FAILURE ANALYSIS OF A FUEL PUMP INJECTION

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Abstract. *This work have the objective to determinate causes of the failure in component of the diesel fuel pump injection cracked in the wear application. That component is used in trucks. The fuel pump injection is submitted by hydraulic pulsation, where the fuel injection pressure is the 1800Bar. That injection pressure is cyclic with variable stress. That fuel injection pump cracked after 20000Km by wear. The examined component is made of the forging steel SAE 4144, hardened, tempered and plasma nitriding. The experimental procedure consisted in the characterization of the fracture aspects of that component. The visual examination by stereoscopy. Fractography method using scanning electron microscopy FEI-Quanta200 and metallographic examination were made by optical microscope Olympus Q color3. The component crack is visible without a equipments in the to the side of part. In the examination by stereoscopy, after crack aperture, it was possible to observe the presence of beach marks. This aspect of the breaking is typical of a alternaded loading of low nominal stress (constant loading amplitude). It was observed two principal points of crack nucleation in the valve hole. The multiple points of crack nucleation suggest high concentration stress, because that component is hardened and tempered. (low tenacity) and shows final crack smaller area. In the fractography analysis can be observed some fatigue crack growth, that cracks initiated on the microcracks in the valve hole surface.. Striations are small ridges that are perpendicular to the direction of crack propagation. The crack nucleation area (valve hole) is grinding by action valve coupling, in the examination that area, the macro etching by Nital 0,3% shows dark and clear areas. The results obtained shows that failure in the component of the fuel pump injection occurred by fatigue mechanisms, and crack nucleation were on the microcracks in the valve hole due burn and re-temper by grinding. It was suggesting the checking grinding parameters (cooling) and periodic metallurgical tests.*

Keywords*: fuel pump, failure, crack, re-temper*

1. INTRODUCTION

Failures in mechanical components are events no wanted, and a lot of times can put in risk human lives and they largely reduce drastically the useful life of the group or of the component, besides to cause the extraordinary costs for it maintenance or it changes.

In the report of the engineering and concerning this study in matter, in the it elaborates automotive, we have several examples of failures provoked by structural failures, project mistakes, wrong material and per times foolproof of the component.

Several techniques and tests are used for the forecast and behavior of the component and also analysis put defective with the intention of determining the responsible factors for the occurrence of that it failures.

To execute such analyses it is had as prerogative the knowledge in the mechanical resistance of the materials used, in the making of the component including the fracture resistance, mechanical properties and metallurgical proprieties of the material, the fracture characteristics, superficial and other damages. Godfroid at all (2002)

During the use this fuel pump injection, the internal holes are submitted the hydraulic pulsation to each injection cycle, where the fuel reaches pressure of up to 1800bar (component subject to cycles no tension uniforms).

Cracks in this system cause powerless of the vehicle due to low injection pressure and in extreme cases, they can happen more severe damages.

The objective of this study is to determine the cause of the failure in the body of the injection pump. The examined pump is used in heavy vehicles and the failure happened after the vehicle to reach 20000km turned (used), provoking stop of the vehicle.

2. METHODS AND MATERIALS

The fuel pump failure was visual examined and recorded keeping. Figure 1

The fractography method used the stereoscope Will Heerbrugg and scanning electron microscope FEI Quanta 200. Figure 2, 3, 4 and 5.

The macrography analysis was made by macroetching – Nital 0, 3% for re-temper visualization. Figure 6

The micrography analysis was made after opening the fracture by microetching – Nital 2% for microstructure visualization by optical microscope Olympus Q color 3.

The fracture surface pump was examined by stereoscopy reveled the presence of the beach marks. The beach marks are indicative of fatigue loading and show the result of changes in loading or frequency, ASM Handbook (2001) and low nominal stress. Godfroid at all (2002)

In this case there are main two fatigue crack origins. Figure 2

These origins are in the valve hole surface. The analysis by scanning electron microscope showed multiple fatigue nucleation from micro cracks in the valve hole surface and the final fracture area was very small indicate high concentration of tensions and the fracture happened under low nominal tensions suggesting low tenacity because heat treated material.

