

CHAPTER 13

PAINTING OF STEEL VESSELS FOR FRESH WATER SERVICE

by

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Inland waterways of the United States have been important to the country's rapid social, industrial and technological growth. They were the first exploration routes and determined paths used by settlers, who chose sites for communities. They became the transportation and communication links of communities, so most of the present great centers of population, production and distribution owe their origins to these arteries. Today 38 states, with about 95% of the nation's population, have commercial transportation services provided by vessels operating on rivers, canals, bays, sounds or lakes; and 131 of the 158 cities with populations of 100,000 or more are located on commercial navigation channels¹.

The earliest commercial use made of the river system was hauling coal from Pennsylvania to the Ohio and Mississippi rivers in the late 1700s. The vessels were flatboats constructed of logs, borne by the current and guided by long tillers. Since they were without power to travel against the current, trips were one way only and boats were usually dismantled at their destinations and sold for lumber.

Steam power made its appearance on the rivers in the early 19th century, and soon increased steel production prompted the use of boats and barges made from steel. Commercial channels now make up more than 25,000 miles of navigable inland waterways plus 1,800 miles on the Great Lakes.

I. TYPES OF VESSELS

Most freight on these water routes is carried on barges made from welded steel. They are large, floating boxes, unmanned and without self-propulsion, with drafts of 6 to 14 feet. Barges are moved in groups by towboats or tugs.

The hopper barge, because of its single large cargo space, is adaptable to a wide variety of loads and finds the greatest use of the several kinds employed. It may vary from 175 to 290 feet in length, 26 to 50 feet in width, with capacities from 1,000 to 3,000 tons.

A typical covered hopper barge is shown in Figure 1. Liquid cargo or tank barges range in the same dimensions with capacities of 300,000 to 900,000 gallons. They may be of single skin design, where the shell of the barge is also the tank wall, or of double skin, with an inner shell forming the tank, as in Figure 2. They may also take the form of hopper barges carrying independent cylindrical

tanks, where they are used to carry liquids under pressure, or where pressure is used to discharge the cargo. The deck barge is a simple box hull with a heavy plated, well-supported deck, and in some cases a cargo box enclosing most of the deck area to contain the load it normally carries. It is usually a little smaller than the hopper or tank barge, varying from 110 to 195 feet in length and 26 to 35 feet in width, with capacities from 350 to 1,200 tons. Other, more specialized barges include dredges, barges used for shipping liquefied natural gas, and tip-up timber carriers.

Although each is classified as a towing vessel, the towboat and tugboat are vastly different, as is seen in Figures 3 and 4. The tug is smaller, has a shaped bottom contrasted to the towboat's almost flat bottom, and is, in effect, an ocean-going vessel most frequently used in harbors, intracoastal canals and the open sea. For this reason the painting of tugs is not covered in this chapter, which deals with fresh water vessels.

There are approximately 1,800 companies in commercial operations on inland waterways. These firms operate more than 17,000 dry cargo barges with a total capacity in excess of 19 million tons, 3,400 tank barges with a total capacity of 7 million tons and 4,300 towboats and tugs with aggregate power in excess of 4.3 million horsepower¹.

There has been no survey of the number of other vessels using inland waters, such as ferries and pleasure craft, but painting recommended here can apply to them.

II. CORROSION OF VESSELS

Literature does not disclose amounts of corrosive damage to steel vessels operating on inland waterways, but preventive efforts have been roughly inversely proportional to the quality of water where vessels operate. Quality has been affected by industry growth and mining ventures in the vicinity. Poor waste disposal practices contributing corrosive substances to rivers cause accelerated deterioration of steel hulls.

There was a period of 25 years after World War II when efforts to protect immersed surfaces were greatly increased and new and effective coatings were developed for this purpose.

Realization of limitations of the environment to absorb continued, unrestricted industrial development led to concerted efforts to reverse the trend of water quality decline. Results have been notable², particularly in



FIGURE 1
Covered hopper barge. Covers roll away to expose cargo compartment.

Courtesy of Dravo Corporation

streams fed by drainage from coal mines. Reduced acidity has diminished emphasis on prevention of hull corrosion by coatings.

Corrosion on ships in the strictly fresh water of the Great Lakes is minimal. Many operators apply coatings on hulls for cosmetic purposes. The most serious corrosion is in areas where coal, salt or other chemicals accumulate for long periods, retaining moisture, such as blind areas on large decks. Good coating procedures can prevent damage.

