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THE TRAWLER & OCEAN MOTORBOAT MAGAZINE

The TRAWLER PHENOMENON —*Its Time Has Come*

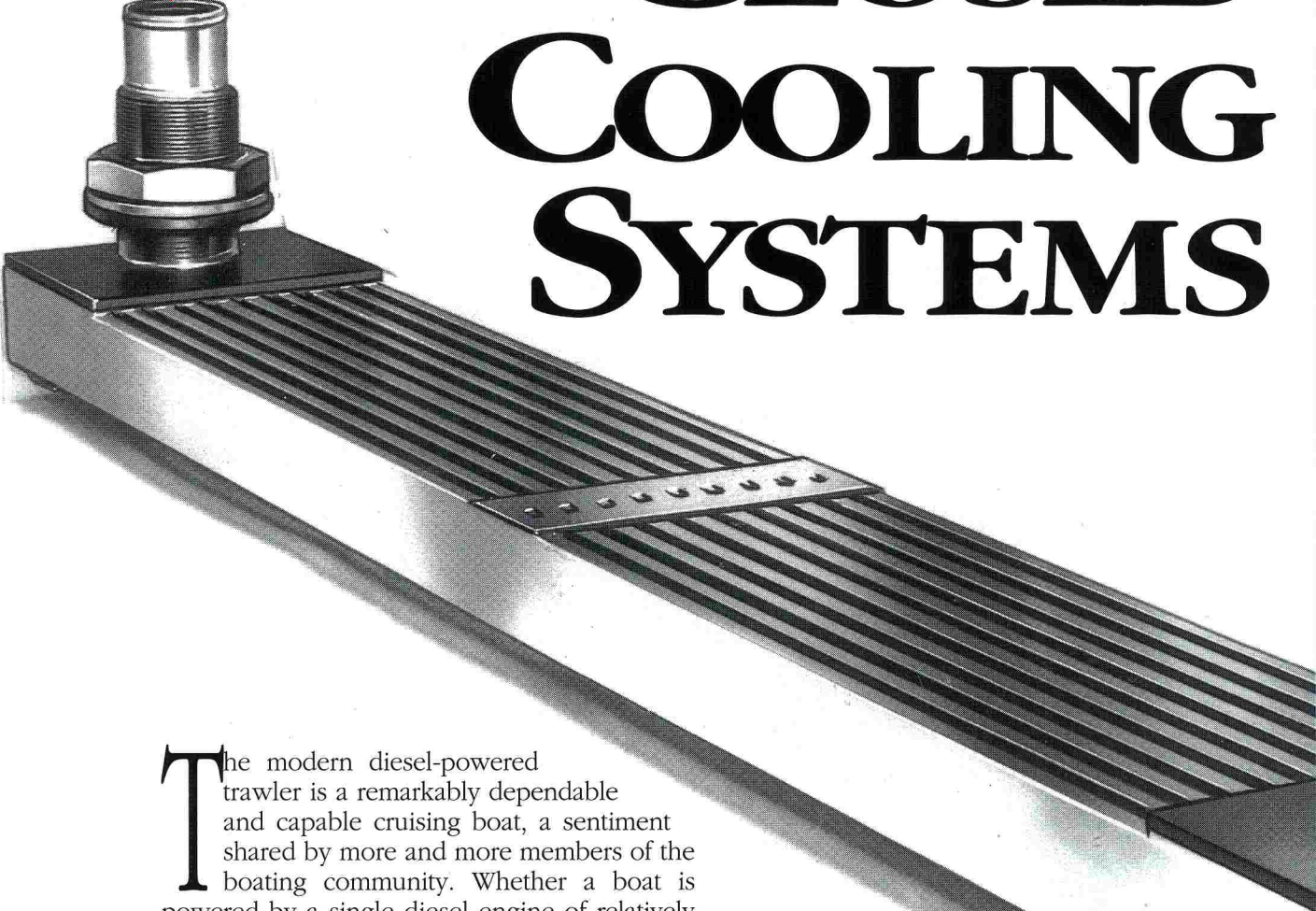
Trouble-Proof
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CLOSED COOLING SYSTEMS



The modern diesel-powered trawler is a remarkably dependable and capable cruising boat, a sentiment shared by more and more members of the boating community. Whether a boat is powered by a single diesel engine of relatively modest horsepower, or is propelled by a pair of turbocharged engines capable of high planing speeds, today's powerplant can provide many hours of dependable service.