In the fracture surface they where found grooves, fig 3, that they appear in the single tension cycle and not depends of the cycles tension variation (nor every cycle produces grooves) and beach marks for example, they indicate the crack origin.

The crack origin surface in the valve hole was made by grinding for the mating of the closing valve.

One face of the fracture was macro etched by Nital 0,3% during 30 seconds for revealed in this surface the presence of the burning and re-temper by grinding. Figure 5

That region was cut and surface preparation by microscopy examination. In the metallographic examination was found presence of the burning and re-temper by grinding with 15µm depth. Figure 7

2.1. Figures

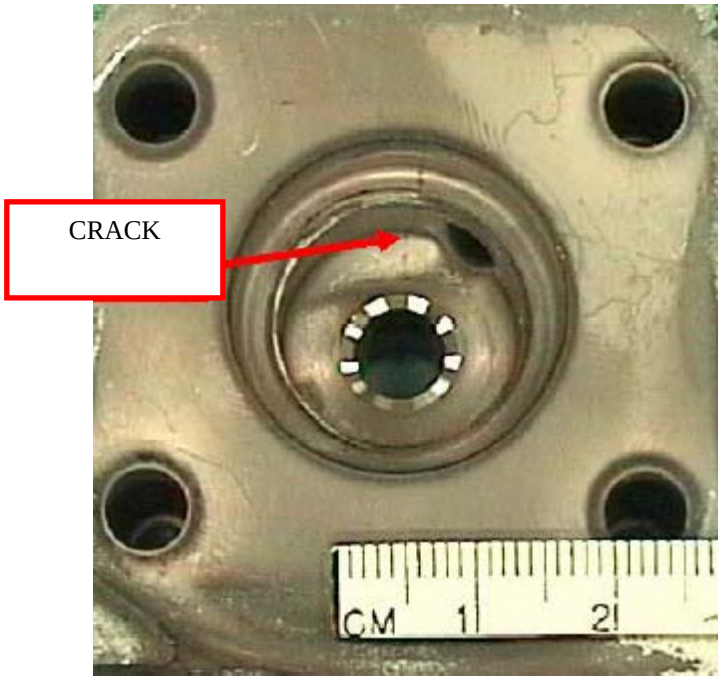

Figure 1. Injection pump body – crack position

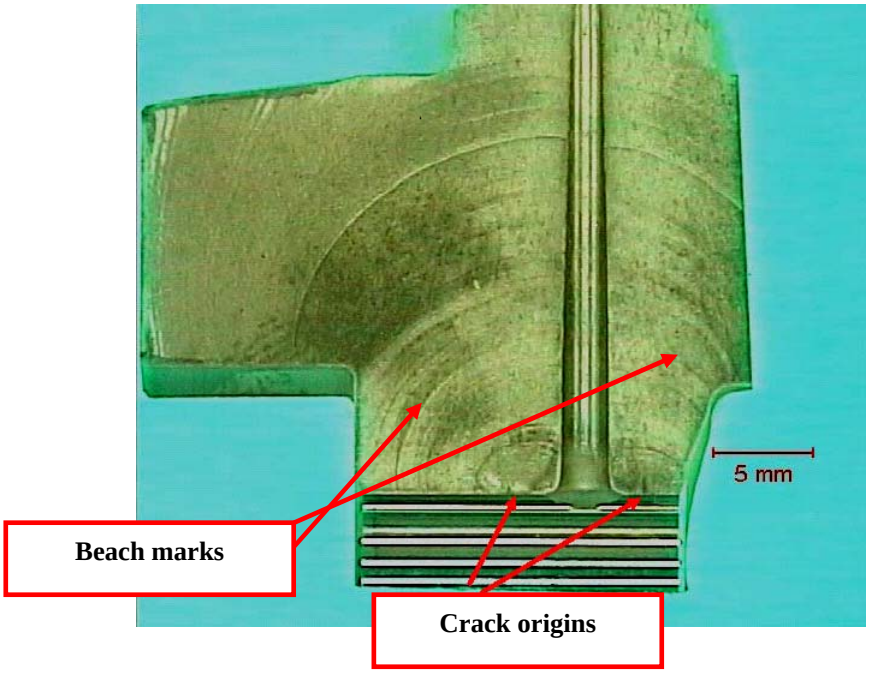

Figure 2. Fracture aspect. Beach marks are observed (concentric marks that never cross and they happen for the significant alteration in the loading cycle) and they indicate the origin of the cracks (arrows) where there is nucleation of the cracks for fatigue in two places indicating high concentration of tensions.

