

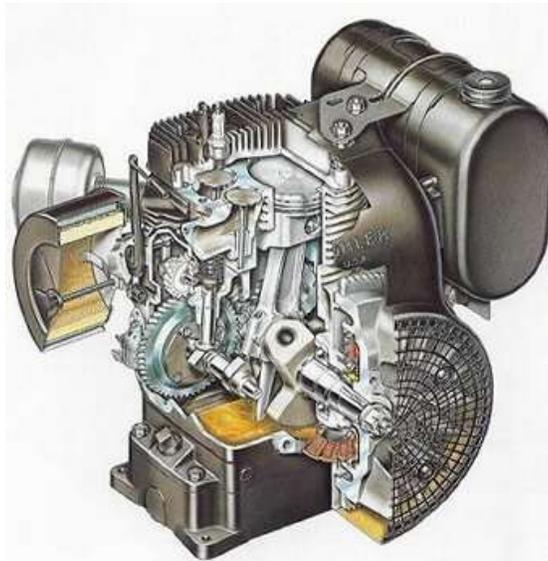
Building A Hot-Rod Kohler K301 For an IH Cub Cadet Garden Tractor

Part II - The Saga Continues

By David Kirk

I admit it – I’m a gear head, engine nut, and dedicated IH Cub Cadet enthusiast. Operating a Cub with an engine that I’ve personally detailed, modified, and carefully assembled is a highly enjoyable and gratifying experience. Those that don’t possess this “sickness” have difficulty understanding why anyone would build a modified engine for a garden tractor. Such clever quips as “Kirk’s goin’ lawn mower racin’, yuk yuk yuk” are occasionally heard, always from a non-credible source. I’m not discouraged – these types merely don’t grasp the concept. This article is dedicated to those who love engines, Cub Cadets, and who possess the same incurable “sickness” that I’ve been afflicted with.

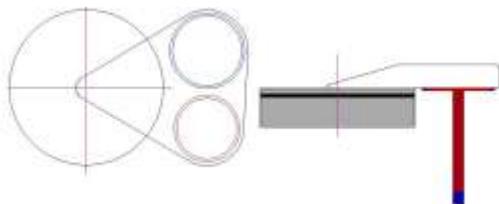
Like many projects of this nature, it never seems to be fully completed. One continues to make changes and improvements with the hope of gaining better performance – that’s what hot rodding is all about. This article will discuss modifications that I’ve done to my Kohler K301 AQS HR (HR for hot rod, and affectionately dubbed Killer Kohler) since the original series of posts were compiled in May of 2001. It’s hard to believe, but my logbook now shows 125 hours have been accrued on this engine. In this time it has never failed to start, has always run without a hiccup, and delivered more than ample performance for every task. It has, in a way, “personalized” my 1250 Cub Cadet and made it even more enjoyable to operate. The Kohler K-Series L-head engines respond well to the usual “souping” methods and tricks and will reward the builder with very noticeable performance gains. As stated before, I encourage anyone with the slightest interest in tackling such a project, to just do it! You won’t be disappointed.



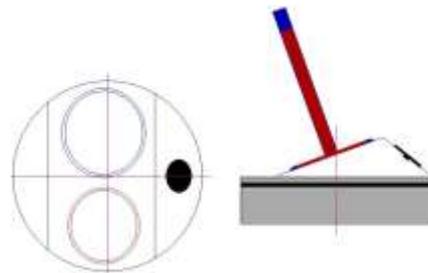
The Kohler K-series single cylinder engines set the standard for a well-engineered product

In the garden tractor competitive arena, there's a great deal of difference between a full competition Pro-Stock puller engine versus a stock class machine. For the former, high horsepower outputs developed at high engine speeds on alcohol fuels result in spectacular performance, but a narrow power band, short operational life, and the general expense just to fuel it, limit usefulness to track competition only. A more mildly tuned "street" engine should produce better performance than its stock counterpart, yet be flexible and docile enough to be used for typical garden tractor chores. My goal was the street engine as it was to be used primarily for mowing and snow throwing. Therefore, improved top end power, good startability in all weather, broad power band with acceptable low speed torque, and clean running with good acceleration characteristics were the prerequisites. Also, something that was comfortably affordable (money-wise) to do was important as well.