New coating systems are being tested and finding use in protection of steel in inland water service. At least one company has met the problem of towboat hull corrosion by cladding the entire hull with stainless steel³. Many protective requirements for boats and barges in fresh water can be met by coatings used for ships in salt water.

Refer to Chapter 12 for further recommendations.

The cost of building river vessels has skyrocketed in the past 20 years. While most vessels are amortized for 20 years, their useful life is 25 to 35 years. During that period many receive new hull side plates and some bottom plates. The majority of damage is due to exterior corrosion, the most noticeable attack occurring at water line areas where variations in load, moisture and oxygen, and dissolved species in water accelerate metal loss. See Figure 5.

Abrasion against concrete lock walls is a serious cause of paint removal and exposure of bare side metal to corrosive elements, just as scraping sand bars and submerged rocks or other objects damages bottom plates and raked or square ends.

Many towboats on inland waterways are equipped with Kort nozzles, which are tube-like enclosures around the propellers, designed to increase propulsive efficiency (Figure 6). They cause propellers to behave like pumps, and a considerable quantity of sand, gravel and debris are driven through the nozzles, particularly when boats are in

shallow water, causing serious abrasion to the leading edges and interior surfaces.

There are many factors in surface condition and exposure to consider in planning a coating system for steel to be used in or adjacent to inland water immersion. Among the most critical factors is the need to remove traces of mill scale, particularly from surfaces to be immersed. Although a tightly bonded intact layer of mill scale can protect a bare steel substrate, it is not possible to fabricate steel plates into hulls and other vessels without producing cracks and discontinuities in the scale layer. If this type of surface is painted and subsequently damaged by scraping or scratching through the paint film, moisture will reach the metal surface, and mill scale will separate from the substrate, carrying with it any covering coats of paint. Under immersion conditions this failure may occur even without mechanical damage because of the permeability of coatings. The likelihood of abrasion also is greater. Proper blast cleaning prior to application can eliminate this.

Another cause of paint breakdown is improperly cleaned welds. The joining process leaves deposits of slag, flux, fume and spatter granules that must be removed before painting. Usually, hand or power scraping or brushing accomplishes the required degree of cleanliness, but the best effect is achieved by power grinding, which also smoothes ripples of the weld metal. Examples of poor and acceptable practice are indicated in Figures 7 and 8.

Resistance to impact damage should be considered when selecting coatings for river transportation service. Not only are hulls subject to collisions with docks, locks and floating objects, but cargo compartments receive frequent encounters with cranes, clamshell buckets and other loading equipment. Flexibility and good adhesion minimize damage.

The variety of liquid cargos transported in tank barges requires coatings to resist solvent and other chemical exposures. Tank lining is the subject of another chapter; coatings for tank exteriors, however, must stand up against frequent cargo spills and splashes.

Interior surfaces of side compartments, rake and square ends and void spaces between inner and outer bottoms are areas usually subjected to high humidity. Also, splashes and spills from cargos may get to these locations, making them vulnerable to corrosive attack. Coatings must prevent perforation from the back side, which is less frequently observed.

Superstructures of towboats and barges require the same attention as land-based steel structures, and probably receive more cleaning and scrubbing. Selected coatings must resist chemical and abrasive action and weathering. Surface preparation requirements are not stringent for these surfaces, but coating adhesion must be adequate.

Good design can prevent early corrosion of all types of structures. The best vessel design is economical over an extended period and minimizes maintenance. Diligent efforts should be made to include design features such as provision for complete drainage of fluids, smooth junctions between adjoining members and elimination of crevices. Improved paint application can be included as a significant contribution. Several builders provide

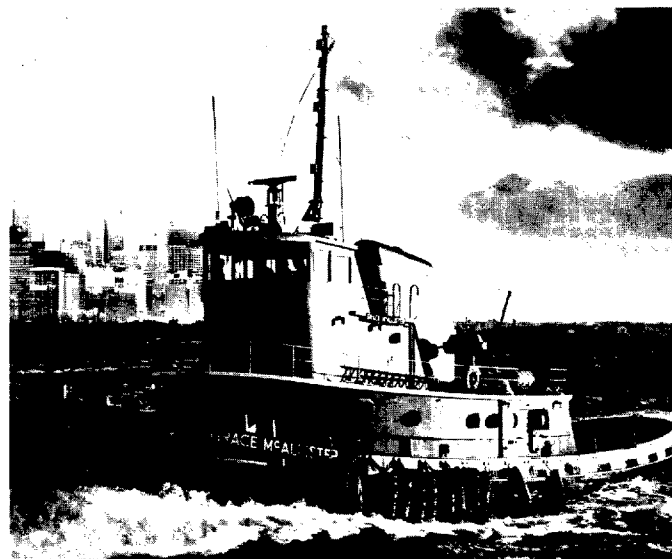


FIGURE 3

Typical tugboat at work in harbor. Generally smaller, with hull lines different from a towboat.

