Safer Alternatives to Copper Antifouling Paints: The Shell Game Must Stop!

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- Small nonprofit technical organization established in 1989
- Identifies, develops, tests and demonstrates safer alternatives in consumer product and industrial applications
- Projects have led to reduction in use of hazardous substances in California by more than 100 tons per day

Background

- Antifouling paints used to control growth of fouling
  - Loss of speed and maneuverability
  - Increased fuel consumption
  - Strain on engine
- TBT used until 2002
- Replaced with copper
  - Toxic to some aquatic species
- Shelter Island Yacht Basin
  - Added to list of impaired water bodies
  - TMDL requires 76 percent reduction of copper loading by 2022
- Other basins in California have high copper concentrations
- Copper antifouling paints
  - Passive leaching or ablation
  - Sources of copper from passive leaching and hull cleaning
- Use of alternative paints can reduce copper loading

Types of Alternatives

- Zinc biocide paints
  - Based on zinc pyrithione
- Organic biocide paints
  - Econea, other
- Combination zinc/organic biocide paints
- Zinc oxide only paints
  - Photoactive paints
- Nonbiocide paints
  - Soft paints based on silicon and/or fluoropolymer compounds
  - Hard paints based on epoxy, ceramic
- Other
  - Nanotechnology
  - Barrier technologies

Presentation Focus

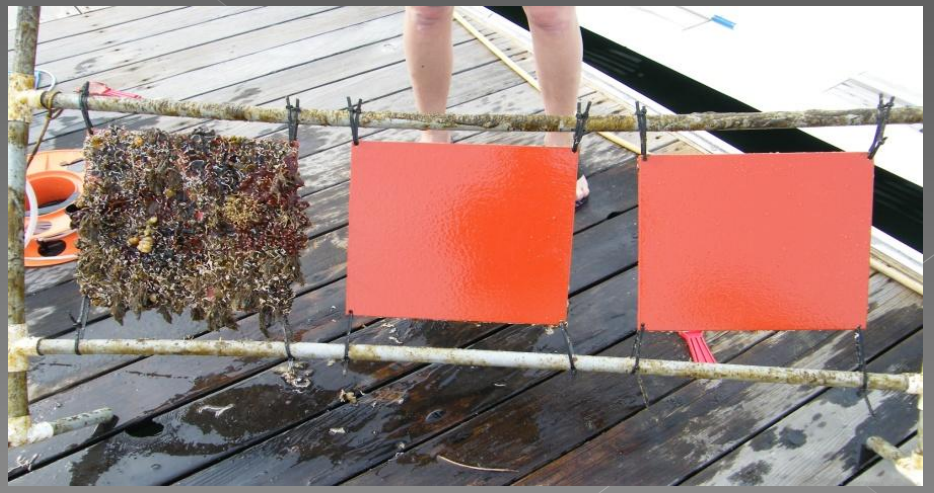
- Review results of Port of San Diego/IRTA project
- Describe detailed results of Department of Toxic Substances Control (DTSC)/IRTA project

Port of San Diego/IRTA Project

- Project sponsored by EPA under PPG Program
  - Port, IRTA, San Diego Diving Services, Consultant
- Many stakeholders
  - Marinas, yacht clubs, boatyards, divers, regulatory agencies, coating suppliers, environmental groups
- Project Aim
  - Evaluate viability of alternative hull paints
  - Assess performance, longevity, cost
- Tested 46 biocide and nonbiocide alternative paints on panels and painted 15 boats with alternative paints

Panel Testing

- Panel configuration
  - PVC frame attached to floating docks at two marinas
  - Three fiberglass panels per frame with gel coat
- Developed protocol
- Four Month Testing Period
  - Inspected and cleaned panels every three weeks



Results of Panel Testing

- Top performing coatings
  - Good at repelling or preventing fouling growth
  - Relatively easy to clean
- Best coatings
  - Five nonbiocide paints
    - All soft nonbiocide paints
  - Two zinc oxide only paints
  - Two organic biocide paints
  - Twelve zinc biocide or zinc/organic biocide combination paints

Boat Test Paints

- Five soft nonbiocide paints
- One hard nonbiocide paint
- One zinc biocide paint
- One organic biocide paint
- One zinc/organic biocide paint
- Two zinc oxide only paints

Boat Paint Application

- Paints applied at four San Diego boatyards
  - According to suppliers' instructions
- Most suppliers attended and some applied paint themselves

Results of Boat Testing

- Total of 15 boats
  - Three removed from testing within three months
- Soft nonbiocide paints
  - Required use of non-aggressive tools
- Hard nonbiocide paints
  - Required periodic use of mechanical brush
  - Required more frequent cleaning in summer
- Biocide and zinc oxide only paints
  - Did not require cleaning every inspection
  - Zinc oxide paints had coating condition issues
  - Organic biocide coating deteriorated over time

