h.m. elliott inc.
CUSTOM PRECISION COATINGS

h.m. REPORT

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I don't know how many people like to read reports or even have the time, but I read them if I find something interesting, or maybe I can learn about a product or how to do something better. I try to make a paper informative, or write about a subject I think will help someone. This paper may answer a few questions about Coated Bearings and why you should use them. There are a lot of benefits associated with our coatings, not only for bearings but many parts in racing that people have not even thought about. Lots of times we have found that just coating things will not yield any great amounts of horsepower but will allow you to change up something in other places that will make a big gain in power or dependability. Maybe we can share some of these ideas later. But right now I would like to spend some time, if I may, on the subject of coating rod and main bearings.

The first thing I would like to note is that you will not gain horsepower in coating rod and main bearings if your purpose is to reduce friction. If everything is working right you will have very little friction at the bearings. Our purpose in coating the bearing is to provide a more durable surface in case something is not quite right, such as too much oil temperature, not enough oil temperature, or not enough oil pressure.

The coating materials we have selected for our bearings are made up of many different types of dry film lubricants which will work well with oils or greases. All these dry film particles have a wider range of temperatures than oils and greases. For the most part these materials are designed to work without other lubricants, but in the case of high RPM engines you still need oil or should I say **Oil Pressure**. Our coating materials are designed to support higher loads in case something does go wrong with your system. And GOD knows if you race long enough something will go wrong!

HOW CONNECTING RODS AND PISTONS EFFECT BEARINGS LOADS

Let's look at the connecting rod first and explain what it has to go through at high RPM's. The connecting rod does just that! It connects the piston to the crankshaft, and at high RPM's the piston gets mighty heavy. Studies have been made on just how heavy the piston can get. The piston assembly will weigh the most on the exhaust stroke.

A piston assembly, (piston, pin, locks, rings) weighing 600 grams will weigh 15,000 lbs. at 8500 RPM's. I know this seems like a lot, but what you have to keep in mind is how far the piston goes up, then it has to come back down on the intake stroke. What goes up must come back down! According to Sir Isac Newton or somebody like him!!

Think about what I just said about being on the exhaust stroke of the cycle. By the time the piston gets to the top of the cylinder all the exhaust is almost gone and the exhaust valve and intake valve are both open. So there is no cushion or pressure to help slow or stop the piston. The only thing to stop the piston at this point is the connecting rod. After the piston reaches its peak point of travel the connecting rod will pull it back down the bore. We have to also throw in the weight of the connecting rod. If the rod happens to be steel you have a lot of weight pulling on the crankshaft rod pin.

INERTIA

Now that 15,000 lbs. is called inertia weight, even if we just use piston weight you can see what kind of force the big end of the rod has to support. Even though it's called inertia weight it is still 15,000 lbs. pulling on the connecting rod. This happens for a very short amount of time but long enough to do some real damage. Ever wonder why you have to run at least .035 to .045 between the piston and head or the piston will touch the head at high RPM's. The parts trying to stop this runaway piston are stretching and the big end of the rod is getting pulled out of shape! As you can see in the illustration, on the next page, the rod is getting smaller at the parting line pressing the bearing closer to the crankshaft. Now if the bearing makes contact with the crankshaft all the oil film will be wiped off. So we have no load support from the oil pressure and the bearing will grab the crank and spin, or the crank will keep wearing at the bearing making the clearance much larger. When this happens oil pressure will drop and not be able to carry the load.

Our coating will not stop the crankshaft from getting to the bearing, but it will stop the crank from wearing the bearing and gaining more clearance.

One thing you need to note about connecting rods is the material it is made of because this will have a great effect on bearing life. Titanium and aluminum rods will reduce the inertia weight, but will have trouble keeping the big end of the rod round at high RPM's.

MEASURING BEARING CLEARANCES

We need to spend a lot of time on this subject. We have made some drawings to help explain what happens to rod bearings at high RPM's.

As I said before when engine speed goes up so does piston weight, which is pulling harder on the connecting rod and pinching the bearing at the parting line. Now all bearings are made with eccentricity built into them, which means these bearings have more clearance at the parting line, especially high performance bearings that will be ran at high RPM's.