The Kohler K-series single cylinder engines are of the L-head configuration (both inlet and exhaust valves located in the block). Also known as a "flathead", this design allows for a compact and simple mechanical configuration at the expense of lesser performance than an OHV (overhead valve) design, mainly due to inferior breathing. This is caused by the cylinder head masking off about 30% of the valve circumference, and therefore curtain area, of both the intake and exhaust valve. With high compression ratios, another restriction is formed in the "trench" portion of the cylinder head's combustion chamber where it communicates with the bore. In comparison, the overhead valve engine will usually produce about 25% more power from the same displacement and valve size, mostly due to the higher delivery ratio (i.e., volumetric efficiency) that unmasked overhead valves offer. Other, less significant advantages of OHV technology are higher combustion efficiency (faster burn with less spark advance), lower surface to volume ratio (less heat loss to the engine structure), and reduced cylinder bore distortion due to the hot exhaust passage being located in the cylinder head, away from the bore. With all this going against the L-head, things can still be done to improve its performance quite substantially.



L-head is compact but airflow restricted



OHV has relatively unrestricted flow paths

But realistically, what kind of performance gain can be achieved by employing the usual hop-up methods? By examining similar engines that have responded well to performance modifications, one may make simplistic, yet accurate, estimates. One of the classic hot-rod engines was the Ford-Mercury flathead V-8, and much can be learned from studying souped-up examples. A really well prepared, streetable, 286 cubic inch Ford flathead

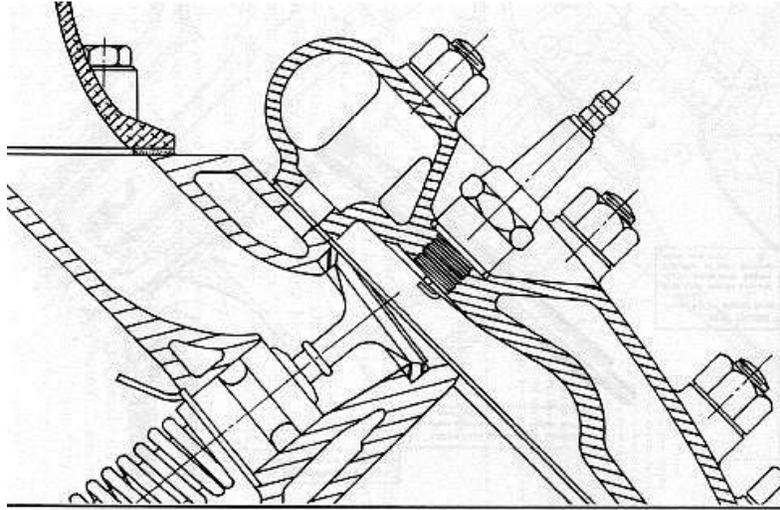
equipped with all the available speed equipment of the day would produce about 200 bhp (brake horsepower) at 4600 rpm on pump gasoline. This translates to .7 bhp per cubic inch, or a BMEP (brake mean effective pressure) of 120 psi at the peak power point.



The flathead Ford-Mercury V-8 – A hot rodding classic

BMEP is a specific term, allowing benchmark comparisons between similar types of engines without regard to size, number of cylinders, etc. It is a theoretical average cylinder pressure, back-calculated from the torque developed at that rpm. Knowing that a well prepared flathead will produce 120 psi BMEP, we can predict what the souped up Kohler will make in horsepower potential. For tractor use, the governor is a necessity and for long service life and safety reasons, we don't want to exceed 4000 rpm. Thus, 120 psi BMEP at 4000 rpm on our 30 cubic inch K301 calculates out to produce 18.2 bhp, or .6 bhp per cubic inch. This is quite respectable for a flathead engine and the 52% increase in power would definitely be noticeable to the operator.

Realistically though, there are a few things working against this performance level being attained from a single cylinder, air-cooled engine. A multi-cylinder V-8 has tuning advantages gained by long inlet runners and exhaust headers that can make use of pressure waves to effectively increase the delivery ratio. The Kohler, with its carburetor mounted in close proximity to the inlet valve, has no inlet tuning capability due to the short tract length. The exhaust system can be tuned though, and a straight header pipe of proper length (or a glass-pack, straight through muffler) can provide attractive gains. The other performance robber is the flywheel blower, which provides cooling air. Fans absorb power as the cube of their operating rpm. But cutting down the flywheel vanes to reduce this power loss also reduces airflow, and is not recommended for long-term engine durability. These additive losses reduce the target BMEP to realistically around 110 psi, where, at 4000 rpm, the engine should then produce 16.7 bhp – still a respectable figure from a stock value of 12.



Flathead Ford inlet passage, angled valves, and combustion chamber.
The Kohler is remarkably similar

The previous article, which originally was a series of posts, listed the basic internal modifications that were performed on a K301. The hot rodded engine was then transplanted into my 1250 Cub after removing the stock unit. After the swap, the performance increase was immediately noticeable over the stock engine (which, incidentally, was in excellent condition and performing up to par). Already a few more tricks were in the planning stages to extract extra potential from the internal alterations.

