

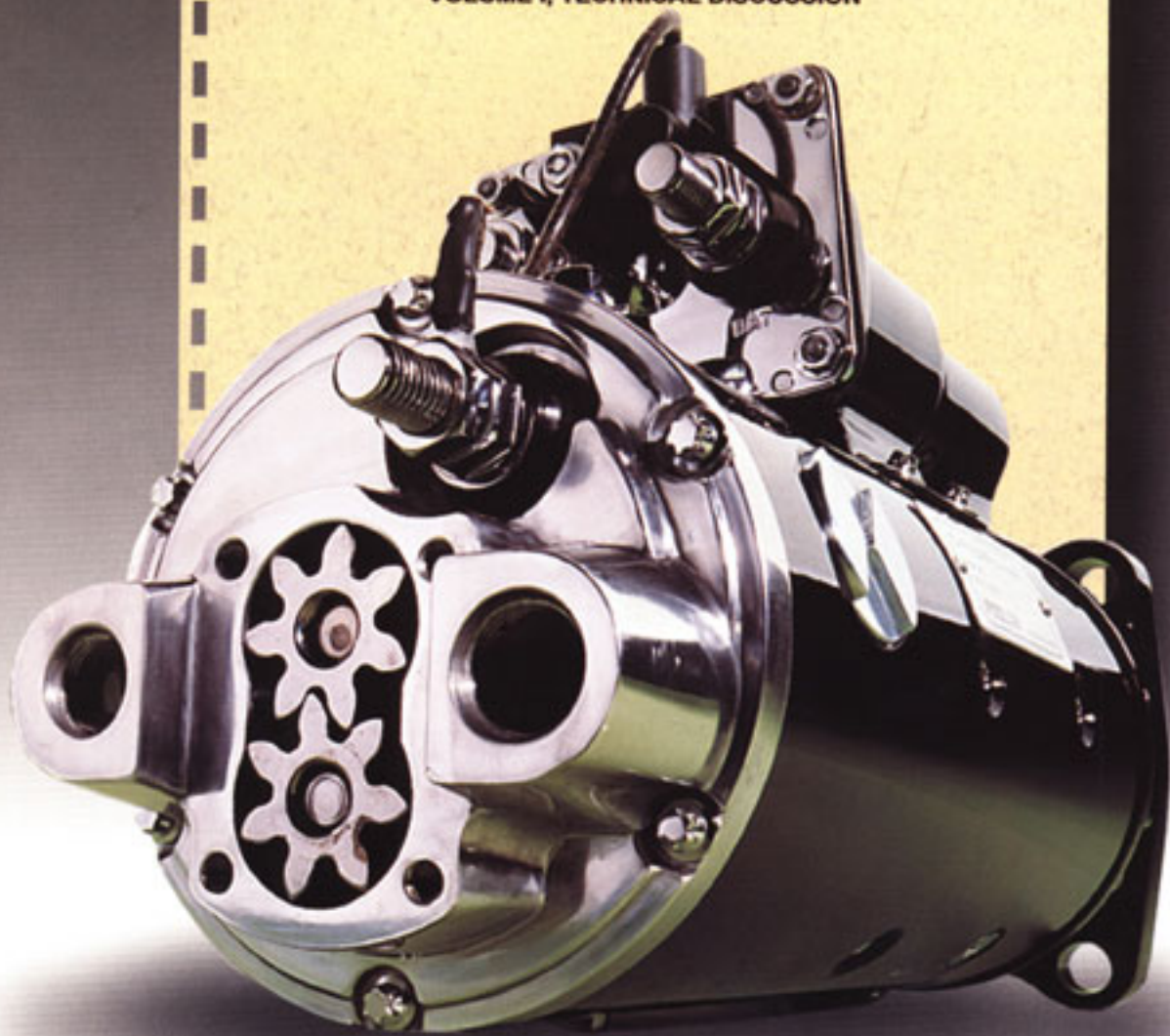
PRELUB™

The Proof You've Been Waiting For...

ENGINE WEAR EVALUATIONS

FINAL REPORT

VOLUME I, TECHNICAL DISCUSSION



The Prelub System... Proven to significantly reduce engine wear. Which really proves our customers were right all along!

