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Study on Liquid Cooled 2 Stroke Engine

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Abstract- A cooling system for a two-stroke engine including a water jacketed cylinder having cooling passages located beneath the exhaust port and beneath the transfer ports in the cylinder wall. Liquid coolant flows up wardly from the crankcase structure into the cylinder wall cooling jacket and fnally upwardly into the head.

Index Terms- Liquid cooled 2 strock engine construction details; design methods and the efficiency variation while using liquid cooling system.

1. INTRODUCTION

As the time passes the technology also advances so as the modification of the engine also varies . In the old days the people invented a engine which was capable of running on by burning coal .The days passed then the invention also advanced then came the internal combustion engine which was running burning this engine was such designed that was performing only two stroke which was compression stroke and expansion stroke .These two stroke engines are much powerful than today’s four stroke engine . Sometimes these engines get overheated due to which wear and tear occurs if any further heating cause then engine will stop working .So in order to cool the engine at first air cooled engines were designed by designing fins around the engine . For sometimes cooling fins worked but that would not give much efficiency . Days passed then the invention of liquid cooled engine started which was much more efficient than the air cooled engine .It takes place all the air cooled engine .The design of the liquid cooled engine was such that the water passes through the outer surface of the engine through a water jacket . another arrangement is required that is the radiator .The radiator is used to cooled the liquid by rejecting the heat form the surroundings . The thin pipes of the radiator helps in the rejection of the heat from the surroundings .The cool air passes through the thin pipes rejecting the heat .So this type of liquid cooled engine arrangement is followed by a water jacket , a radiator fan ,a radiator and a pump , to pump the water from the engine to the radiator then again from the radiator to the engine . So in this time we required a much power and efficient and a cooled engine .

2. WHAT IS A COOLOING SYSTEM

A typical 4 cylinder vehicle cruising along the highway at around 50 miles per hour, will produce 4000 controlled explosions per minute inside the engine as the spark plugs ignite the fuel in each cylinder to propel the vehicle down the road. Obviously, these explosions produce an enormous amount of heat and, if not controlled, will destroy an engine in a matter of minutes. Controlling these high temperatures is the job of the cooling system. The modern cooling system has not changed much from the cooling systems in the model T back in the '20s. Oh sure, it has become infinitely more reliable and efficient at doing it's job, but the basic cooling system still consists of liquid coolant being circulated through the engine, then out to the radiator to be cooled by the air stream coming through the front grill of the vehicle. Today's cooling system must maintain the engine at a constant temperature whether the outside air temperature is 110 degrees Fahrenheit or 10 below zero. If the engine temperature is too low, fuel economy will suffer and emissions will rise. If the temperature is allowed to get too hot for too long, the engine will self destruct

3. HOW DOES A COOLING SYSTEM WORKS?

Actually, there are two types of cooling systems found on motor vehicles: Liquid cooled and Air cooled. Air cooled engines are found on a few older cars, like the original Volkswagen Beetle, the Chevrolet Corvair and a few others. Many modern motorcycles still use air cooling, but for the most part, automobiles and trucks use liquid cooled systems and that is what this article will concentrate on.

The cooling system is made up of the passages inside the engine block and heads, a water pump to circulate the coolant, a thermostat to control the temperature of the coolant, a radiator to cool the coolant, a radiator cap to control the pressure in the system, and some plumbing consisting of interconnecting hoses to transfer the coolant from the engine to radiator and also to the car's heater system where hot coolant is used to warm up the vehicle's interior on a cold day. A cooling system works by sending a liquid coolant through passages in the engine block and heads. As the coolant flows through these passages, it picks up heat from the engine. The heated fluid then makes its way through a rubber hose to the radiator in the front of the car. As it flows through the thin tubes in the radiator, the hot liquid is cooled by the air stream entering the engine compartment from the grill in front of the car. Once the fluid is cooled, it returns to the engine to absorb more heat. The water pump has the job of keeping the fluid moving through this system of plumbing and hidden passages

