Table of Contents

Go To Technical Menu

REF: Engine Mechanicals

Evo Crankcase Pressure and Engine Breathing

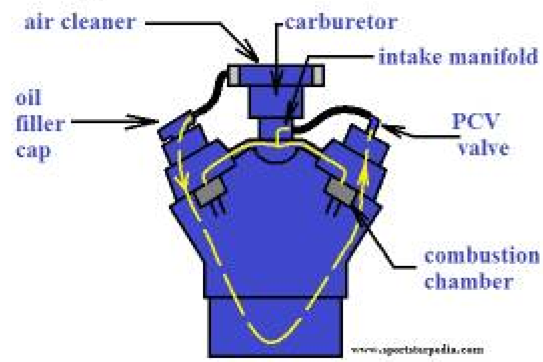
Engine Breathing

The one way breather style system is more like a car PCV system. [1] Unlike an auto PCV, a Sportster has a faster acting type one way valve.
A deep (dry) sump was added to 77> casings and the scavenge side of the oil pump pulls the oil from the scavenge port in the rear of the sump area.
Holes were added between the crankcase and the gearcase wall (much the way your car's crankcase is vented out the top thru the valve covers)
Those holes in the walls are an open passage for crankcase pressure into the gearcase.
So the gearcase is also pressurized. Crankcase pressure is sent thru the one way valve in the cover and then vented to atmosphere out the vent.

However, crankcase ventilation works a little differently on these motors than a Chevy. [2]
What you see on cars is an inlet, generally coming from the air filter, into the motor. Then an outlet, regulated by a PCV valve, going into the intake manifold.
So it's designed to flow a little air through the system.
The other thing is that a V8 crankcase stays at a constant volume, because for every piston going up there's a piston going down.
On a Sportster motor there's no air inlet. The engine vents into the intake flow on the upstream side of the carb instead, where there's much less vacuum.
It's not designed to flow air through it. What's more, the crankcase volume is constantly changing. There are check valves in line with the breather outlets.
Their function is to expel the air when the pistons go down but then restrict the air from entering the motor when the pistons go up.
The result is that beyond the first revolution, if the check valves are working properly, all you see out the breathers is the pulsating pressured air.
On a good motor, it's very little. But if the check valves are not working properly, the motor goes into an inhale/exhale mode.
That causes a whole lot air movement and it also causes a lot of oil to get carried out at the same time.
Many cases of excess breather oil is caused by poorly functioning check valves.

Typical automobile V-8 engine breathing: [3]

V-8 Engine Crankcase Ventilation



**Flow control of the PCV valve is done by use of a hose from intake vacuum.
The intake is the main pressure source for the PCV (vacuum pressure).
Fresh air is pulled into the crankcase from the air cleaner and circulated back to the combustion chambers through the PCV valve.
Air circulation carries combustion blowby out of the crankcase and back into the cylinders to be burnt.**

1986-Up Engine Breathing Cycle

A mixture of crankcase air and oil mist is produced on each piston down stroke.
Upstroke pulls oil up into suspension but in tiny particles to mix with the air moving around and thrown here to there for lubrication in the crankcase.
The air/oil mix is blown into the cam chest cam wall to lube cam gears, bushings, bearings etc. which also separate oil from air.
The oil is separated from the air by way of collision as it lands on anything in it's path on the way to the vent.
Everything the air/oil mix touches on the way out separates some oil from the air. And each time oil drops out of suspension, it makes the air lighter.

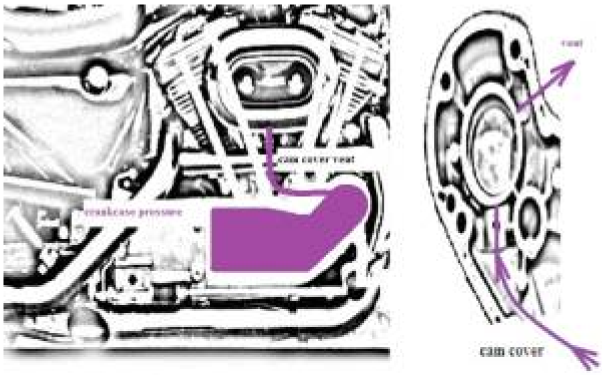
1986-1990 Engine Specifics

The air/oil mix is blown from the crankcase into the gearcase through holes in the cam wall where it lubes moving parts and separates.
After initial separation, the remaining air/oil mix is blown to a one way umbrella valve in the cam cover.
The majority of oil still in suspension hits the back side of the valve, separates from the air and falls back into the cam chest.