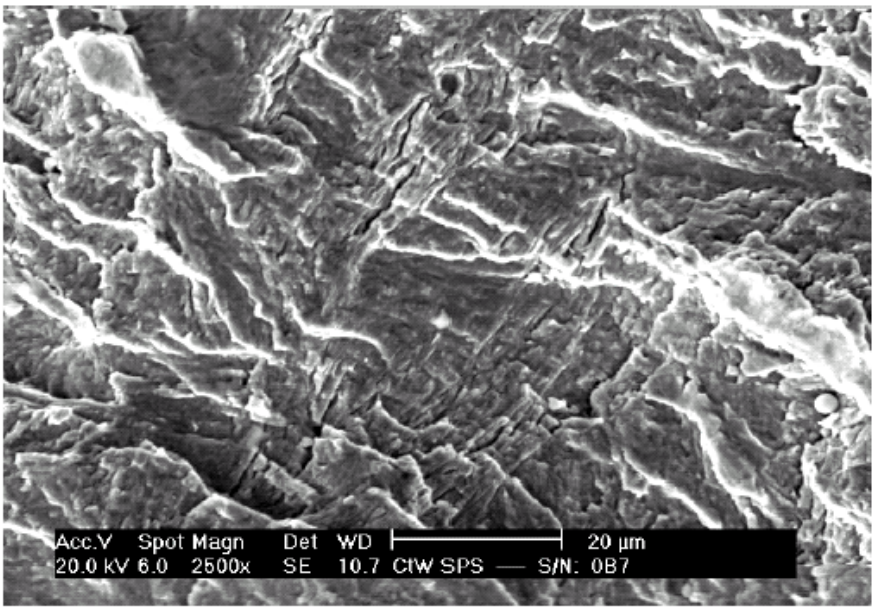

Figure 3. Grooves proving the mechanism of fatigue. They exist independently of the loading cycle to be variable or uniform (to contradict of the beach marks) and they correspond to the front position of the crack in a certain instant.

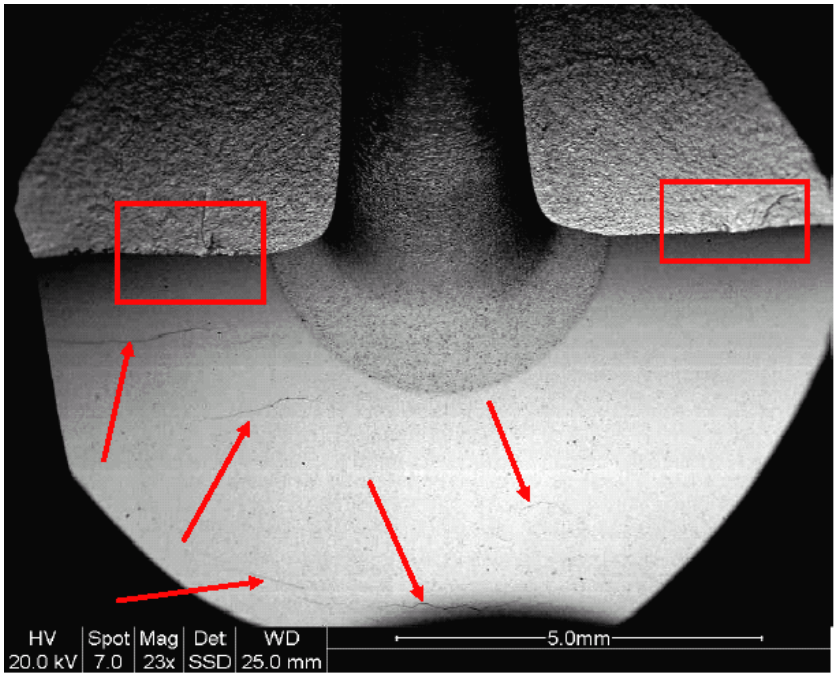

Figure 4. Micro cracks in the valve hole surface. (arrows)