4. CIRCULATION

The coolant follows a path that takes it from the water pump, through passages inside the engine block where it collects the heat produced by the cylinders. It then flows up to the cylinder head (or heads in a V type engine) where it collects more heat from the combustion chambers. It then flows out past the thermostat (if the thermostat is opened to allow the fluid to pass), through the upper radiator hose and into the radiator. The coolant flows through the thin flattened tubes that make up the core of the radiator and is cooled by the air flow through the radiator. From there, it flows out of the radiator, through the lower radiator hose and back to the water pump. By this time, the coolant is cooled off and ready to collect more heat from the engine. The capacity of the system is engineered for the type and size of the engine and the work load that it is expected to undergo. Obviously, the cooling system for a larger, more powerful V8 engine in a heavy vehicle will need considerably more capacity then a compact car with a small 4 cylinder engine. On a large vehicle, the radiator is larger with many more tubes for the coolant to flow through. The radiator is also wider and taller to capture more air flow entering the vehicle from the grill in front

5. TYPES OF COOLING SYSTEMS

5.1 AIR COOLING SYSTEM

Air cooled system is generally used in small engines say up to 15-20 kW and in aero plane engines. In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc. Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins, heat will be dissipated to air.

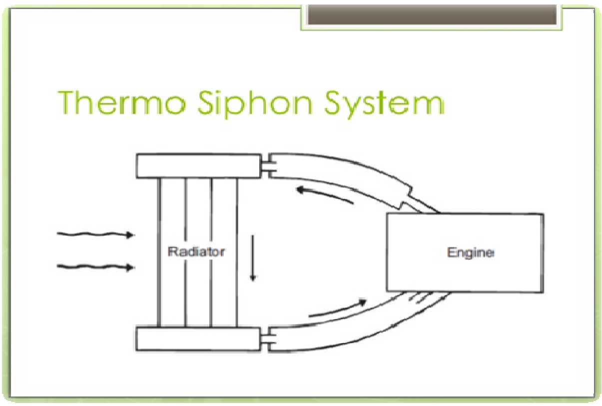
5.2 LIQUID COOLING SYSTEM

In this method, cooling water jackets are provided around the cylinder, cylinder head, valve seats etc. Thewater when circulated through the jackets, it absorbs heat of combustion. This hot water will then be cooling in the radiator partially by a fan and partially by the flow developed by the forward motion of the vehicle. The cooled water is again recirculated through the water jackets.

THERE ARE 2 TYPES OF LIQUID COOLING SYSTEM

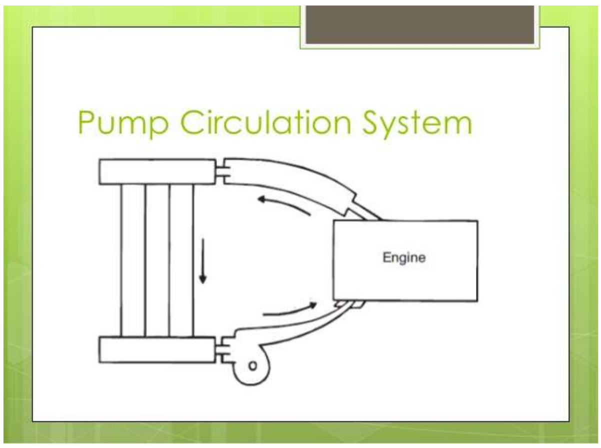
5.2.1 THERMO SIPHON SYSTEM

In this system the circulation of water is due to difference in temperature (i.e. difference in densities) of water. So in this system pump is not required but water is circulated because of density difference only.



5.2.2 PUMP CIRCULATION SYSTEM

In this system circulation of water is obtained by a pump. This pump is driven by means of engine output shaft through V-belts



5.3 ANTIFREEZE MIXTURE

In western countries if the water used in the radiator freezes because of cold climates, then ice formed has more volume and produces cracks in the cylinder blocks, pipes, and radiator. So, to prevent freezing antifreeze mixtures or solutions are added in the cooling water.