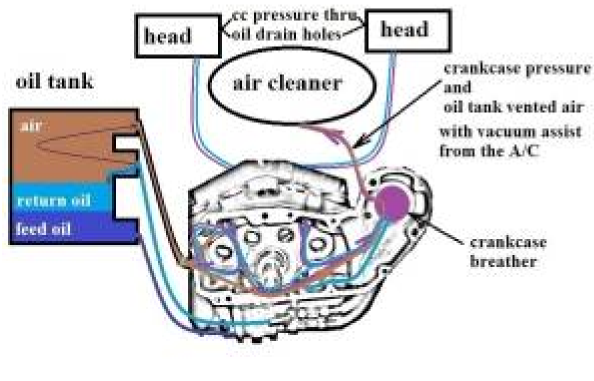
The valve holder is installed into a pocket molded in the cover. Air/oil mist enters the pocket and flows past the valve.
Just past the valve (between it and the vent outlet) is another smaller chamber. That is the final separation chamber for air and oil.
Oil droplets fall out of suspension there, down into a small hole between the valve and the cover which leads back into the cam chest.
Engine vacuum, on upstroke, pulls oil droplets back into the cam chest from the tiny hole in the separation chamber.
If / when any oil is present and being pulled back into the cam chest, the tiny hole is an oil drain hole.

After the oil has been removed from that small (separation) chamber, a small amount of atmosphere is pulled into the engine thru the tiny hole.
At that point, the tiny hole is a slight air (atmosphere) intake hole.

The crankcase air pushes past the breather valve and exits the engine out the breather vent (which is factory plumbed into the air cleaner backing plate).



86-90 Sportster Crankcase Venting 4)



86-90 Sportster Engine Breathing 5)

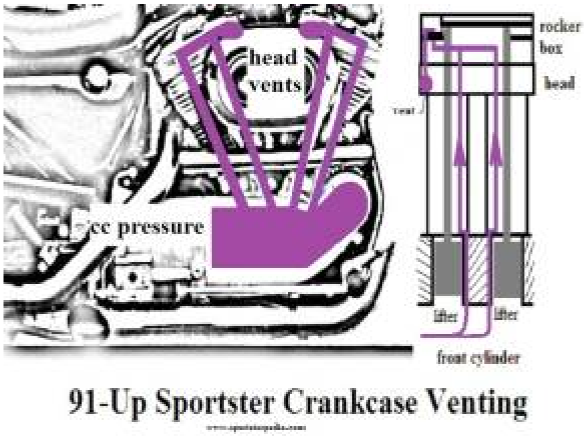
1991-2003 Engine Specifics

The air/oil mix is blown from the crankcase into the gearcase through holes in the cam wall where it lubes moving parts and separates.
The holes in the cam wall changed sizes also from 91-03.
After initial separation, the remaining air/oil mix is blown to two separate one way umbrella valves (one in each rocker box).
The cam cover no longer contains a fitting to install a vent hose.
The air/oil mix is forced thru (4) 3/8“ holes (1 drilled beside and into each lifter bore) from below and up the pushrod tubes into the rocker boxes.

One umbrella valve is placed in each middle rocker box on the intake side. Each of the two umbrella valves are identical and smaller than the 86-90 umbrella valve.
The majority of oil still in suspension hits the back side of each valve, separates from the air and falls back into the rocker box.

There is small compartment in the middle box (spacer) that is sealed off from the lower rocker area by castings in the middle spacer.
This can be thought of as the final oil separation chamber and is sealed off by the top rocker box cover.
Occasionally, oil droplets will make it past the breather umbrella valve and fall into a tiny hole built in that separation chamber in the middle box spacer.
Engine vacuum, on upstroke, pulls oil droplets back into the rocker area from the tiny hole in the separation chamber.
If / when any oil is present and being pulled back into the rockers, the tiny hole is an oil drain hole.
After the oil has been removed from that small (separation) chamber, a small amount of atmosphere is pulled into the engine thru the tiny hole.
At that point, the tiny hole is a slight air (atmosphere) intake hole.

The crankcase air pushes past each breather valve and exits through the heads.
A hole in each head connects the path from the outlet of the breather vent to atmosphere.
A hollow bolt installed into each head passes the air into the air cleaner backing plate.