The next modification to be applied was a carburetor change that really brought out the best in the mildly hot rodded K301. I did this to both a Walbro and Kohler carburetor and they both ran great on my engine, with the Kohler carb having the slight edge in good transient response.

The standard Kohler carb for the 12 horsepower K301 engine is the #26, with a 1.067 throttle bore diameter and .81 diameter venturi. The 16-horse carburetor is the #30, with a 1.197 diameter throttle bore and .935 venturi. As I've mentioned before, a relatively broad torque band and good, crisp throttle response was desired. It's used to mow and throw snow so going too wild is not good. When it comes to carburetion, bigger is not always better and in many cases, can be worse in the part throttle and transient ranges. In putting a #30 on a 12 horsepower block, one discovers that the carb throttle bore is larger than the inlet port diameter. This means grinding the port to match the carb. In my opinion, it's a lot of unnecessary work for an engine that isn't going to turn over 4000 rpm. Basic calculations show that the velocity of the air through the venturi of the stock #26 carb at WOT on the inlet stroke at 3600 rpm yields a Mean Mach Index of .503 (Mean Mach Index is defined as the calculated air velocity divided by the local sonic velocity). For high performance engines, you'd like to stay below .6 and the stock carburetor already is! But now we'd like to turn the souped up engine a little faster to extract more horsepower.

By boring the carb venturi of the #26 carburetor from the original .81 diameter to .875, the area increases from .515 to .601 sq. inches, or a 16.7% increase. Now recalculating the Mach Index at an increased 3900 rpm, we get a value of .467, clearly lower therefore less restrictive than the original at 3600 rpm. One could go bigger yet on diameter, and some remove the venturi all together. I think this is unwise for a working tractor for reasons mentioned above.

Proof is in how well it works and this modification seemed to put the finishing touch on the engine. Throttle response is unaffected with crisp, clean acceleration when the throttle is slammed open. Full throttle operation is where one will really notice the power increase. To compliment the potential airflow improvement, a K&N high flow air filter, part number E-4655, is fitted. This filter element is an exact replacement for that used in the Kohler AQS engines found in Quiet Line Cub models.

A picture showing a stock Walbro and the identical carb with venturi machined is shown below. It's hard to tell from the picture, but the bored one is on the right. Although the Walbro is an excellent carburetor and can be made to perform well, it is difficult to work on and requires special tools to completely disassemble. The Kohler-made carburetor can be completely torn down with a few common tools, making modifications much easier to execute.



Walbro carburetors – modified one on right

The exhaust system was the next component to tackle. As previously stated, a tuned length straight exhaust stack provides beneficial peak power increases, this being accomplished by a negative pressure wave timed to arrive at the cylinder during the valve overlap period. The sub-atmospheric pressure pulls fresh charge into the cylinder thereby scavenging the remaining exhaust residual, increasing trapped charge purity, and ultimately power output. The downside to all of this is that a straight exhaust is just too noisy to operate in a residential neighborhood (even though I'd love to). A second alternative is to substitute a low-restriction muffler in place of the stock system.

The standard muffler used is a three-chambered affair, housed in a 12 inch long by 5 inch diameter can. While effective at reducing noise, it is somewhat restrictive to gas flow as compared to a straight through glass pack. Searching several catalogs yielded nothing in a high performance muffler in this size and configuration. A serviceable, used, standard muffler was thus obtained and the end cap removed by grinding away the crimp. The internal baffles and central tube were then removed by chisel and hammer, carefully breaking through the spot welds. After removal, an empty can remained. A ¼ inch thick sheet of muffler fiberglass wool was carefully measured and cut to line the inside of the can diameter. A matching sheet of perforated steel was cut and placed inside of the fiberglass wool. The perforated sheet was tack welded on the seam such that it forms a rigid cylinder to tightly hold the fiberglass against the outer can walls. The end cap was welded back on and the muffler painted with high temperature “barbeque black” paint. It looked totally stock from outward appearances.



The Quiet Line muffler, in stock form



Fiberglass wool and perforated metal

I reassembled it to the engine, eagerly anticipating the sound to be pleasingly noisier. To my amazement, the muffler was actually quieter than stock! But it did have a nice, deep, healthy sound, especially when the engine was carrying a heavy load. I had to slightly richen the high-speed needle setting on the carburetor – a positive sign indicating that airflow had been increased by this modification. Instead of the exhaust flow having a tortuous and restrictive path to the outlet, it now exits into a large volume plenum with pressure waves muted by the absorption properties of the wool. The engine now felt stronger than ever with a baritone authority to its voice.

