Note. Major changes and/or additions are in bold face font. Contributions by web members are underlined with dots and credit given when known. Minor changes, usually just wording, are not drawn attention to by any special font.

************* COOLING*************

Revised April 25, 2009

************* Cooling in General *************

OPERATING HEAT RANGE: Ford shop manuals specify the normal operating range of a flathead is 180-200 degrees F. Great if you're not 5000' above sea level where water boils at 202 degrees F. Sure makes a pressurized system more appealing.

BOILING POINT OF WATER FOR INCREASED ELEVATION: The boiling point of water decreases 2 degrees for per 1000' of altitude. Example: The boiling point of water at 5000 feet in a non-pressurized cooling system is:

$$(2 \text{ degrees})\frac{(5000')}{(1000')} = 10 \text{ degrees.}$$

And (212 degrees)-(10 degrees)= 202 degrees F (remember this is for a non-pressurized system).

EFFECT OF GASOLINE OCTANE ON COOLING: Engines run cooler with lower octane fuel rather than higher octane. (High octane fuel burns slower and causes higher operating temp.)

EFFECTS OF BOILING: Boiling will damage any engine. This is well known. However, we normally only think of cracking or warping problems. But boiling causes other things to happen that we're probably unaware of.

Boiling causes bubbles to form. These are bubbles of steam. These come into contact with the cooling system side of cylinder walls. Because there isn't any cooling in steam, an *extremely* hot spot is instantly created on the cylinder wall. It is very hot and penetrates through the cylinder's wall. When a piston ring passes over such a hot spot, the ring will actually weld itself for a micro-millisecond to the cylinder wall. It doesn't slow the piston's travel and can't be detected at the time, but the mini-weld causes a tiny particle of ring to separate. These minute welds appear as tiny gray shadows on the inside of the cylinder wall. These gray shadows are about the size of the head of a pin. It's not uncommon to see as many as 20 of these per cylinder.

A pressurized cooling system boils at a much higher temperature. This higher boiling point is more difficult to reach which will delay formation of steam bubbles and the resulting gray shadows and ruined rings.

*************** COOLANTS & ADDITIVES *************

WATER VS ETHYLENE GLYCOL AS A COOLANT: Ethylene glycol anti-freeze feels oily to the touch. It acts as a kind of insulator on surfaces it contacts, which slows the transfer of heat from the metal surfaces to the coolant mix. As can be expected, anti-freeze also retains heat considerably longer than straight water. The stronger the mix of anti-freeze the more heat the coolant retains and the hotter an engine will tend to run. A 50/50 mix causes an increased operating temperature of about 15 degrees over straight water. Straight water will absorb and dissipate heat faster and will normally reduce operating engine temperature. Be sure to use a good rust inhibitor.

ETHYLENE GLYCOL IN NON-PRESSURE RADIATORS: Addition of anti-freeze alters both the freezing and boiling points in accordance with the percent of mixture. System pressure and altitude also affect the boiling point, but not the freezing point. Therefore, the following table reflects only the freezing point with various anti-freeze percentages.

% of anti-freeze	freezes @
0%	32 deg. F
39%	-10 deg. F
44%	-20 deg. F
48%	-30 deg. F

FREEZE PREVENTIONS: Running a 40% ethylene glycol mix will give protection to about 10 below zero. Below that temp it will first turn to slush which will not damage the radiator or engine. But if it gets colder than 4 degrees below the protection point, it can freeze and turn to ice. Usually the radiators (engine and heater) are the first to freeze. But there are a few things you can do to prevent it from freezing. The following are not in any order.
Example: Say you stop for the night and the temp forecast is for it to get colder than your anti-freeze protection.

(1)Covering the grill and hood with a blanket (motels get upset with this!) will slow heat loss considerably.

(2)If the temp drop is not to get 10 degrees colder than your anti-freeze protection, run the engine until it’s up to operating temp just before you retire for the night..... say around 11 PM. This will usually prevent any freezing until about 6 AM or so.... especially if you’ve thrown a blanket over the hood and grill.

(3)If the temp is to get colder than 10 degrees colder than your anti-freeze protection, set an alarm clock for a couple of hours after you retire. Start and warm the car for about 5 minutes every two hours during the night. I’ve done this when temperatures got down to 5 degrees F with no problem.... and I use only water in my flathead! Sure is cold going outside in the middle of the night though (and the bed isn’t too warm when you get back either..... which isn’t at all bad if there is someone who will warm you up!!