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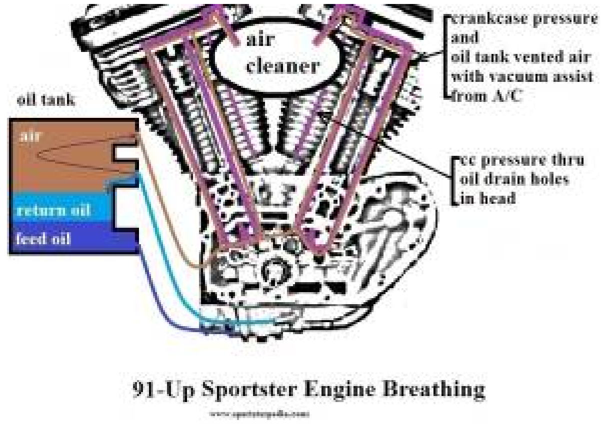


7)

2004-Up Engine Specifics

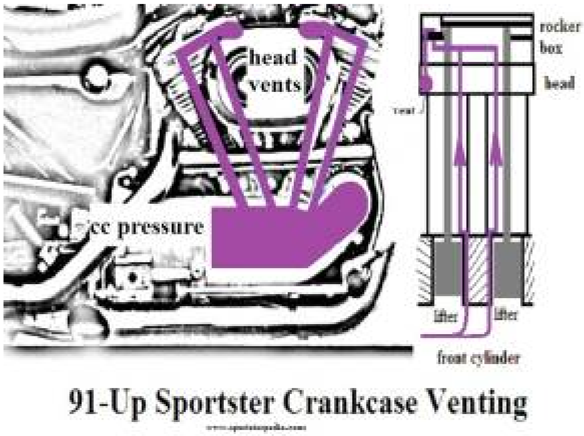
2004-up engines blow the air/oil mix out by the pinion gear bearing where it bounces around and is separated as before.
The holes in the cam wall were resized and repurposed to act as feed oil galleys for oil jets to spray the pistons.
The oil mist is separated from the crankcase air somewhat by collision as previous models.
After initial separation, the remaining air/oil mix is blown to two separate one way umbrella valves (one in each rocker box).
The air/oil mix is forced thru vertical holes in the cam wall to from below, to the pushrod tubes and into the rocker boxes.

One breather valve is placed in each lower rocker box on the intake side. The breather valve is now a covered plastic assembly with an umbrella inside.
Each of the two umbrella valves are identical as before but the breather assembly is now directional (1 front and 1 rear).
There is a fiber mesh on the lower side of the umbrella for initial separation of oil before entering the assembly.
The majority of oil still in suspension hits the fiber mesh, separates from the air and falls back into the rocker box.
The mesh will have a tendency to collect oil.

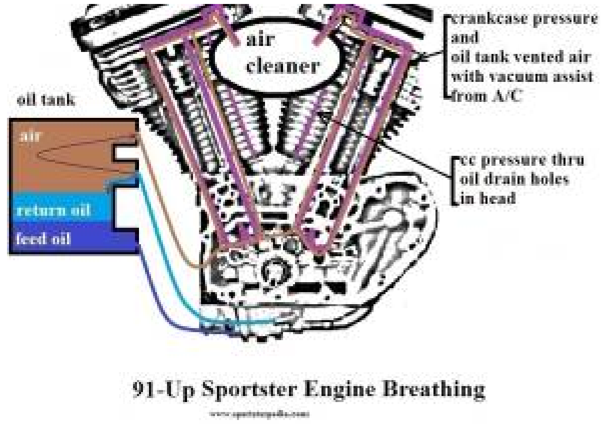
There is small compartment in the middle box of the breather assembly for oil separation as well.
This also can be thought of as the final oil separation chamber and is partially sealed off by partitions on each side of the chamber.
Occasionally, oil droplets will make it past the umbrella valve and fall into the final separation chamber.
There is a tiny hole built in the bottom of that chamber as well. Engine vacuum, on upstroke, pulls oil droplets back into the rocker area from the tiny hole.
If / when any oil is present and being pulled back into the rockers, the tiny hole is an oil drain hole.
After the oil has been removed from that small (separation) chamber, a small amount of atmosphere is

pulled into the engine thru the tiny hole.
At that point, the tiny hole is a slight air (atmosphere) intake hole.

The crankcase air pushes past each breather valve, past the final separation chamber and exits the other end.
A hole in each head connects the path from the outlet of the breather vent to atmosphere.
A hollow bolt installed into each head passes the air into the air cleaner backing plate.

