

or 10 miles per hour, and would realise in all weathers at sea, an average of 8 miles while under weigh.

What is the greatest proportion in tonnage and power for a steamer going a long voyage? The greatest proportion of tonnage for vessels going long voyages may be stated at 4 tons per horse-power. For short sea-voyages 3 tons per horse-power; and for river vessels, as Margate or Gravesend, 2 tons per horse-power.

What results does the power give to a vessel of the same tonnage with different powers as to the rate of going? Great power in small vessels gives great speed, but they carry a small quantity of coal and are soon exhausted, while larger vessels being able to carry a greater quantity of coals, work longer and perform greater distances.

Then you draw this inference—the longer the voyage the less the speed? The smaller the power the greater capacity there is left for coal, and, therefore, the greater number of days' coal it would carry.

And the less speed? And less speed, having less power.

And the smaller proportion of power would, of course, consume less fuel in an equal time? Exactly so.

Would not the greatest proportion of power consume the least fuel in equal distances? Against winds or tides it is so, but in calms and fair winds it is not.

What is the greatest distance you suppose a sea-going steamer to run without changing? The same steamer should not go more than 2,000 or 3,000 miles without a relay, or time to put the machinery in order.

Does that also include without taking in coals? A voyage of 2,000 or 3,000 miles may be performed in one stage, but it would be desirable on every account to divide it and take less coal.

What is the greatest distance she would go without coming to a station to take in fresh coals? The distance is limited only by the quantity of coal she can carry.

What is the greatest distance you think a steamer could go without taking in fresh coals? The greatest distance I have known a steamer to perform was the *Enterprize*, on her voyage to the Cape, in which she carried 57 days' coal.

With continued steaming, do you mean? Yes; she steamed 54 days, and had three days coal left.

Do you mean steaming day and night? Yes.

Besides the coal, is it not necessary to give the engines rest? It is; and the more frequently they can be stopped to clean and adjust, the better they will perform.

Then your observation must be supposed to apply to both? Yes.

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On the immersion of Copper for Bolts and Ship Sheathing in Muriatic Acid, as a test of its Durability. By DAVID MUSHET, Esq.—The durability of copper for bolts and ship-sheathing being an object of great national importance, and as there is no better test of its resistance to waste, than immersion in muriatic acid, the following experiments, made thirteen years ago, will, it is hoped, be found not uninteresting.

Small quantities, presenting nearly equal surfaces of each of the kinds of copper described in my last communication, namely, pure shoted copper

of the quality from which brass is made, and shots obtained from unrefined copper, were separately immersed in equal weights of muriatic acid. The immersion having been continued for 48 hours, the acid was poured off, and the copper washed repeatedly, and thoroughly dried. The pure copper had lost at the rate of $5\frac{1}{2}$ grains in 100. But the unrefined copper, on being weighed, seemed to have gained half a grain; so that either a mistake must have been made in the weighing, or else a portion of unexpelled moisture had remained in the porous flakes of the copper.

Six ounces of unrefined copper were mixed with three times their bulk of charcoal, and exposed for six hours to a high heat of cementation much beyond what in the absence of the cementation would have sufficed to melt the copper. The flakes of copper were found surrounded by the charcoal, welded together without fusion, and soft and extremely flexible. Six ounces of the pure copper shots were treated in a similar manner, but the result was so far different that no adhesion of the masses had taken place, and the only perceptible change was a slight cracking or bursting upon the surface of the spheroids, which may be considered as a prelude to fusion. Both results were melted down with charcoal and run into iron moulds. The unrefined copper, when cold, was the strongest and softest; a bar of it, about $\frac{1}{8}$ ths of an inch thick, cut easily across with a knife, and in colour and general appearance it very nearly resembled Swedish copper. Another piece was flattened out thin when cold for the purpose of immersion in the muriatic acid. The pure copper was melted in rather a higher degree of heat, and although not teemed until it had assumed a creamy surface, and the crucible had fallen to a low red temperature, it was crystalized throughout the whole fracture. The surface and the fracture of this copper were of a red colour; the body weak, and tearing with facility into pieces. Fragments for immersion were cut off and flattened.