During this time I had started a small business to make some engine components that other forum members had shown interest in. The billet breather cover, mentioned in the original series of posts, generated several inquiries so I decided to have some produced, along with a matching fuel pump cover. Red anodized billet aluminum parts have always been a speed equipment standard, hence the surface treatment and color chosen for these covers. Really not a performance enhancer, they do, nevertheless, dress up the engine in the hot rodders tradition. The increased breather passage cross-sectional area in the billet breather is less restrictive and this appears to keep the oil cleaner, but there’s no scientific

proof of this. The extended hose for breather gasses to exit keeps the exterior of the engine oil-free.



Billet aluminum covers

The next system improvement was that of the ignition. I'd never experienced any problems with the stock system, but read of other forum members complaining about burning points and failing condensers and coils. Remembering the transistorized aftermarket systems popular in the '70's when cars still had contact breakers, a search was made to find a company still producing them. Nothing of any value was found. Discussion then ensued with a friend who is expert in electronic systems. He discovered several semiconductors available that would do the switching job much more efficiently than the older transistorized circuits and came up with a module that installs between the ignition coil and breaker points. The condenser is disconnected, as it is no longer required. Current to the points is reduced from around 2.7 amps down to 100 milliamps. This 96% reduction in current enables the points to last virtually the life of the engine, as pitting and deposit formation no longer occur. The semiconductor allows faster current switching and elimination of the condenser causes no current oscillations in the circuit. This yields a higher secondary voltage discharge translating into a hotter spark at the plug. Without current oscillations, inductive tachometers (like the TinyTach) can be used and operate with accuracy. The semiconductor chosen is highly over-designed for the voltage and current loads imposed thus imparting high reliability. An LED static timing light was incorporated to allow easy and accurate ignition settings.

Several prototypes were made and I installed one on the tractor in September of 2003, along with a set of new breaker points. The system performed well during the winter with the engine starting very reliably even on the coldest days. It was decided to market

these units under the name “PointSaver”, as that was the strongest feature. I’m still running this unit on my engine today, along with the same breaker points and spark plug.



Prototype PointSaver installation



Bosch “Blue” ignition coil

A Compu-Fire brand, oil-filled, aftermarket ignition coil supplied juice to the spark plug and worked well with the PointSaver. But I was aware of the praise that the Bosch “Blue” coil has among pullers. These coils are epoxy filled which is highly desirable, especially on a single-cylinder engine where vibration is severe. They seem to be totally reliable – I’ve never heard of one failing. I purchased a Bosch “Blue” and pressed it into service during the spring of ’04. It really complimented the PointSaver with both running quality and starting being superb. I then decided to market both the module and coil through my mail order business, as they offer a significant upgrade in ignition performance, reliability, and lowered maintenance. My tractor and engine had become a research vehicle for product development – an interesting scenario.

After approximately 50 hours were obtained on my Kohler, I switched to Mobil 1, 10W-30 synthetic oil. The chrome top compression ring on a cast iron bore takes a while to break in properly, and 50 hours is considered about average. A pure synthetic lubricant in an air-cooled engine is ideal, mainly due to the higher oil temperatures these engines generate when compared to their liquid cooled counterparts. The synthetic maintains a more stable viscosity and offers higher film strengths at temperature plus superior dispersant and detergent additives. Oil is changed every 25 to 30 hour intervals, which for me, works out to one change per year. It’s amazing how clean the oil looks after this amount of time – certainly not black, but a dark, amber color. It could easily go to 40 hours, but that’s not recommended. The engine needs a topping off about every 10 hours but it only takes a few ounces to reach the dipstick “full” mark. Killer will get a steady diet of Mobil 1 throughout its operational life.

I’m also a believer in Marvel Mystery Oil and use it religiously in the fuel, mixed at 2 fluid ounces per gallon of gasoline. It has been conclusively proven (to me) that hard carbon buildup on the cylinder bore top land area and in the ring grooves, is greatly reduced by use of this additive. I’ve talked with aircraft A&P mechanics who have

praised MMO for how clean it keeps the internals of the air-cooled engines they service. This is convincing evidence that MMO is one additive that really works. I've also experimented with running different fuels, from 87 octane unleaded to 100 low lead avgas. I cannot tell any difference in performance or running characteristics, other than the smell of the 100 LL – absolutely wonderful! The long-term effects of running this leaded fuel will contribute to more combustion chamber deposits and is probably not the wisest selection of fuel to run, to say nothing of the price. The engine has never shown any tendency to spark knock, detonate, or run-on, even when operating on 87 octane gasoline. Normally, 89 octane unleaded is used just for a safety cushion.