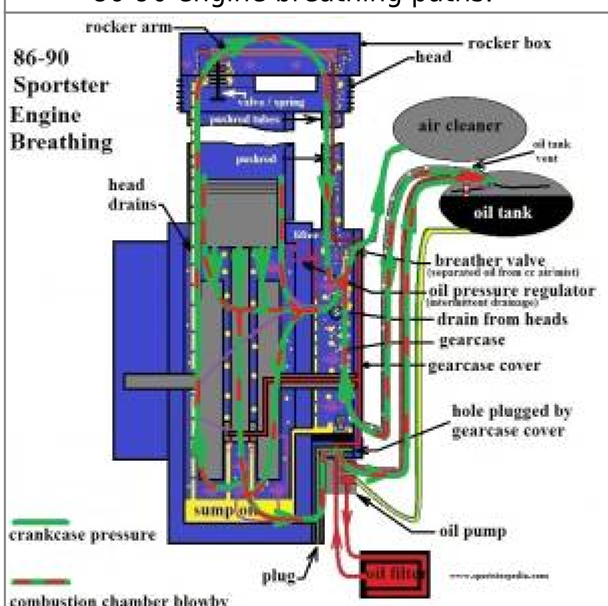
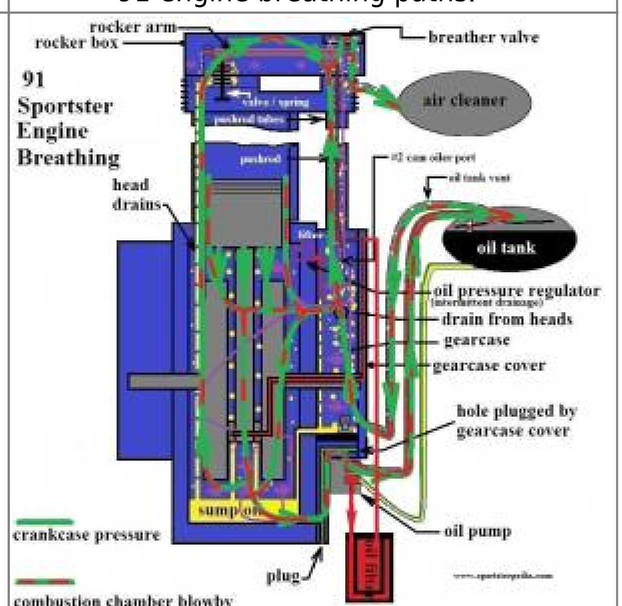


[8]

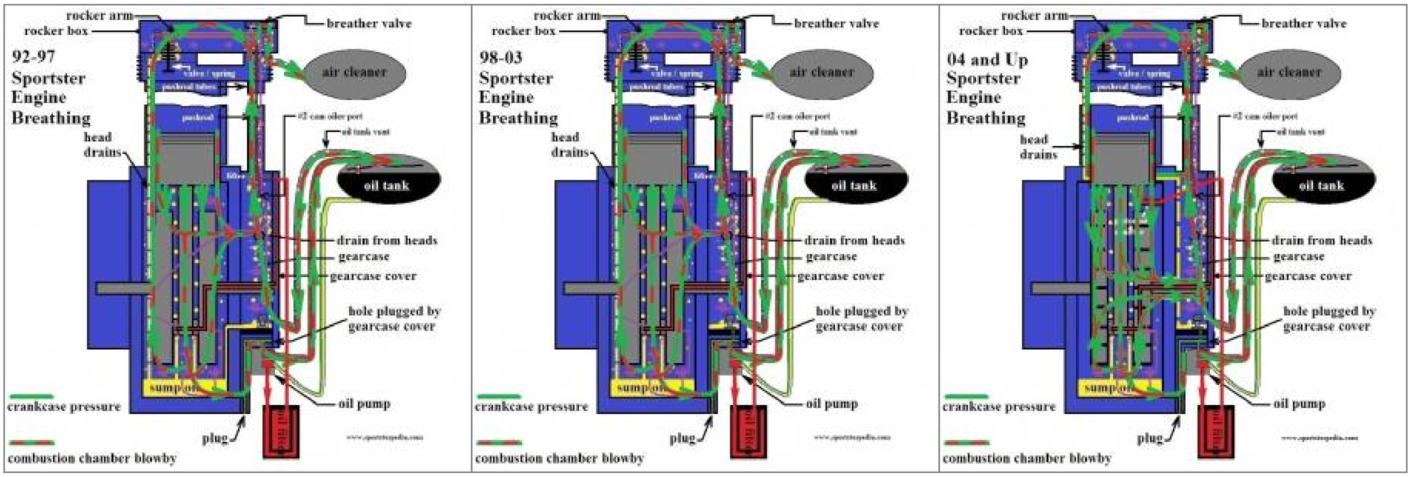


[9]

OEM oil paths and engine breathing drawings

86-90 engine breathing paths. [10]	91 engine breathing paths. [11]
	

92-97 engine breathing paths. [12]	98-03 engine breathing paths. [13]	04 and up engine breathing paths. [14]



Engine Breather Valves

Sub Documents

- Breather Valves (1957-Up) (list of breather valve changes)
- Further Study of Evo Sportster Breather Valves
- Oil Drainback and Supplemental Air Intake from Breather Valves
- Breather Venting / Relocation (list of breathing mods and aftermarket breathers)
- Head Vents vs Cam Chest Vent
- Wet Sumping
- Why Oil Pukes Out the Breather

Symptoms of Breather Valve Problems

The most notable signs of breather valve problems include weeping / leaking gaskets or blown gaskets / seals.
L82-up rubber umbrella(s) get hard and if they don't flex well enough, they'll allow the engine to fully inhaler and exhale on every stroke uncontrolled.
Stopped up breather valves won't allow the engine to breath well and can create excess vacuum and implode gaskets.
Or it contributes to too high of oil density and slings excess oil out. Other factors are involved so results will vary.
However, a slight amount of oil in mist form coming out the vent/air cleaner is totally normal and does not quantify as puking oil.