The following specimens were then placed separately in muriatic acid.

No. 1, Pure copper, cut off with a chisel,	53 grains
2, Ditto, flattened,	30 —
3, Unrefined copper, cut off with a knife	$39\frac{1}{2}$ —
4, Ditto, flattened, in which stuck a minute } portion of the knife,	45 —

On the morning of the third day the following remarks were made upon their respective solutions:

No. 1, Light green colour, very transparent when dashed against the sides of the glass. No. 2, equally transparent, but the green was brownish and not so decidedly cupreous. After continuing the immersion for 48 hours longer, the acid was poured off and the specimens were well washed and dried.

No. 1, That weighed 53 grains, now weighed . . . $39\frac{1}{2}$ grains.

Loss $13\frac{1}{2}$ grains, equal to 25.4 per cent.

No. 2, That weighed 30 grains, now weighed . . . $11\frac{1}{2}$ —

Loss $18\frac{1}{2}$ grains. Equal to 61.2 per cent.

No. 3, Unrefined copper flattened, $39\frac{1}{2}$ grains, now }
weighed, . . . } 19 grains

Loss $20\frac{1}{2}$ grains. Equal to 50 per cent.

No. 4, Unrefined copper bar, 42 grains, now weighed, $38\frac{1}{2}$ —

Loss $3\frac{1}{2}$ grains. Equal to 8.33 per cent.

It would appear from this experiment that the unrefined copper resists

waste in the muriatic acid, in the same way, and to nearly the same extent, as in the cementation with lime mentioned in my last previous paper.

In corroboration of this fact, we may take the following abstract of another series of experiments, wherein the specimens were weighed three times, at intervals of 48 hours between each weighing.

Unrefined copper, 1st immersion, lost,	15	per cent.
Ditto, 2nd ditto	8 $\frac{3}{10}$	—
Ditto, 3rd ditto	6	—
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	29 $\frac{4}{10}$	
Pure copper, 1st immersion, lost	25.4	per cent.
Ditto, 2nd ditto	9.7	—
Ditto, 3rd ditto	11.1	—
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	46.2	

In favour of the unrefined copper, principally containing tin,—16.9 per cent. Two pieces of copper, the one pure, the other unrefined, were immersed, under similar circumstances, for seven days. The unrefined copper lost 17 per cent., and the pure copper 45 per cent. To ascertain whether the greater indestructibility was owing to the tin which remained in the unrefined copper, I formed a bar of alloy as follows:

Pure copper	2880	grains
Block tin	84	—

a proportion of tin about equal to 3 per cent. A piece from this bar weighing about 183 grains was exposed for seven days in muriatic acid, at the end of which time it was found to have lost 30 grains, or 16 $\frac{4}{10}$ per cent. The unrefined copper, above mentioned, lost in the same time and under similar circumstances, 17 per cent., which is a striking correspondence. The same piece of tin alloy, at the end of five weeks, was found to have lost in all 76 grains, or 38 $\frac{1}{2}$ per cent. Pure copper by the foregoing results lost in seven days' immersion 46.2 and 45 per cent.

In the first instance I was inclined to attribute the indestructibility of the unrefined copper in the acid, partly to the effects of the charcoal in the cementation, seeing that the effect produced by that operation was much greater upon unrefined than upon pure copper. Whatever advantages may belong to the proper use of charcoal in the reduction and cementation of copper (and I consider them not unimportant), the addition of a small portion of tin will be sufficient to account for the superior resistance to waste which this alloy presents in the muriatic acid, over that of the common refined copper of this country. This incapacity to rapid oxidation which is presented by the alloy of tin with copper, suggests many useful hints to the artists and the manufacturers, of which advantage has already been taken in forming ship-sheathing and other articles.

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Progress of Physical Science.

*Experimental researches in Electricity. Tenth Series. By MICHAEL FARADAY, D. C. L. F. R. S., &c. &c. [From Phil. Trans. 1835, Part. II.]**

The subjects embraced are, on an improved form of the Voltaic Battery,

* Received by the Franklin Instituté, through the kindness of the author.