Another modification made, while not a performance enhancer, was to the starter motor. During the winter, I had problems with slow cranking speed and usually several false starts (Bendix drive kicking out during the first combustion event) before engine would self-sustain. The hydrostatic transmission puts an additional torque load on the system in cold weather, which exacerbates the problem. I had come across a starter for a newer, vertical shaft Kohler that was exactly the same physical size as the K-series starter. Part number is 36264. Only major difference being the new model was flange mounted while the K-series is a side mount. Disassembly and examination of the new starter revealed that the wire diameter on the armature windings was .050 versus .046 on the original. Also, the new one had epoxy on the windings for better retention. Armature diameters, lengths, and shaft sizes were identical, as were pinion gear travel and number of teeth. Thus, it seemed rather straightforward to put all the newer parts into the old starter frame and wind up with something that would give a little more cranking effort.



Newer armature (on right) had larger wire diameter

A nice improvement in the newer starter is the Bendix drive pinion has a friction clutch such that false starts are eliminated or greatly reduced. The pinion and driver are a two-piece component versus the older style single piece. The pinion gear and return spring is retained by a snap ring and collar arrangement rather than the older style threaded nut. Some machining was required on the front bearing plate to remove the flange mounting

ears that the newer starter featured. The new armature and modified bearing plate mated up perfectly with the old frame and brush end cap. The modified starter is shown below.



The Super Starter – a mix of old and new parts

Well I'm happy to report that this super-starter works GREAT! It spins the engine over at a noticeably faster rate yielding instant light-offs. It's also much quieter and has a nicer, precision sound versus the original, "grind some for me" racket that reminded me of an old school bus I used to ride as a kid. The thicker front bearing plate posed no installation problem and everything cleared and fit fine.

As is typical of these types of projects, there are a few things that I'd have done differently if given another chance (and it's never too late to redo). One is the exhaust valve, which on the K301, is 1.10 outer seat diameter versus a 1.36 diameter on the K321 and K341. The larger diameter is the same as the inlet valve size, which is common to all three engines. Simple calculations had shown that the area increase was hardly worth the machine time and effort to fit the larger valve. Sometime later, and after the engine was all together and running, I modeled the system using Virtual Engines, a powerful piece of computer software allowing highly accurate performance predictions to be made. This program (which will subsequently be discussed) indicated a ½ horsepower increase at 4000 rpm with the larger valve. While this isn't spectacular, going with the "every little bit counts" mindset is what cumulatively makes for a strong engine.

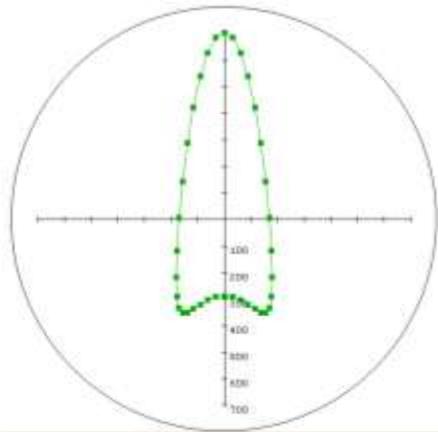
Another item on the "wish I'd done that" list is rebalancing the crankshaft. Balancing a single cylinder engine is a compromise – that is, forces can be reduced in one direction at the expense of increasing them in another. Altering these rotating and reciprocating dynamic forces is accomplished by changing the mass of the crankshaft counterweights. Weighing the pertinent parts, measuring the counterweight moment on a static balancer, and then performing some calculations, I was surprised to find the K301 RBF (Reciprocating Balance Factor) to be only 26.8%. The K321 and K341 are a little better at approximately 40% (these are all determined for engines without balance gears). There is a theoretical "ideal" RBF, in which the dynamic forces are equal along both the vertical and horizontal axes. This is a function of the engine L/R ratio (connecting rod length/crank throw radius) and for the engines in question, results in a balance factor of 64%. In practice it is found that a RBF of 50-55% is preferred for the "system", that is,

engine mounted in the tractor. To accomplish the rebalance, a steel counterweight plate is fabricated with the appropriate thickness, and attached to a machined side surface on the pto-side crank counterweight via screws. This alters the effective counterweight moment and therefore the RBF. A modified crankshaft is shown below.