Courtesy of Dravo Corporation

automated blast cleaning and application of pre-construction primers to flat sheets and formed members prior to fabrication^{4,5}. The use of airless spray equipment is now common, and experiments are in progress with electrostatic spray methods⁴.

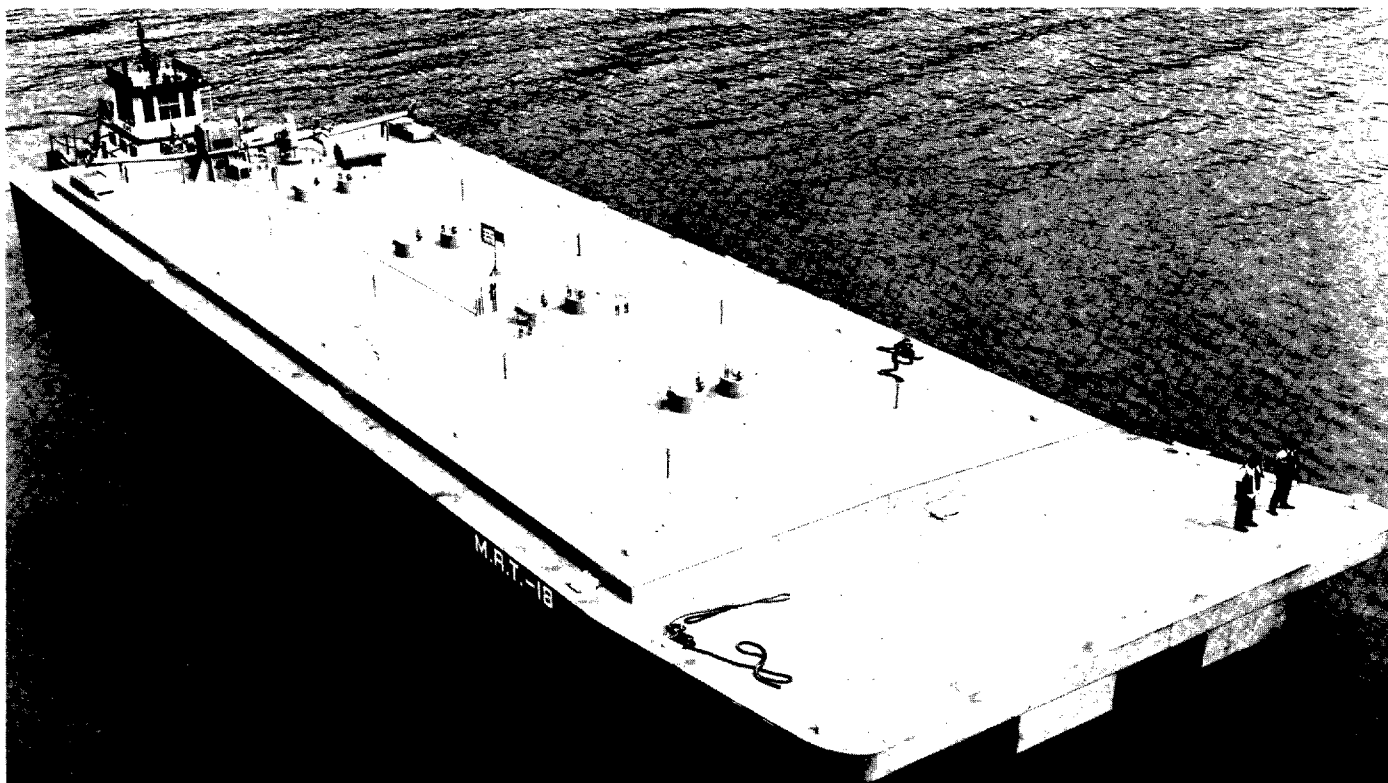


FIGURE 2
Double-skin tank barge.

Courtesy of Dravo Corporation