

phorus, and passes over in a gaseous inflammable state. The qualitative test for arsenic, at this stage of the process, is a convenient saving of the time and trouble of a separate digestion, and is no hindrance; for when the test is completed, the apparatus is to be taken apart, and the flask, covered with a watch glass, transferred to the ledge of the sand bath, and there left until the residue becomes floatant. Solution is then complete, and the liquid must be evaporated to dryness, redigested in very dilute hydrochloric acid, filtered, washed with hot water and hydrochloric acid, and lastly with hot water. After drying the filter, it is ignited in a platinum crucible over a "Russia" lamp to burn off carbon, and then weighed to ascertain the amount of residual calx which consists of silex and slag.

Care must be observed not to use acid stronger than specific gravity 1.06, or the slag will be attacked and its bases dissolved; nor must it be weaker, as it will cause loss of time in the digestion.

The insoluble portion on the filter must be invariably washed with hydrochloric acid, to remove any traces of iron or oxide that may remain accidentally, and which would afterwards add undue weight to the slag, for it is not removable by subsequent boiling with potassa solution.

Having obtained the silica and slag together, and accurately noted their united weight, they are transferred from the platinum crucible to a small silver capsule, and boiled for two minutes with a half fluid ounce of caustic potassa solution of 1.10, (specific gravity, 1.25, diluted with two volumes of water.) After sufficient repose for the subsidence of all suspended particles, which from their extreme fineness would otherwise pass through the paper, it is filtered on the finest paper, and washed with hot water until the filtrate leaves no stain when heated to dryness on a platinum spatula. Silica is dissolved, and the slag remains untouched.

Lye of greater density than above prescribed would decompose the slag by abstracting its silica, while a lesser strength would not take up all the free silica. Nor is carbonate of soda, even in dense solution, a good substitute, for although it may imperfectly dissolve silica while boiling, it cannot retain it on cooling, but drops it partly in a free state and partly as soluble silicate of soda. The strength before directed has been found by experiment to answer best; it takes up the silica while hot and retains it on cooling, but does not attack the slag.

After the filter has been washed and dried, it is ignited in a platinum crucible and weighed; the weight expresses the amount of slag, and this deducted from that of the silica and slag united, gives the proportion of soluble silica; whence its content of silicium is to be calculated.

To be Continued.

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For the Journal of the Franklin Institute.

### *Models for Steamships—A Comparison of the Performance of the U. S. Steamships Susquehanna and Powhatan.*

In the science of ship building, as at present understood, a variety of opinions exist respecting the proper form to be given to vessels propelled at high speeds by internal power, so as to combine the requisite displacement and stability with a minimum resistance. Of these conflicting

theories, two of the principal and most opposed to each other, refer to the position in the length of a vessel, of the "dead flat" or amidship section, involving also that of the centre of displacement. According to one party, this centre of displacement and fullest lines should be forward, and the finest lines of the ship abaft, so as to give every facility for the easy return of the disturbed liquid to its original position, after the vessel has passed through it. By the other theory, the finest lines should be those which divide the water forward, and the centre of displacement, therefore, be abaft the centre of length. Without pretending to discuss or argue a question of such importance, we shall submit certain facts bearing upon it, which being well authenticated are worth more in forming a correct judgment, than all the unsupported opinions which have been or can be advanced upon the subject.

The United States steamers *Susquehanna* and *Powhatan* are vessels of the same dimensions of length, breadth, and beam, intended to carry the same weights, sparred precisely alike, and provided with engines and wheels of the same size and description; the only difference (of any importance) between them consisting in their models.

In former numbers of this Journal, (Vide vol. xxiv, p. 251-6; vol. xxv, 127-36,) Mr. Isherwood, Chief Eng. U. S. Navy, has furnished very correct and reliable data, respecting the peculiarities and performance of each vessel; the latter being the result of several hundred hours steaming at sea, carefully tabulated from the engineer's logs. It appears from these statements that the models of the two ships present, respectively, great approximation to the forms above alluded to, as advocated by the opposing parties in ship building. The *Susquehanna* being fullest forward, but with generally sharper lines below water, (requiring increased draft to obtain the same displacement,) in the most approved "old school" style. The *Powhatan*, on the contrary, having her bow and stern lines alike, and therefore not going quite so far in the innovations advocated by the "new school." Although the difference between the two is, therefore, not that of extremes, it is quite enough to produce a marked effect upon results.

A mean of 947 hours' steaming, without assistance from sails, and in average weather at sea, for the *Susquehanna*; and of 221 hours' steaming under the same circumstances for the *Powhatan*, present the following results:

	<i>Susquehanna.</i>	<i>Powhatan.</i>
Speed in knots, . . . . .	7.433	9.679
Revolutions per minute, . . . . .	10.259	12.627
Slip in per cents, . . . . .	19.73	16.45
Pressure in boilers, . . . . .	8.6	10.4
Average cut-off, . . . . .	5 ft.	4 ft. 8 in.
Proportion of throttle open, . . . . .	.375	.292
Back pressure in condenser, . . . . .	2.	2.
Draft of water, . . . . .	18 ft. 3 $\frac{1}{4}$	18 ft. 1 in.
Dip of paddles, . . . . .	5 ft. 3 $\frac{1}{4}$	5 ft. 0 in.
Displacement at that draft, . . . . .	3487.9	3489.6

By a fortunate coincidence (for a comparison) it will be seen that the displacement is precisely the same in both cases; therefore, *practically* speaking, the resistance to be propelled was the same, although we shall see that the *actual* resistance and therefore power required, differed materially.

The effective diameter of paddle wheel differs slightly, owing to the boards not being of the same width.

For the *Susquehanna* the effective diameter is 29.10 feet.