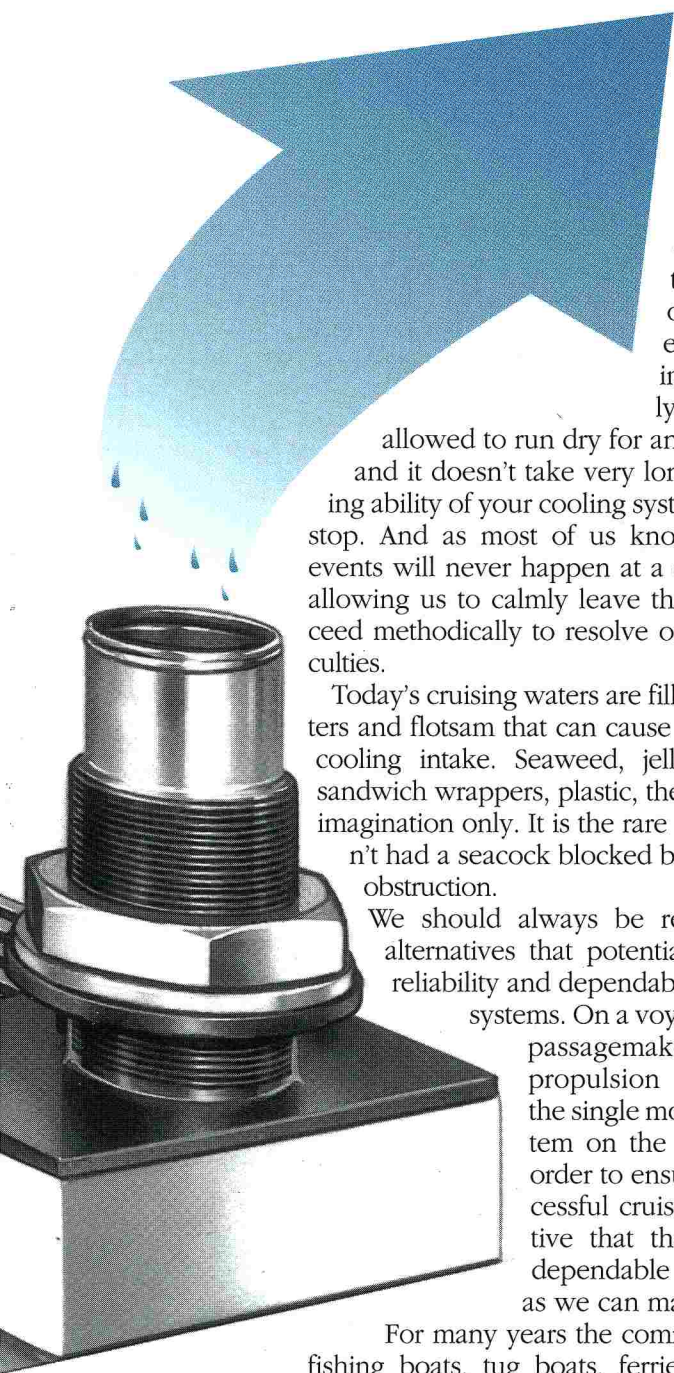
"No one would ever consider pouring muddy or dirty water into their car's engine or radiator, yet that is exactly what people do with internal heat exchangers or raw water cooling."

It is also well known that engine problems, when they do occur, usually originate in two likely areas; the fuel system or the cooling system. These two potential trouble spots are most easily avoided by routine maintenance and an attention to detail in the planning and operation of the engine room. The fuel management system, and the precautions that can be taken to optimize the efficiency and dependability of the fuel system, will be discussed in future issues. For

this article we will look at the cooling system, and discuss an alternative that has provided tremendously reliable service to commercial and fishing boats which are in many ways similar to our own trawlers and passagemakers.