5.3.1 The ideal antifreeze solutions should have the following properties :

(a) It should dissolve in water easily.
(b) It should not evaporate.
(c) It should not deposit any foreign matter in cooling system.
(d) It should not have any harmful effect on any part of cooling system.
(e) It should be cheap and easily available.

(f) It should not corrode the system.

5.4 Advantages of liquid cooling system

(a) Uniform cooling of cylinder, cylinder head and valves.
(b) Specific fuel consumption of engine improves by using water cooling system.
(c) If we employ water cooling system, then engine need not be provided at the front end of moving vehicle.
(d) Engine is less noisy as compared with air cooled engines, as it has water for damping noise.

5.5 Disadvantages of liquid cooling system

(a) It depends upon the supply of water.
(b) The water pump which circulates water absorbs considerable power.
(c) If the water cooling system fails then it will result in severe damage of engine.
(d) The water cooling system is costlier as it has more number of parts. Also it requires more maintenance and care for its parts.

6. Engine cooling system

The cooling system is a key to efficient engine operation. An internal combustion engine only uses one-third of the power produced. One-third heats oil or goes out the exhaust and one-third must be controlled by the water cooling system.

1. An engine wears out four times faster if it continually operates at a low temperature.
2. A tractor doing the same work will use 3.8 gallons of fuel per hour at 400 and only 2.8 gallons of fuel per hour at 1800. Warm up your engine before putting under load.
3. Too much heat can damage an engine, increase oxidation to the oil, and reduce the effectiveness of the additives in the oil.
4. Excessive heat may attack seals, liners, gaskets, and sealants
5. A thin (1/16") layer of calcium carbonate build-up on an engine is equal to 4" of solid cast iron in heat transfer

7. Internal combustion engine cooling over view:

Heat engines generate mechanical power by extracting energy from heat flows, much as a water wheel extracts mechanical power from a flow of mass falling through a distance. Engines are inefficient, so more heat energy enters the engine than comes out as mechanical power; the difference is waste heat which must be removed. Internal combustion engines remove waste heat through cool intake air, hot exhaust gases, and explicit engine cooling. Engines with higher efficiency have more energy leave as mechanical motion and less as waste heat. Some waste heat is essential: it guides heat through the engine, much as a water wheel works only if there is some exit velocity (energy) in the waste water to carry it away and make room for more water.

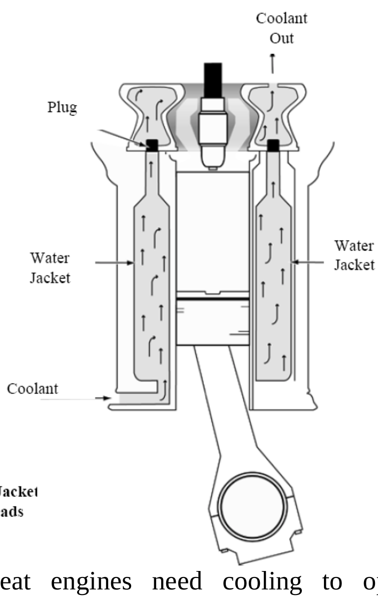


Figure 25 Water Jacket Cylinder Heads

Thus, all heat engines need cooling to operate. Cooling is also needed because high temperatures damage engine materials and lubricants. Internal-combustion engines burn fuel hotter than the melting temperature of engine materials, and hot enough to set fire to lubricants. Engine cooling removes energy fast enough to keep temperatures low so the engine can survive.

Some high-efficiency engines run without explicit cooling and with only accidental heat loss, a design called adiabatic. For example, 10,000 mile-per-gallon "cars" for the Shell economy challenge are insulated, both to transfer as much energy as possible from hot gases to mechanical motion, and to reduce reheat losses when restarting. Such engines can achieve high efficiency but compromise power output, duty cycle, engine weight, durability, and emissions.

