Kart Engine Preheating : An Idea Whose Time Has Come

Adam Cornford

The No-Revving Revolution

Warming up the engine is one of the essential rituals every motor racer performs before getting on the track. Until recently, this ritual for karts just meant starting the engine cold and revving it. But

preheating the kart engine is gaining popularity worldwide because it eliminates this noisy, polluting, and potentially dangerous ritual. Even without the issues of racket, risk, and stink, though—not to mention new rules forbidding teams to rev their engines in the paddock—starting a racing engine cold is always a poor choice if there's an alternative. That's because you're using metal-to-metal friction , incomplete combustion, and expensive race fuel to warm it up.

A universally accepted solution to this problem elsewhere in auto racing is to use an *engine preheating system*. This method quietly builds and maintains exact temperatures of 135°F to 210°F using inexpensive unleaded gas from a small, quiet generator. Ten years ago, after thirty-odd years of precision engineering work at a National Laboratory in Livermore, CA, Pete Davis founded Hot Products Engineering Inc. and began designing and supplying preheating products for motor racing. Today, his Hot Head engine heaters are used by racing teams all over the world. Davis has now combined his engineering background and his own racing experience to develop a new product line that gives kart

racers the same advantages that other modern race teams—Indy Car, Le Mans, and SCCA—rely on. The newly offered Hot Head KartPro Competition Engine Heater is a TaG- and shifter-specific design and will generate an engine's optimum temperature before the flag drops. Industry leaders agree. Jason Berry of SwedeTech Racing Engines told me: "The Hot Head product line is going to change the way karters operate at the racetrack. This product is simply brilliant. My customers are saying, 'Why am I just now hearing about this?'"

Not Only Affordable, But Economical: The Preheater Advantage

In days past, only the upper echelon of race teams could afford to build or purchase engine preheating systems. These "white collar" F1, IndyCar, and NASCAR teams paid big money for systems to reduce the risk of engine failure and also relied on the power advantage during qualifying and initial starts. More recently, as "blue collar" teams have recognized these benefits and gone in search of them, they have spurred the development of a variety of lower-cost options. Pre -1980 engine heating systems were mostly crafted by team engineers at unimaginable costs. But commercial systems began to surface in the early '90s at price points that clustered around $4,000. While these solutions are still popular, the new millennium saw the arrival of systems in the around-$1,000 price range. Today, small-engine (that is, single-cylinder) preheating units can be had for as little as $639.00.

In karting, cost-vs.-benefit arguments always come up when teams are considering additional pit equipment. The data and statistics below show that investing in an engine preheater will improve a team's racing and reduce the costs of maintenance and engine failures. Once these costs are factored in, the $639.00 (base unit) price of the KartPro is on a par with the costs of other kart racing support products—even a simple kart stand. And unlike kart stands—or for that matter wheels, tires, engines, axles, or brakes—the heater pays for itself in maintenance and repair savings. Arguably, a preheating system is the only thing you can buy for racing that saves you money.

What Preheating Does For Your Engine

Two-stroke kart engines will only achieve peak power at a very specific temperature. An engine preheater will ensure that your engine is always within a narrow (+/- 3°F) range of that temperature, so that maximum power will be available right from the start. That ideal temperature depends largely on the type of kart being raced. John Sefcik, owner of SRS Kart Racing Engines, has found through testing that optimum temperatures are 135°F for (Stock Moto) kart engines that do not have engine-case cooling and 140°F for TaG-type engines that have coolant circulating through the passages below the cylinder. Achieving peak power is important to the outcome of a race, but not achieving it is unlikely to cause a DNF. What *will* cause a driver to not finish a race—and triple the cost of a race weekend for the driver's team—is a cold-temperature–related engine failure. Engine-manufacturing engineers responsible for assigning tolerances to critical engine components warn users about this type of failure when they are operating cold engines in cool weather.

[Sidebar]