" *Powhatan* " " " 29.56 "

The loss from oblique action of paddles was in the former  $19\frac{3}{10}$  per cent.; in the latter  $18\frac{8}{10}$  per cent.

Now calling A = collective cylinder area, (sq. in.)

L = length of stroke, (in feet.)

P = mean effective pressure on piston during whole stroke.

sin.  $^2\delta$  = difference between unity and the per centage lost by oblique action.

D = effective diameter of wheel, (in feet.)

R = revolutions per minute.

S = per centage of slip.

C = coefficient of vessel's resistance.

The pressure exerted by the engine is 2 A P; and in a horizontal direction, 2 A P sin.  $^2\delta$ .

The pressure of the resistance is  $C \times V^2 = C \times \left( \frac{R(1-s) 3.1415 D}{60} \right)^2$

The ratio between the velocity of the resistance and that of the power is,  $3.1415 D$ , to  $2 L$ .

Then  $2 A L P \sin. ^2\delta = C (.0086 D^3 R^2 (1-s)^2)$

$$\text{or } C = \frac{A L P \sin. ^2\delta}{.0043 D^3 R^2 (1-s)^2};$$

The mean effective pressure, deducting 2 pounds less cylinder than boiler pressure, 2 pounds back pressure, 1.5 pounds for working engine, and 5 per cent. in the remainder for friction of load, would be in the

*Susquehanna*,  $\frac{95}{100}((6.6+14.7) \cdot 85 - (2+1.5)) = P = 13.87$ , and for the

*Powhatan* in like manner,  $P = 14.57$ , whence we have for the coefficient of resistance as follows:

$$\text{Susquehanna } C = \frac{7696 \times 10 \times 13.87 \times (1-.193)}{.0043 \times 24642 \times 105.24 \times .645} = 119.75;$$

$$\text{Powhatan } C = \frac{7696 \times 10 \times 14.57 \times (1-.188)}{.0043 \times 25829 \times 159.24 \times .697} = 73.88.$$

It therefore appears that the power required to drive these two vessels respectively at the same speed, with the same displacement, and under the same circumstances precisely, is really as  $119\frac{3}{4}$  to  $73\frac{7}{8}$ , or as 1.621 to 1.000; or that with the same consumption of fuel, supposing steam to be cut off at the same point in both, their respective speeds must be as  $\sqrt[3]{1.621}$  to  $\sqrt[3]{1.000}$  or 1.175 to 1.000. By analyzing the causes of the great superiority in the *Powhatan's* model, it will be found traceable to two circumstances only; one is the reduced midship section at the same displacement, being but 644.25 instead of 673.65 square feet, owing to her having fuller lines below water than the *Susquehanna*; and the other, the position of the centre of displacement, which is 4 feet farther aft than in the *Susquehanna*, giving a cleaner and more easy entrance.

From the same log it will be observed that the consumption of fuel

was in the *Susquehanna* 3279, and in the *Powhatan* 3951 lbs. per hour. Had steam been cut off in the engines of the latter at 5 feet, instead of 4 feet 8 inches, her consumption would have been increased to 4228 pounds per hour, doing the same work, while the speeds were respectively, 7.433 and 9.679; the resistances, therefore, with the same model, should have been as  $(7.433)^3$  to  $(9.679)^3$ , or as 410:907, or as 1:2.212, while the relative consumptions were 3279 to 4228 :: 1.00:1.290, hence,  $(1.00 \div 1.00) : (2.212 \div 1.290) :: 1:1.714$  for the ratio of resistances in the two vessels, instead of 1:1.621, as before obtained; showing that from some cause, the evaporative effect per pound of fuel was better in the *Powhatan*, in the ratio of 1.621:1.714 :: 1.00:1.057.

M.

For the Journal of the Franklin Institute.

*Steamers Andes and Alps.*

Hulls built by Wm. Denny & Sons; Engines by Tulloch & Denny, Dumbarton, Scotland, for the British and North American Royal Mail Line, (Cunard,) to run between New York and Liverpool.

Length on deck,	236 feet 6 inches.
Breadth of beam—at midship section above the main wales,	34 " 1 "
Depth of hold,	24 " "
Draft of water at load line,	16 " 9 "
Capacity of coal bunkers,	400 tons.
Length of engine and boiler space,	76 "
Tonnage,	1807 "
Weight of engine,	336000 lbs.
Weight of boilers, with water,	336000 "
Total weight,	300 tons
Frames, shape and dimensions, double angle iron,	L 5½ × ¾ × 3
Frames, distance apart at centre,	15 inches.
Keel, dimensions,	9 × 3
Plates, thickness,	¾ to 1 inch.
Keelsons, number and dimensions,	2, same as frames.
Masts and rig,	Barque.
<b>ENGINES.</b> —Two vertical beam.	
Diameter of cylinders,	5 feet 6 inches.
Length of stroke,	4 " 6 "
Maximum revolutions per minute,	25
Geared 1 to 2½ of propeller.	
<b>PROPELLER.</b> —True screw.	
Diameter,	14 "
Pitch,	18 "
Number of blades,	2
<b>BOILERS.</b> —Two tubular,	
Length,	15 feet 6 inches.
Breadth,	9 " 6 "
Height, exclusive of steam chimney,	14 "
Number of furnaces,	12
Length of grate bars,	6 " 9 "
Number of flues or tubes,	832
Internal diameter, of "	3½ "
Length of "	6 " 6 "
Diameter of smoke pipe,	5 " 11 "
Height of " "	40 "
Maximum Pressure of steam,	10 lbs.
Consumption of coal per hour,	2000 lbs.
Description of coal,	Bituminous.

*Remarks.*—Rivets ¾-inch in diameter, and 3½ inches apart; plates double riveted and abutted at ends; strakes clincher laid. C. H. H.