Bearing clearance will be measured at the tightest point (In line with the wrist pin end of the rod). This is the measurement you will most likely record. You should also measure the clearance at the parting line. I would like to see 3 times as much. Example: I always like to run between .002 to .0025 at the tightest point, and try to have .007 to .0075 at the parting line. Drawing (A) will help you get the idea. As engine speed increases the clearance at the tightest point begins to grow (Drawing (B) and the clearance at the parting line begins to shrink.

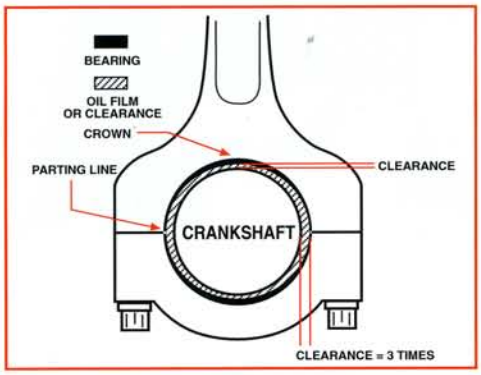
Now make sure you have good equipment when measuring and adjusting these clearances. The numbers need to be accurate. I have a system for measuring bearing clearances that is almost mistake free. Note I said almost! Give me a call and I will explain it to you. The system is much faster and will cut down on some confusion.

HOW AND WHERE TO MEASURE BEARING CLEARANCE

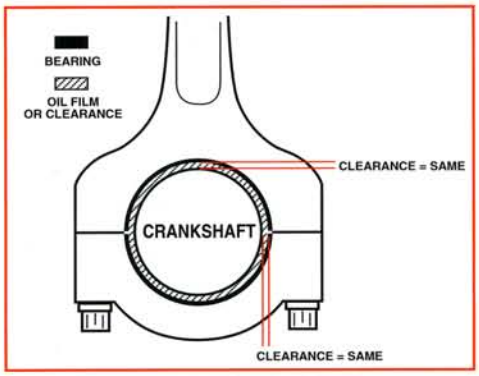
In drawing (A) our rod and bearing assembly are at rest. This will be the first measurement you will take and record. Drawing (B) would be at high RPM's. Notice the shape of the bearing bore in the drawing (A) and compare it to drawing (B), the bearing bore in (B) looks almost round. This is the product of the piston pulling on the rod and making the rod bore out of round, but because of the eccentricity of the bearing (thinner at the parting line) this brings the bearing bore almost round. This is good because now we have an equal amount of clearance, oil film, and pressure all the way around the diameter of the crank. The bearing has a way to go before touching the crank. This is the ideal shape for both rod and bearing at high RPM's. Now drawing (C) shows what happens if you either lose oil pressure or get the inertia weight too high. Note that the bearing has no clearance at the parting line and all lubrication has been wiped away.

If you see the bearing has been rubbing at the parting line, here are a few things you should look for.

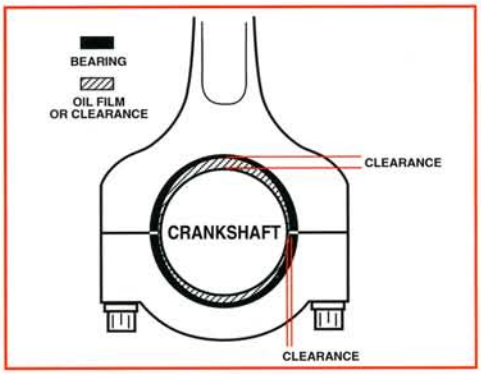
1. Too much RPM's for piston and rod weight.
2. Not enough bearing clearance at the parting line.
3. Too much overall bearing clearance (leaking too much oil)
4. Not enough oil pressure for RPM's. No.-4 could be a result of No.-3. In this case pressure would drop as RPM's increase.



DRAWING (A) 0-RPM
Note: More Clearance At The Parting Than At The Crown.



DRAWING (B) HIGH RPM's
Note: Clearance Is The Same On All Sides Of The Crank.



DRAWING (C) TOO MANY RPM's
Note: No Clearance At The Parting Line.