(4)Lay a drop light on the top of the engine. Don’t let it lie on anything rubber or on wire insulation. This really helps keep the engine warm. This has an additional benefit. A battery loses about 50% of its power when the battery gets down to zero degrees F. When it’s really cold, the oil gets as thick as grease and causes a tremendous amount of drag.... drag a weakened battery sometimes cannot overcome. Result is your engine can’t turn over fast enough to start. If the car battery is under the hood, lay the light close to (but not against) the battery to keep it warm.

(5)Guess this as good a place as any to add this. Sometimes the weather at home gets super cold. If it’s going to get down to 30 below zero or colder, give it up and add a 55 gallon drum of industrial strength anti-freeze... or load up and head south. Chances are the engine won’t start in the morning even with anti-freeze. A drop light or two helps, but the oil gets so cold and the battery so weak, the starter is unable to turn the engine over..... let alone start it. Put an electric hot plate under the pan (not against it, but about an inch below it using bricks etc. for spacing) before you go in for the night. Run an extension cord up to the porch light or outlet and plug it in. In the morning before you're ready to tough out the cold…. Start the hot plate by turning on the porch light (a timer works super). The engine temp instrument will probably be off cold when you go out 15 to 20 minutes later! The engine spins over like its summer time! I've even used BBQ briquettes on stacked bricks for this a few times when there wasn't any electricity, but I'm nervous about fires around a gas engine. Besides, the briquettes are a real bear to get started in the morning when it gets that cold (even a match doesn't want to light!).

Ever blown the top tank radiator seam open while driving in bitter cold weather? I have. Story time: Middle of the night in my '48 convertible and coming home on Christmas leave in December of 1955. Had to come over Donner Pass in CA. It doesn't freeze in sunny CA so my flathead had only water in it. Outside air temp was a mite bit the wrong side of zero. Heater began throwing cold air all at once. The temp gauge had suddenly pegged on the hot mark. It had been on the normal side of the temp gauge like it always was. Pulled over to the side of the road and shut the engine off. Talk about cold! Felt it right a way since all I had were my dress blues. Thankfully I had my Navy Pea Coat. I popped open the hood and shined a flashlight around. Looked normal and no boiling sounds coming out of the radiator!!! Strange… it showed boiling. I gingerly loosened the radiator cap to the first notch to remove the pressure. It had lots of pressure. After releasing it, I removed the radiator cap.... it was barely hot to my hand! Strange. The water in the radiator was full. BUT IT WASN'T BOILING AND WAS ONLY ABOUT 140 DEGREES OR SO!!!! What was going on? Fired it up. Instantly the heater began throwing heat! I made a U-turn..... and watched the temp gauge while driving the 10 miles back to the last town I'd been through. Everything fine until just before the town. Then the heater started throwing cold air and the temp gauge climbed rapidly to hot..... then all hell broke loose...... the top of the radiator tank let loose and radiator water spewed out everywhere and quickly formed ice. Nothing to do, but limp on. There was an all night gas station (this was in 1955 when there were still such things as gas stations with service bays). The night shift kid let me use a shop bay while he looked over the customized convertible and it's dressed-up flathead mill. I managed to talk him into using his acetylene torch (after considerable discussion) to re-solder the top tank back together. I re-filled the radiator with water and started it in the service bay. Ran it for nearly an hour sitting in the bay while we emptied his coffee pot..... nothing happened and the temp stayed on normal. Headed on down the road. About 20 miles later it started to throw cold air out of the heater. Was watching really close and caught the temp gauge when it first came off the bottom end of normal. Pulled over to the side and shut it off. Pulled the cap off. Like before, lots of pressure but the water was full and about 140 degrees to the touch! And, like before, it was full to the brim. Started engine with the cap off. Heater began throwing heat within seconds. Dumb. Sat there with the engine running and the hood open while I smoked a couple of Camels from the ships gyp joint (I still smoked in those days) and thought about the problem. Finally dawned on me (who said smoking is bad?). Got out of the car and grabbed the overflow pipe extension at the bottom of the radiator. Frozen solid! I had clamped a rubber hose extension on the end of the radiator's metal overflow pipe to direct any radiator overflow away from the engine compartment (this was long before there were catch tanks). Condensation from the hot metal overflow pipe combined with the normal radiator puking and collected in the rubber extension tube where it soon froze solid since it was hanging down below the car. Air and water from the radiator couldn't escape which caused pressure to build. The pressure radiator cap opened like it was supposed to, but the pressure vapor couldn't escape. The pressure would continue building and soon the heater wouldn't get any water circulation and it would start throwing cold air. Pressure would build very fast until it got high enough and something had to fail..... like blowing apart the seam of the top tank. Simple cure once you figure things out. Removed the rubber extension and threw it into the cold night air. Started up and went on my way. No further problems except for an occasional blizzard or such. You might want to remember this if you're running straight water and have a rubber extension on your radiator overflow pipe (don't forget tubing for the catch tank) in cold weather.