Wetsumping can be a result of poor engine breathing but not always.
Blowing oil out after extended shutdown periods is a condition of bad oil pump sealing, bad check valve or regulator (if equipped) sealing.
Blowing oil out the vent/air cleaner during riding first looks to the oil tank being overfilled.
If the engine is not at operating temp before checking the oil level, you'll end up adding too much oil to the system.

Blowing oil out the vent/aircleaner during high sustained RPM may be high crankcase pressure or poor oil scavenging.
Also see the full article on wetsumping in the sub documents above.

Crankcase Pressure

Sub Documents

- Example of Air Pulses Using a 1000cc Motor
- Affects of the 45° Rod / Piston Arrangement
- Differential Pressure
- Blowby and Ring Seal
- Further Study of Internal Engine Pressure
- Oil Tank Pressure
- Liquid Drag vs Fluid Drag
- Vacuum Pump for Reducing Crankcase Pressure

How crankcase pressure is generated

Crankcase air pressure is mainly generated by the up and down movement of the pistons.
Additional air pressure is created by blowby from the combustion chambers past the rings and into the crankcase.
Additional air can be created by other small air intake areas as well as from gasket leaks.
Crankcase pressure also initiates the splash and mist process (the movement of the pistons and flywheels splash oil around in the engine).
The piston motions create a pulsating blast of air pressure (push pull condition as each piston rises and falls).
Without the one way breather valve(s) before the vent(s), crankcase pressure would inhale and exhale at a high air volume and sling lots of oil out of the engine.
So the breather valve(s) keep crankcase pressure more stable.

The full crankcase pressure compartment

Engine ventilation is connected to the rockerbox, crankcase, cam gear case and the oil tank. [15)]
If you blow down the oil tank line…air comes out the rockerbox vents (or cam breather hose).
There are airways linking these compartments together and in looking at these airways.
If one pressurizes, they all pressurize and air can pass between them;

- **Rocker Box**:
  - Pushrods connect the rockerbox to the gearcase.
  - Gravity oil:
    - 03 and prior: Heads drain oil to the crankcase sump (through passages in the

cylinders).
        - 04 and Up: Heads drain oil to the gearcase (through passages in the cylinders and gearcase wall).
        - All: Pushrod tubes drain oil into the gearcase.
- **Gearcase / cam chest**:
    - Rockerbox oil return connects to the gearcase.
    - Airways thru the wall joins the sump and the scavenge side of pump.
        - Piston downforce pumps air and oil from the sump to the gearcase compartment.
    - This would equalise air pressures in the two chambers.
- **Crankcase**:
    - Piston downstroke creates a positive pressure against the oil in the sump.
        - This forward pressure is connected to the oil tank thru the oil pump.
            - It also helps to push oil into the scavenge chamber from the sump upward into the scavenger side of the oil pump.
    - Piston upstroke creates a negative pressure (noted as vacuum for this article).
        - Some of the oil either draining to the sump or collected from the sump is picked up by the vacuum in the form of oil mist.
        - Also some of the oil is picked up in the form of oil droplets (or splash oil) and is moved around by the next positive pressure condition.
          Splash oil is further moved by the action of the flywheels, connecting rods, cam gears, air pressure and gravity.
    - The pinion gear shaft is hollow and connects the crankcase to the gearcase (but would only pass air with the engine off).
    - 03 and prior engines connect rockerbox oil to the crankcase.
      04 and up do not.

Oil pump pressure isn't directly connected to crankcase pressure

Secondary affects of pumping oil to the rocker boxes and rod bearings is the added oil in the bottom. Drain oil aids in splash lube and cooling features but if it's not removed fast enough, it creates thicker oil in suspension.

- The pressure side of the oil pump is fed from the oil tank and is connected to the rocker box and the crankpin.
    - Gravity from the oil tank initially feeds the oil pump.
    - But once the engine starts, the motion of the gerotors creates a suction in the feed line from the tank.
    - Pressure in the oil tank also adds pressure on the gravity feed to the pump.
- The pump creates non pressurized oil flow from the feed gerotors.
    - Restrictions (oil line / feed passage sizes) to the oil filter pad and through the engine create back pressure on the pump.
    - This pressure builds and is sent to the lifters and rocker box as well as the crankpin through the hollow pinion shaft.
    - The pressure is increased at the pump as oil flows through more restrictions to get to these places.
      (strictly as a non tested example, 10 psi on the feed side of the pump may equate to 4 psi or lower once it reaches the crankpin)

Pressure is restricted in the cam cover,
Less restricted with the wider opening at the pinion shaft bushing,
Then restricted again thru the shaft hole and the turns in the flywheel to the crankpin.

