SUPAR®

ENGINE VALVES GUIDES and SEATS

Assembling

Engine Valves

&

Causes of Valve Failures

Written By:Dr.M.Şekip ALP

SUPAR

Konya

Phone: +90 (332) 248 23 94-95

Fax: +90 (332) 248 75 21

Introduction

Valves have had a big role on running engine economically and productive. Parts of valve mechanism work under pressure of various forces such as high speed, heat, corrosive ambiance, pressure, friction etc. As a result of all these environmental factors, each part of this mechanism becomes worn, leakage begins, and lack of product and strength occurs in engine during inlet and compression periods. In this case, engine valves should be renewed or repaired. Valve mechanism, which is usually used in engines, is seen on the figures below. Figure 1, inferior camshaft valve and figure 2, upper camshaft valve, show each part of the mechanism.

As seen on figures 1 and 2, Even though their delicate structures, valves seem to carry the hardest mission in auto engine. Having worked together in an accurate harmony with the other elements assisting valves will surely extend valves' lives. Today's competing conditions pushing producers to build stronger and faster engines. Additions such as Turbocharger and intercoolers to encourage engine's strength are certainly forcing and damaging the engine parts, and therefore shortening their life-time. Before making these kinds of additions; maybe the entire construction of engine should be changed, and each part ,as a material and shape, should get into a better condition. This failure catalog will be based on valve and valve train components, and its mechanism. This catalog will only focus on valves' failures and search for the reasons causing failures. However, effort of manufacturer or engine assembler about valves cannot be always sufficient, customer should indicate an equal sensibility as well. We as valve manufacturers have been using the most modern technology according to international standards. In a valve mechanism along with a perfectly completed engine reconditioning associated with customer's concern, none of the explained failures will occur. By the time, only the usual wear occurs. Figure 3 determines the valve sections that can possibly be worn out by the time and shows their appropriate locations.

As seen in figure 4, axis valve marked with "AA" is also the common axis of the valve and its train components such as guide and valve seat. While engine reconditioner grinding valve seat, it is essential that axis of valve seat must not clash with axis of guide.

The main causes of valve failures:

1. **misalignment between the axis of guide and valve seat.**
2. **gas leakage from combustion chamber to manifold.**
3. **Inaccurately taken valve clearance tolerances.**
4. **Soften and bended valve springs**
5. **Poor quality fuel**
6. **High engine velocity and excessive loading**
7. **Concavity in engine.**

Paying not enough attention to these reasons that are listed above may cause valve overheating. Ruined engine synthesis, insufficient cooling, and lubricating are the considerable factors that cause valve failures as well.

Guide and valve seat, as seen in figure 5, have a significant role on cooling of the valves. Parts written on the figure state the regional heat. Regional heat is considered to be the superficial heat fallen down into the explosion inside the exhaust valve and the inlet period, which is suddenly occurred inside the exhaust period. Contact faces of the valve seat and the guide toward the valve should contain the satisfactory size, and space among the stem and guide should not be more than the required size in regards not to extend the depth of the head and the bottom part of the head.

Besides the changeable forces reaching the head and the stem, the other reasons of fatigue of valve material are the variable strains caused by the changeable heat (As explained above). At any rate, if working in regular basis, valves consistently show their best performance. Furthermore, other extra forces related to customer errors along with assembler and production errors on the mechanism may produce enormous failures such as mechanism failures, loss of time, loss of money etc. We as manufacturers and you as an engine (cover) rebuilder and assembler should support and warn each other technically, and we must inform the customer concerning this catalog with our best efforts.