Cost Analysis Approach

- Analyzed cost of boat paints
  - 30 and 40 foot sailboats and powerboats
- Two types of costs
  - One time cost of paint job
  - Ongoing cost of hull cleaning
- Used copper as baseline
- Cost of paint job determined with data from five boatyards
- Cost of maintenance determined with three diving companies
- Analyzed/compared annualized cost over life of paint and over 30 year period

Results of Cost Analysis

- Alternative paints more costly to apply
  - Coatings themselves are more expensive
  - Some systems more complex
  - Nonbiocide paint alternatives require a stripped hull for first application but can be applied over themselves in subsequent paint jobs
  - Nonbiocide paints must be sprayed
- Biocide/zinc oxide only/soft nonbiocide paints have same cleaning schedule as copper paints so maintenance cost is the same
- Hard nonbiocide paints require more frequent cleaning in summer so maintenance cost is higher

Results of Cost Analysis Cont'd

- Use of alternative biocide and zinc oxide only paints more costly than use of copper paints over life of paint
  - Paint jobs more expensive and have shorter lives
- Use of soft nonbiocide paints comparable in cost to use of copper paints over life of paint
  - Paint jobs much more expensive but have longer lives
- Use of hard nonbiocide paints more costly than use of copper paints over life of paint
  - Paint jobs and maintenance more expensive but have longer lives

Project Findings

- Four top performing paints
  - Two nonbiocide paints
  - One combination zinc pyrithione/organic biocide paint
  - One zinc pyrithione paint
- Conclusions are that soft nonbiode paints are best option and are cost effective
- Cleaning of biocide paints should be limited
- Best alternative paints depend on boat and boater characteristics
  - Racing sailboats, trailered boats, infrequently used boats

Important Implications

- Soft nonbiocide paints perform well on panels and boats
  - Are cost effective to use over life of paint
- Paint job cost for nonbiocide paints is higher than paint job cost for copper paints ($4,600 to $6,400 vs.. about $1,000)
  - Boaters unwilling to pay high up-front cost even with longer life
- Need to focus on methods of reducing cost of paint job for nonbiocide paints

DTSC/IRTA Project

- Project sponsored by EPA under PPG program
- Focus exclusively on nonbiocide paint alternatives
- Project aim
  - Investigate methods of facilitating use of nonbiocide paints
    - Simplify application methods
    - Reduce cost of paints, paint jobs and maintenance

DTSC Project Tasks

- Conduct panel testing on new and emerging nonbiocide paints
  - Need more paints on market to reduce cost
- Evaluate alternative stripping methods
  - Highest cost component in nonbiocide paint jobs
- Evaluate alternative application methods
- Test emerging paints and alternative methods on boats
- Institute copper recycling
  - Can reduce overall boatyard costs
- Examine reduced cleaning frequency

Additional Panel Testing

- Worked on this task with Port of San Diego
- Coordinated panel painting
  - Most were nonbiocide paints
- Panels were tested for one year and testing was completed in August 2011
- Some new emerging nonbiocide paints performed well
- Put several of these paints on boats

Alternative Stripping Methods

- Current practice is to apply copper paint over old copper paint and rarely strip boat
- Nonbiocide paints require stripped hull for first paint application
  - Stripping is most expensive part of paint job ($2,200 to $3,200 for 30 foot boat)
  - Boaters reluctant to authorize stripping because of expense
- Current stripping practice
  - Chemical stripping
  - Hand sanding

Characteristics of Chemical Stripping

- Chemical strippers contain methylene chloride
  - Commonly used formulation called Klean-Strip Aircraft Remover which contains methylene chloride, a carcinogen
- Process is messy and waste is hazardous
  - Often put in garbage
- Cost of process for 30 foot boat is $1,434

Hand Sanding/Stripping

- Use DA or vacuum sander to abrade paint from surface of boat
- May have to shroud boat with plastic so particulate matter does not affect other boatyard paint jobs
- Sanding dust generated in process is hazardous waste because of copper
  - If dry, must handle as hazardous waste
  - If wet, will enter the clarifier or become airborne
- Cost of hand stripping a 30 foot boat is $1,313

Perspective on Stripping Cost

- Cost of copper paint job for 30 foot boat averages about $1,038
- Cost of chemical or hand stripping to boatyard for a 30 foot boat is about $1,300 to $1,500
- Average cost of stripping to boater is $2,270 with high end cost of $3,200
  - Markup by boatyards is substantial

Alternative Stripping Methods

- Examined and tested three alternative stripping methods to see if using them is less costly
  - Dry sodium bicarbonate
  - Wet volcanic rock
  - Dry ice blasting
- Tested on boat destined to be demolished at Marine Group
- Conducted cost analysis