DISTILLED WATER: I use only distilled water in a cooling system whether using straight water or mixing it with anti-freeze. All tap water contains impurities which will attack cooling system metals.... especially aluminum because it's soft, but it will also attack brass, copper, and zinc. When using plain water, with no anti-freeze, be sure to add a good rust inhibitor.

CHECKING COOLANT FOR RUST INHIBITORS AND THEIR CONDITION: As we all know, anti-freeze never loses its anti-freezing ability. It may get dirty, but it still has the same anti-freeze characteristics as when it was new. HOWEVER, the inhibitors last only a fairly short time. The most common solution to this problem, and I think what the manufacturers want us to do, is to replace the anti-freeze. But why not just replenish the wore out rust inhibitors? Problem is how to determine the inhibitors are no longer active.

Remembering our old high school physics..... Whenever dissimilar metals are immersed in a liquid in motion, D-C voltage will result.... or something along these lines. This will cause softer metals (like aluminum, zinc, brass, and copper) to transfer to harder metals by electrolysis. Inhibitors prevent this by reducing or eliminating electrolysis. Determining the condition of inhibitors can easily be checked using a Volt-Ohm-Meter (VOM). A digital VOM is easier to use than an analog (analog have scales and a needle) for this test. Turn the function selector to D-C volts. You'll be measuring voltages of less than 2 Volts so select a voltage of 5V or less. Hold one of the probes (either one) suspended in the coolant in the top radiator tank. Don't let it contact any metal. Ground the other probe to the metal of the radiator filler or tank. Read the voltage on the VOM. When the voltage exceeds 0.5 Volts D-C, the inhibitors are worn out and are no longer doing anything. Adding a can of rust inhibitor is all that's required. A voltage reading of 0.5 Volts DC or less show the inhibitors are still active and there is no need to replenish them. Remember, anti-freeze never loses its anti-freeze capabilities...... it only looses its inhibitors.

RUST INHIBITORS: There are many brands and types of inhibitors on the market. The one I use is called "No Rosion" and is used by most of the serious collectors of rare and exotic cars (would you believe our flathead Fords are exotic?). Price in the year 2009 is in the $30 range for a half gallon (4 pints), but it is available in smaller sizes. One pint treats a 22 quart system and one treatment lasts 3 to 5 years. It's red in color and is not sold over the counter to my knowledge, **but it is available direct from the manufacturer. Call Jay P. Ross. His cell phone is 847-477-9262.**

**************** PUMPS & RADIATORS ****************

REMOVING/INSTALLING A LOWER RADIATOR HOSE: These are tough because there isn't room to work in addition to the hoses always being stuck tight. Closeness of the radiator outlet and the water pump inlet certainly doesn't help matters either. The close proximity to the radiator fins usually ensure several cuts on knuckles in addition to flattened radiator fins. Using a screwdriver to pry around a stuck hose always ends up ripping the hose and sandwiches a few radiator fins in the process.

A tool I use that makes this a whale of a lot easier is a called a Cotter Pin Extractor. These look like a sharpened screwdriver that has been bent severely by an ape picking his teeth. These tools are very strong and won't straighten out. Each tool manufacturer uses slightly different bends, but any bend works fine. Craftsman and Snap-On are the ones I use. Loosen the hose clamps considerably so they hang on the hose and are not stuck to it. Then work the end of the cotter pin extractor tool in-between the hose and radiator outlet (or water pump inlet). It usually slips in without a lot of problems. Then work it around the hose to break the hose seal loose. Do the same to the other end of the hose. Then use the tool to pry up the ends of the hose and pull on off the radiator pipe or water pump. It makes things a lot easier. Oh yeah, they work great when installing a hose too. I wipe some engine assembly lube around the inside of the hoses to help things slip together easier. Boy am I lazy!