8. Basic principle

Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. Marine engines and some stationary engines have ready access to a large volume of water at a suitable temperature. The water may be used directly to cool the engine, but often has sediment, which can clog coolant passages, or chemicals, such as salt, that can chemically damage the engine. Thus, engine coolant may be run through a heat exchanger that is cooled by the body of water.

Most liquid-cooled engines use a mixture of water and chemicals such as antifreeze and rust inhibitors. The industry term for the antifreeze mixture is *engine coolant*. Some antifreezes use no water at all, instead using a liquid with different properties, such as propylene glycol or a combination of propylene glycol and ethylene glycol. Most "air-cooled" engines use some liquid oil cooling, to maintain acceptable temperatures for both critical engine parts and the oil itself. Most "liquid-cooled" engines use some air cooling, with the intake stroke of air cooling the combustion chamber. An exception is Wankel engines, where some parts of the combustion chamber are never cooled by intake, requiring extra effort for successful operation.

However, properties of the coolant (water, oil, or air) also affect cooling. As example, comparing water and oil as coolants, one gram of oil can absorb about 55% of the heat for the same rise in temperature (called the specific heat capacity). Oil has about 90% the density of water, so a given volume of oil can absorb only about 50% of the energy of the same volume of water. The thermal conductivity of water is about 4 times that of oil, which can aid heat transfer. The viscosity of oil can be ten times greater than water, increasing the energy required to pump oil for cooling, and reducing the net power output of the engine.

Comparing air and water, air has vastly lower heat capacity per gram and per volume (4000) and less than a tenth the conductivity, but also much lower viscosity (about 200 times lower: 17.4×10^{-6}Pa·s for air vs 8.94×10^{-4} Pa·s for water). Continuing the calculation from two paragraphs above, air cooling needs ten times of the surface area, therefore the fins, and air needs 2000 times the flow velocity and thus a recirculating air fan needs ten times the power of a recirculating water pump. Moving heat from the cylinder to a large surface area for air cooling can present problems such as difficulties manufacturing the shapes needed for good heat transfer and the space needed for free flow of a large volume of air.

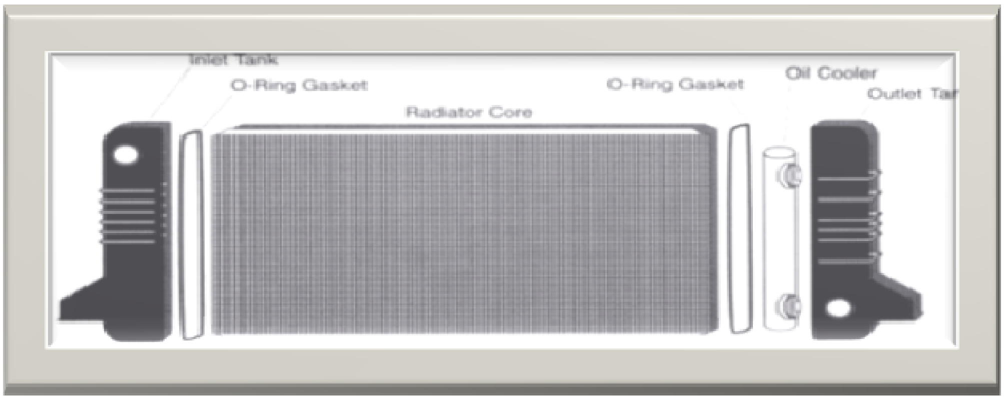
9. The components of a cooling system

- The Radiator
- Radiator Cooling Fans
- Pressure Cap & Reserve Tank
- Water Pump
- Thermostat
- Bypass System
- Freeze Plugs
- Head Gaskets & Intake Manifold Gaskets
- Heater Core
- Hoses

9.1 The Radiator

The radiator core is usually made of flattened aluminium tubes with aluminium strips that zigzag between the tubes. These fins transfer the heat in the tubes into the air stream to be carried away from the vehicle. On each end of the radiator core is a tank, usually made of plastic that covers the ends of the radiator,