- Once the pressurized oil reaches the rocker arms and crankpin, the pressure is released into the wider openings in the oil path.
  From there it is added to and becomes a part of crankcase pressure and is used and vented as such.

In contrast to the Sportster breather valve location, Buells breath through reed valves placed in the cam wall.
Buell crankcase breathing:

This is a Buell XBRR with reed valves through the cam chest wall. [16]	
	

The pressure in the crankcase is not from oil pump pressure

Static oil pump pressure has already been dissipated by the time it reaches the crankcase.
(although it takes static oil pressure to get the oil from the pump to the crankcase)

Crankcase (CC) pressure will have an average and constant change in velocity.
Gravity oil (from the drain ports in the heads) returns to the crankcase.
Gravity oil (from the pushrod tubes) returns to the gearcase. Oil in the crankcase adds resistance to the air pressure generated (raising the pressure).

Role of the breather valve

CC pressure both pushes to and sucks from the breather valve.
The breather valve allows for controlled air pressure to both leave and enter the engine to obtain what is referred to as a “slight running vacuum” in the crankcase.
If the breather valve isn't there;
The pressure generated from upstroke and downstroke would both push all the under piston air volume out of the engine and back into the engine.
(including any oil that was suspended with it. Also that would create thicker oil suspension and more oil blowing out of the engine but not returning.

The volume between positive and negative pressure decreases as RPM goes up.
The speed of the breather valve action is important as it has to keep up with RPM changes.

See also, Example of Air Pulses Using a 1000cc Motor, in the sub documents at the top of this page.

Oil Tank's Role vs Wetsumping

See the full article, * Oil Tank Pressure, in the REF section of the Sportsterpedia.
There should not be any pressure difference in the oil tank than the engine although it does transfer pressure.
The oil tank vent line to the cam chest allows the pump to send oil and CC pressure to the tank without over pressurizing the inside.
So if you have pressure in your oil tank and the vent to the cam chest is not blocked then the cam chest is also pressurized.
If the cam chest is holding pressure, then your breather valve can not be venting properly.
Bottom line is that if the vent system is working properly, you shouldn't have excessive pressure build up in the oil tank. [17)]

Lowering the oil level in the oil tank

It has been said by many that lowering the oil level in the oil tank will stop oil puking out the breather.
While this may work in application, by design, you should not have to lower the oil level.
This practice is not just restricted to rubbermounts although due to the CC pressure change in 04, it is a more accepted practice.
The tank acts as an oil / air separator like the breather valve but the air only expels the engine from the engine breather vent.

Affects of the 45° Rod / Piston Arrangement

Since Sportster piston movement is not equalized, we get the potato, potato sound we all love but the equilibrium in the crankcase is off by design.
This constant push / pull from offset pistons contributes to an imbalance of pressure that needs to controlled.

See, Affects of the 45° Rod / Piston Arrangement, in the sub documents at the top of this page for more information.

Differential Pressure (vacuum and air pressure)

Vacuum and (positive) air pressure are the terms that describe the amount of molecules of a gas in a given unit of space. [18)]
More molecules inside the engine than outside = inside air pressure.
Less molecules inside the engine than outside = inside is vacuum pressure.

57-76 engines are subject to the most volume of vacuum in the crankcase.
77-85 engines are subject to the same volume of vacuum in the gearcase, rocker box, oil tank, gearcase and primary compartments.

Oil scavenging:
Positive crankcase air pressure aids scavenging.
It pushes oil against the suction chamber of the pump creating more Net Positive Suction Head Available (NPSHA) to the pump which is a requirement of the pump design.
This push is needed in order to assure there will be oil at the suction inlet of the pump especially upon higher RPM.
With lower NPSHA, the oil may may not enter the pump's suction chamber fast enough which can lower the amount of oil the pump will pump.
Negative (vacuum) pressure on the incoming oil makes the pump's job harder. Vacuum makes the downstroke push to scavenge less powerful.
The oil pump wants to receive more oil on higher RPM. Higher vacuum is created in the suction chamber near the gears as the pump speeds up.
Without a positive “push” ushering the oil to the suction chamber, vacuum in the chamber can slow (or partially choke) oil coming into the chamber.
This slows down the delivery of oil to the oil pump (lowers NPSHA) and can result in wetsumping the motor.