Lubrication is the life blood of a diesel engine, especially today's high performance, fast starting diesels. For years, the Prelub starter has been protecting engines by requiring full oil pressure prior to cranking. Our customers have consistently reported extended engine life from 25% to as much as 40% more hours between overhauls. These additional hours are generating financial paybacks of as little as 5 months, and return on investments (ROI) of well over 70% per year – numbers even the fleet financial people have noticed. That's why more and more fleets order the Prelub Starter as part of new machine specifications and upgrade existing equipment at engine overhaul.

Still the question has remained, "Exactly how much does the Prelub system actually reduce engine wear?"

We decided to find out, once and for all.

We asked a major independent research institute renowned for its work in engine and lubricants testing to analyze engine wear both with and without the Prelub system (i.e. conventional start). This important research has documented conclusively that use of the Prelub technology will reduce engine bearing and ring wear by up to 60% on average under typical and severe start up simulations, which parallels actual field data reported

by our customers. As we look at the study, the research has proven what we should have known all along: that our customers were right. The Prelub system really is "Protection from the Start"™, and now we have proof.

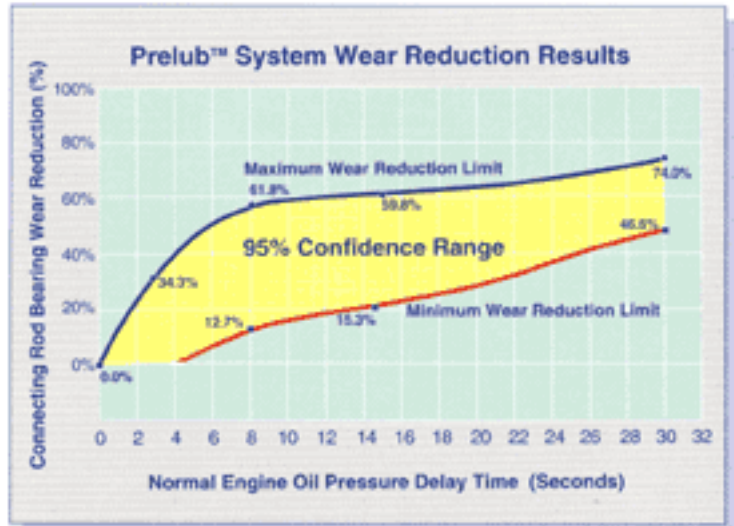


Figure 2.) This chart shows the minimum and maximum amounts of bearing wear reduction for various delays of oil pressure.

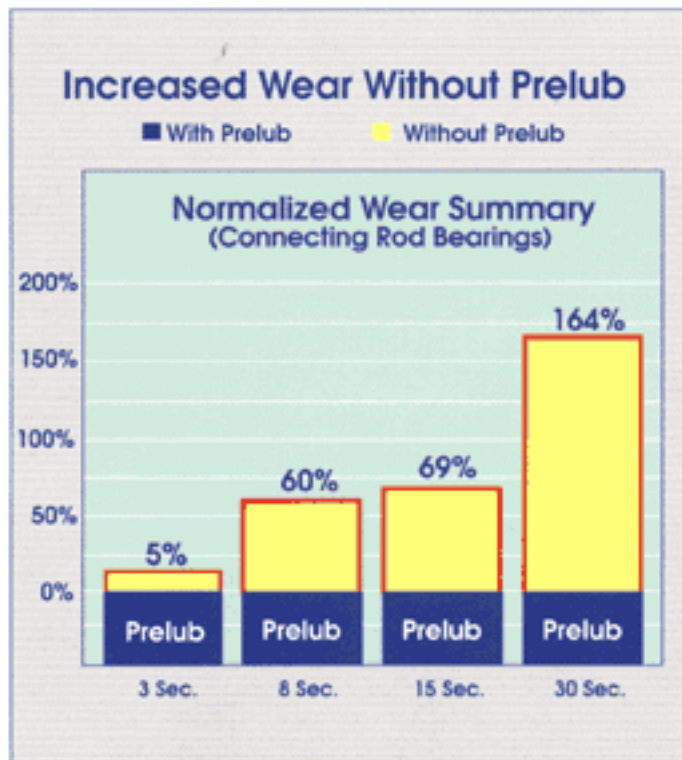


Figure 1.) The yellow bars represent the increase in bearing wear for various delay times prior to oil pressure.