Dissembling, Controlling and Assembling of Valve Mechanism

Initially, the valves installed on the cylinder head should be taken out by using basic armed dissembling tool (6). In a condition of changing the guide, pressing without damaging the cylinder head or using hammer assisting with a mandrel will give the best result. A sharp pointed small hand spike is usually used for dissembling the valve seat as well. (7-8)

The Cylinder head should be washed inside of a cleaning liquid (solvent). If pressured water or steam being used for washing purposes, guide clearances and valve seat faces should immediately be lubricated after the high pressure air being held. Otherwise corrosive ambiance immediately applies on these surfaces, and may cause the unilateral guide wear through spreading out in the mechanism. After the washing process, carbon accumulation and dirt in the valve seat inserts should be cleaned with a small hand cloth attached to a brush. Cleaning materials, such as oakum, which contain fibres should not be used in any circumstances. (9-10) Cylinder head should be controlled carefully. Especially, valve seat inserts should be checked for possible cracks. Bending on face should also be checked crosswise, if bending is bigger than 0,15 mm, then it should be grinded.

Cylinder head should be heated in an electric oven between 80-100'C. In a different way, only the valve seat insert zone should be heated by an ox hydrogen blow-pipe until reaching the appropriate temperature. Valve guides that have satisfied the pursuing requirements should be pressed or else should be forged with a hammer by using the right size of mandrel. (11-12) Guide cavities should be measured by an assistance of cavity comparator or micrometer. Handle-guide clearance exists by itself, if there is no shrinkage at the cavity. Otherwise, cavities should be reamed with an undamaged reamer in the right diameter size. Reamer should be applied alongside of cover of valve seat inserts. (13)

Conic reamer should not be used. After reaming, bottom part of guide cavity margins should be left sharp but with no burr. Burrs can be taken off by using a thin, indelicate emery.

Unfortunately, this process can not be applied on some engine guides.

We strongly recommend you to use new valves with new guides.

Even though valves which have complete their regular life time still look clean, as mentioned before, material fatique especially at exhausts should appear. Because the medium of valve running needs this situation. In general, fatique incident is a damage of material due to continuously changeable forces and heat. If you use a valve like this, you can not know the behavior of valve and guarantee a certain life time. The best way is to use new produced valve instead of some valves

which are machined from old and used ones. It must be carefully examined before use. Valves must have no any defects like micro cracks, deformation on seat and tip surfaces, wear on stem, defects on grooves etc. valve seat is ground in the valve grinding machine as taking very sensitive stock removal. (16). After the grinding, the run out of seat is measured according to stem as max 0,03 mm tolerance by using comparator.

Valve seats that fit the quality requirements should be assembled at the proper tightness. Sitting surface should be grinded with using a grinding tool. Width of the surface and should be in an equal distance all around the circle. Centering pin of grinding tool should tightly be fastened to the guide cavity. Guide and valve seat axles should be coincided(18-19).

Grinding angle of a valve seat is usually manufactured half degree smaller than an angle of a valve sitting face to possess the valve sit on the sitting face linearly in the beginning (20). If assembling is completed carefully, then drilling valves would not be essential. Sitting face should be checked as seen on figure 21. If seat has not been perfectly completed, then valves should be drilled. Furthermore, height of a head comparing to a cover should be checked by a portable comparator.

8. **Perpendicularity and tension of valve springs should be checked. Undersized or nonperpendicular springs should not be used. Shortened in height and non-perpendicular valve springs should not be used. Reusing the spring by back stretching is not valid. Narrow-pointed side of spring should be pulled to the bottom while assembling.**

9. **Groove and some of the heads that obtain crush or wear should be renewed entirely. With an armed tool used for dissembling valves; valve, spring, groove and head group should be reassembled to the cylinder head. Valve handles should be lubricated sufficiently. Valve felts or rubbers should be placed cautiously. Top of the valve head should not be numerated randomly. Electric pen can be used or marking can be applied lightly in the middle of head. Additional operations such as turning, filing, and grinding should not be done for new valves. New valves should not be dropped during the assembling. Head run-out of the ones that have been fell down should be checked. Upper part of head can be knocked softly by a plastic mallet to ensure that whether groove and head are assembled appropriately or not.**

Seat surfaces of rocker should obtain their original curve and should shine as a mirror. Otherwise, these can be grinded or changed at special counters. There should not be any clearance between rocker and its pin. At the end of the assembling, rocker tips should push the top of the valve

10. **in the middle; if not, then alignment needed. Springs on top of the rocker pin are used for locating rockers. Those should not lose their tensions at all and should not be fractured. (22)**

