ALTERNATIVE BLASTING TECHNIQUES

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SUMMARY

ADI Limited operates a major ship repair facility at Garden Island in Sydney Harbour.

For many years, the facility has blasted ships hulls by the traditional method of open grit blasting using either copper slag or garnet as the abrasive media.

Due to the impact of open blasting on other trades, and the anticipation of increasingly stringent environmental legislation, ADI has been actively seeking a more environmentally acceptable method of paint removal.

Alternate paint removal techniques such as Contained Dry Blasting, Vacuum Blasting, Plastic Media Blasting, Wet Abrasive Blasting, Water Jetting, Ultra High Pressure Water Jetting, Sodium Bicarbonate Blasting, Carbon Dioxide Blasting, Paint Removal by Light, Vacuum Power Tool Cleaning and Chemical Stripping have been considered.

Investigations in recent years have led ADI to adopt Ultra High Pressure Water Jetting, operating at a pressure of around 35,000 psi. This paper discusses the investigations into alternative blasting methods and the experiences of operating UHP Water Blasting equipment.

1. INTRODUCTION

The ADI Garden Island Facility is a significant ship repair yard located in Sydney Harbour.

As well as servicing ships of the RAN, the facility also services merchant ships requiring amongst other tasks, a dry docking and repainting.

The method of surface preparation of ship's hulls at the Garden Island Facility has for many years been an open dry blast primarily using copper slag as the abrasive media.

By its very nature, open blasting is a noisy and dusty operation that impacts significantly on other trades working on or around the vessel. As a result, open grit blasting of hulls has usually been relegated to periods outside normal working hours, when a minimum of other workers are in the vicinity.

Furthermore, in consideration of the neighbours and in compliance with EPA requirements, an open blasting curfew applies between 10 pm and 7am.

Open grit blasting is becoming more limited in its application due to environmental concerns, therefore it became essential to actively address improving paint removal methods as quickly as possible.

This paper outlines;

a) the steps that have been taken to improve the traditional method of dry blasting
b) research that has been undertaken into new and more environmentally friendly hull preparation procedures.
c) recent experiences with UHP Water Blasting

2. EARLY SOLUTIONS

WET BLASTING

The initial reaction to solve the problem was to return to wet blasting which had been in use many years before.
Wet blasting in this context is blasting with a mixture of blast media and fresh water. Two methods are used:

1. a dry blast nozzle has water introduced at the nozzle tip,

2. the water and abrasive are mixed prior to entering the blast hose and a slurry is blasted out of the nozzle.

A trial of the process was undertaken using very high pressure equipment at approx 20,000 psi blasting a slurry of zinc slag and fresh water. The surface preparation achieved was a good SA 2.5. However, the blast rate was extremely slow, and was considered to be not worth pursuing. Another problem with wet blasting is that there is still a large amount of slag to be cleaned up at the completion of blasting, now made more difficult since the slag and debris are now wet.

INITIAL ATTEMPTS AT CONTAINMENT

The first attempt at containing blasting was to wrap two layers of shade cloth around the submarine HMAS ONSLOW whilst on the slave dock. The logic was that the prevailing breeze would move the dust through the enclosure and leave the majority of the dust on the shade cloth.

The cloth contained the ricochet but an unacceptable amount of dust escaped the enclosure. The situation was improved when garnet was used as the blast media since the residue from garnet is less offensive than that from copper slag.

CHERRY PICKER WITH SHADE CLOTH

Rather than attempting to wrap the entire vessel in fabric, a box was fitted to a cherry picker and wrapped in shade cloth. The blaster and driver worked inside the box fully suited in protective clothing.

In practice, since the containment box was quite small, the blast air quickly pressurised the cabinet and the dust poured out.

It was immediately obvious that the cabinet required impervious material and a dust extractor.

In addition, the prototype cabinet was constructed out of softwood for its cheapness and was quite heavy. Concerns were felt regarding overloading the capacity of the cherry picker basket.

SCISSOR LIFT ENCLOSURE

A timber enclosure wrapped in plastic was constructed on a scissor lift and fixed with an 8000 cfm dust extractor.

This unit proved to be very successful on flat vertical surfaces and was used on HMAS SUCCESS. Use of this unit reduced the docking period for this ship by 2 weeks.

The difficulty with this unit was that it had limited access in that it could only raise to 26 feet and on vertical flat surfaces. The unit was also difficult to manoeuvre.