Alternative Stripping Methods Cont'd

- Cost of using sodium bicarbonate blasting is slightly lower than cost of chemical or hand stripping
  - $1,275 vs. $1,313 or $1,434
- Use of alternative technologies better from overall health and environmental standpoint but do not reduce cost of paint job

Alternative Application Methods

- Investigated two alternative application methods
  - Rolling on nonbiocide paints instead of spraying them
  - Applying nonbiocide paints over old copper paint

Rolling On Nonbiocide Paint

- Current practice is to roll on copper paint
- Wisdom is that nonbiocide paints need to be sprayed
  - Need smooth surface to repel fouling
  - Spraying very expensive
  - Average cost is $600 but can be as high as $1,000
- Can reduce cost of paint job by rolling rather than spraying
  - Does not affect performance

Applying Nonbiocide Paint Over Copper Paint

- Suppliers developing "sealers" to go over old copper paint to allow application of nonbiocide paints
- Prepare surface of boat as is done for a copper paint
- Tested application of three nonbiocide paints over copper on four boats
- Cost analysis indicates this method will reduce costs
- More work required on other paints, sealers

Sealers Cont'd

Cost Comparison of Copper and Sealer Paint Jobs for 30 Foot Boat		
System	**Description**	**Cost**
Copper Paint	Baseline	$1,038.00
Intersleek 900	Stripping	$4,556 to $6,358
BottomSpeed	Sealer	$3,324.00
Intersleek 900	Sealer	$2,268.00

Boat Testing of Nonbiocide Paints

- Painted 10 boats with nonbiocide paints during project
  - Important to have more new paints that perform well so price will decline
- Range of boat owners and types of boats
  - Four boats had metal hulls and six had fiberglass hulls
  - Types of boats included dinghies, inflatables, powerboats and sailboats
- Eight boats painted with new and emerging paints
- Rolled paint on eight boats
- Three paints were applied over copper on four of the boats

Characteristics of Boats Painted

Boats and Application Methods Tested During Project			
Boat/Owner	Paint Tested	Hull	Application Method
Auerbach	Intersleek 900	Stripped	Sprayed
Port of San Francisco	XZM 480 (E)	Stripped	Rolled
Port of San Francisco	XP-A101 (E)	Unpainted	Rolled
City of Newport Beach	Hempasil X3 XA 278 (E)	Stripped—sodium bicarbonate	Rolled
San Diego Diving Service	BottomSpeed (E)	Half stripped, Half Over Copper	Rolled
Heinem	BottomSpeed (E)	Over Copper	Rolled
Pasha	BottomSpeed (E)	Unpainted	Rolled
Cal. Dept. Fish and Game	XZM 480+ hardener (E)	Over Copper	Rolled
Cal. Dept. Fish and Game	SherRelease (E)	Stripped—sodium bicarbonate	Sprayed
Rhoades	Intersleek 900	Over Copper	Rolled
Note: E signifies emerging paint			

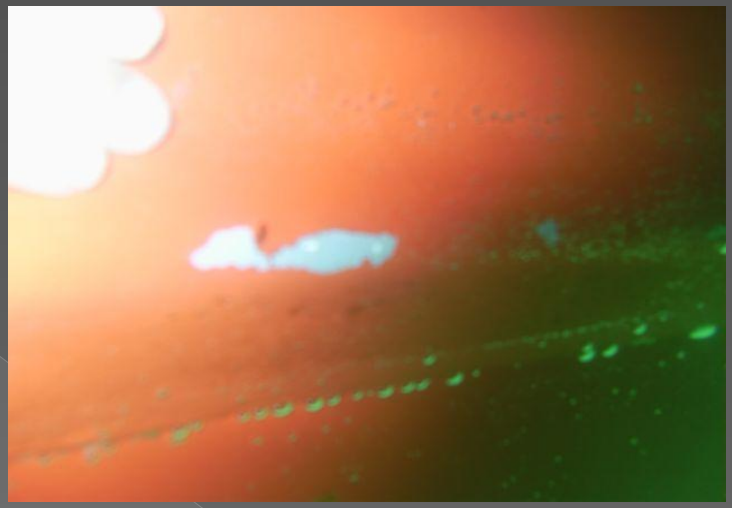
Auerbach Boat

Port of San Francisco Boats

City of Newport Beach Boat

San Diego Diving Service, Heinem and Pasha Boats

Fish & Game Boats



Rhoades Boat

Copper Recycling

- Price of copper very high presently
- Three copper streams from boat yards
  - Dry sanding waste
  - Stripping waste
  - Clarifier waste
  - All classified as hazardous waste in California but many boatyards do not handle it as such
- IRTA worked with copper recycler
  - Investigated possibility of recycling boatyard streams
- Collected/analyzed samples of all three streams
  - Copper content, recyclability