OIL PRESSURE AND OIL FLOW

One of the main reasons for bearing failures I've found, is lack of oil pressure or volume. And of course no pressure means no volume. So let's look at why oil pressure is so important and how it works. At this point I feel that pressure is more important than volume. We will cover volume later in the paper.

We all know oil pressure and oil flow are key factors in keeping bearings alive. Oil pressure is one thing that will help keep the connecting rod bearing bore round. So we must keep this pressure confined to as small a space as possible. Tighter clearances will certainly help maintain oil pressure at the bearing.

After I started to use coated bearings I found I could go tighter on clearances without getting into scuffing problems. After tightening the rod and main clearances I found we had more oil pressure. By backing down the pressure to where we normally run we saw quite a drop in the oil temperature. Everyone would think going tighter with bearing clearances would increase oil temperature. However smaller clearances mean not as much oil is escaping by the shaft and bearings and being whipped around by the crankshaft, counterweights and other moving parts. This is where most oil temperatures come from anyway.

HOW MUCH OIL PRESSURE DO YOU NEED?

We have learned over the years that 10 lbs. for every 1,000 RPM's engine speed will work well. For example, if you turn your engine 7,000 RPM's you need 70 lbs. of oil pressure, 8,500 RPM's you need 85 lbs. of pressure. Also I would recommend checking oil pressure as close to the engine bearings as possible. If you check your pressure before going through lines, coolers and oil filters you may get a false reading. Some of the things I mentioned may restrict oil flow. So you should check oil pressure after oil has passed through these items. You should be able to find an oil plug somewhere on the block to get your oil pressure. At times having lots of oil pressure means you are not getting enough oil to the most critical areas.

COATED BEARINGS WILL PREVENT COLD START-UP WIPING

Cold start up can do as much to damage bearings as anything. The reason is the oil

pump by-pass valve. The valve is designed to by-pass pressure so you will not blow off oil lines or rupture oil filters, because the cold oil is thick and will not flow well until it heats up and thins down. We learned about oil flow by installing a flow meter on the dyno. We were able to see that no matter how much pressure we had when we started to pump cold oil we had almost no flow. After the oil warmed up to about 150 Deg.F we noted about 2 gallons/Min. flow. When the temperature got to 200 Deg.F we saw about 7 gal./Min flow. This is being checked with 80 lbs. of oil pressure. Now I know what you are thinking, how can we have 80 lbs. pressure and no oil flow? Well our by-pass valve in the oil pump is set to by-pass at 80 lbs. If we did not have a valve to regulate the pressure we would see about 120 lbs. of pressure, too much pressure for filters and stuff.

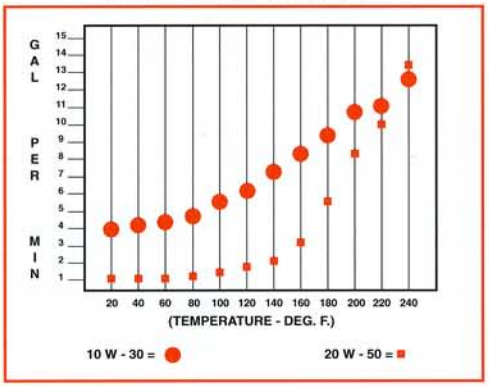
WHERE IS THE OIL GOING THAT IS BEING PUMPED

When the valve opens oil is pumped back to the negative side of the oil pump gears. So you can see we have almost no oil at the bearings. The 80 PSI you see on the gauge is the drag or resistance the heavy cold oil is fighting. Some oil is moving but not enough to support the weight of the connecting rod and piston assembly. This is the time when the bearings are most likely to touch the crank and wipe away some of the soft material. Our coating materials are designed to take this abuse. They are designed to work without other lubricants, but lubricants such as oil only improves its load-carrying ability.

