Bollard test

The Bollard test measures motor thrust. Specifically, a Bollard test measures the thrust of different propellers mounted on a single motor. The Bollard test can also be run with multiple motors and multiple propellers to determine maximum overall thrust. The combination of motor and propeller that gives the most thrust is often desirable, but other factors, such as amperage draw, may limit motor-propeller choices.

A comprehensive Bollard test will look at a number of different propellers mounted on a variety of motors. However, there is a simple way to demonstrate the Bollard test in a classroom using minimal materials.

Materials for a Bollard test:
- Motor
- Propeller adapter*
- A variety of different propellers and/or an airplane propeller.
- Spring scale
- Fulcrum device
- Test tank with water
- Battery or power supply for motor
- Amp meter with sufficient range for motor
- Power leads and ON/OFF Switch

For this Bollard test, we will use a variety of propellers and attach them to the same motor. Thrust and amperage will be measured for each propeller in both forward and reverse. An alternative, or additional experiment, uses a large airplane propeller that is systematically cut down to a smaller and smaller size. Thrust and amperage are measured at each propeller size in both forward and reverse.

The bollard test can be done in a test tank of any size, but very small containers may set up a circular flow which can give an inaccurate force reading. To construct and use a bollard test device, a motor is mounted to the bottom of a fulcrum device, often a ¾-inch PVC cross. The top end has a hook on both sides. A spring scale is attached to the hook to measure thrust. As the motor is activated, it will thrust forward, pushing the upper bar of the fulcrum in the opposite direction. Holding the spring scale stationary will cause the spring to be pulled open a certain amount. The amount the spring opens is recorded. This amount is the measure of thrust for the motor.
Note: True thrust is measured in Newtons (N), but for the purposes of this test, thrust is represented in grams. A Newton is mass times acceleration (F = m x a). Many scientific spring scales provide both a Newton and kilogram scale.

If both vertical lengths of PVC pipe are identical in length, the true motor thrust value will be measured. If the two vertical lengths of PVC pipe are different in length, a relative thrust value will be measured. This will not give a true value of thrust, but can still be used to determine best motor-propeller thrust configuration.

For each propeller tested, record the thrust in both the forward and reverse directions. Also record the amperage drawn for each propeller in both forward and reverse. Once all the available propellers have been tested, create a chart for all the value points. Then examine the data to determine which propeller will work best for your vehicle and the tasks you must perform. Often times thrust forward is the most important factor, but thrust in reverse might also need to be taken into consideration. Amperage draw must also be taken into account, as it will limit the number of motors on the vehicle, or may exceed the amperage rating of the bilge pump.

Note: The ammeter should be connected in series with the positive lead to the motor. Connecting an ammeter in series means that you break the circuit (open up your circuit somewhere, preferably at an alligator clip or battery connection) and attach the circuit’s positive connection to the ammeter’s positive lead, the circuits negative connection to the ammeter’s negative lead. You essentially break open the electrical connection and insert your ammeter in to fill the break. Once the ammeter is inserted, briefly, start the motor out of the water and verify that the ammeter is reading current. If it is reading zero, reverse the connections to the motor and try again. Record the motor current for each propeller. Motors can be run at 125% to 150% of their rated current without much problem. Above that, you run the risk of damaging or burning up your motor.

You can also use current as a measure of thruster efficiency.

* Note that a propeller adapter is an easy way to attach the propeller to the motor. Other methods of attachment may be used. Scientific spring scales can be purchased at www.sciencekit.com

Bollard pull is a conventional measure of the pulling (or towing) power of a watercraft. It is defined as the force (in tons or kiloNewtons (kN)) exerted by a vessel under full power, on a shore-mounted bollard through a tow-line, commonly measured in a practical test (but sometimes simulated) under test conditions that include calm water, no tide, level trim, and sufficient depth and side clearance for a free propeller stream. Bollard pull, the average of measurements over an interval of, for example, 10 minutes. An equivalent measurement on land is known as drawbar pull, or tractive force, which is used to measure the total horizontal force generated by a locomotive, a piece of heavy machinery such as a tractor, or a truck, (specifically a ballast tractor), which is utilized to move a load. Bollard pull is primarily (but not only) used for measuring the strength of tugboats. [From Wikipedia.]