11. **480-640 FIAT and old type of BMC 140-150 inlet valves are shrouded. (Ears). Worn wedges of shrouded valves should be changed.**

12. **Rotocap should be installed for some of the valves' endings. Height of a rotocap should not reach top of head. If so, it should be grinded. In some valves such as Anadol 1300, groove to tip distance appears to be insufficient. In this case, rocker might break up mechanism by pushing head.**

13. **Following assembling section, leakage test should be done on valves by using an air pressure device. (23)**

14. **To keep valve mechanism working properly, only an effort of an engine rebuilder cannot be sufficient. While assembling engine, deformation and wear of rocker pin, pusher, cadet, cam shaft pin and bushing should be checked. Due to excessive grinding of cover or some other reasons, upper face of piston might contact with valves. At the end of the assembling, this should also be checked to avoid off bigger problems.**

15. **Engine adjustments should be done considering the catalog information while engine is cold. (24) You as engine rebuilders should rely on this given catalog information and recognize what kind of engine character you are working on. Assembling completed with outdated methods and randomly given clearances can not be decent.**

Signs of Valve Failures

1. **Blue smog comes out of exhaust and creates loss of lubricant.**
2. **Engine begins making noise and force increases.**
3. **Engine does not start at all or runs with a low velocity.**
4. **Back firing occurs in inlet manifold**

These signs, as explained above, takes time to appear. As soon as noticing these signs, cover reconditioning should be applied. These signs, as explained above, takes time to appear. As soon as noticing these signs, cover reconditioning should be applied.

Sudden valve breaking and these broken parts of valve caught between cover and piston lock up engine, and stop rotating of crankshaft pin. Regarding serious damages might arise in engine, meanwhile it is essential that not to go hard on engine. Then engine should be taken into an engine

reconditioning immediately and cause of failure should be identified. In general, neither material errors nor production errors are the reasons of valve breakage except if valves are the unidentifiable, low quality. Overheat caused by overloading, excessive increased engine reconditioning, frequently used engine breaks, high loading of vehicle, or piston to valve contact are the main reasons of unexpected failures.

Valve Failures and Causes

Assembling, material and usage errors cause unexpected valve damages and shortens valves' life times.

(While looking at the valve failures and causes, material and production errors will not be considered below.)

Excluding few exceptions, Valve failures are observed to start after the initial engine reconditioning. When there is a brand new engine, the whole mechanism certainly runs with its maximum potential. Therefore, the purpose of this failure catalog is to determine the problems exist by the cause of the initial and other following engine reconditioning.

Carbon Accumulation At Valve Head and Its Reasons

Reasons of the most valve failures are the unwanted accumulations gathered around the valve head. These accumulations, formed by oxide and carbon fragments, settle around head and neck of a valve and even damage the stem. (Figure 25-26)Difference between a clean worked valve and a head part of an excessive carbon accumulated valve.

Reasons of Accumulations:

Due to any kind of a failure, lubricant inside of a carter of an overheated running engine becomes oxidized. Unless lubricant has not been changed for a long time, it turns out to be a muddy liquid and loses its lubricating feature. Lubricant going into a space between stem and guide becomes

1. **stuck in there and carbonizes by reason of overheating. Under these circumstances, Carbon layer accumulating around the stem faces ruins the valve.**
2. **Engine without retaining an air filter or running with a ripped filter takes in dirty and dusty air. By the time, dirt accumulates at valve head.**
3. **Liquid fuel and unwanted adhesive components such as Varnish in fuel, lead accumulate around the head and produce the same effect as well.**
4. **Rich mixture in gasoline engines, injector leakage in diesel engines and excessive repulsing in combustion chamber cause carbon accumulation in both valve and combustion chamber. Accumulation makes valve cooling laborious. Furthermore, hot dots created from accumulation are a reason of untimely firing.**

Parts where the valve failures usually take place are:

Valve head concavity:

Valve overheating or working with damage cause this sort of failures (27).
Overheated head material loses its solidity and head edges become bent all around.

