Table of Contents

Go To Technical Menu

REF: Engine Mechanicals - Sub-04P

Vacuum Pump for Reducing Crankcase Pressure

Most of the information on the web involves the use of a vacuum pump on autos.
There's not much published on using them with motorcycle engines.
That doesn't mean anything other than speed shops may not want to divulge their secrets. Also big pumps are for big displacement autos.
You can use a vacuum pump that's too big for a Sportster engine and cause more harm than good.
They are used for compensation as well as for better ring seal, but mostly advertised for better ring seal.
There are pumps spec'd for vacuum measurements and also ones spec'd by RPM range.
But, along with the addition of a vacuum pump, there is also the addition of a performance multi-stage oil pump.
If you vented from the crankcase area:

Splash is an important element in the sump area. Too much vacuum and you lose scavenge ability of the oil pump.
You may be able to tap into the side-top with a vent line and a reed valve.
The more the vacuum, even lower the positive will begin.
The rings act as a buffer between these two conditions as excess pressure could run both directions.
But positive pressure aides in oil scavenging.
So lowering positive pressure by default also hinders scavenging.
That's why racers with vacuum pumps use multistage scavenge pumps to account for the imbalance to scavenge and improve it.

Regardless, it's evident that some racers use vacuum pumps to increase vacuum pressure in the crankcase of a Sportster engine. [1)]
It's been said that positive crankcase pressure upon piston upstroke gets between the rings and basically causes bad sealing at the ringlands.
This is also in the high RPM range when ring flutter is present. So there are several things happening then.
But racers record higher power when using a vacuum pump.
However, it has also been said that inducing higher vacuum in a street engine may do more harm than good. Lower RPM may suffer from the imbalance.

A vacuum pump, in general, is an added benefit to any engine that is high performance enough to create a significant amount of blow-by. [2)]

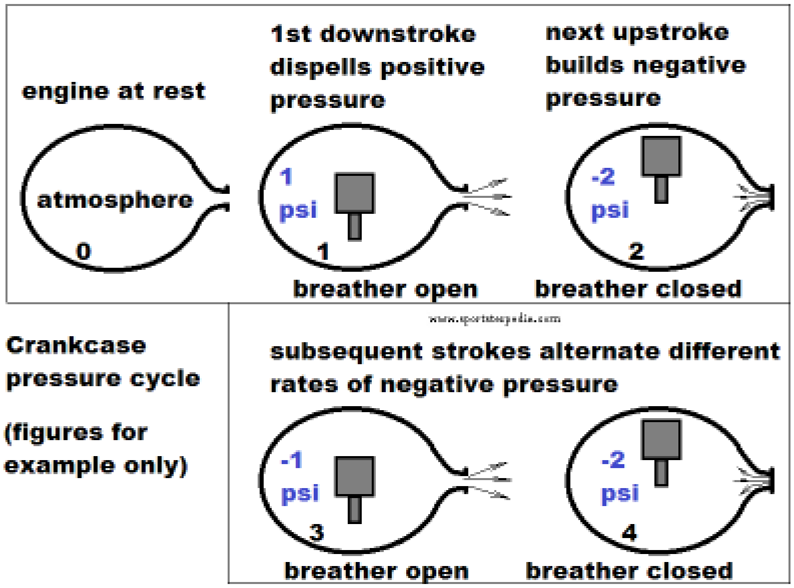
(that's high performance enough…. not worn enough)
It will, in general, add some horse power, increase engine life and keep oil cleaner for longer (in a high performance engine).

The first thing that happens on downstroke is that positive pressure (greater than atmosphere) is generated due to the restrictions of:

- Case volume
- Path to the vents
- Vent hole size
- Vent line (if applicable) length
- Any induced air from the breather valve(s) not closing properly

These things will bring the pressure inside to higher than atmosphere, else there would be nothing to expel.
As the air is pushed out of the vent, at BDC, the air returns to atmospheric.
That is the problematic condition, the higher pressure before returning to atmosphere.
Blowby adds to positive pressure which throws out the balance.

- Using X (+1) as positive and Y (-1) as negative pressure.
- In a perfect world, X goes down and Y comes up —— X+Y=0.
- Add ring blowby and you get —— X+1>Y—— or the real result.
  Balance is off by nature of the moving parts.
  The pistons move up and down almost together.
  That makes the push/pull environment more violent.
- Now add a vacuum pump with Z (-1) amount of pull.
  Now you get X+1=Y-Z… seems the balance (to zero) is restored even though positive pressure is compiled of blowby.
  But the lower the negative pressure is at the beginning of the downstroke, the lower the next positive pressure will be.
- If you are generating 2 psi of positive pressure on downstroke but reduce it's beginning surge to -1 psi (Z),
  the result will be only 1 psi of positive pressure during downstroke.
  -1 (+) + 2 equals +1.