The advantage of the particular scissor lift used was that it had the capability to laterally crank the work platform hard up against the hull to obtain a seal.

In order to use scissor lift enclosures at a height greater than 26 feet, a 40 foot scissor lift was hired and an enclosure fitted to it. Scissor lifts other than the purpose built ones owned by ADI cannot be cranked in hard against the hull. Therefore, the hired unit was a failure, since a good seal could not be maintained due to the very light pressure of the enclosure against the hull.

BLAST CABINET ON A CHERRY PICKER

Since a powerful push against the hull was required to achieve the seal, we moved back to the cherry picker concept.

An aluminium box was designed at ADI and mounted onto one of our Fabtek units. The box had an observation window and a rubber slotted access for the blaster to put his hands into the box. A spigot was mounted on the side of the unit to take a 3000 cfm extraction fan exhausting into a hessian bag.

The box proved to be a good concept but concern was felt that the weight of the enclosure was acting effectively outside of the basket.

ASSCO BLAST HOOD

The concept of a cherry picker mounted blast box was discussed with the cherry picker hire company ASSCO. ASSCO were interested in the idea and agreed to construct a special basket which incorporated an enclosure of the ADI type with all weights within the area of the original basket.

ASSCO constructed this unit and supplied certification that the unit was approved for use by workcover.

In the first trial of the ASSCO hood it was found that the window quickly became crazed from the ricochet. A new window was fitted with tear off plastic sheets. However it took only 10 min for the sheets to require changing. Also the reflected sunlight on the window made it hard for the operator to see inside the box.

An eductor was fitted to the bottom of the box to draw the spent grit and paint back into the blast hopper, thereby avoiding clean-up of the dock floor. Because of the very good seal achieved and the 3000 cfm air extraction, when the eductor was turned on the window imploded and was sucked down the eductor pipe.

Another problem with the eductor, was that if a blockage in the pipe occurred, this could not be seen and there was a danger of the basket filling with grit and overloading.

The best solution to the above problems was to remove the window completely and have the blaster look through the opening protected by his blast hood with a curtain draped over his back to stop the light reflection from behind. The negative pressure from within the cabinet prevented dust escaping from the window opening.

Another improvement was to replace the hessian bag dust collector with a commercially available dust sock.

In the end, this unit was extremely successful with negligible dust coming from the unit and the noise level dramatically reduced.

The shortcomings of this unit are:

a) it can only be used on ship's vertical or near-vertical sides, b) it is slower to operate than open blasting,

c) spent grit still requires cleaning from the dock floor.

One possible outstanding advantage of this unit has not yet been tried. That being to blast ship's sides afloat by booming out with a blast box from the dockside.

LARGE ENCLOSURES

When large areas require blasting, particularly other than ship's sides greater productivity is obtained from large fabric enclosures of material such as MONAFLEX, fitted with a dust extractor.

The monaflex material is translucent and requires no extra lighting In daylight. Cherry pickers are operated inside the enclosures with their exhaust ducted outside.

Initially, the enclosures were slow to set-up, requiring approximately one day to set up for one day of blasting. The technique of setting up and moving was improved with the fabric suspended from tensioned wires and slid along the hull like a curtain.

The major problem with fabric enclosures is from high winds blowing them down unless many guy wires are used.

VERY LARGE ENCLOSURES

For very large ships and for dockings of short duration, the best containment which could be provided within the time available was to deploy large curtains attached straight to the dockside.

To enable other trades to work in the dock at the same time, additional transverse curtains were used to partition off the forward and aft sections of the hull. In addition, gangways were enclosed in fabric to protect personnel travelling on and off the vessel.

3. FUTURE TECHNIQUES OF PAINT REMOVAL AND RECOATING

With the ever increasing environmental concerns associated with open grit blasting, alternate methods of surface preparation are being actively investigated in the ship repair industry.

At ADI, extensive research and trials of available alternate surface preparation methods were carried out with the expectation that open grit blasting will be eliminated in years to come.

To select a suitable alternate method, the following objectives have to be considered.

The Environmental Impact

As previously mentioned, dry grit blasting produces noise, dust and spent grit. An alternate method of surface preparation would have to address these environmental issues.

Noise levels which exceed the limits set by the State Pollution Control Commission will lead to a restriction of allowable times of operation.