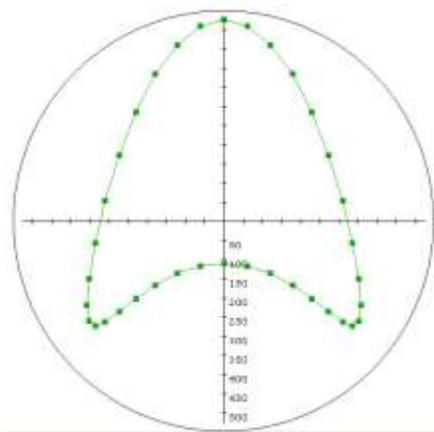


Rebalanced crankshaft

Advantages of this modification are (first and foremost) less transmitted vibration into the tractor. This is especially true when removing balance gears on engines so equipped. Additionally, the reduction in the peak vertical forces result in lower loads imposed on the main bearings, and the slight force couple caused by asymmetry in the stock counterweight thickness difference is virtually eliminated. The change in a stock 26.8% versus 53% RBF is graphically shown in the polar plots below. This is the unresolved dynamic force (that causes transmitted vibration) calculated at 3600 rpm.



26.8% RBF. 703-lbf vert., 181-lbf horiz.

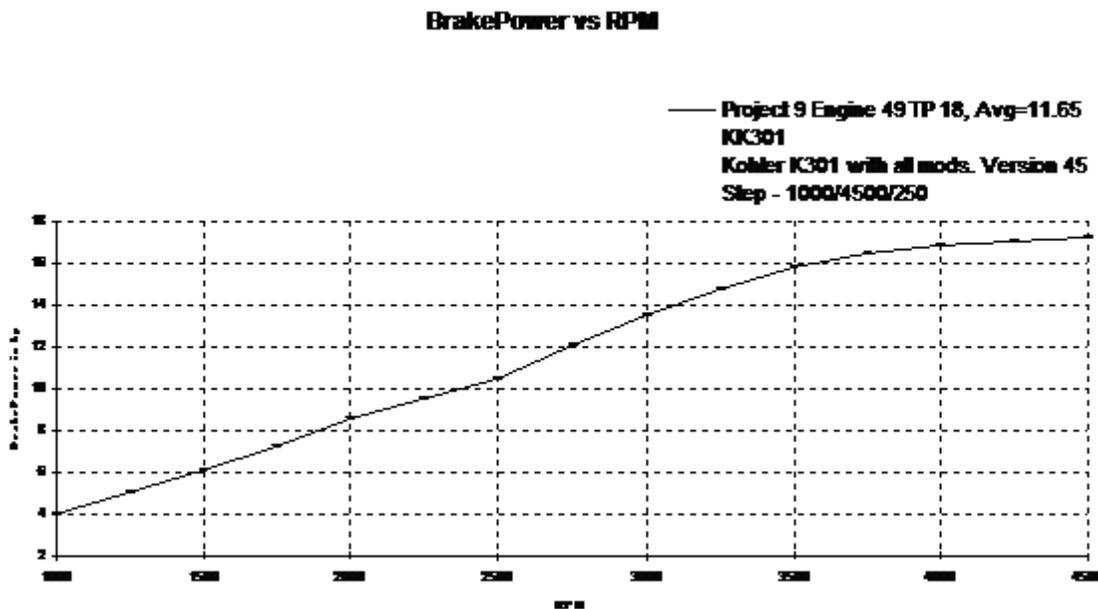


53.0% RBF. 526-lbf vert., 358-lbf horiz.

For the technical purists, this is the summed primary and secondary force magnitude neglecting the higher orders. Note that plots are shown at the same picture scale, which is somewhat deceiving – the peak force magnitudes (stated below each plot) are the comparative parameters.