Reasons of head overheat:

1. **Leakage of valves**
2. **Early firing**
3. **Excessive engine velocity and overload**
4. **Stoppage of cooling system**
5. **Inordinate stem-guide clearance.**

Damaging and burning of the faces

Face damages, as seen on inlet valves, can frequently be seen on exhaust valves as well. Damages appear as a form of burning around the head edges (30-31-32) or wear pits and carving along the face (28-29).

Reasons of damaging and burning as seen an the figures:

1. **Wear pits as seen on figure 28 is a corrosive effect formed by hot exhaust gases found on faces. Detonation removing additives such as lead-tetra-ethyl in fuel cause very strong corrosions above 750'C. Constant heat of head should not exceed the particular limit. Conflict between valve and valve seat materials also creates the same result. Covering the face with stellite will prevent us from this kind of damages.**

Similar incidents in inlet valves, conflict between valve and valve seat materials, carbon accumulations stuck on the face or other reasons can be defined as results of leakage.

2. **As seen in figure 29, surrounding concavity along the face or partial concavity is the cause of the deformation of the head material by heat. Excessive valve alignment clearance, excessive engine reconditioning, and valve seat manufactured by a hard material are also considered to be the other reasons as well. Partial carve is a sign of valve's parallel sitting. Because continuation of concavity moves the valve alignment clearance, leakage and valve burnt occur.**
3. **Valve burnt, as seen in figure 30, proves that valve alignment clearance is built very tight. Edge material and its surrounding become melted and carved by reason of gas leakage.**
4. **At figure 31, melting on face of a stable valve by a regional heating concentration is obviously seen.**
5. **Insufficient cooling of valve seat causes a loss of valve seat's circularity. Because this case is going to be the other reason of valve leakage, valve face becomes damaged as seen on figure 32. Side factors also cause various head failures beside the main factors as you have seen above.**

Poor mix in gasoline engines, too early or delayed firing, inappropriate alignment of fuel repulse point in diesels, injector drips, clogged exhaust system and silencer, cracked or removed valve seat, replaced guide, clogged water channels, inactivated thermostat or using excessive temperature thermostat, engine being forced under overload, usage of bad quality or juicy fuel are the factors that reason the excessive heating of head.

Deformation at the bottom of head, thinning and cracking at the end of head

Overheated and corrosive valve heads may exceed their material capacity (particularly seen in thin-headed and groove topped valves with a tulip shape). As seen in figures 33-34, cracks on the bottom of head are usually seen on the valves that are excessively coerced.

At the figure 35, we are looking into a thinning which starts from the head's end part of a valve worked heated under the circumstances of corrosive effects, and then (Figure 36) cracks appear by the reason of thinning. Later, these cracks, located at the end of the head, may cause breakage on valve.

Valve Breakage and fractures

Even though valve fracture occurs very rare, it may create considerable damages to other parts of engine. Fracture usually occurs from either head edges or head ends where merged with stem. If there is no mechanic collision, such as piston strike, to cause a fracture, then the reason of a fracture is usually the worn material. Wear can be defined as stretching modulations that force the material and temperature changes. In normal conditions, period of fatigue fractures can not be approximated. However, it usually takes longer than the installing period of valves. Reasons related to the form of a fracture are explained below.

1. **In many cases, serious heat differences by sudden temperature changes cause structural alteration on head material. Moreover, heat differences loosen the material, and cause fractures in aspect, as seen on figure 37.**
2. **Valve, while working, sits on surface partially by reason of a leakage on valve seat and guide axis misalignment or excessive clearance between stem and guide. properly seated valve seen in figure 38, and partially seated valve seen in figure 39. Single-sided seat causes changeable bending stretches on seated side and stem beginning. After a while material fatigues, and fractures occur. In figure 40, stem preface fractured by a result of an cam shaft seat, and side fracture picture of BB.**
3. **As long as Thermal and mechanic forces congregate at the same time, fracture of fatigue accelerates. Fractured section pictures as seen in figures 41-42-43 are similar with the other figures.**

4. **While marking, valve head run-out increases by reason of the numbers enumerated on head of a valve away from the center. This case either causes cam shaft seating again or creates side fractures with an effect of notch by depending on the depth of marking.**

5. **Other factors causing fracture can be summarized as below;**

Excessively increasing engine velocity by a result of overspeeding or downhill going vehicle with low gear,

Corrosion, caused by poor or juicy fuel and excessive heat, goes into structure of head material.