The vast majority of recreational boats use either raw-water cooling or an internal heat exchanger system to handle the cooling duties to the engine(s). Our own trawlers, powerboats and motorsailers are no exception. We are accustomed to the concept of having raw water (sea water, Great Lakes water, canal water, or whatever water we happen to be in) enter the boat through a seacock, pass through a strainer, and flow either through the engine block directly or into a heat exchanger attached to the engine block.

Most people have, at one time or another, had a problem with obstructions blocking the sea-



**The installation
of a keel
cooler is adaptable
to most engine
applications.**

cock or clogging the raw water strainer. In some cases, this blockage caused damage to the impeller, overheating the engine. The impeller can easily self destruct if

allowed to run dry for any length of time, and it doesn't take very long for the pumping ability of your cooling system to just simply stop. And as most of us know, the chain of events will never happen at a convenient time, allowing us to calmly leave the helm and proceed methodically to resolve or repair the difficulties.

Today's cruising waters are filled with little critters and flotsam that can cause blockage to the cooling intake. Seaweed, jellyfish, mud, silt, sandwich wrappers, plastic, the list is limited by imagination only. It is the rare person who hasn't had a seacock blocked by some matter of obstruction.

We should always be ready to explore alternatives that potentially improve the reliability and dependability of our major systems. On a voyaging or cruising passagemaker, the main propulsion unit represents the single most important system on the boat. Period. In order to ensure safe and successful cruising, it is imperative that the engine be as dependable and trouble-free as we can make it.

For many years the commercial fishing boats, tug boats, ferries, and work boats have relied on closed cooling systems for their main engines. Known also as keel coolers, these units are used on vessels routinely operated in dirty water conditions, or in conditions where it is imperative that all systems be functioning properly.

Sean Fernstrum, of R.W. Fernstrum & Company, a leading manufacturer of keel cooling systems, is amazed that people are so indifferent when it comes to their boat's engine cooling. "People operate their boats in the filthiest water imaginable, yet they are always surprised when their engines

develop problems.

"No one would ever consider pouring muddy or dirty water into their car's engine or radiator, yet that is exactly what people do with internal heat exchangers or raw water cooling."

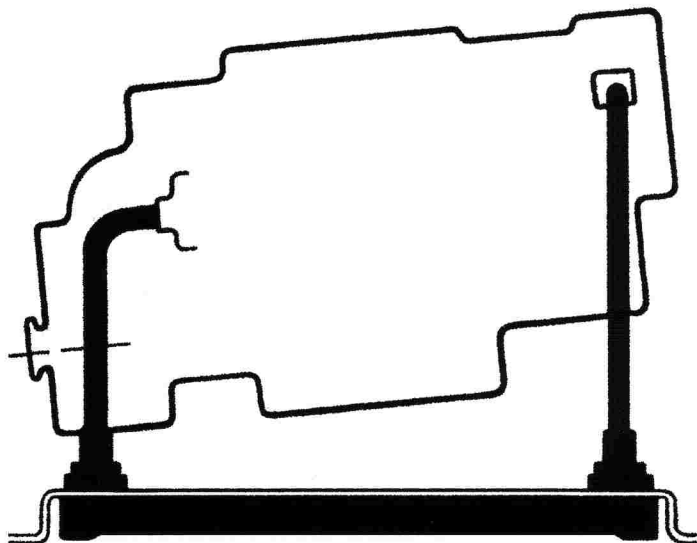
His company makes a line of keel coolers that was used successfully on military landing craft during World War II. Our military leaders were desperate for a solution to overheating problems of landing craft ferrying troops ashore. Sand was being sucked into the intakes of the cooling systems, clogging up intakes and pumps, and the boats were overheating while landing assault troops. The keel cooler systems developed by his grandfather helped solve the overheating problem, bringing flexibility and reliability to the landing craft vehicles.