Copper Recycling Cont'd

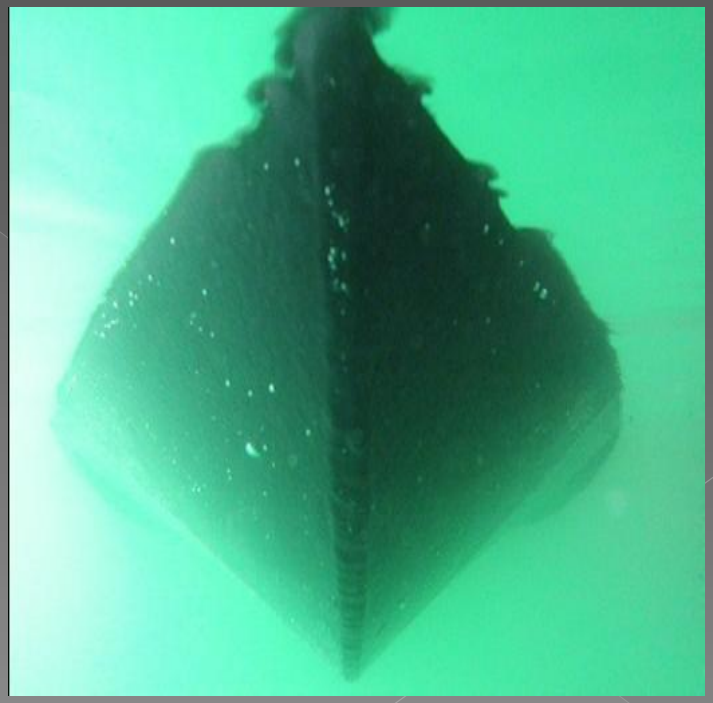
- Findings indicate
  - dry sanding waste contains between about 35 and 60 percent copper
  - Sodium bicarbonate stripping waste contains between about 11 and 13 percent copper
  - Clarifier waste contains 3 to 5 percent copper but can contain up to 25 percent copper
- In general, if boatyard generates 5 to 10 dry tons per year with a 30 percent copper content, there would be net zero cost
  - Boatyard pays for disposal and receives a payment based on copper content and recyclability

Copper Recycling Cont'd

- Recycling of dry sanding waste likely to be cost effective for 16 drums per year of sanding dust
  - Hazardous waste disposal--$2,424
  - Copper recycling (38 percent copper)--$400
  - Copper recycling (60 percent copper)--0
- Recycling of spent blasting media and clarifier waste may be cost effective, depending on the circumstances

Reduced Cleaning Frequency

- Examined for four boats in Southern California
  - Heinem and San Diego Diving Service—BottomSpeed
    - Did not clean for six months, including summer
  - Fish & Game—Sher Release
    - Did not clean for five months, including summer
  - Rhoades—Intersleek 900
    - Did not clean for five months, including winter



Reduced Cleaning Frequency Cont'd

- Results indicated that for four boats/three paints in question, reducing cleaning frequency had no effect on coating
- Results are limited but promising for reducing maintenance cost of using soft nonbiocide paints

Emerging Non-Paint Alternatives

- Barrier technologies available and doing well on pleasure craft and commercial boats
- One technology is like velcro and is applied to boat hull with adhesive backing
- Other technology is a silicon based material and is applied to boat hull with adhesive backing

Micanti Technology

Conclusions

- Shell game is the norm in this industry
  - TBT banned, converted to copper, now want to use zinc and organic biocides
  - Not productive to do further investigation of biocide paints
- Need more new and emerging nonbiocide paints for commercialization
- Alternative stripping methods better than current methods but don't reduce cost of paint jobs
- Alternative nonbiocide paints can be rolled on and this reduces cost of paint job

Conclusions Cont'd

- Applying nonbiocide paints over copper paint substantially reduces paint job cost and needs more investigation and testing
- Boatyards can implement copper recycling
- Cleaning frequency for soft nonbiocide paints can be decreased and this reduces cost of maintenance
- Emerging non-paint technologies require investigation and testing

Future Work

- Nearly all of research and testing on nonbiocide paints has been conducted in Southern California
- Should conduct project focused on Northern California
- More new and emerging paints and other non-paint alternatives need to be tested on panels and boats
- Alternative application methods need further investigation and testing
- More outreach to boaters and boatyards about nonbiocide paints is needed

Materials

- IRTA website can be accessed at www.irta.us
- Two reports available
  - Port of San Diego/IRTA final report
  - DTSC/IRTA final report
- Five fact sheets available
  - Alternative nonbiocide paints
  - Alternative stripping methods
  - Alternative application methods
  - Copper recycling for boatyards
  - Cleaning practices for nonbiocide paints

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