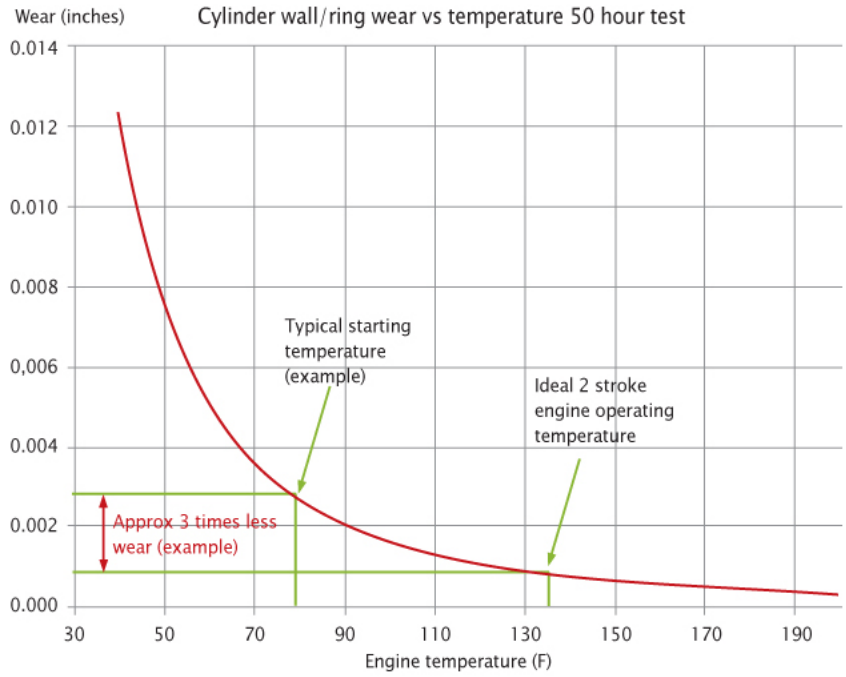
Running in cold weather (from the Rotax factory manual)

When the engine is used in colder temperatures (below 10°C or 50°F), using the standard main jet causes the engine to run leaner. From this a higher piston temperature appears due to hotter combustion causing the piston to become hotter and increase in diameter. Due to cold outside temperature, the engine might not reach the recommended minimum coolant temperature of 45°C or 113°F. In this case the cylinder will be less increased compared to the diameter of the piston. Due to the above, the piston -cylinder clearance might be at the lower end of the tolerance and increases the risk of piston seizure.

[Insert damaged piston image here]

[Caption] *Oil-lubricated sliding parts like it hot*

The benefits of preheating extend well beyond maximizing power output and avoiding engine seizures and other cold-engine, cool-weather damage. The life of an engine is directly influenced by the temperature it is started at. There is no debate about the fact that "cold starts" cause significant engine wear. What many may not realize is that high-rev starting even on relatively warm days can produce 300% more wear than starting after preheating. The plot below shows the results of combining heated lubricating oil and sliding metal parts that are also hot. Reine Persson, owner of Swedetech Racing Engines, agrees: " Starting a warm engine is always better than a cold start." What Persson says is confirmed by the data plot (below) showing the relationship between temperature and engine wear.



As you can see, the reduction in engine wear between a relatively warm 80°F starting temperature and preheated 135°F operating temperature is almost three times greater. Now consider an engine being started on a chilly (but unfortunately common) 40°F morning. The wear is *10 times* that on a preheated engine when started. To get a better sense of the significance of this huge benefit, Davis asks his customers to consider semi tractors and the fact that their engines last much longer than those of

conventional cars and trucks. Their service life routinely spans 800,000 to 1.2 million miles. Arguably their engine speed is about 1/10th of a modern karting engine's, so the adjusted value in engine lifespan is about 16,000 hours. There is no hope for this kind of longevity in kart engines, but the point is that semi tractor engines are run almost continuously, with limited cold starts. Karts, on the other hand, are started frequently and spend significant time coming up to temperature in these high-wear conditions.

