



## Insight Article

# Marine propulsion systems

Next in Gard News' non-mariners' guide to ship construction and operation is a basic guide to marine propulsion systems, which produce the thrust to push a ship across water. Most modern ships are propelled by mechanical systems consisting of a motor or engine turning a propeller.

The propulsion system on a vessel can be as simple as a diesel engine directly connected to a propeller shaft, which drives the propeller, or more complex systems containing diesel engines powering an electrical generator, supplying electrical power to an electrical motor through a sophisticated control system. The set-up of the propulsion system depends on the vessel size, trade or type of operation.

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## Most common systems

On larger cargo vessels the most common system is a slow speed main engine with a maximum speed of 100–130 revolutions per minute connected to a fixed pitch propeller. The engines are normally operated on heavy fuel oil. This heavy fuel has to be heated to 120–140°C to allow it to be injected into the engines and burn. These slow speed engines rotate both clockwise and anti-clockwise to allow ahead and astern movements.

On smaller vessels the propulsion system often consists of medium speed engines, often 720–750 rotations per minute, connected to a reduction gear reducing the revolutions from the engine speed to a more optimal propeller speed of about 100–120 revolutions per minute. The gear is connected to a propeller shaft with a controllable pitch propeller. These engines will normally run with a fixed rpm and rotate only clockwise or anti-clockwise.

Specialised vessels such as offshore support vessels and some cruise vessels use diesel electric propulsion systems with thrusters, commonly known as pods. This system usually consists of four to six diesel engines powering generators which in turn supply electrical power to electrical motors that drive two or more propulsion thrusters. These engines can operate on either heavy fuel oil or diesel oil. The offshore support vessels often use diesel oil during operations, diving, crane or other critical operations. This is done because diesel oil is considered a more reliable fuel and will provide increased safety. The thrusters are usually equipped with controllable pitch propellers. In addition to the mechanical components, the system consists of highly sophisticated control systems, both controlling the propeller speed and pitch. The thrusters are installed under the vessel and are used for steering purpose as well as propulsion. This obviates the need for a rudder. The propulsion thrusters can turn 360° and can be used to give a side thrust if required.

## Propeller types

There are two main types of propellers used for propulsion of vessels: controllable pitch propellers (CPP) and fixed pitch propellers.

When CPP propellers are used, the direction of rotation on the propeller is the same. To increase or reduce the vessel's speed the pitch is altered – increased pitch will give increased speed. To give astern movement the propeller blade is turned to give astern thrust.

As the name suggests, a fixed pitch propeller is a propeller with fixed pitch. A propeller's pitch is defined as the distance the propeller would move during one complete revolution if operating in a solid material, if in water the movement will be less due to slip. If a propeller has a pitch of 40 inches it will move forward 40 inches during a complete revolution. To increase or reduce the vessel's speed, the rpm of the propeller is increased or reduced. To give astern movement the direction of rotation is reversed, i.e., the propeller rotates the opposite way to ahead movement.

The propeller size and design is dependent on the size of the vessel and type of operation. Most commonly used propellers on cargo vessels have four or five propeller blades, but six blades have been used. The propeller may have a diameter of more than nine metres and a weight of 130 tons. The most commonly used materials are stainless steel or a bronze alloy.

## Other types of propulsion systems

Steam turbines are today mostly used on LNG tankers. This system consists of high pressure boilers which produce steam used to power steam turbines. The steam turbine is connected to a gear which is connected to a propeller shaft with a fixed propeller. The boilers use dual fuel, i.e., heavy fuel oil, diesel oil or so-called “boil-off” gas vapour from the cargo tanks.

Gas turbines, as opposed to the name, are normally operated on diesel oil, but they can be dual fuel, i.e., operating on different types of fuel. This type of propulsion is normally used in specialised tonnage where size and output is critical.