



Common Causes of Cylinder Head Gasket Failures

The AERA Technical Committee offers the following information regarding common causes of cylinder head gasket failures. AERA members often encounter blown head gaskets and would benefit from understanding why the gasket failed before doing a repair. Physical examination of the failed head gaskets can provide a clue as to the root cause.

Head gasket can fail for a variety of reasons and some of the common ones are listed below.

Detonation and Preignition	Excessive cylinder pressures distort or destroy the combustion seal.
Improper Surface Finish	Composite gasket surface finishes too smooth and MLS Gasket surface finishes too rough.
Clamp Load	Dirty Threads or Lack of Lubrication

Detonation and Preignition:

Detonation and Preignition occur when there is an abnormal combustion event. The air-fuel mixture spontaneously ignites preventing a smooth burn and this collides with the normal flame front producing extreme cylinder pressure. Common causes of detonation and preignition are listed below with explanations.

High Compression	Increased pressure at compression stroke raises temperature of air-fuel mixture, leading to spontaneous combustion.
High Temperature	Elevated engine temperatures from high load, improper cooling or hot spots can trigger spontaneous combustion.
Fuel Octane Rating	Using fuel with too low octane rating can lead to spontaneous combustion.
Improper Tuning	Incorrect ignition timing and lean fuel mixtures or excessive boost can contribute to spontaneous combustion.
Carbon Deposits	Carbon deposits can act as hot spots and ignite combustion.
Spark Plug Issues	Damaged or improperly gapped plugs can cause pre-ignition and lead to detonation.

Below shown in Figures 1-3 are examples of Detonation and Preignition head gasket failures.

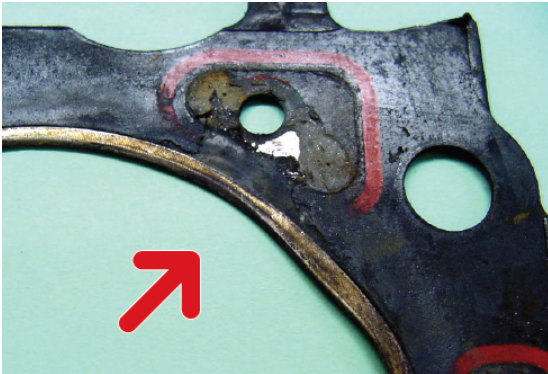


Figure 1: Detonation has distorted the combustion seal and gases escape into the cooling system.



Figure 2: Excessive pressure waves eventually burned through the gasket.



Figure 3: Another example of excessive pressure waves burning through the gasket.

Surface Finish:

Surface finish is critical to the success of the head gasket sealing. Improper surface finish for the type of gasket being used contributes to failures.

Composite gaskets require a rougher surface finish compared to modern MLS gaskets. The roughness of the finish helps bite into the more conformable composite gasket and hold it from shifting in operation. The composite material being more conformable can fill the taller peaks and valleys in the finish to seal fluids. Using a smoother surface finish on a composite gasket will not bite into the gasket to hold it, the gasket can shift in operation, eventually tearing the facing material and lead to leakage. Composite gaskets generally use a surface finish of 60-100 Ra for cast iron heads and 50-60 Ra for aluminum heads.



MLS head gaskets as described earlier use a smoother surface finish due to the thin rubber coating on the outside of the gasket. This coating is .0005-.0010" thick, this thin coating can fill the peaks and valleys of the smoother finish and hold the gasket from shifting in operation. Too smooth a finish can be an issue as the gasket will tend to shift in operation and this movement can wear off the rubber coating leading to a leak. MLS head gaskets generally use a 20-30 Ra if using OE gaskets and up to 60 Ra on some aftermarket head gaskets as the coatings on them are usually thicker.

It is recommended to check with the gasket manufacturer for the finish requirements of their gaskets. An example of a head gasket failure due to rough surface finish is shown in Figure 4 below.

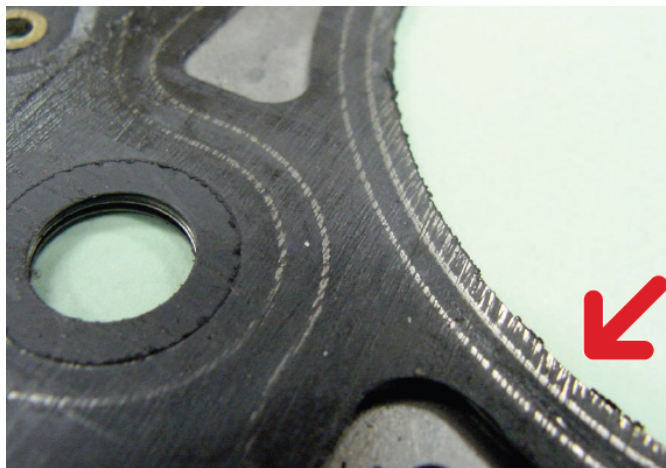


Figure 4: Rough surface finish shown – Peaks and Valleys too tall to seal.

Clamp Load:

Clamp load is essential for head gasket sealing, threaded fasteners that are torqued to a specification provide the clamp load on the gasket that helps fill in the peaks and valleys of the surface finish. Using fasteners with dirt or debris creates more friction while turning them, this friction reduces clamp load. The same is true for not using lubrication on the threads. Lubrication reduces friction and in return increase clamp load.

Inspecting the failed head gasket is an important step in diagnosing the failure's root cause and then that issue or issues can be addressed to ensure repeat failure chances are reduced. Using good installation techniques along with following the manufacturer instructions is key to a successful installation.