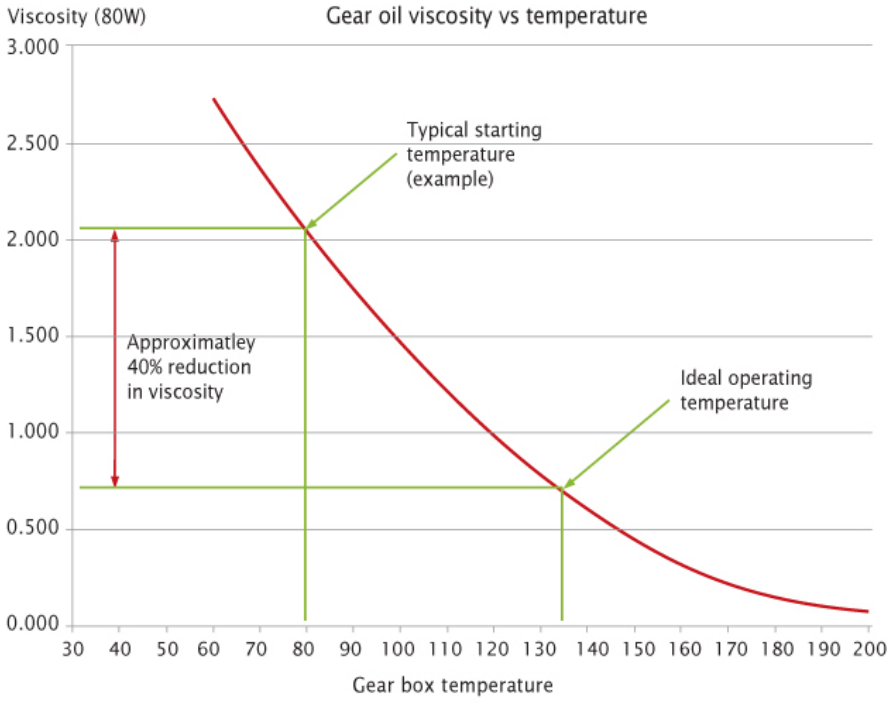
Improved Racing Performance

Preheating systems provide a number of performance benefits. To start with, primary engine power output produces acceleration and is dependent on temperature. So a driver whose engine is already operating at optimum temperature when the flag drops has an early advantage. Justin Bennett of Stock Honda Masters (Red Line Oil Championship Series) whose team preheats their engines, is enthusiastic: "Every time I get on the track, the engine feels like it does in the middle of a race, snappy and responsive. […] We get 'em when they're going slow—passes are way easier when you're freed up and everyone else is still building temperature."

Preheating has multiple advantages over running the engine on a kart stand. This is because the preheating process initially delivers heated fluid to the engine cylinders' water passages. In about 10 minutes the upper end and radiator are at temperature. Extending this process allows the heat to migrate into the crank case, clutch pack, transmission, and gear oil. This "heat soaking" delivers ideal piston, bearing, and gear clearances.

A thermal image of a preheater heating a single-cylinder engine. The vertical bar at right indicates the temperature gradient.

The kart will accelerate noticeably faster (than when it's run on a stand) because the migrating heat also heats the gear oil, reducing its viscosity, which in turn significantly reduces the drag caused by viscous sheer. The Engine temperature vs. Viscosity plot (below) shows how acceleration after prolonged "heat soaking" can be compared to acceleration after briefly running the engine.



The red line in the plot represents the recommended weight of gear oil for a shifter engine and the acceleration gains from heat-thinned oil. As already noted, heat-soaking to 135°F can reduce frictional losses by up to 300% when compared to losses at the typical 80°F gear box temperature.

Preheating maximizes the power your engine can deliver

No one will argue about the performance benefits from having ideal engine combustion temperature and spot-on carburetion. Preheating guarantees that ideal combustion temperature, but it also gives a team mechanic or an engine tuner the ability to take a quick listen throughout the day. Tuning by ear is common—but it can only be precise when the engine's combustion temperature is ideal. And of course, engine tuners are very busy, especially at national events. They warn their customers: "I can't wait here for you to start your engine and run it for five or ten minutes. Get it warmed up and I'll try to come back." A preheated engine will allow for immediate and frequent attention from a team's tuner because the engine is at temperature and ready to test. You can observe for yourself the evidence of engines not at temperature or not "jetted" correctly. Just watch the start of almost any race. FIA Championship team manager Miguel Governo puts it this way: "Even after warm-up laps, a smoking engine at the start of a race is evidence of power loss due to cold combustion temperatures. Since our team started using an engine heater, our preheated engine starts right up without using the choke. Our engine doesn't smoke—that's evidence that we are getting maximum power at the starting line."

[Insert smoking karts picture here]

Preheaters Pay For Themselves—And More

I mentioned that specific benefits are tied closely to the type of car or bike being raced. In karting, the savings from fuel usage may not be that compelling. However, consider the TaG Kart racing series, which requires "factory- sealed" engines. Karting champion Bob Hurst has been racing his Rotax TaG

kart for many seasons and had this to say: "Our team has historically stretched three sealed-engine rebuilds to be competitive through a full race season. We have been using a preheating system for two full seasons and have safely eliminated one rebuild each season because tell-tale signs of piston and ring wear don't show up as soon. This saved us well over $300 per season and a lot of downtime. We easily recovered the cost of our preheater well before the end of the second season of use. "

Preheating can save a kart racing team hard dollars while reducing engine wear, saving on expensive rebuilds, and virtually eliminating the risk of an expensive cold-piston seizure.

And Finally, the Zen Factor

Fritz Leesmann, top US karting champion, looking calm and collected with his team before the start of racing at Lancaster. The KartPro heater he used is indicated by the red ring toward the bottom of the picture.

Teams that use preheating systems tell of benefits that cannot be easily plotted or tied to savings. Nic Leduc, S1 SKUSA racer, says: "I chuckle when we see our competitors checking the line-up sheet, looking at their watches, and scrambling to get their kart out of their tent to get it warmed up. I'm relaxing and thinking about race strategy." Team owner Ron White tells us: "The time saved not running the engine allows us to take care of last minute set-ups from changing (track and weather) conditions. We can't

imagine practicing and racing without it." Preheating the engine, it seems, also saves wear and tear on the nerves of drivers and their teams.