What the research found:

The Prelub system "...can significantly reduce connecting rod bearing and ring wear in diesel engines."

"Connecting rod bearing and top piston ring wear are more severe at start up than during steady state operation."

"Connecting rod bearing and ring wear were reduced by up to 60% on average under typical and severe startup simulations." (see fig. 1)

"Rod bearing wear increases significantly after about 5 seconds of oil delay. Ring face and side wear ... increase rapidly after 20 seconds."

"Connecting rod and top piston ring wear increase with increasing dwell (shut down time) between engine starts."

Rod bearing wear using the Prelub system was 13 to 62 percent lower than wear during conventional starting where only 8-10 seconds of oil delay are experienced. (see fig. 2)

Where overnight and weekend shutdowns occur, total bearing wear rate is reduced by an average of 53%.

Research Results

The research study looked specifically at how long it takes an engine started without a Prelub system to achieve oil pressure. It then measured total wear for these "times to pressure" when the engine was started both with and without the use of the Prelub system. The results were dramatic. Where an engine sees as little as an 8 to 10 second time delay before achieving full oil pressure, use of the Prelub starter will reduce total rod bearing wear by as much as 60%...with a confidence of 95% (see fig. 2). In these conditions, the MINIMUM benefit will be a 12% reduction in wear. As times to pressure reach 25 to 30 seconds (as in severe cold ambients or following routine oil changes) use of the Prelub system will reduce total bearing wear by a minimum of 47% to as much as 74%. Where customers routinely experience overnight and weekend equipment shutdowns, use of the Prelub starter system will reduce the total bearing wear rate by an average of 53%.

Interpreting the Results

The data is clear: use of the Prelub system will significantly reduce key engine component wear; which, in turn, can mean significantly longer engine life and lower operating costs. Where customers have consistently been reporting improvements in engine life of as much as 25 to 40 percent, these ranges fall directly within the 95% confidence ranges as determined by the research (see fig. 2). In effect, the research has helped us better understand what's happening in the engine during start up, and how much cumulative engine wear can be reduced by using Prelub technology. Where overnight and weekend shutdowns are common, the Prelub system will reduce key component wear rates by as much as 53%. This has important implications for single shift operations, for marine and prime power and industrial applications where engines are operated for less than 2000 hours per year.

Other Benefits

Beyond significantly reducing engine wear, the Prelub system is the only such system that ensures oil pressure is built before the engine can crank. If an engine lacks oil, the Prelub system keeps it from starting, preventing catastrophic damage. The system can be used as an effective diagnostic tool to help detect fuel and/or glycol dilution. It can also be used to widen the effective temperature operating bands for 15w40 oils whose low end temperature spec normally is +5F. Where temperatures fall below the +5F threshold, the Prelub system will ensure oil pressure and flow BEFORE engine cranking can begin. In all these situations, the Prelub system WILL SIGNIFICANTLY REDUCE ENGINE WEAR AND HELP TO LOWER YOUR OPERATING COSTS PER HOUR.



Here's what the Prelub system has meant to one of our customers, reported in June, 2006.

Background: Montana coal mining operation, operating dozers, loaders, trucks...

- Average engine overhaul value (\$30,000)
÷
engine life *before* Prelub systems (9000 hrs.)
= \$3.33 cost per hour
- Average engine overhaul value (\$30,000)
÷
engine life *after* Prelub systems (13,000 hrs.)
= \$2.31 cost per hour

Cost savings = \$1.02 per hour

- **Total Savings = \$13,260**
($\$1.02 \times 13,000$ hrs.)
- Prelub System Cost Per Hour (Initial Cost Only):
12 cents per hour
- Actual Return On Investment (ROI):
129% per year per engine
 - Payback Period:
9 months per unit
- Eliminates one engine overhaul over 30,000 hour machine life

The Prelub™ system really is "Protection from the Start" and now you've got the proof!