SEALING A LEAK: I've used lots of different things to seal radiators that leaked when racing stock cars. Everything from shredding cigarette tobacco to a half teaspoon of black pepper. Many worked pretty well, but would often clog the radiator if used frequently. Commercial sealers were never available at the track and most failed at sealing anything larger than a small drip. Alumnaseal and Barr's Leak seemed to do the best, but the Alumnaseal really loaded up the cooling system.

Recently I came across BG Cooling System Sealer (part #571). ABSOLUTELY SUPER STUFF! I saw a demonstration where the bottom of a beer can (I volunteered to empty it first) had been punched with an ice pick several times. They filled the can with water and held it up so the water poured out the holes. Then they added a mix of water and their tan colored sealer. The water completely stopped streaming out of the holes in less than 5 seconds!!!! Great stuff. Since it's organic, it doesn't harden in the system and plug things up like some other sealers I've tried over the years. It simply stays in suspension until there is a leak. Another thing I like..... flushing the system flushes it out. It doesn't adhere to the walls of the cooling system. I use it to seal head studs and head bolts when building an engine in addition to sealing radiator leaks on the road. It's so good I carry a can of it in my heap all the time. You never know when a rock or something will cause a leak. Oh yeah.... it will seal blown head gaskets if the hole is fairly small... even though it's not intended for that purpose. Least it did on a friend's blown head gasket. (Wonder if it'll work on a cracked block?)

WATER PUMP REBUILDING:

1) Press the shaft through the pulley from the front. Heating the pump shaft on the pulley side first helps. If it won't press through easily, drill a 3/8" hole (maximum size) down the center of the shaft from the pulley side.

2)Remove the shaft, bushing, and seal from the housing.

3)Press the new impeller onto the new shaft.

4)Press new bushing (or bearing) into the casting.
5)Install the spring, seal, etc.
6)Press in the shaft and pulley from the front.

PRESSURE RADIATORS: Ford radiators prior to 1949 were not designed to operate under pressure. The large top tank wasn't intended to have high pressures and would often split open the seams if a pressure cap was installed. A common flathead rule was: Never install more than a 4 lb pressure cap on an early radiator. Also see the following section on RADIATOR CAPS. Some, like the '40, had a vent line located some distance from the cap which vented the tank. Installing a pressure cap in one of these in hopes of making a pressure radiator system won't do a thing.

WATER PUMP FOR '37-'48 BLOCKS: The pumps to use on these earlier blocks are truck pumps. Regular pumps have bushings. Truck pumps have bearings. Truck pumps have a 5/8" shaft compared to the 1/2" shaft on the bushing type pumps so they can easily be identified. They usually have a double pulley. If you don't want to change pulleys and bore the bushing type pulleys to 5/8", grind off the outer pulley sheave.

WATER PUMP FOR 8BA ENGINE IN AN EARLY FORD CHASSIS: Use '49-'53 truck pumps with a single belt pulley. These have the same motor mounts as the 59AB series water pumps have. These are sealed bearing pumps too. It can't get much better than this.

CHECKING FOR A PLUGGED RADIATOR: This is from several local radiator shops. Remove the hoses. Plug the lower radiator outlet(s) with your hand or tennis balls. Then fill the radiator. Remove your hand and watch the water as it pours out the lower outlet. If the water comes out of the outlet in a swirl (like a whirlpool), the radiator is flowing good and doesn't need cleaning.

Although the radiator shops around here rely solely on this to determine if a radiator needs cleaning, I have reservations that any test which works can be that simple. It could be open in a few places and plugged in others. I always have the top and bottom tank removed and the radiator cleaned. Just my two cents worth.

RADIATOR FLUSHING: Most of the radiator flushes we get today are too weak to do much of a job. Back several years ago the instructions on the can warned users not to leave the flush in for more than 15 minutes. This was because the flush was potent and would eat holes in the soft radiators. Today's flushes are so weak (thanks again Big Brother) many instructions say to leave it and drive it for 24 hours! The following are listed in accordance to my preference....

(1) After market radiator flushes. There are probably many of these flushes on the market today that do a great job. They're all pretty simple and easy to use. The product I've had the best results with, and the one I use exclusively at this time, is BG Cooling System Flush (part #540). This flushes the system without fear of damage. Just follow the instructions. If you have a good parts house that deals in BG products, they will usually arrange for you to use BG's portable power flush machine at no cost. This really cleans the system quickly and easily.