Ring seal and pumping loss:
Too much positive pressure is harder on the pistons on downstroke since they are having to expel that air pressure on the way down.
High positive air pressure in the crankcase is said to rob horsepower.
So it is good to have a slight vacuum in the crankcase when the downstroke begins.
A vacuum condition when downstroke begins lessens the restriction on the descending pistons and doesn't lower overall horsepower.

In most engines negative crankcase pressure allows less ring pressure and the combination of both means more hp. [19)]
Over the years folks have used exhaust system energy to pull pressure from the case for this reason.
Guys have won championships with an engine that had an electric vacuum pump to reduce (positive) crankcase air pressure.
Crankcase pressure in these engines fluctuate wildly from positive to negative. [20)]
However, high vacuum can have a dramatic affect on scavenging.

See, Differential Pressure, in the sub documents at the top of this page for more information.

Symptoms of High Crankcase Pressure

Picture a balloon inside the engine being blown up.
It puts internal pressure against the weakest structural points (gaskets and seals).

Symptoms include: [21)]
Sweating oil from the cylinder base gaskets and rocker boxes.
As well as the push rod tubes and lifter blocs on the other side.

Blowby

Normal blowby:
In the absence of any blow-by getting past the rings, the crankcase alternates from atmospheric (pistons down) to a vacuum (pistons up). [22]
But in the real world, a little gets past the rings, so there's a net outflow equal to that.
Conventional rings have a ring gap and the combustion pressure is very great. [23]
So you can bet some of this tremendous pressure is entering into your crankcase instead of 100% of it exiting your exhaust pipes.

Excess blowby:
The ringlands on the pistons 'should be' sealing but sometimes are not.
You can end up with 'out of round' or scratched cylinders from different conditions.
Imperfections in ring seal increase the amount of air from the combustion chambers getting into the crankcase.

See, Blowby and Ring Seal, in the sub documents at the top of this page for more information.

What causes extra air in the crankcase (air leaks)?

Ring seal, as mentioned, is not as good on higher RPM even on a healthy engine.

Gasket / air leaks can introduce more air in the crankcase.
They allow more air into the engine that add to the positive and take away some of the negative (vacuum).
So the introduction of air leaks into the crankcase lowers the RPM at which pressure changes affect the system.
Worn / stiff breather valves will allow more or less air at atmosphere into the crankcase.
This changes the average vacuum and contributes to higher positive pressure on downstroke.
The timing of the breather valve opening and closing can also bring in air to the crankcase during upstroke.
The faster it closes, the more vacuum is kept in the crankcase on upstroke.
The slower it closes, the less that vacuum can be contained in the crankcase.

The breathing system is designed for a one-way valve venting system.
Air goes out but doesn't come back in.
Air leaks (into the engine) will increase positive pressure and air / oil density = oil puking out the breathers.
Some potential air leak areas are in the pic below.
If these areas allow air to be pulled in the engine on upstroke, the added air will compound any other existing breathing problems.

24)

25)

Why is the ratio of positive and negative pressure important?

It takes a balance of the two to run a Sportster engine.
Piston upstroke creates negative pressure and suction of oil from the sump.
It pulls oil up in the form of oil mist to be tossed around on the moving metal parts.
So it is important for lubrication and it keeps down aeration in the oil.
But without the reciprocating piston downstroke, there wouldn't be a lot of force to help splash it around other than the spinning wheels.
The upstroke pulls oil into suspension (air/oil mist) so the downstroke can help blow the mist around working in conjunction with flywheel and cam rotation.
Negative pressure is also important for ring seal as it allows the rings to seat better on high RPM.
Too much negative pressure is detrimental to oil scavenging as it allows thicker oil to be pulled up into suspension.
The thicker oil separates slower and can wrap around the flywheels (instead of moving toward the scavenge port in the sump).
The bulk of gravity oil on the sump floor is heavier than the moving air.
But the spinning action of the flywheels can pull that oil up to be slung around the wheels creating more drag as it does.
So it's important to get the excess oil in the bottom out of the engine as fast as possible to keep down flywheel drag.
That's where the positive pressure comes in.

Positive pressure is important for oil scavenging as it works in conjunction with splash lubrication as well as the suction of the oil pump.
The positive pressure generated by the downstroke pushes oil toward the scavenge pump to be sucked vertically into the oil passage to the pump.
So there is a balance of positive and negative pressure that has to be maintained for overall engine operation.

The role of positive and negative pressure can be confusing.
Even though there is a positive 'push' on internal pressure through piston downstroke, the overall internal pressure is still negative.
It's just less negative than it was before the downstroke until high RPM changes that.
This creates a pulsing effect on oil in the sump which helps shift the oil toward the scavenge port.

Even though there is normal blowby throughout the RPM range, the vacuum created buffers that.

