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Portable Bearing Machines

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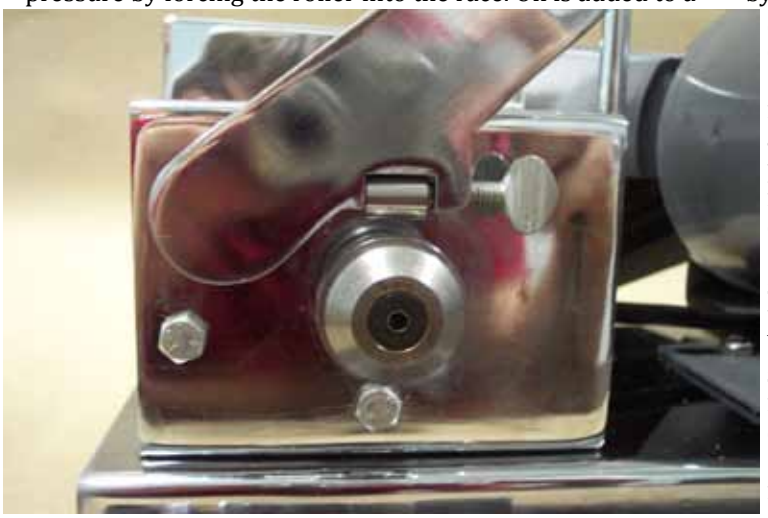
Portable bearing machines seem to be making another appearance. Just as one company settles with the Federal Trade Commission[1] or a multi-level company goes broke on unfulfilled promises, another one seems to spring up to take its place. They demonstrate with portable bearing machines on late-night infomercials, or send out an army of new recruits armed with the device to hoodwink unsuspecting consumers.

The purpose of this article is to expose the tricks being played with portable bearing machines. Let's take a look up the magician's sleeve.

The Apparatus

Portable bearing machines are small test instruments used to demonstrate EP (Extreme Pressure) performance in the field. Although EP tests are more appropriate for gear lubes or metalworking fluids, portable bearing machines are typically used to demonstrate motor oils or motor oil additives.

Portable bearing machines have a bearing race rotated by a motor. A roller from a roller bearing is clamped into the machine. A handle is used to apply pressure by forcing the roller into the race. Oil is added to a cup positioned so that the lower part of the race runs through it.



There are variations among portable bearing machine models. Some have a plain handle, some use a beam-style torque wrench for a handle, and others apply pressure by adding weights to a handle rather than hand pressure. Some bearing machines have a meter to measure current drain on the motor to indicate relative efficiency.

The bearing race used in these machines often carries a Timken stamp. Similarly, the box of rollers often has a Timken label on it. The slight-of-hand artists who use portable bearing machines usually call them "Timken bearing machines," which makes it sound legitimate and is easily confused with the Timken OK load test.

The demonstration is impressive. The magician puts some oil supplied by a member of the audience into the cup under the rotating race and applies pressure to the handle. Very little pressure is applied to the handle when the parts seize and the rotating race stops. He removes the bearing roller (that does not roll in the machine), and shows the deep wear scar left by the audience's inferior oil.

The magician clamps a new bearing roller into the machine and changes to the brand of oil he is selling or adds some of the additive he is selling and runs the test again. This time, tremendous loads are applied and the parts do not seize.

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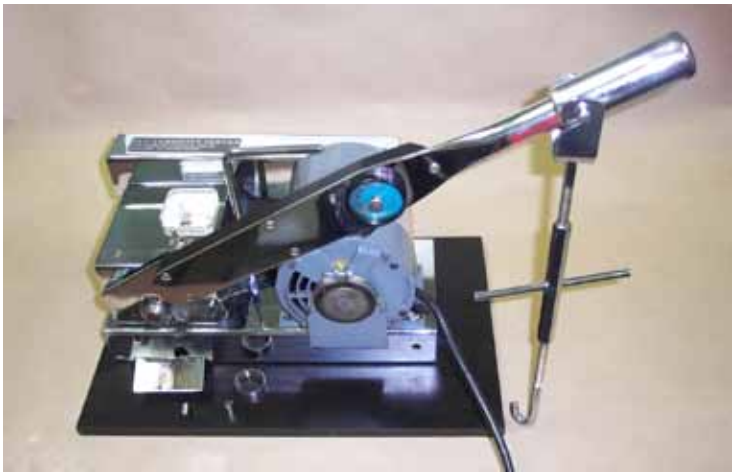
Sometimes anti-freeze is added to the magician's oil and it still does not seize. Then the cup of oil is removed from



under the race, and even running without oil, the machine does not seize. The magician tells the audience that his miracle product will save their engines if the oil becomes contaminated with anti-freeze or if all of the oil leaks out. Then he removes the bearing roller and shows a relatively small wear scar. In a mechanical sense, the magician's pretty young assistant has just been sawed in half, and it is hard to refute because you saw it with your own eyes. But how did he do it?