Dust, in its airborne state, becomes a nuisance to other trades working in the near vicinity thus preventing other work preceding in parallel to blasting operations.

Spent grit along with the contamination of removed paint debris is becoming an ever increasing concern with its disposal.

Operator Safety

An alternate method of surface preparation would have to conform to Operational, Health and Safety Standards. Operators of the equipment are exposed to the effects of the operation for an average of eight hours a day.

The Surface Profile Achievable

To achieve a well adhered bond of the initial paint coating to the prepared hull surface, an anchor pattern is required. Suitable anchor patterns are produced using current methods of Grit Blasting. Surface profiles of up to SA3 are achievable.

With ship repair, it is not necessary to produce a new surface profile when preparing the surface for recoating. The original profile, produced at the time of the ship construction, can be re-used if effectively exposed.

The Paint Removal Rate

In this competitive age of ship repair, production rates can not afford to suffer with the introduction of an alternate method of surface preparation. The paint removal rate would need to be around that offered by the current method of open grit blasting ie. on average 10-20 sq m / hr (100-200 sq ft / hr). Ideally, an alternate method of surface preparation would have the benefit of being acceptable for use during extended working hours, allowing the paint removal operation to be completed in a shorter time frame.

Initial Cost Of Equipment And Serviceability

Capital costs of equipment can be a determining factor in making the selection of an alternate method of surface preparation. If the alternate method offers reduced set up and clean-up time and cost, then the initial cost should be recoverable in the long term.

With the maintenance of the new equipment, it is essential that the equipment can be fully serviced locally and a system of component modular interchanging is available to enable the continuation of the operation whilst servicing the removed unit in the workshop, reducing downtime.

Compliance With Paint Manufacturers Surface Preparation Requirement

Before the initial coating is applied to the ship's hull an Inspection is made by the paint manufacturer's representative giving approval that the surface preparation is in accordance with the preparation specifications. This same approval would be necessary regardless of the method of surface preparation.

The Ability To Remove Full Range Of Paint Schemes Associated With Ship Repair

The paint schemes common to ship hull coatings are amongst the toughest of paints to be removed from steel substrates.

The Ability To Remove All Salt Contamination On Prepared Surfaces

Salt remaining on the prepared surface can cause premature failure of the paint adhesion during in-service conditions. Paint manufacturers insist on the complete removal of salt before applying any coatings.

4. SELECTING A SUITABLE ALTERNATE SURFACE PREPARATION METHOD

When considering the pre-mentioned objectives, not all alternate methods of surface preparation are suitable for ship repair. The following methods were investigated to determine their suitability.

PLASTIC MEDIA BLASTING

Plastic media blasting involves coating removal with high density plastic beads being propelled by air pressure, centrifugal wheel or water blast. The high cost of beads requires that they be recovered and reused. No profile is imparted to the surface during the process. This method of surface preparation is used in the aviation industry but is not considered suitable for ship repair.

Reference: 'Alternate Coating Removal Methods and Techniques Paper presented by Steven G. Pinney at SSPC 1992 National Conference and Exhibition, Kansas City, Missouri, USA.

CARBON DIOXIDE BLASTING

This method of coating removal uses pellets of CO2 as the blast media. The system requires a means of refrigerating the media. The velocity of the blast and the size and density of the pellets can be adjusted through manual regulation. When the pellets strike the substrate, the pellet mushrooms under the paint layers and lifts the coating from the substrate. The residual CO2 dissipates into the atmosphere. The system does not generate waste other than the contaminates on the surface. From the information available, this method of surface preparation is not considered suitable for ship repair applications due to the slow paint removal rate and the restriction of distance you can have the refrigeration unit from the workface. The CO2 will start to vaporise if it has to travel too far from the refrigeration unit.

Reference: 'Alternate Coating Removal Methods and Techniques Paper presented by Steven G. Pinney at SSPC 1992 National Conference and Exhibition, Kansas City, Missouri, USA.

PAINT REMOVAL BY LIGHT

High density light from either a laser source or a xenon arc flash equipment or from infra-red devices is used to incinerate paint on the surface, reducing the paint to ash. Accurate data is not available for this method and until such time as information comes to hand this method is considered to be experimental.

Reference: 'Alternate Coating Removal Methods and Techniques', Paper presented by Steven G. Pinney at SSPC 1992 National Conference and Exhibition, Kansas City, Missouri, USA.