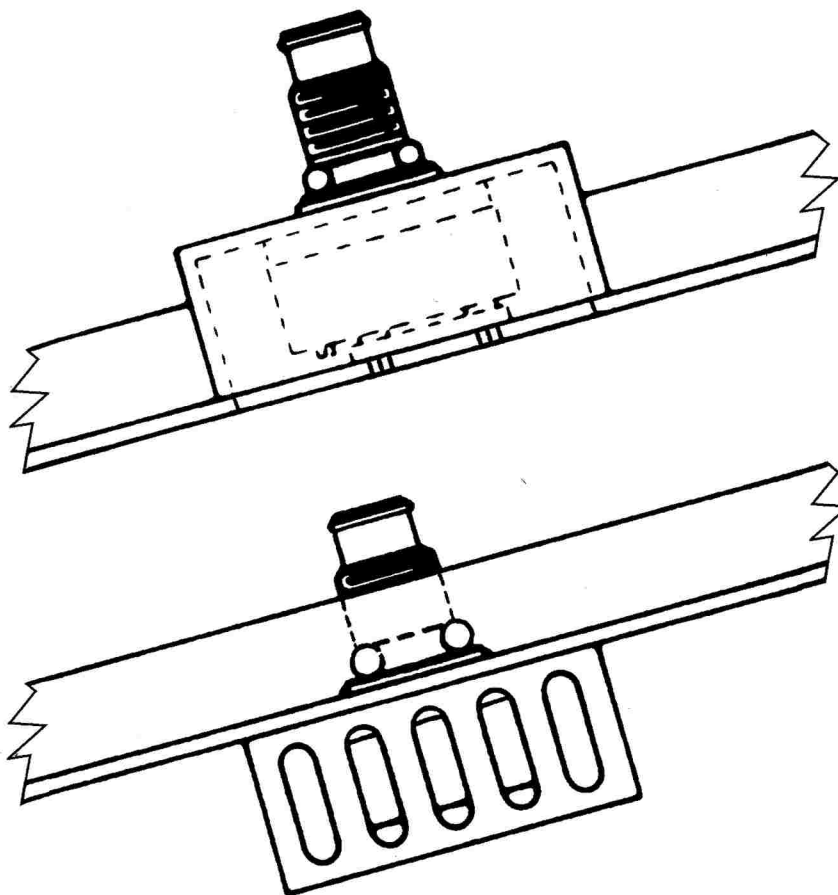
Your own boat may not find itself assaulting enemy beaches, but the same factors can affect your engine's cooling system.

Components of A Closed Cooling System

The basic components of a closed cooling circuit are much the same as an automobile cooling system. The radiator in our car is a series of bundled cooling tubes, placed out front of the automobile in order to transfer heat to the outside atmosphere. Coolant is circulated through the engine block, carrying off heat to be cooled in the radiator. The entire system is sealed and requires very little maintenance.

Closed cooling systems on boats are similar in both concept and performance (Diagram 1). The keel cooler (which resembles a radiator) is a packaged bundle of tubes or channels mounted on the outside of the hull, transferring heat directly from the engine to the surrounding water. Coolant is circulated between the engine





Keel coolers can be either recessed into the hull or mounted with fairing blocks to minimize drag.

and the keel cooler within a closed cooling circuit. The system is self contained, sealed and pressurized.

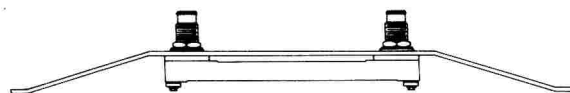
A closed cooling system is much less mechanical than either a raw water or internal heat exchanger system. It does not require the pumps, strainers, or plumbing, and does not involve bringing outside water into the boat.

What about the effects of drag and water resistance? Mounting a keel cooler on the outside of the hull is not as inefficient as one might think. In most all applications, the drag of the cooling unit on a trawler is negligible, especially considering the slower speed of these hull shapes. Even the finer hull form of a motorsailer would experience little additional drag due to a cooler mounted on the hull.

