# Expensive fuck-ups to avoid when building CIH performance engines!

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## Why using flat top pistons is important

The Opel CIH engine uses a form of combustion chamber that depends on a flat area in the head, and a corresponding flat area on the piston, to "squish" the air/fuel mixture into the area near the spark plug, where the mixture can get efficiently burnt. For best results, the gap between the two flat areas (the Squish area) should be between 1.0mm and 1.4mm (standard Opel/Vauxhall gasket thickness is about 1.1mm, after being crushed). So, in most circumstances, ensuring that the piston top is flush with the top of the block, when at TDC, will give the right gap.

For example, do not use standard 2.4L Opel pistons when building a 2.4L engine. The standard piston has a dish in the top of the piston 77mm in diameter and 2.5mm deep. This dish will not only reduce the compression ratio, but also cause a reduction in combustion efficiency, especially in high performance engines with high lift camshafts, because the squish area is reduced in size (and phyisically it is deeper) and the air/fuel mixture is not pushed towards the spark plug.

You can detect poor combustion, by excessive carbon deposits being left in the squish area. In more serious cases, the timing will have to be advanced significantly to get better combustion.

If you have to cut a dish in the piston to help reduce the compression ratio, then only cut the dish in the area nearest the valves. Do not reduce the size of the squish area.

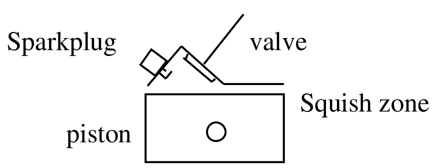
You should not use domed pistons, as again the dome will reduce the effectiveness of the squish area, so causing poor combustion, poor fuel economy and power loss. If you need a compression ratio above about 11:1 in a 2.4L engine, then you will have to use a 2.0L or 1.6L head.

## Squish Area and Piston Position Theory

## Squish Area

**Action**: When the piston and head squish surface come together during the compression phase, the combustion gasses in this area are pushed over into the open part of the chamber, creating turbulence that improves the combustion process. This pushed mixture will be better homogenized, reducing combustion time and also mixing any residual exhaust gases still present with the fuel charge. This serves to speed up combustion by preventing stale gas pockets from forming. Such pockets slow down, and in some instances can prevent, flame propagation.

Turbulence caused by the squish effect also serves to enhance heat transfer at the spark ignited flame front. Without proper heat transfer, jets of flame would tend to shoot out toward the edges of the comb chamb, prematurely heating the surrounding gasses to start off the cycle leading to detonation



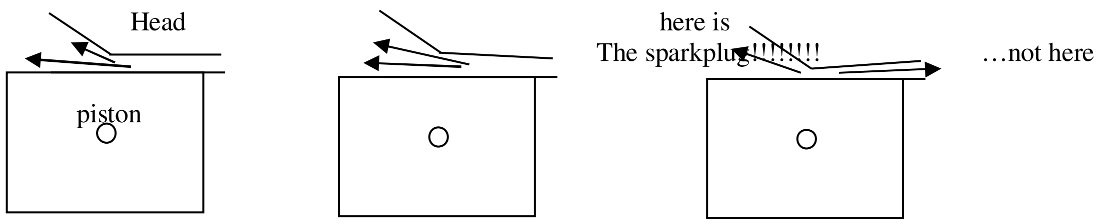

The squish height for our engines has to be around 1-1.5 mm. The squish area (the zone between the face of the head and the top of the piston) is proportioned (=calculated keepin' in mind) to the cylinder bore, the bearings (conrods+main) clearence, and the piston clearence. Also the material of those elements plays a part in calculating this height (ie, an aluminium rod, will be longer at high RPM than a steel one…bla, bla). If the piston has too much clearence in the bore (i.e.with forged pistons), it will rock at TDC rather badly and thus increase the risk of contacting the head. A thickness such as this (1mm), will be very beneficial for the engine. Lower emissions (lower HC, unburnt gases due to the reduced room for dead zone), lower fuel consumption, higher CR, and more power….

Basically, the shorter the igntiion process, the better the combustion is and so the performance. I don't mean the spark advance timing (that is dependent on Volumetric efficiency, RPM and the dynamic and physical condition of the inlet charge), but rather the duration of the combustion process , from when a spark is generated until the mass is completely burnt.  As an example: assume that a combusted charge had required a time of xx to burn completely (it does need time, it is a matter of the laws of Physics).  It was necessary to use a certain amount of ign advance to tune the engine.  Therefore, we “placed” the spark (better, the moment it starts!) at the right place (crank degreees) to have the maximum effect on the piston.  This advance will be some degreee before TDC.  Why is it necessary to start the igniton preocess so early, when the piston is still climbing the liners?  The power at the begining of the burning cycle will not be strong enough to ping the piston , (we can hear it when it happens) but could be enough to reduce, or slow down the piston movement, which means lost power.

If we can reduce the time required for the charge to burn completely (squish, head, piston top layout) assuming other things have not changed, we will discover that the igntion advance will de reduced, gaining more combustion efficiency, thus more power.

Any disruption inside the comb chamber will disturb and slow down the igntion process.  The worst thing happens with domed pistons.  The dome masks the flame propagation.  The dome has to be as low as possible to avoid this (it’s not heplful to have the force of the gases acting against the side walls of the dome!), and possibly , its shape has to be very smooth.  To achievie the CR you want, it is better to skim the head as much you can.