CHEMICAL PAINT STRIPPING

Chemical strippers cause the paint to either swell or dissolve. The chemical strippers can be categorised as alkaline, acid or solvent based. In application, the stripper is coated over the paint layer and allowed to chemically react. The paint is than either scaped or washed from the surface. Due to the large amount of stripper required to remove the paint from a ship's hull, there would be concern about the hazard potential of the waste product.

Reference: 'Alternate Coating Removal Methods and Techniques', Paper presented by Steven G. Pinney at SSPC 1992 National Conference and Exhibition, Kansas City, Missouri, USA.

VACUUM ABRASIVE BLASTING

This method was hired and trialed to evaluate its effectiveness as an alternate method of grit blasting. The system has a blast nozzle with attaching supply and vacuum hoses which circulate the grit to and from a remote blast machine. Due to the combined weight and jet effect, the nozzle with attaching hoses was found difficult to handle for long periods of operation. Although containment of the dust and grit was very effective, the paint removal rate was unsatisfactory offering around 1/4 the rate of open grit blasting.

SODIUM BICARBONATE BLASTING

Demonstrations using Sodium Bicarbonate Blasting have been undertaken at on a number of occasions. This method of blasting uses Sodium Bicarbonate as the blast media supplied to the blast nozzle at a pressure of 80 psi. It can be delivered as a dry media blast or, with the addition of water at the nozzle, as a wet blast.

Dust is created with the dry delivery at a level similar to that of copper slag grit blasting. The advantage of this media is that it is water soluble and has a pH level of 8, making it environmentally acceptable.

To eliminate airborne dust, water is introduced at the nozzle. Water on the work surface causes a secondary problem with the formation of ginger rust upon drying.

The paint removal rate was considered unacceptable for ship repair at approximately 1/3 the rate of open grit blasting.

ULTRA HIGH PRESSURE WATER JETTING

Water being delivered to the work surface at pressures between 20,000 psi and 35,000 psi is known as Ultra High Pressure Water Jetting. UHP Water Jetting offers

the greatest potential to ship repair facilities preparing surfaces for recoating since it can resolve most of the environmental problems.

Two demonstrations of this equipment were undertaken at ADI Marine, both with encouraging results.

The first demonstration was conducted during a ship refit in March 1993. The equipment used for the demonstration was an Ultra High Pressure Pump with a discharge capacity of 90 litres/min at 1400 bar (21,000 psi) supplying fresh water under pressure to a hand held lance with a rotating jet nozzle.

During the demonstration, there was a noted pressure drop at the work face down to approximately 1000 bar (14,700 psi). This was due to the supply hose of 6 mm ID not coping with the 90 litre/min delivery rate.

The enamel paint schemes above the waterline were removed, exposing the bare metal. At this pressure, the vinyl-tar anticorrosive below the waterline could not be removed.

UHP Water Jetting also removed surface and flake rust back to bare metal.

Although the paint removal rate was measured to be about 1/2 that of open grit blasting, a time saving occurred with the absence of spent grit clean-up and hopper filling prior to and during blasting.

The surface, as expected, did form a ginger rust upon drying.

A second demonstration was undertaken in June 1993. The equipment used for this demonstration was an Ultra High Pressure pump with a discharge rate of 20 litres / min at 32,000 psi. Once again, the water was delivered to a hand held **lance** with a rotating jet nozzle through a 6 mm ID hose. There was minimal pressure drop at the lance this time due to:

a) the reduced water delivery rate,

b) the rotating jet nozzle was independently (hydraulically) driven.

At this pressure all paint coatings were removed back to bare metal, exposing the original surface profile.

During the demonstrations the following advantages of Ultra High Pressure Water Jetting over traditional paint removal methods were observed:

- The elimination of airborne dust,
- The elimination of spent grit clean-up operations,
- The elimination of containment enclosures,
- The ability to remove individual paint layers by adjusting the delivery rate,
- The reduction in set-up time,
- The reduction in noise levels compared to Open Grit Blasting,
- The elimination of breathing equipment normally worn by operators during blasting operatio

The UHP Water Jetting demonstrations clearly showed the potential of this method of surface preparation.