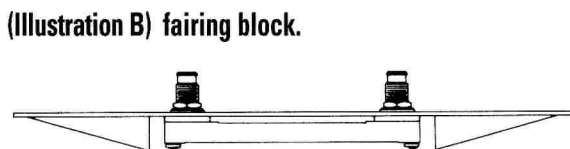
A keel cooler can be recessed into the hull for minimum drag (Illustration A), or can be mounted externally with fairing blocks to reduce drag and provide premium cooling to the system (Illustration B). As we will discuss shortly, the location of the unit on the hull is important for several reasons, but drag is not generally a concern.

Advantages of Keel Cooling

The advantages of a closed cooling system are significant. The reliability of the overall cooling system is improved because there is much less complexity to the system itself. There are no



(Illustration A) recessed.



(Illustration B) fairing block.

additional thru-hulls, strainers, or pumps. The coolant is circulated using the jacket water pump already on the engine. If the engine's exhaust is a dry exhaust system, the raw water intake components are eliminated entirely. Potential problems associated with broken down impellers, clogged seacocks and strainers are removed. This is especially important in areas where the water quality is less than pristine. It is no coincidence that ferries in New York Harbor use keel coolers.

Since the cooling system is a closed cooling circuit, there is no additional need to winterize the system. An outstanding side benefit of this closed system is that each spring, the antifreeze used for the winterizing process (either ethylene or propylene glycol) is not exhausted into the water. Think of this from an environmental viewpoint. In sounds, bays, and lakes, as well as ocean areas, each spring brings the first starting of winterized engines. Over a period of weeks, many thousands of gallons of ethylene and propylene glycol are dumped into the water as a result of our annual spring commissioning procedures. While the long term effects are not well known, it just can't be a good thing for our water environment.

Another advantage of the system is that the keel cooler will last a long time. The military and commercial users rate some of these systems for greater than twenty years. Certainly a testament for longevity and durability!

Installation Considerations

Installing a closed cooling system on your boat is not an overwhelming task. In fact it is entirely within the capabilities of the mechanically-inclined owner, but a great deal depends on the way the engine room is set up. Obviously if you are building a new boat, the installation will be somewhat easier as you won't be replacing existing cooling components.

It is important there is room to move around

the engine itself, certainly a benefit of most trawlers. Hoses will have to be disconnected and rerun, and may be necessary to accommodate a larger expansion tank. If there is enough room to accomplish these tasks, the biggest hurdle is solved.

Keel coolers are generally not shared between engines, but installed one keel cooler for each engine. Since we are trying to isolate the heat transfer functions to create a simple and closed system, it is important to have a dedicated cooling system for each application.

Sizing the Cooling System

The companies that manufacture keel coolers have several formulas to determine the correct size and model keel cooler for each application. While the actual calculations are proprietary, there are four major considerations for properly sizing the cooler:

- The make, model, and year of the engine. It is important to determine the heat rejection requirements specific to each engine, which takes into account the jacket water pump capacity as well.
- The hull speed of the boat, to determine the water flow past the cooler unit. A balance is struck between when the boat is running at normal cruising speed and the other hull speeds when the engine is running (including zero knots)
- The temperature of the water where the boat is normally used. For the voyaging passagemaker, this makes little difference, as the boat will likely cruise in areas of extremes in water temperature
- The coolant used in the system. It is important to know the existing coolant type for each engine, as cooling properties vary considerably between products. In particularly warm climates, coolant is often a mixture of water and an engine treatment additive. Boats primarily used in northern climates use either ethylene glycol or propylene glycol. (Incidentally, these two common forms of coolant must never be mixed, as it is then impossible to accurately determine the range of protection offered by the cooling circuit.) Use the coolant recommended by your engine manufacturer.

Some idea of cooler size can help in our discussion. Sean provided some estimates for keel cooler sizes that may be helpful in thinking out

your own possibilities:

- Caterpillar 3208 DIT(290hp), operating in 85 degree water, with a hull speed of 10 knots, would require a keel cooler approximately 5 feet long, 9 inches wide, 2 inches thick
- Caterpillar 3208 DINA(150hp), same temperature and hull speed, would require a cooler approximately 4 feet long, 9 inches wide, and 2 inches thick.