Timken OK Test

Before discussing how portable bearing machines work, it may be helpful to see how the Timken OK Load Test (ASTM D2782) is run for industrial gear lubes.

The Timken EP test machine is analogous to portable bearing machines. A stationary block is forced against a rotating Timken tapered roller bearing cup, creating a sliding surface interaction like a low-speed plain bearing. Oil is gravity-fed over the parts from a one-gallon temperature-controlled reservoir, and then returned to the reservoir. The bearing rotates at 800 rpm, and load is applied by weights to a lever with a mechanical advantage of 10.

In the ASTM D2782 procedure, runs are 10 minutes long. The block and cup are inspected for scoring. If there is none, the load is increased for another 10-minute run. The process is repeated and the load increased until scoring occurs.

EP tests often suffer from variation, and the Timken EP Test is no exception. The procedure is run three times and the highest load where the block and cup are acceptable (no scoring occurs) is referred to as the Timken OK Load. The lowest load where the block or cup scores during the three tests is called the Timken Score Load. Although many people are familiar with Timken OK Loads, not many have heard of the Timken Score Load because it never finds its way into marketing literature.

The fact that the test must be run three times and the Timken OK and Timken Score Loads are recorded, and often vary significantly, indicates the variability inherent in the test. Keep in mind the testing is performed on a large and expensive piece of laboratory equipment where the temperature and load are controlled.

Variability with a small portable bearing machine is much greater, and one must question their results. Casting additional doubt on the quality of results from portable bearing machines is the fact that having the D2782 procedure run by a reputable laboratory can easily cost more than a portable bearing machine.

Sleight of Hand

The way to make an oil fail the portable bearing machine test is to apply the load immediately. Do not allow the parts to wear into each other, which increases the contact surface and reduces the load on a per square inch basis. Just apply the load right away, whether the load is applied by hand or with weights, and the parts will seize.

To make an oil succeed, apply a small load and wear the parts into each other. Remember that a good magician diverts his audience's attention away from the trick. As the parts wear in, it is the ideal time to explain that your additive has to plate out, or attach to the metal, or fill in surface asperities, or some similar story.

Listen for the squeak. As soon as the squeak goes away, you can practically stand on the handle of the portable bearing machine, and it will not seize. Remember to grunt, grimace, and imitate muscle spasms so that it appears that you are using all your strength. The audience always appreciates a good show.

With practice, you can feel the amount of load that is just before seizure, and apply load according to your desired result. The concept is the same if you are using weights; it becomes a matter of timing the next addition of weight. If you need the machine to lock up, a little jerk on the handle or dropping a weight on the handle will initiate the seizure. To prevent seizure, apply the force or weight very smoothly.

To make a deep wear scar in the bearing roller, apply pressure at a level just below where seizure would occur. Then hold it there and listen for the squeak. As the squeak

diminishes, rapidly apply load to seize the parts. You have just made the test oil fail, and you can remove the bearing roller and show your audience a big nasty wear scar.

When the parts are properly worn in and you can apply a full load, add antifreeze, or water, or diesel fuel to the oil. Then remove the oil cup from the machine. The parts will not seize, and you can entertain your audience with speculation

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Case Study 1

Several years ago I received a call from salesman who was selling an additive that he demonstrated with a portable bearing machine. We scheduled an appointment for a demonstration for Thursday of that week.

The additive was making a big splash at the time, and I had received several questions about it in the weeks previous. In fact, someone had dropped off a bottle of the product for me. So, I went to the lab and carefully measured out the 2% recommended on the label, and added it to a quart of oil and secured a tamper-evident cap.