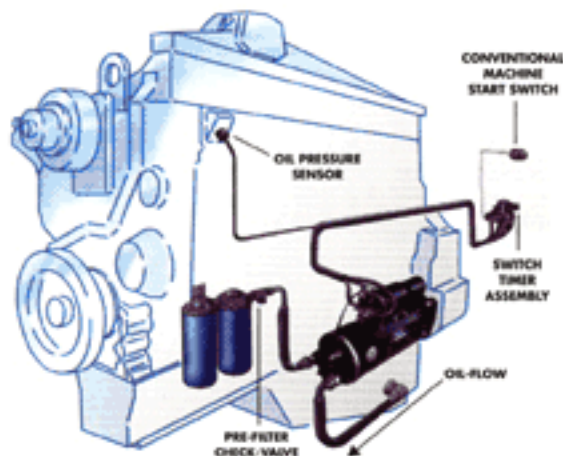


Figure 3.) The Prelub system works automatically from the machine start switch, and pressurizes the entire engine before it can crank.

What it Does

All engines suffer from accelerated wear as a result of periodic dry starts...especially today's high performance, fast starting diesels. And the larger the engine the more significant the cost. Dry starts can occur in very cold weather, very hot climates, after prolonged shut-downs, or following routine oil changes. Even remote-mount oil filters pose no problem as the Prelub system automatically, safely and quickly fills filters and all oil passages *prior* to cranking — every time the engine starts. And should someone forget to put oil in an engine, the Prelub system will not even allow the engine to begin cranking...a nice added benefit that means added protection.

Simple Installation

The Prelub system is as easy to install as changing a starter. Simply remove your conventional starter and install the Prelub starter. Attach two hoses, a pressure switch, and a simple wiring harness and you're done. The Prelub system is automatically wired to your machine's existing start switch and ready for immediate, simple and trouble-free operation.

Only three basic Prelub starter models fit virtually all Caterpillar®, Cummins®, Detroit Diesel® and other heavy duty diesel applications. Air start applications can also be accommodated.

How it Works

The patented Prelub system is automatically wired to your machine's existing start switch (see fig. 3). Simply turn the machine's existing start switch to the "start" position and the Prelub starter will automatically pressurize your

engine with oil pressure. Only then will the engine be allowed to crank. Your engine's oil passages, oil filters, and all critical parts from turbocharger to crankshaft are pressurized with oil before anything in the engine moves, every time the engine starts. The Prelub system's new automatic switching blends the best of solid-state technology with the simplicity of electro-mechanical components for a dependable and compact package. Special silver switch contacts and patented vibration protection are part of the package.

One time Cost

The Prelub system's one time cost on initial installation ranges from approximately \$700 to \$1000 (U.S.) over the cost of a conventional starter. And once installed, Prelub starter exchange units cost about the same as a conventional rebuilt starter. For this nominal one time investment the Prelub starter can save you thousands in engine overhaul costs, improve parts salvage at overhaul, and help you lower operating costs-per-hour. Payback period for the initial investment can be as low as six months. And remember, if the Prelub system saves even one turbo over the life of the engine overhaul, it has virtually paid for itself!

Who's Using it Now?

After it was introduced in 1985, the Prelub system has met with acceptance by fleet customers, dealers and OEMs. At Cummins Engine Company, the Prelub starter is a Cummins-branded mandatory feature on all industrial/construction applications of the K38, K-50, QST-30, QSK-45 and QSK-60 engine platforms. And it's available for fleet customers, dealers, and OEMs. The Prelub system is available as an option on most other Cummins engine applications. Caterpillar offers the Prelub starter as a factory installed production option, making it available on most earth moving models. Both new and remanufactured products are available. (The Prelub system is also available for other manufacturers, including Detroit Diesel, Komatsu, Deere and Volvo.)

Who Else Can Use it?

While the Prelub system has seen service mainly in the construction / industrial markets, it's useful for diesel engine users in virtually any industry. These include: Marine, On-highway Trucks, Transit, Municipal, Prime Power, and Standby Power.

Where Can I Get the Prelub system?

If you'd like the name and phone number of your closest Prelub Distributor, call RPM toll-free at 1 (800) 255-2250 or 1-888-4-PRELUB (1-888-477-3582).

PRELUB™

Protection From The Start®

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