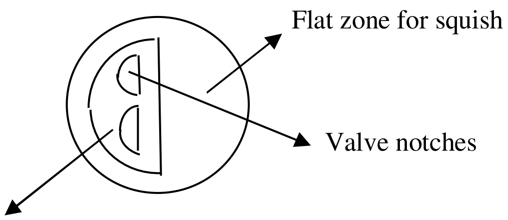
Another thing about squish: We have to be sure that the plane between the head and the piston top must be parallel, or at least “open” toward the sparkplug.  If the angle is wrong, the squish area will only trap the mixture with detrimental effects!




Parallel= good    open=good, but less CR    close=shit!

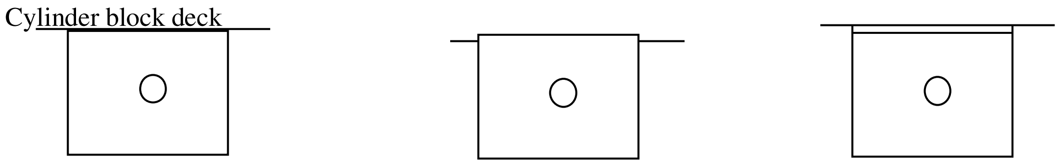
Instead, if you want to lower the CR, apart from grinding the head around the valves to unmask them from the combustion chamber walls, it would be better to machine the pistons, as shown below:

Piston Top view




“depressed zone to lower the CR

## Piston position at tdc:
**Here are three possibilities**:




Piston at zero deck    positive (piston above cyl deck)    negative (below deck)

The worst situation is to have the piston top below the block deck. Gas forces are wasted because they're pushing the liners, not the piston. This can lead to excessive carbon build up, bad flame propagation , lower CR, and the sharp edges of upper land of the liners (the edge) could lead to self-ignition.

Piston at zero deck is good, but even better , in theory, would be to have the piston top "positive" to cyl block (I have made it so, on my engine!).

**The reason**: the peak of the ignition phase has to occur after the a/f charge has been fully compressed, to get the max power from it. Then we have the forces acting on the piston. If the piston has passed the TDC point slightly, it will be in a more favorable position to get the shot. In fact, the lever (angle) between the rod and the piston is reduced…think of a bycicle and your effort to push the pedal when it is at "tdc"….after TDC the effort will be much less…
and as the revs go up and the combustion forces are acting on the piston, it will be nearer the combustion chamber keeping useful CR….less volume for gases to expand=more power to wheels….

## Inlet valve shrouding
If you fit enlarged inlet valves, then the combustion chamber wall near the valve will shroud the valve and restrict flow past the valve in that area.

Taking a <u>used</u> cylinder head gasket as a template, open up the area around the inlet valve up to the edge of the fire ring. Do not open it any further as the fire ring will not be compressed properly, causing hot spots and early failure of the gasket.

## Watch out for induction reversion
If your head has been ported, then the inlet tract will have been opened up. Firstly ensure that the inlet manifold is also opened up to match the head inlet ports, especially at the bottom of the tract. When replacing the manifold gasket, ensure that the gasket inlet ports have been opened up to match the ports in the cylinder head. Failure to do these checks may cause the effects of induction reversion in the inlet tract to be made worse, giving poor combustion, fuel economy, and it will make it more difficult to tune the engine.

Normally, you can do almost nothing to enlarge the gasket...but the steps on inlet side have to be: induction manifold with "holes" smaller (or better, same diameter) than the gasket, holes in head bigger than the gasket. On the exhaust side, the header's holes have to be bigger than the gasket, and holes in head have to smaller (or same diameter) than the gasket.

However, sometimes engine tuners build inlet reversion reduction into the inlet tract. In the case of the CIH engine, this will occur at the junction between the cylinder head and the inlet manifold. The inlet port, in the head, will be opened up at the top, so it is bigger than the port in the inlet manifold.

## Inlet/Exhaust valve seats Problems
When having the valve seats re-cut, or new seats installed, do ensure that they have three radiuses, at 30, 45 and 60 degrees. This will ensure that there is a smoother transition for the air/fuel mixture to bend around. This is especially important on the bottom of the inlet tract where the angle that the mixture has to flow around is acute (greater than 90 degrees). **Special Note:** Don't grind the seat angles too deeply in the head tract (that angle at 60°). Just gently grind it, smoothing it to the head junction. If you are too agressive, you can easiliy delete this radius…just a light bend has to be present there

As your valve seats wear and get pitted, the seats may need re-cutting, and the valves will certainly need re-lapping. This will cause the valves to sit deeper and deeper in the head.

There are two problems here. Firstly, as the valve sits deeper in the head, it will become more shrouded by the combustion chamber wall, and flow around the valve will be reduced. Also, the runner in the head will become shorter, so there will be less time for flow to change direction, from going parallel to valve stem.

Secondly, as the valve sits deeper in the head, the valve stem sticks out of the guide further, and due to the geometry of the rocker arm system, this will affect valve acceleration and valve lift detrimentally. It may be better to have new stainless steel seats installed. But again, ensure that the new seats have radiuses at 30,45 and 60 degrees. Also ensure that the new seat is blended into the surrounding material properly.