It is normally recommended that the keel cooler be placed on the aft portion of the hull, well below the waterline. This avoids any possible aeration that might occur. It is also important to locate the unit in a location offering protection from floating debris, snagging lines, or other obstacles. In many applications, locating the cooler on the hull beneath the engine works well.

Semi-displacement trawlers that travel over 12 knots may find it worthwhile to recess the cooler in the hulls, while slower displacement boats will benefit from the maximum cooling provided from an externally mounted cooler.

The keel cooler should never be painted with antifouling paint, as the coating will greatly affect the cooling abilities of the keel cooler. The heat of the cooling process itself will keep growth to a minimum. It is important, however, to make sure the areas around the keel cooler are well protected with antifouling paint, so as to prevent the interruption of water flow.

Most fresh water cooled engines already include an expansion tank in the cooling circuit. When the cooling system heats up during normal operation, the coolant expands, flowing into the expansion tank. Installing a keel cooler will often increase the total volume of coolant in the overall cooling system, so it is important to resize the tank capacity, to make sure it is sufficient for the demands of the new system. An expansion tank is generally 10%-15% of the total capacity of the cooling system. Your engine manufacturer can recommend the proper size tank for your engine.

Once a keel cooler is installed on the hull, hoses are run to pipe engine jacket water directly to and from the keel cooler. Existing heat exchanger equipment can be removed from the engine, if desired. Unless the raw water seacock, strainer, and external water pump are still needed for a wet exhaust system, these items may also be removed or blocked off.

Installations for twin diesel engines are duplicates of the single diesel installation. The cooling circuits are kept separate to simplify the cooling systems of both engines.

Gensets, A/C and Refrigeration

The application of a closed cooling system to the diesel genset is also an excellent idea. It eliminates the familiar small, easy-to-clog intake seacocks and strainers, and makes the cooling system bullet-proof. Fitting an appropriately-sized insulated dry exhaust muffler keeps the noise down to acceptable levels, and further simplifies the entire system.

Other superb candidates for keel cooling are air conditioning and water-cooled refrigeration units. While these systems rely on an intermediate cooling circuit, a keel cooler can be readily fitted to supply the cooling requirements. Gone forever is the exhaust water discharge from the numerous waterline thru-hulls seen on many boats in warm weather cruising areas.

Sizes for generators, A/C, and refrigeration units are considerably smaller than main propulsion unit keel coolers. They are calculated for zero knot hull speeds, in order to maximize cooling efficiency when anchored or at the dock.

Costs

The components of a closed cooling system are not expensive when viewed as a long term investment in your boat. Small keel coolers start around \$300. Prices vary considerably due to differences in cooling requirements (Fernstrum makes over 8,000 models), but the installation of a keel cooler for a single diesel-powered 40 foot trawler could probably be accomplished for less than \$1,000. Not a large sum considering the advantages and piece of mind from such a system.

Maintenance

Back to our analogy with the automobile, the closed cooling system requires a minimum of maintenance, beyond reasonable care not to paint the unit with antifouling paint. It is recommended that the internals of the system be cleaned every couple of years, using readily available radiator flush products.

Should it be necessary to repair the keel cooler, or get at the hull behind the mounted cooler, the keel cooler can be removed without much trouble from the hull. Hoses are disconnected, the mounted collar nuts are backed off, and off it comes.

Summary

The characteristics that make trawlers and ocean motorboats so attractive to many of us include reliability, seaworthiness, and cruising capability. The addition of a closed cooling system provides one more safeguard against potential problems, and helps us prepare for the next successful cruise.

Coupled with a dry exhaust system, the closed cooling system eliminates a major source of maintenance and potential trouble in your engine room. We will present a detailed look at the subject of dry exhausts in a coming issue, and discuss the options and considerations you need to know if you opt for a dry exhaust system. Stay tuned.

Keel coolers may not be for everyone, but they have been used successfully in many tough situations; ferries, fishing boats, tugs, work boats, and landing craft, in the worst water conditions imaginable. It might be worth considering a closed cooling system for your boat. And you just might be helping the environment at the same time. ●

For more information

The following companies manufacture high quality keel coolers, and can be contacted for further information.

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