Deformation of engine synthesis, unilateral stem wear to guide.

head striking the piston, due to weakened valve springs, tightness of notch wedge in shrouded valves, groove escape etc. loosened valve seat and guide or deformation in shape.

Compression of valve stem inside of guide

There are mainly two reasons of compression;

1. **if clearance between stem and guide is not sufficient, this clearance disappears during working process and unilateral stem wear to guide. Clearance between stem and guide should be aligned to block gas leakage and to provide slipperiness by forming a thin lubricant film. Stem and guide materials and their surface roughness values are also substantial. In figure 45, end of unilateral stem wear in valve with insufficient work clearance.**

Because unilateral stem wear will result valve compression inside of guide, collision between piston and valve head becomes definite.

2. **Excessive clearance between stem and guide**

When the clearance is excessive, large amount of lubricant slips in the clearance and carbonizes due to poor cooling conditions. This case continuously repeats itself and ruins stem. Thick lubricant layer becomes varnished and carbonized at valve stem as seen in figure 46. Excessive clearance does not allow valve to work perpendicular and results unusual wear in stem and guide.

Fracture on Groove and under groove clearance, regional wear on stem

Rocker tips not sitting stem top is the main reason of this failure. In figure 47, misaligned seating from axis rocker tip marks, in figure 48, as a result of this, fracture from under groove clearance and in figure 49, fatigue signs at fractured part can be seen.

Another effect of misalign is seen on stem. Corresponding unusual wear occurs on stem end clearance and region continuing towards head. (50) figure 51 shows that end fracture occurs as a result of improper head-groove to channel assembling.

Stem End Crushes and Cracks

This kind of failures are seen on non-rotating valves, extremely fast rotating valves, or valves with excessive clearance.

Figure 52 shows crush marks on non-rotating valve. In figure 53, because of the excessive clearance, rocker strikes stem extremely hard and results cracks and crushes. Circular crush marks is seen on top and face parts of a fast rotating valve on figure 54.

improper rocker end curve and randomly and roughly grinded rocker end are two other reasons that cause excess wear of stem end.

Rotocap should be installed on some valve ends for rocker to seat on rotocap. Various crushes occur on top of groove when seat is not centered as seen in figure 55.

***Rotating Valves*:**

Rotating valves certainly last longer. Balanced heat of faces in other words not having regional heat accumulation around, preventing from a possible carbon accumulation, resulting possible errors with least damage during engine reconditioning, providing homogen wear on stem and stem end is depended on rotating of valves.

For valves with no rotators, rotating incident happens along with engine's natural vibration and each stroke of valve springs which hardly spin valves. Weakened springs can not rotate valves at all. However, rotator installed valves run efficient.

Wear and Reasons of Valve Mechanism Parts

Each part of the valve mechanism worn alike all engine parts working with each other. Anomalous wear of some of these parts effects the whole mechanism. Searching and taking precautions for causes of wear are very essential to allow the system work efficient. The most common reasons of wear are:

1. **Insufficient lubrication and dirt (such as dust, sand, solid carbon, pieces of stone and metal) are the most significant reasons of wear. Dirt accumulation, if not able to hold by the filter, creates wear through absorbing into engine with air.**
2. **Bad quality lubricant used in carter or unchanged, oxidized carter lubricant loses its lubricating specialization. Particles, coming off from metallic surfaces, mix with lubricant and accelerate wear.**
3. **Clogged or damaged oil filter, insufficient pressure in oil pump, leakage on safety valve, and excessive crank bed clearance decrease engine oil pressure, and leaves valve mechanism without oil since oil can not go though channels.**

Preventing from all the reasons explained above will keep wear in its regular progress.

