

Valve head cracking / breaking

1. Valve Headchordal Failure

This is the most typical form of valve head failure. The valve head breaks through a chord line, i.e. a failure stretching across two points on the circular edge of the valve head. This usually produces considerable secondary damage to the piston, cylinder head and sometimes the cylinder bore.

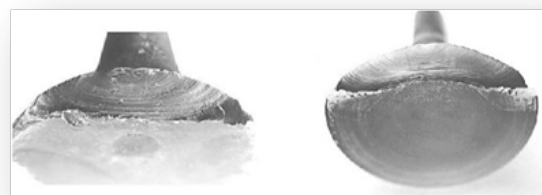
This is a fatigue type failure, the causes of which are:

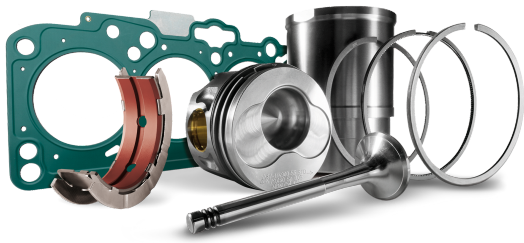
- The valve head's inability to stand up to the stresses from the gas loading.
- The valve head temperature effect on the ultimate tensile strength of the valve material.

The initiation point is usually about halfway up the underhead radius. This does vary to some extent according to the section design of the valve head. This is a problem mainly confined to the engine manufacturer during the development of a new or uprated product but it can occur in service.

Although the term chordal is applied, there may be many variations on the shape of the developing crack. This sometimes travels a considerable way round the underhead radius before propagating out to the valve seat. Fundamentally, the skin of the underhead radius at some point being too highly stressed causes such valve head failures. In service the reasons for this could be:

- a. Excessive load on the engine coupled with over-fuelling or other maladjustment, resulting in excessive valve temperature and gas pressures.
- b. Poor finish on the underhead radius on highly stressed valves. Note, some valves are shot peened or spiral-polished to increase resistance to skin fatigue.
- c. Damage marks on the underhead radius.





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2. Valve Head Tuliping

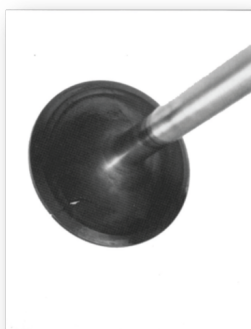
In this instance, the head of the valve cups downwards resulting in poor sealing and loss of power. This relates to chordal failure as environmental conditions, valve head design and type of material initially produce a plastic flow. However, it is possible to spot valve tuliping before final chordal failure occurs due to the resultant poor sealing and power loss.

With this type of condition, current belief is that plastic flow increases due to over-speed dynamic effects.

3. Radial Rim Cracking of Inlet and Exhaust Valve Heads

“Radial Rim Cracking” of inlet and exhaust valve heads is also traditionally known as “Thermal Fatigue”. Research over the last few years has clearly indicates that many failures attributed to classic thermal fatigue have other factors influencing the result. A radial crack is one that starts in the rim of the valve and travels inwards to the centre of the valve.

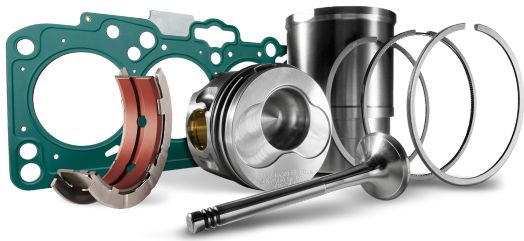
As with chordal failures, these failures also vary. Sometimes the propagation line turns through 90°, travel across the valve head in the form of a half chord and, then travels back to the valve seating face. The piece that breaks away is roughly triangular in form.



In other cases, the initial crack line branches into a 90° turn to both left and right. This produces two triangular breakaway pieces that are very often lost. Initially it appears that the valve has a chordal failure. These failures may sometimes be obvious but, in other cases, they may require expert identification.

The causes of true thermal fatigue are:

- a. Extreme cyclic temperature variations throughout the valve head. Excessive temperature and pressure in the combustion chamber bring these about.
- b. Continually overloading of the engine followed by abrupt unloading or frequent engine shutdown after high loading.
- c. Poor temperature distribution across the valve results in high tensile rim stresses. Abnormal deflection of the valve head due to excessive combustion pressures often accompanies this.
- d. Damage marks on the rim produce stress raisers
- e. The rim or peripheral land of the valve head is too thin and with sharp edges. This is usually due to too frequent reclaiming or regrinding.
- f. Pre-ignition conditions
- g. Incorrect material specification.



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4. Burn Through On Rear of Valve Face

On occasions, a hole burns through the exhaust valve head at the back of the seating face that leaves the seating face virtually unmarked. Close examination, however, shows the start of the failure is a rim crack. With rapid erosion of the valve head material, combustion gases can escape through the crack. This is also another example of radial rim cracking or, thermal fatigue.

