmental pollution as well as the costs to the society.