The salesman arrived for his appointment as scheduled, made a couple of claims that were impossible to support, and began his demonstration with the portable bearing machine. He reached for a quart of a leading brand of passenger car motor oil, but I interrupted and said, "Here, try this." I handed him what appeared to be a bottle of new oil, but of course, it was the sample I had treated with his additive.

He dropped three weights on the handle of the portable bearing machine and it seized up. He then squirted some of his additive into the mixture at a concentration far in excess of 2%, and proceeded to slide weights on one at a time. He was able to get his entire stack of twenty weights on the handle of the portable bearing machine without it seizing.

The demonstration continued for quite some time with various contaminants, no oil, and a comparison of wear scars. When he was done, I told him I had forgotten what the wear scar of the initial test had looked like, and asked him to run it again. This time the machine seized up on the oil treated with the recommended 2% of his additive using only two weights.

I watched carefully, and it was very subtle. When he wanted the machine to seize, there would be a small "click" as he dropped the weight about one-eighth of an inch. When he did not want the machine to seize, he would slide the weights on very carefully and there was no "click." The additive was probably of the EP variety, and was added into the cup of the bearing machine at a concentration that was probably over 20%.

I showed the salesman the bottle of his product I had used to treat the sample used in his baseline tests, and asked why it had not worked. He did not have an explanation.

By then we had wasted most of the morning, so he offered to investigate and come back with answers. I agreed on the condition that I would make up samples marked "A," "B," and "C," and he would test with his portable bearing machine to tell me which samples were treated with his additive. He declined.

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as to what would happen if all their oil leaked out, or antifreeze leaked into the crankcase, or fuel contaminated their oil.

With practice, you can make any engine oil look good or bad with a portable bearing machine. In fact, you can perform all the above "successes" and "failures" using the same sample of oil. You can make the wear scar on the bearing roller larger or smaller. It is all determined by the amount of force you apply and how quickly you apply it, before applying the full load.

When you become particularly accomplished in the art, you will be able to prove that water is a better lubricant than oil. That is precisely what a gentleman did to prove his point with the Better Business Bureau[2].

EP Additives

Slight of hand is not the only way to make a sale with a portable bearing machine. An extreme pressure (EP) additive can make a performance difference that is noticeable with a portable bearing machine. Motor oils contain anti-wear additives, but not EP additives. Simply add an EP additive, like those used in formulating gear lubes or metalworking fluids, and a portable bearing machine will sing and dance.

Using EP additives for this trick is more likely to be in an aftermarket oil additive than in a finished motor oil. The test is first run with a sample of oil from the audience. Predictably, it fails. The aftermarket additive is added to the oil that has just failed without changing to a fresh sample, and it is added directly to the little oil cup on the portable bearing machine. The directions on the additive's container may say to use one or two percent additive in your motor oil, but when it is added directly to the oil cup, concentration can easily be 20 to 30 percent.

This is a no-brainer. An EP test machine is used to compare oil without EP additive to the same oil with EP additive. Obviously, the oil with EP additive is going to perform better in an EP test. But is that what you want in your engine?

Apples and Oranges

The trickster with the bearing machine will usually claim the portable bearing machine indicates performance in bearings. It is an easy association—bearing machine with engine bearings, but an incorrect one. The bearing race and bearing roller used in the machine are steel on steel. Engine bearings are generally alloys of copper, lead, and tin: and soft enough to scratch with a fingernail. This difference in materials makes most EP additives undesirable.

Anti-wear additives and EP additives work similarly. They are activated by the heat of local hot spots and break down or react with the surface to form a chemical lubricating film that keeps relative surfaces from scoring or welding.

The "extreme" in Extreme Pressure is a relative term. Some people refer to anti-wear additives found in motor oils, such as ZDDP, as EP additives. However, like most people, we will use the term "EP" to refer to more highly reactive compounds, such as those of sulfur or chlorine that are used in gear lubes and metalworking fluids.

EP additives are more active and more corrosive than anti-wear additives. Generally speaking, there is a direct correlation between activity and copper corrosion. The more "active" an EP additive, the more likely it is to cause copper corrosion.

When the wear surfaces are the steel teeth of heavily loaded gears, EP additives greatly prolong their life. When the wear surface is copper or an alloy of copper, such as brass or bronze, the reaction of an EP additive can cause a corrosive attack and premature failure.