Recommendations About Valve Mechanism

The most significant measurements in valve are stem diameter, head diameter, head margin thickness and run-out of sitting surface. The significant measures for guide are crater diameter, exterior diameter and height.

During cover reconditioning, if stem-guide clearance is more than 40% of its original clearance, then valve and guide should be replaced.

Thickness of valve head margin should not go under the recommended smallest size.

If you can not find the catalog value of work clearance, measure stem diameter. You can approximately get the lowest and the highest clearance values by multiplying stem diameter with 0,004 or 0,007 in inlets, with 0,0075 or 0,009 in exhaust.

Tightness of guide on cover:

should not be between 0.02 and 0.05 mm. in inlets between 0.03 and 0.06 mm. in exhaust.

Cavities should give at least 50% of the tightness.

If widened more, then use a different guide which provides the particular tightness.

Stem end should not be grinded over than 0,2 mm. While grinding, you should pay attention on perpendicular and face roughness of stem end.

If valve springs have lost 10% of their original strains , they should not be used. Deviation of spring perpendicularity should not go over than 0,8 mm. for 25mm.

Bent on cover, when controlled crosswise, should be at most 0,15 mm. If more, then it should be grinded. Thickness of several times grinded covers should not go under the min. value.

Conclusion

Short summarization of all material explained in this catalog is:

1. **Assembling with using proper tools,**
2. **Accurate measurement,**
3. **Clearance alignments according to the catalog,**
4. **Special care on cleaning,**
5. **control on each stage of assembling,**
6. **sufficient lubrication.**

Suggestions for customers (during the delivering process);

Customers

1. **should not play with pump,**
2. **should not overload,**
3. **should use appropriate gear at the proper speed,**
4. **should not overload**
5. **should not overheat the engine**
6. **should take his/her vehicle into a service not later than the appropriate date.**

7. This should not be forgotten that Manufacturer, engine assembler and customer should complete the excellent trio on working and helping each other in harmony to achieve their goal. Reaching the success will certainly benefit these three in any case.

CERTIFICATE

TÜV NORD

Management system as per

TS EN ISO 9001 : 2008

In accordance with TÜV Teknik Kontrol ve Belgelendirme A.Ş. procedures, it is hereby certified that

Supar Supap ve Parça San. Tic. A.Ş.
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No 150, Selçuklu,
Konya,
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applies a management system in line with the above standard for the following scope

Manufacture of engine valves and valve guides

QM Element 7.3 excluded (Product design)

Certificate Registration No 1001313
Audit Report No TR 1522

Valid until 2016-07-31

Certification Body
at TÜV Teknik Kontrol ve Belgelendirme A.Ş.

Istanbul, 2013-08-01

The certificate remains valid until the above stated date if and only if there is an uninterrupted compliance with the requirements of the standard and certification contract

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CERTIFICATE

TÜV NORD

Management system as per

ISO/TS 16949:2009

(3rd edition, 2009-06-15)

Evidence of conformity with the above standard has been furnished and is certified in accordance with TÜV NORD CERT procedures for

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with the functions according to appendix

Scope

Manufacture of engine valve and valve guide
without product design responsibility (according to section 7.3)

IATF Registration No. 0169442
Certificate Registration No. 44 111 131030
Audit Report No. 3512 1219

Valid from 2013-08-30
Valid until 2016-08-29

Certification body
at TÜV NORD CERT GmbH

Essen, 2013-08-30

This certification was conducted in accordance with the TÜV NORD CERT auditing and certification procedures and is subject to regular surveillance audits.

CERTIFICATE

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Appendix to IATF Registration No. 0169442

ISO/TS 16949:2009

(3rd edition, 2009-06-15)

Remote Function	Function
Supar Supap ve Parça Sanayi Ticaret A.Ş. Atatürk Cad., No 12, Oto Sanayi, 4. Levent Istanbul Turkey	Marketing

- End of the List -

Certification body
at TÜV NORD CERT GmbH

Essen, 2013-08-30

This certification was conducted in accordance with the TÜV NORD CERT auditing and certification procedures and is subject to regular surveillance audits.