(2) The following was contributed by NIRVANA on the Flathead Forum on 2/21/01. Distilled vinegar for an approximately 20 quart cooling system. Drain and flush with water. Partially fill the system with water before adding 1 gallon of white

vinegar (vinegar is weak acetic acid). Top off the radiator with more water. Drive for about a week (it's a weak solution). Drain and flush with tap water. Refill with water. Add rust inhibitor. This weak solution will not hurt aluminum, brass, or copper. I tried this and found it worked pretty good.

(3) Oxalic Acid. Oxalic acid powder is available from paint and hardware stores. Warm the engine up to operating temp. Mix 12 ounces of powdered oxalic acid in a quart of water. Pour it into the radiator. Run for about 20 minutes. Drain it and flush it at least twice with tap water. Then neutralize any remaining oxalic acid with ½ glass of powdered baking soda or bi-carbonate of soda mixed with tap water. Run for about a half hour and then drain and flush it with tap water a couple of times. Drain and fill with distilled water and add rust inhibitor.

*************** FANS ******************

FANS: Early Ford bulletins specify fans are to turn at 1½ times crankshaft speed to cool better during idle and slow speeds. This is a compromise since turning them faster increases fan noise. Turning them slower than 1½ times crankshaft speed will encourage engine heating at slow engine speeds. Adjust fan speed by changing the fan's pulley diameter. [[[[A puzzlement to me: Why did Ford install fans directly to the crankshaft in '39-'40? This makes for a 1:1 ratio. Is this why these get hot while idling or running at slow speeds?]]]]

FAN BLADES: The number of blades, blade pitch, and blade spacing all affect the amount of air flow.

(1) The more blades the more cooling. Five and six blade fans are found on trucks and other heavy duty applications where cooling is a big concern. Some fans come with the tips of their blades bent forward. The bent tips act somewhat like a shroud in reducing air being slung off the ends of the fan blades. Consequently, they cool better than a fan with straight tips.

(2) Four, five, and six blade fans all come with both equal and unequal blade spacing. Unequal spacing of fan blades seem to cool slightly better than equally spaced blades. A big advantage of unequal spacing is the reduction of fan roar.

(3) Flex blades. These are designed to flatten at speed since fans supposedly don't cool appreciably above 1200 rpm. It's been my experience all engines run hotter at all speeds without a fan. The cheaper after market fans of the stainless steel, or plastic, variety tend to flatten out too soon which results in overheating at anything close to highway speeds. The more expensive stainless fans don't flatten as easily and work better, but I use stock steel ones. I think the stainless varieties get weaker with use and age which leads to premature flattening of blades.

ELECTRIC FANS: Scott Cooling Fans advertise they have 6V, 12V, and 24V fans. 1-800-272-FANS. I've never dealt with them, but would certainly look carefully at amps the 6 Volt fans pull. Probably more than a stock 6 Volt generator will handle when normal loads are considered.

*************** RADIATOR CAPS **************

PRESSURE RADIATOR CAPS: For each pound of pressure cap, the boiling point will be increased 3¼ degrees F. Example: A 5 lb cap will increase the boiling point (212)+(3¼)(5 lb) = 212+16¼ =228¼ degrees F. Stock Ford radiators which did not come pressurized from the factory will usually tolerate a 4 lb cap, but many exceptions were discovered when the top tank blew! The large top tanks use thin brass which expands and contracts easily. This can lead to the soldered joints weakening and failing under pressure and elevated temperatures. New after market brass type pressure radiators will usually withstand 10-12 lbs even with their large top tanks due mostly to their improved crimping methods and thicker brass tanks. Aluminum radiators (they're brazed instead of soldered) are commonly built to withstand pressures to 40 lbs.... a lot more than our old flathead head gaskets will usually tolerate.

PRESSURE RADIATOR CAPS FOR '51 FORDS: Ford's '51 model cars increased the depth of their radiator necks for some hokey reason. The '49 & '50 radiators have a shallower neck depth. Consequently if a radiator cap for a '49 is used on a '51 radiator, it will not contact the seat and the coolant will be pumped out the overflow pipe at about the same rate as if the cap was left off. The '51 radiator neck is about 1/8" deeper than the '49-'50 if I remember correctly. Current parts catalogs and computers show the same cap for '49 thru '53 Fords. The best source is an early Genuine Ford parts supplier. Shimming with three layers of rubber "donuts" cut from inner tubes has been used successfully when a '51 cap was unavailable, but is not advised.

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