[3]

Another example:

Considerations for running a vacuum pump:

1. A vacuum pump will create negative pressure in the crankcase. [4]
   And that negative pressure will remove air mass and create less atmosphere on the bottom side of the rings.
   (which creates a more stable environment)
   So positive pressure is removed around the rings / ringlands.
   There is no opposing force to keep the rings from seating on the ringland bottom.
   On piston upstroke, the rings sit against the bottom of the ringlands.
   On piston downstroke, the rings sit against the top of the ringlands.
2. The more stable environment change has allowed engine builders to reduce the size and tension of the ring stack; [5]
   creating less friction, less heat, and less power being robbed from the combustion process.
   Better ring seal is a nice advantage too.
3. The major gain with vacuum pumps comes from sealing the top ring better on the intake stroke; [6]
   Pulling more air and fuel in with better ring seal, which allows for a bigger charge to be burned and making more power.
4. It’s not just the rings, it’s the whole package; pistons, rings, quality machine work to get the right cylinder finish, and a proper tuneup. [7]
5. Piston downstroke (positive pressure) aides in sump oil scavenging.
   And unfortunately, vacuum pressure fights the oil pump.
   You need more positive pressure in the crankcase to help force the oil out of the sump as the oil pumps pulls vacuum on the sump.
   However, if the vacuum on upstroke is lower, there will be more than normal negative head pressure by the time the downstroke happens.
   Less pressure on downstroke means less force pushing against sump oil to scavenge.
   Too low of vacuum head pressure when downstroke begins and you end up with more oil left in the sump.
   (which marches toward a wet sumping condition)
   So a multi-stage oil pump that doesn't depend on crankcase pressure assist will be better suited with this setup.

6. The updraft on sump oil is lower, creating more loose suspended oil.
   The updraft is what aides in bringing oil into suspension with the air.
   Once suspended, the 'mix' is able to 'float' and it will move in the same fashion that air will move (wherever it's pushed or pulled).
   The mix separates on impact when it hits the crankcase / cam chest walls, cams / bushings etc.
   Loose suspension (lower pressure) drops the air /oil mix ratio faster upon impact.
   Tight suspension (higher pressure) drops the mix slower.
   During high CC pressure, more oil is left into suspension by the time it reaches the breather valve.
   When it hits the breather valve (on impact) more oil stays in suspension past the valve and out the vent.
   Lower pressure hitting the valve drops the ratio fast enough that less oil is left in suspension by the time it reaches the vent.
7. Lower vacuum in the crankcase also hinders splash oil due to the lower updraft.
   So it is possible to starve splash lubrication in the interest of lowering crankcase pressure.
   Windage is also lowered and this is the propellant for splash oil.
8. Crankcase pressure is lowered even more below atmospheric pressure.
   However, combustion chamber blowby (thru the rings) adds positive pressure to the crankcase at the same time it's being lowered.
   So there is a balance there like when you turn on a single water faucet.
    - 1/2 a turn cold, half a turn hot gives you warm water.
    - 1/2 a turn cold, full turn hot makes the water hotter.
9. Gapless rings allow less blowby during upstroke which creates less fill pressure in the crankcase.
   (thus, lowering vacuum head pressure at piston downstroke)
   This may be the reason gapless rings increase wet sumping.

In summary:

Racing bikes can pump enough vacuum into the engine to create better ring seal = more power at high RPM.
This is fine as long as the oil pump system is modded to return more oil to the tank by itself, without the need for CC pressure assist.

The use of a vacuum pump on a Sportster street engine can easily create wet sumping issues.
Street bikes will only occasionally see high enough RPM to warrant a vacuum pump but even then still running on the OEM oil pump.
So the possibility for wet sumping goes up on them.

If you want to run a high level of crankcase vacuum (18 inches HG or more); [8)]
There must be provisions in the engine to supplement the lubrication loss (splash oil through windage).
There can be problems with at least wristpin lubrication also.

Running a vacuum pump also would require scheduled diagnostics.
The amount of vacuum pulled depends on the general status of crankcase pressure at the time of use.
(I.E. current conditions such as; ring seal, breather valve wear, vacuum leaks, head valve leaks etc.)
You can't just install one and forget about it else you've defeated the purpose of installing it.

So it is possible to run a vacuum pump on a street engine.
But there are more considerations than just hooking one up.

Go To Technical Menu

[1] Hippysmack of the XLFORUM https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-bottom-end/197307-sportster-crankcase-pressure-engine-breathing-wetsumping-and-mods?t=2073932

[2], [8] https://www.gzmotorsports.com/why-use-vacuum-pump.html

[3] drawing by Hippysmack

[4], [5], [6], [7] https://www.dragzine.com/tech-stories/engine/tech-boost-vacuum-finding-hidden-horsepower/