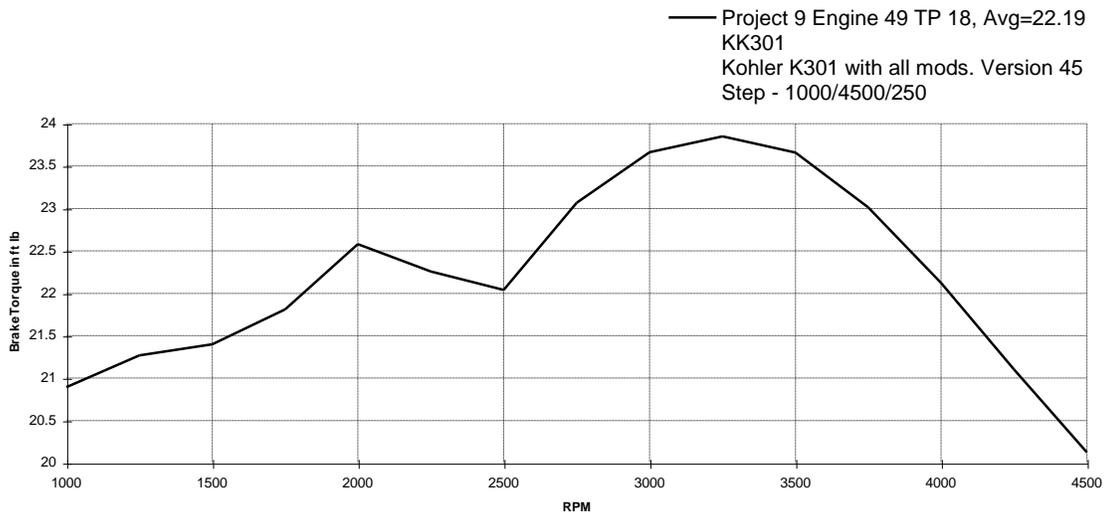
The final item on the wish list is to actually run this engine on a dynamometer. The dyno test is the only conclusive proof of engine performance. It's the standard tool for the engine developer to quantify the gains he's hopefully made in his endeavor. Dyno testing would involve removing the engine from the tractor. If I decide to implement the three above-mentioned modifications that involve a complete teardown, this would be a convenient time. In the interim, I've taken a more expedient approach as to making a very exact estimate of the performance by using a computer simulation. As previously mentioned, Virtual Engines is a powerful and sophisticated program for modeling both two and four-stroke engines and predicting all facets of performance without ever constructing a real machine. It has proven invaluable to the engine designer who doesn't have the time or resources to develop by the traditional trial and error methods. It also will predict performance of an existing engine once all the numerous inputs describing the physical geometry of the machine are entered.

Being trained in the use of this software (I use it almost daily in my job), I modeled the hot rod Kohler as an off-hours project. With all the modifications accurately input, including those mentioned in this article, the following performance predictions were obtained and output in graphical form.



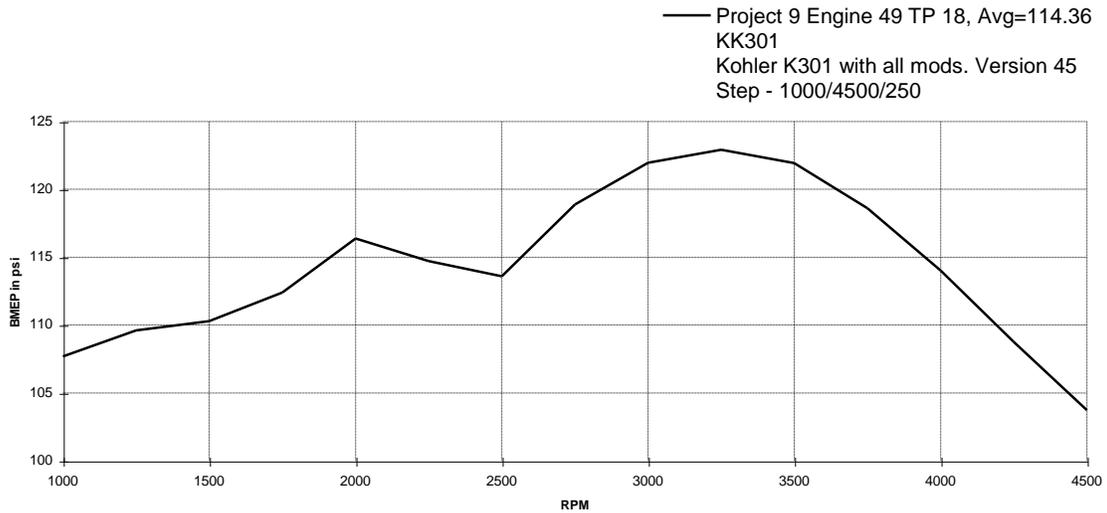
Predicted horsepower is 16.8 at 4000 rpm. Note still climbing (slightly) at 4500 rpm!

BrakeTorque vs RPM



Predicted brake torque curve shows peak of 23.8 ft lbf occurring at 3250 rpm.
Note second peak of 22.5 ft lbf at 2000 rpm.
Curve appears “lumpy” due to condensed ordinate scale, but is actually quite flat.

BMEP vs RPM



Predicted brake mean effective pressure inherently corresponds to shape of torque curve.
Note 114 psi at 4000 rpm, the peak power point.
123 psi developed at 3250 rpm, the peak torque point.

More recent optimization of this model indicates that advancing of cam timing by 6° moves both peak power and torque down by 500 rpm to place it perfectly in the operational range. This would be another item to add to the to-do list.

Virtual Engines is an incredible tool for designing and optimizing both new and existing machines. But notice how close we came to predicting peak power output in the initial study by calculating the BMEP values of an existing, similar type engine, and plugging these values into the Kohler geometry. The simple analysis yields 16.7 bhp at 4000 rpm, where the computer model predicts 16.8 at the same speed. This is not to discredit the value of computer analysis – you can't draw a complete power curve using simple predictions! Nevertheless, to make quick estimates as to the maximum potential one might expect, simple, comparative predictions can be amazingly accurate.