We have learned that oil flow and oil temperature are very much related. Higher oil temperature will produce more oil flow. Oil weight also has a great effect on flow. Naturally the thinner the oil the more flow. The oil flow meter helped us understand more about different oil viscosities. We tested two oils of different viscosities made by the same manufacturer. First, we tested 10W-30 at different temperatures. Our second test was performed with 20W-50 using the same temperature range. We were trying to determine how much difference temperature and weight made on flow. (See oil flow chart)

You can see the 10W-30 oil flows quite a bit more at lower temperatures than 20W-50. Now remember what I said earlier about cold start-ups, see how much more oil you have to the bearings when the oil is cold. It is very important to take care when you first start your engine using the heavier oil. You need to start the engine and let the thing idle at a good smooth RPM until you get some oil temperature. Do not rev the motor at all if possible.

OIL FLOW CHART



With high temperatures at racing speeds the lighter oil will still lubricate as good as the heavier oil. However some people just feel better using the heavier oil. If you go with 20W-50 oil you need to heat the oil quite a bit before starting the motor. Like I said the lighter oil is a bit more forgiving at lower temperatures. In some cases you may not be able to heat the oil at all, like a wet sump system. It is hard to install heaters on the pan or anywhere that will heat the oil properly. With a dry sump system you have the supply tank which makes it easy to wrap with heating blankets or use a heating probe screwed into the tank. You should always pump some oil through the engine before starting, cold or hot it will still make a difference. Remember to keep the engine speed at a good steady low RPM, around 2000 RPM's until you see some oil temperature. The combination of light oil and coated bearings always look better in these cold conditions. Keep in mind when engine RPM's go up so will the demand for oil pressure at the bearings. If you rev. the engine up with the oil cold you may have lots of pressure on the gauge but none at the bearing.

HOW OFTEN SHOULD YOU CHANGE BEARINGS?

I have seen people run the same coated bearings twice and in some cases three times as long as non coated bearings. I think that depends on the conditions the engine had to go through. Too much oil temperature may cause the bearings to lose some crush and not fit in the housing bore anymore. If this happens I think I would change the bearings, even if the surface finish looks good. Bearings are not that expensive to replace, but some of the stuff they tear up when they fail can cost you a lot of money. Even if you ran this motor all season and had no problems, I would replace the bearings while I had the motor tore down.

If you are a Winston Cup Engine Builder the engine gets rebuilt after every race, short or long you are still going to look inside, or at least I would. But if you are late-model you may not rebuild the engine but one time a year. Even though you don't make as much horsepower or turn as many RPM's the bearings still get beat up. I think the problem is cold start up. In most cases the engine gets shut down on Saturday night and all the oil runs off the bearings and crankshaft. The engine doesn't get started up again until the next Saturday afternoon. Like I said before, it takes a little time to pump some oil to the bearings so they run dry for a short amount of time, just long enough to do some damage. This is the main reason our coated bearings will make a difference.

TAKING CARE OF YOUR ENGINE CUSTOMERS

Trying to sell coated bearings to a customer can be hard sometimes. But when the customer has a bad race where something goes wrong with the oiling system or they experience an overheating problem and the coated bearings save them from having to buy a completely new engine, they realize what good insurance they have bought. I know if I were building engines to sell, each one would have coated bearings in them before it went out the door. I feel this would be one way to protect my good name. A driver or car owner may not yell too loud if the motor is down on power a bit, but if it blows up you will hear about it real quick!

I feel that Winston Cup Engine Builders have the advantage over the guys that build engines for other people, mainly because they build the same engine week after week. They are a part of the whole experience, tuning and maintaining the engine throughout the life of the thing. They also get to examine the car and the people that have anything to do with it. If anything happens the engine guy is always there to make the right decision.

The guy that sells engines to someone and never even sees the car it goes in can be at a great disadvantage. Believe me, a lot can be wrong with the car and the people that take care of it. The car has to be filled with water and oil. This sounds simple, but mistakes can and will be made, not purging the air out of the water and oil system is the most common mistake I've seen. Maybe the customer has done something the same way for years, but what if he's done it wrong for years? Sometimes it's hard to find out what happened to the motor when the thing comes back to you in a basket. You will always hear the same thing, I did

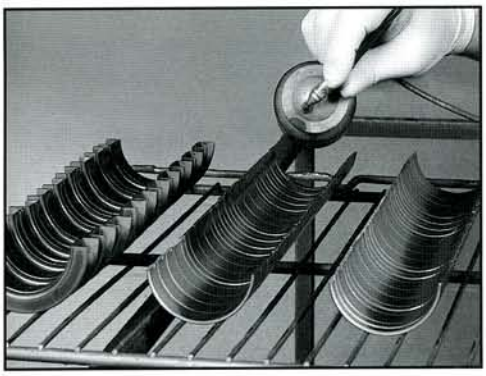
everything the same way as I have for years.