Crankcase Pressure Testing

Sub Documents

- Dyno testing using the timing plug location for an additional crankcase vent by aswracing
- Breather System Air Volume Test by DK Custom
- Testing with a Slack Tube (Manometer) by bustert
- Building Your Own Slack Tube
- Using / Diagnosing with a Slack Tube (Manometer)
- Slack tube testing on a 1998 1250S model
- Breather Catch Can Test For Oil Leaks Out the Vent

Crankcase pressure can be tested to see what the pressure is doing, when it does it and the affects of changes to the breathing system.
Testing can also be done to determine pressure issues before they become a big problem as well as diagnosing that there is one.

57-76 engines:
Vacuum in 57-76 engines should be checked to make sure it's not creating too much especially if oil leaks / weeps keep happening.
If everything is percolating nicely, a test then is a good base line. Oil leaks can easily be a result of too much vacuum.
And that depends on gasket / seal conditions and limits. The head drains are also possible vacuum routes, thus rocker boxes and down.
How many have had reoccurring pushrod tube leaks? Surely the 3rd or 4th set of seals were installed correctly.
Too much vacuum can implode the tube seals. Testing the amount of vacuum at that point may reveal too much.
What can you do if you have too much vacuum in 76< engines?
Check for the breather gear out of time or gasket / seal leaks.
Seal leaks on downstroke lower mean pressure and allow more vacuum to generate on upstroke.
Other things to consider are a plugged / kinked vent tube or breather vent mods that could have raised vacuum.

In the sub documents above are some examples of different testing that was done on Evos. Below are some noted results of that testing.
Each of the tests above do basically support each other given the different variables.
But the results have to be taken in context as each have different criteria for testing.

- **Testing from DK Custom**:
    - The criteria for their testing was to see how much air was passed out the breather vents (outside the engine) at idle, under a load, at cruising speeds and on throttle let-off' for

    different model engines. They sell modified breather venting configurations and was doing some R&D presumably in the interest of same.
  - Their testing supports bustert's slack tube testing as normally at most of the RPM range, there is more vacuum than positive pressure. And it's the positive pressure that leaves the engine. Therefore, their results for the Sportster are equaled out more. Even though there is normal blowby throughout the RPM range, the vacuum created buffers that.
  - In example, 15” of vacuum at idle that all of a sudden is hit by 5“ of positive pressure rolling the throttle still yields 10” of vacuum at the time. So there would be no air moving into the balloon or container at that point. In theory and during that transition from 15“ to 10” vacuum, more oil is pushed toward the scavenge hole in the sump, the pump gets a fatter supply of oil to send to the tank, pressure goes up in the air space in the tank due to the restriction size of the vent.

- **Testing from bustert**:
  - This was a test of the differential pressure changes (inside the engine) through the RPM range up to 6000 RPM.
  - You may have read and heard from many sources that the Sportster requires a 'slight vacuum'. But the slack tube testing puts a visual to the process showing that the 'slight vacuum' is not really a stagnant number but a constantly moving range.

- **Testing from aswracing**:
  - Dyno testing was with the normal head breather vents in place (with and without the timing hole plug removed) to see if either would show increased HP over the other.
    The dyno sheets show the affects (HP changes) between the stock setup and with addition of air induced into the engine through the RPM range.
    However, it does not show internal pressures during the testing.
  - The testing revealed a dip in performance starting around 5700 RPM which coincides with bustert's slack tube testing showing positive and negative pressure equaling out up in that range. But the Dyno test is a load test as where the slack tube was done with no load on the engine… more variables.

What does all this mean?

The testing shows that there is more potential for crankcase pressure problems in the high RPM range.
There will be a normal amount of air passing the rings by design.
As the rings heat up and expand, there will be less air passed by them until you run up past the 5000 RPM range.
Then, questionable ring seal comes into play to pass more air through the rings which creates more positive pressure in the crankcase.
So normal blowby increases with engine speed.
Couple that with the increasing speed of the pistons which helps to equalize positive and negative pressure during operation.
As engine speed increases, there is not as much time to build vacuum on upstroke or positive pressure on downstroke due to the faster changing piston positions.
Just as you can inhale air slowly and fill up your lungs but faster breathing will not allow you to fill them due to the faster time that you exhale.
This would make for a shorter range of (both vacuum and positive) pressure that would be able to build in the crankcase.
So the internal pressure is more stable until extra air (or blowby) is induced into the crankcase.

Testing CC pressure on the dyno. [26]

Go To Technical Menu

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[24)]
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[25)]
photo by Hippysmack

[26)]
photo by Jörgen
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-motor-engine/sportster-motorcycle-engine-conversions/38153-xr750-883-series-race-engine-venting-etc/page9?t=75740&page=9