On most modern radiators, the tubes run horizontally with the plastic tank on either side. On other cars, the tubes run vertically with the tank on the top and bottom. On older vehicles, the core was made of copper and the tanks were brass. The new aluminum-plastic system is much more efficient, not to mention cheaper to produce. On radiators with plastic end caps, there are gaskets between the aluminum core and the plastic tanks to seal the system and keep the fluid from leaking out. On older copper and brass radiators, the tanks were brazed (a form of welding) in order to seal the radiator



9.2 Radiator Fan

Mounted on the back of the radiator on the side closest to the engine is one or two electric fans inside a housing that is designed to protect fingers and to direct the air flow. These fans are there to keep the air flow going through the radiator while the vehicle is going slow or is stopped with the engine running. If these fans stopped working, every time you came to a stop, the engine temperature would begin rising. On older systems, the fan was connected to the front of the water pump and would spin whenever the engine was running because it was driven by a fan belt instead of an electric motor

9.3 Pressure Cap & Reserve Tank

As coolant gets hot, it expands. Since the cooling system is sealed, this expansion causes an increase in pressure in the cooling system, which is normal and part of the design. When coolant is under pressure, the temperature where the liquid begins to boil is considerably higher. This pressure, coupled with the higher boiling point of ethylene glycol, allows the coolant to safely reach temperatures in excess of 250 degrees. The radiator pressure cap is a simple device that will maintain pressure in the cooling system up to a certain point. If the pressure builds up higher than the set pressure point, there is a spring loaded valve, calibrated to the correct Pounds per Square Inch (psi), to release the pressure.

9.4 Water Pump

A water pump is a simple device that will keep the coolant moving as long as the engine is running. It is usually mounted on the front of the engine and turns whenever the engine is running. The water pump is driven by the engine through one of the following

A fan belt that will also be responsible for driving an additional component like an alternator or power steering pump A serpentine belt, which also drives the alternator, power steering pump and AC compressor among other things.

The timing belt that is also responsible for driving one or more camshafts.

9.5 Thermostat

The thermostat is simply a valve that measures the temperature of the coolant and, if it is hot enough, opens to allow the coolant to flow through the radiator. If the coolant is not hot enough, the flow to the radiator is blocked and fluid is directed to a bypass system that allows the coolant to return directly back to the engine. The bypass system allows the coolant to keep moving through the engine to balance the temperature and avoid hot spots. Because flow to the radiator is blocked, the engine will reach operating temperature sooner and, on a cold day, will allow the heater to begin supplying hot air to the interior more quickly

9.6 Freeze Plugs

When an engine block is manufactured, a special sand is molded to the shape of the coolant passages in the engine block. This sand sculpture is positioned inside a mold and molten iron or aluminum is poured to form the engine block. When the casting is cooled, the sand is loosened and removed through holes in the engine block casting leaving the passages that the coolant flows through. Obviously, if we don't plug up these holes, the coolant will pour right out.

9.7 Head Gaskets & Intake Manifold Gaskets

All internal combustion engines have an engine block and one or two cylinder heads. The mating surfaces where the block and head meet are machined flat for a close, precision fit, but no amount of careful machining will allow them to be completely water tight or be able to hold back combustion gases from escaping past the mating surfaces. In order to seal the block to the heads, we use a head gasket. The head gasket has several things it needs to seal against. The main thing is the combustion pressure on each cylinder.

9.8 Heater Core

The hot coolant is also used to provide heat to the interior of the vehicle when needed. This is a simple and straight forward system that includes a heater core, which looks like a small version of a radiator, connected to the cooling system with a pair of rubber hoses. One hose brings hot coolant from the water pump to the heater core and the other hose returns the coolant to the top of the engine.

9.9 Hoses

There are several rubber hoses that make up the plumbing to connect the components of the cooling system. The main hoses are called the upper and lower radiator hoses. These two hoses are approximately 2 inches in diameter and direct coolant between the engine and the radiator.

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