CURRENT SITUATION

In November 1996, ADI purchased two (2) Ultra High Pressure Water Blasting machines from Woma in Germany Each machine supplies two guns and each gun is supplied from a separate pump, therefore there is no efficiency loss when two guns are operated as opposed to one gun. With the exception of a grit blasting trial using garnet in September 1997, for the past nine months all blasting at Garden Island Facility has been by UHP water only. The machines have clocked up approximately 350 hours of operating time.

The applications for UHP Water blasting have included:
Upper Decks - HMASs SUCCESS, MELBOURNE & NEWCASTLE
Hydrofoil foils
Harbour tugs - spot blast underwater
MV Iron Dampier - spot blast underwater

To date , UHP water blasting has not been widely accepted as an underwater preparation method and is primarily used for above water applications.

Treatment of runoff water is also achieving attention. On the floating dock, a collection tank has been fitted which pumps into a holding tank ashore for disposal by contractor.

When blasting upper works of ships afloat, the blasting supervisor has requested that the ships attain a slight list to the wharf. The deck coamings provide effective bunding of the area and the deck scupper and drainage system is used to collect the runoff water. A branch pipe is fitted from the scupper discharge to a holding tank ashore.

In the Graving Dock, filtration through hay bails is still used. However, a system is being developed which involves:

- Damming of the dock drains to collect runoff
- Submersible pumps pumping the water through existing redundant dock pipes to a treatment centre on the dockside. The design of the treatment centre is currently with a contractor.

PROBLEMS

The problems with UHP water jetting are:

- The cost of the machines
- The cost of maintenance
- The productivity rate - approximately 1/2 of that for dry grit blasting
- Customer confidence with UHP blasting particularly underwater

The productivity of UHP water blasting is still well below that of dry grit blasting (approx 50%). By way of comparison, a large commercial ship docking would require 8 grit guns to remove the paint. At present the two UHP machines supply only 4 guns in total. In addition, the UHP guns have 50% of the productivity of the dry guns.

Therefore the overall capacity to remove paint with UHP blasting is currently approximately 25% of that for dry blasting.

However, the advantages of UHP blasting include:

- Longer blasting window per day than for dry grit due to lower noise and less impact on other workers.
- No clean up after
- No purchasing or disposal of grit
- No need to protect shipboard equipment to the extent necessary for dry grit blasting

For very large areas of paint removal in a short time scale and for where the customer stipulates dry grit blasting only, dry blasting is still the method which is used. However, the Dock Office at Garden Island is currently investigating upgrading the dry grit blasting equipment to obtain higher efficiencies with less dust. Productivity and dust in dry blasting is linked to the pressure of the air at the blast nozzle and the media used. ADI is currently taking steps to increase the air pressure delivered to the nozzles and evaluating the benefits of moving from copper slag to garnet as the preferred media.

5. NEW GENERATION COATING SYSTEMS

A new generation of coating systems is being developed by the leading paint manufacturers. One of the areas being addressed Is the development of surface tolerant coatings which will adhere to surfaces which are not of white or near white metal standard. These coatings will support the use of alternate surface preparation methods such as Ultra High Pressure Water Jetting which bear a slight ginger discolouration due to flash rusting when the surface is drying. Once a coat of surface tolerant paint has been applied to the bare metal the normal paint scheme can follow.

Decks are already being recoated using this method and it is only a matter of time before underwater surfaces can be recoated in the same way as a matter of course.

6. THE FUTURE

Open grit blasting is becoming an unfavourable method of surface preparation. Not only is it an environmental concern but from a production point of view, it has an unacceptable impact on other work being performed.

After looking at the various alternate methods of surface preparation available today, Ultra High Pressure Water Jetting offers a solution which is favourable to ADI Limited's role as a ship repair facility.

ADI has recently committed to buying a third blasting machine. This will increase the capacity to six (6) UHP guns. ADI is also improving the performance of dry grit blasting equipment for those applications where dry blasting is the best option.

It is likely that ultimately, Garden Island will use UHP water blasting as the only method of paint removal on ships hulls. However, in the near future, the approach will be a mixture of the two techniques but using improved equipment for the dry blasting.

Acknowledgments

The author was closely involved with the investigations into alternative blasting techniques when employed in the former roles of Dock Manager, ADI Limited and Environmental Manager, ADI Limited. The author gratefully acknowledges the advice and information provided by the following ADI staff - Brad Lovegrove, Dockmaster and Bob Armstrong, Environmental Manager and Jack Lennon, Industrial Engineer regarding recent developments and productivity rates.

References

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