Killer powers my 1250 Cub Cadet Quiet Line, originally manufactured in 1975, and is shown in the photo below. This tractor was purchased in 1996 from the original owners family. Over the years that I've owned it, several additions and modifications were made. A lighting kit, hydraulic lift with booster spring, tapered roller bearing front wheel hubs, stainless steel hood ornament, stainless steel tie rod and drag link with heavy duty ball joints, instrument panel-mounted tachometer, and chrome exhaust stack extension, are some of the custom touches. It is a working tractor, used all year around. I keep it clean and serviced on a regular schedule and it has always rewarded me with excellent reliability and performance. It is completely adequate for my needs and a joy to run and operate.



My ride – a slightly customized 1250

This concludes my saga – at least for the time being. Here's hoping this article provides some technical information and stimulus to those who have considered assembling a hot

rod Kohler for their tractors. I'm confident that you'll derive as much satisfaction and enjoyment from the project as I have.

KOHLER K301AQS HR ENGINE BUILD SUMMARY

Serial Number – 7345447: Specification Number – 47541d: Factory Build Date – 1976

- General- Bore = 3.385 in Stroke = 3.250 in Displacement = 29.25 in³
 Low idle rpm = 950 High idle rpm = 3900
- Block- Intake and exhaust runners ported and polished, all corners radiused
 Intake port chamfer filled and matched to carburetor thermal isolator
 Intake and exhaust valve pockets relieved on deck surface
 Bored .010 oversize to 3.385 diameter
- Head- Decked .040
 Spark plug hole radiused and blended in combustion chamber
 Compression ratio = 7.45:1
- Camshaft- Reground “Cheater” cam supplied by Madson
 Lift* – Ex = .310 In = .320
 Duration* – Ex = 280° In = .314°
 Overlap = 87° Lobe center separation = 105°
 Large base lifters from Wisconsin Engine Co.
 *Measured seat-to-seat with lash set .014 ex, .008 in
- Valves- Stellite exhaust valve, stock intake valve, both polished and lower seat
 edge radiused
- Crankshaft- Cast surfaces ground and polished and gun bluing applied
 Crankpin turned .010 undersized and polished

Piston-	Style “D” Mahle brand with supplied chrome ring set
Con Rod-	Kohler forged aluminum rod, P/N 45 067 18 (for K-361 engine) Rod shank polished and oil holes chamfered
Breather-	Billet aluminum breather cover with extended draft tube
Carburetor-	Kohler brand with venturi machined to .875 diameter for 15% area increase
Air Filter-	K&N low restriction element (p/n E-4655) in production filter housing
Muffler-	Specially constructed glass pack straight through design using production outer shell.
Ignition-	Bosch “Blue” ignition coil triggered by PointSaver module via production breaker points. Ignition advance = 20° btdc.
Lubricant-	Mobil 1 brand, 10W-30 multi-viscosity synthetic, used year round.

ACKNOWLEDGEMENTS

Thanks to Prof. Blair and Associates for permission to use diagrams that appear on Page 2.

Thanks to Optimum Power for Virtual Engines, unquestionably the ultimate engine modeling software.

RECOMMENDED WEB SITES

Brian Miller's great website is a wealth of information on modifying Kohler K-series engines and quarter scale tractor pulling. <http://members.aol.com/pullingtractor/tips.htm>

Here's a great website for information on the Ford-Mercury flathead V-8.
<http://www.btc-bci.com/~billben/flathead.htm>

Here's a website to see the potential that an L-head engine is capable of. How about over 600 bhp from 307 cubic inches of flathead iron??? <http://www.flatfire.com/index.htm>

Site explores potential in a flathead Ford model A 4-cylinder engine. Hot rodding supported by well documented dyno tests. <http://members.aol.com/gmaclaren/dyno.html>

Contact Don Vogt for Kohler engine and IH Cub Cadet parts. He builds highly competitive pro-stock puller tractors and engines.
<http://www.geocities.com/dvogtvp/VPE.html>

More information on the capabilities of Virtual Engines can be had from the Optimum Power website. <http://www.optimum-power.com/main.htm>

Excellent engineering software for the design and analysis of valve systems for 4-stroke engines is located here.
http://www.profblairandassociates.com/GPB_Products_ValveTrainAnalysis.html

To obtain the PointSaver ignition module, Bosch coil, and billet covers mentioned in this article (along with some other special components), please check out my website.
<http://www.kirkengines.com/>