Everytime you sell a new engine to a customer you should give them a manual on how to care for this engine. The manual should cover what we talked about earlier with cold start-up's and purging water and oil systems. If they will follow the manual and tell you the truth about everything it will be easier to find out what happens when something goes wrong.

I have seen where the height of the radiator and oil tank can cause engine problems that are hard to diagnose. So you need to explain to the people in charge the proper way to mount these parts. Oil tanks and oil filters are almost always mounted in the wrong place. Almost all plumbing for the oiling system has too many ninety degree fittings which will really restrict the oil flow. Pressure will look good but no flow! You should go look at the car before the engine is started, it could save you some time and money.

COST OF COATED BEARINGS

Most engine builders I know will not or cannot afford to keep a lot of expensive parts on the shelf. It can get costly trying to keep up with all the changes in high performance parts today. A few years back we started keeping coated bearings on the shelf for some of the Winston Cup Teams because they were



always running short and needed bearings coated in a hurry. This way we could keep up with them or help them out when they were in a panic. This is why we try to keep a good stock of the most popular bearings on the shelf coated and ready to go. I think we can save you some time and money. I feel our prices are as good as anybody. Plus we have the best technical people in the business. We not only help a lot of people with their bearing problems, but we help them with other engine problems as well. Our staff has a lot of experience in racing and would be more than happy to share it with you.

Our best sellers are Clevite and Federal-Mogul. We also sell ACL coated cam bearings. Just give Lisa or Marie a call and tell them you read the newsletter and you would like to have the best deal they have. These girls know a lot about bearings and will be glad to help you with your bearing questions. Both of them will be posing for our swimsuit calendar later this year!

Well I hope you got something out of this report that will help you. If you have any questions about what you read or anything about racing engines please give me a call. Maybe my eighteen years as a Winston Cup Engine Builder can help you solve some of your problems.

We have learned a lot about our coating business in the last few years. I think we've learned which things to coat that will make gains in horsepower. We have learned that the engine is not the only place to get extra power. Some of the areas we have worked in are places that have to do with heat. Such as under the hood, insulating everything as well as we can to keep the carburetor air as cool as possible.

We have been doing a lot of work with the Dynojet people. I can tell you there is a bunch to be learned with this machine. One thing the Chassis Dyno has showed us is how much friction we have in the transmission and rear end. With one run on this Dyno we can look at the graph and tell exactly where to go for more power. We have done a lot of work in this area in the past two years. We have used the Chassis Dyno to greatly improve our coatings. We have had engines lose as much as 75 horsepower from the engine dyno to the car.

20 horsepower gains are not uncommon to see if you know where to look. We won't share anybody's secrets but we will share what we learned by doing our own tests. We found we were giving up a lot of energy when we put the engine in the car. Now we are not going to get all this power back but we can regain a great deal of it by coating the drive train.

If I had an engine shop, selling engines to customers I would find a way to buy one of these Chassis Dynos. It could be the best investment you've ever made. Like I said before you need to know everything about the car that you are building that engine for. Before it left my shop I would be satisfied that everything is working the way it should be. This way if the engine comes back to you in a basket you won't have to hire a detective to find out what happened.

NEXT REPORT

We will explain more about Drive train friction and what coatings will do to reduce it. The guys with quick change rear ends will learn alot from that paper. Also, I'll show how you can gain some power by keeping your late-model stock tuned for weather changes. Most people I've talked to run the same jets in the carburetor all year! So I know if you tune the engine right there is alot of speed to be gained. We have put together a kit that will help you keep the motor a little closer on jetting without hurting anything. Give me a call and I will explain the kit to you. Once you learn how to use it you will help your program in a lot of ways.

NOW OFFERING POWDER COATING