Here is an example. In the early 1980s, a 50-truck fleet in Texas switched to a different brand of diesel engine oil[3]. This oil contained a "moly" additive and was proven to be

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superior with a portable bearing machine prior to purchase. Within the first three months, 15 of the truck engines failed. Eventually, the majority of the remaining engines experienced early death from the same failure mode. Further investigation revealed that the problem was not isolated to that fleet or any brand of diesel engine, but occurred in many instances where the "moly" additive was used in an engine oil.

The "moly" additive was not molybdenum disulfide, which is the passive gray solid one normally associates with moly. It was the active EP additive, sulfurized molybdenum dithiophosphate. The engines' bronze cam follower pins experienced excessive wear due to corrosion and caused the engines to fail.

Due to this experience, Cummins devised a bench test where a four-sided box is immersed in oil at 250° F[4]. Each side of the one-inch box is a different metal—lead, copper, tin, and bronze. Air is bubbled into the box to promote oxidation for 168 hours. Upon completion, the oil is analyzed for metal content, and the copper side of the box is examined for discoloration[5]. Alarms are set to exclude aggressive products.

This Cummins bench test is part of the current API CJ-4 specification for diesel engines. There is a reason engine manufacturers specify oils that meet their requirements in nearly one-half million dollars worth of testing. Everyone would prefer a test that could be run in the field for 10 minutes with a machine that costs less than $500, but such a test can be dangerously misleading.

Aftermarket oil additives should be avoided because the finished formulation that is mixed in the crankcase has never been run through the specification's battery of tests. Although an aftermarket additive may improve one performance area of the oil, it is likely to compromise other performance areas that can shorten engine life rather than prolong it.

Disclaimer

This article does not suggest that everyone who demonstrates a product with a portable bearing machine lacks integrity. Sometimes a member of the audience is selected to operate the portable bearing machine, and instructed on how to use it. Certainly their integrity is not in question. EP additives are effective in portable bearing machines, and do not require any deceptive manipulation of the machine to show an enhancement in EP performance. Some sales reps using an EP additive in a bearing machine may be unaware of the harmful side effects, which makes them ignorant, not dishonest. Therefore, not everyone who demonstrates with a portable bearing machine is a "magician" that intends to deceive.

The purpose of this article was to reveal that portable bearing machines can easily be manipulated by the operator or a chemical additive to illustrate the desired outcome.

When you see a magician saw a lady in half, you know it is just an illusion. When you watch someone demonstrate a lubricant or additive with a portable bearing machine, the same level of skepticism will help you make the correct decision. Now that you know a few of their tricks, you can be amused by performers with bearing machines rather than victims of them.

References

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2. Better Business Bureau of Northeast Louisiana Newsletter, March 1982, Vol. 11, #3.
3. "Reduced Durability due to a Friction Modifier in Heavy Duty Diesel Lubricants" by R.D. Hercamp (Cummins Engine Co), SAE Paper 851260, 4/1/85.
4. "Development of a Bench Test to Detect Oils Corrosive to Engine Components" by Jerry C Wang and Carmen M Cusano (Cummins Engine Co), SAE Paper 940790, 3/1/94.
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Case Study 2

I happened by the bearing machine and instructions of an oil manufacturer that uses portable bearing machines for demonstrating their motor oils. It is interesting that the instructions do not treat the prospective customer's oil and the manufacturer's oil the same way.

The instructions say to ask for a sample of the customer's oil and pour it into the cup on the portable bearing machine. They say, "Start your demonstration by pressing the handle until it actually stalls the motor."

When it describes how to demonstrate the manufacturer's oil, the instructions say "Gradually increase your pressure, the machine will grind at first, but just as soon as the film takes over she will smooth right out…"

I obtained samples of the manufacturer's diesel engine oil and the leading brand of diesel engine oil. Armed with the instructions, I set out to compare the two products. The only difference was that I started with the manufacturer's product.

With the oil manufacturer's product, I pressed the handle until the motor seized, just like the instructions said. I switched to the leading brand of oil and followed the instructions by gradually increasing pressure. After it "smoothed right out," I could not make the machine seize. I used the oil manufacturer's instructions to "prove" that their product was inferior to the leading brand.

Then I started testing the machine with other brands and types of oil. The only engine oil I could find that could not be easily manipulated to look like a miracle product in the portable bearing machine was a non-detergent oil.