Shhh! There Is a Quiet Rule

Anyone who has experienced the engine warm-up ritual in the paddock will agree that the smoke and noise are annoying—and polluting. These environmental issues coupled with recent injuries (a bystander was injured when a clutch failed at high revs) have led to a new ruling in Europe that is working its way around the world. This new FIA "quiet rule" forbids running the engine prior to practice or racing. So championship teams that preheat their karts benefit from the quiet and the cleaner air without the cold-engine performance degradation and risk of seizure. The new FIA regulation is quite firm and will undoubtedly prevail worldwide:

> ***13.2. Running of Engines In The Pit Lane, Grid and Pre Grid Area – Quiet Rule***
>
> *No engines are to be started or run in the Pit Lane or Grid area prior to a start of a practice, qualifying or race session until the signal to start is given by an Official. The starting up, running in, warming up or testing of engines cannot be carried out in the Paddock or Paddock lanes. This can only be carried out in an area designated in the Event Supplementary Regulations. You may start and run your engine for one 10-second period in the designated area prior to an on-track session.*

[Sidebar]

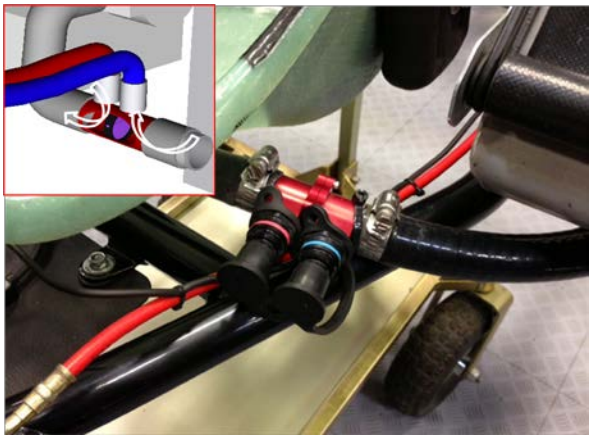
Collision imminent: The Quiet Rule and local preheater bans

Preheaters have been used at FIA-sanctioned events by championship-winning teams without scrutiny. However, there are series here in the US that do not allow preheated engines in the staging area. This isolates them from the world of auto, motorcycle, and R.C. car racers, who rely on the performance improvement and cost savings associated with preheating. Technical and business experts will undoubtedly continue to study the rules and present reasoning to pave a path to acceptance. Consult with your local organization(s) to learn their position on preheating.

The KartPro Solution: How It's Installed and How It Works

The Hot Head KartPro preheater base unit generates the heat and cycles coolant through the engine and cooling system. The compact and lightweight (15 lb) base unit uses the latest technologies including a seal-less, computer-controlled pump, which builds pressure using a magnetically driven impeller that spins on a ceramic bearing. Coolant flow is directed through a casting that houses a thermostatically protected heating element. Indy-car quality, lightweight, quick-disconnect (dry-break) fittings are used to supply and return fluid to and from the kart's cooling-system lines.

There are several ways to make the supply-and-return connection to the cooling system. The most efficient and convenient method is to use an *Integrating check valve*. This CNC-machined aluminum component houses a low-resistance flapper valve that generates a closed-loop path through the engine and radiator. The check valve's



color-coded, lightweight fittings accept the base unit's supply and return lines. In some circumstances there may be insufficient room between the engine's water pump inlet and radiator outlet to fit the 3-3/4" overall length. In this instance, two compact tees can be used: one can be fitted to the lines on the radiator supply and the other to the return. (This method does not take advantage of the flapper-style check valve feature, so some nonuniform heating occurs.) Each option is designed for a 10-minute installation, making it one of the quickest and most effective performance products for karting. A single unit can be used on several team karts or multiple karts can be heated simultaneously by "looping" them together with a "patch" line in series.

Conclusion: Preheating, Performance, and Price

Preheating not only dramatically reduces engine wear—it gets karts off to a flying start by optimizing acceleration and overall engine performance from the first seconds of a race. It lowers the risk of cold-engine piston seizure and of mishaps caused by high revving in the paddock, where it also eliminates smoke and engine noise before the race. And now that the “quiet rule” is spreading through racing, preheating systems offer the only way to get engines to optimum operating temperature before flag drop. According to the teams and builders who now use it, the KartPro will do all that, effectively and affordably. The KartPro is nationally distributed by Swedetech Racing Engines and is now available through local karting shops.

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