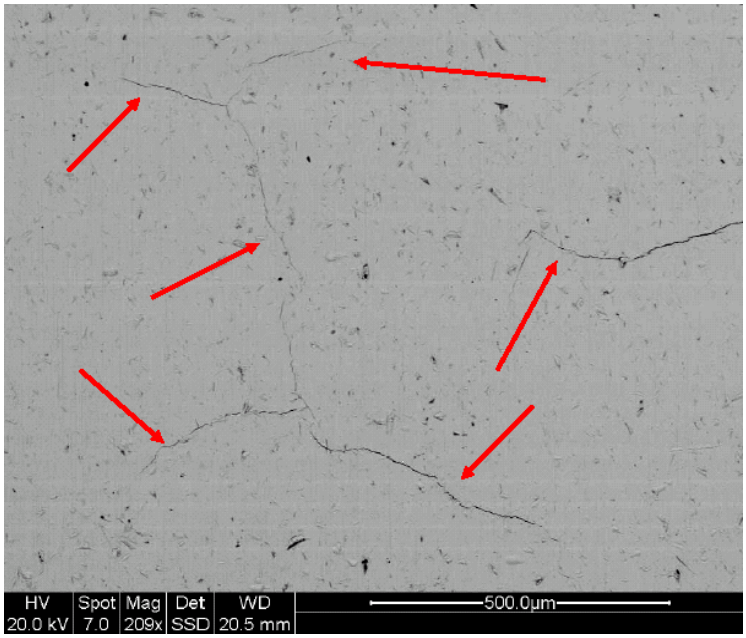

Figure 5. Micro cracks in web form in the valve hole surface. (arrows)

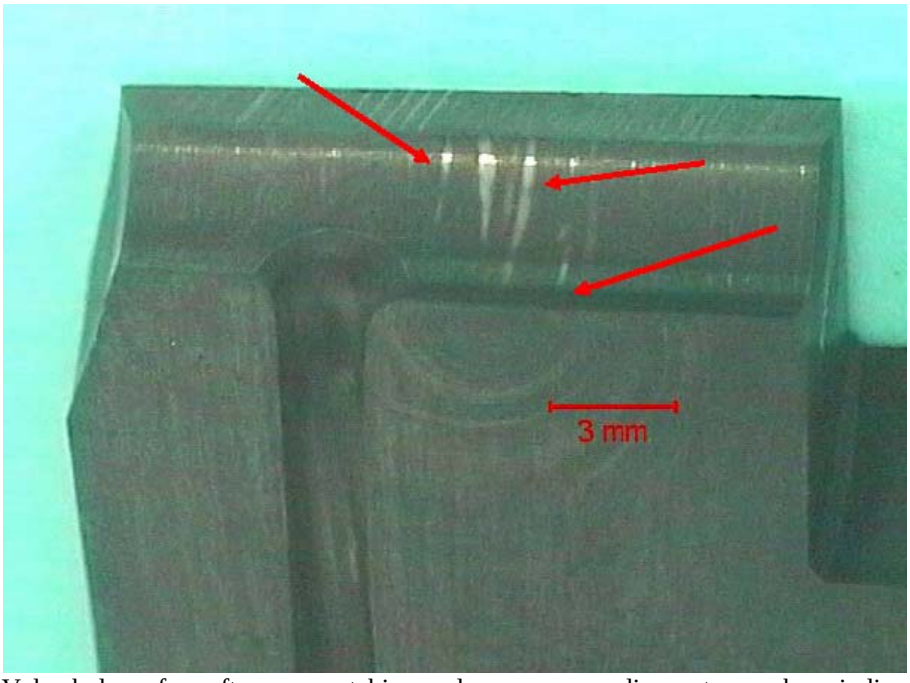

Figure 6. Valve hole surface after macro etching - clear areas regarding re-temper by grinding. (arrows)

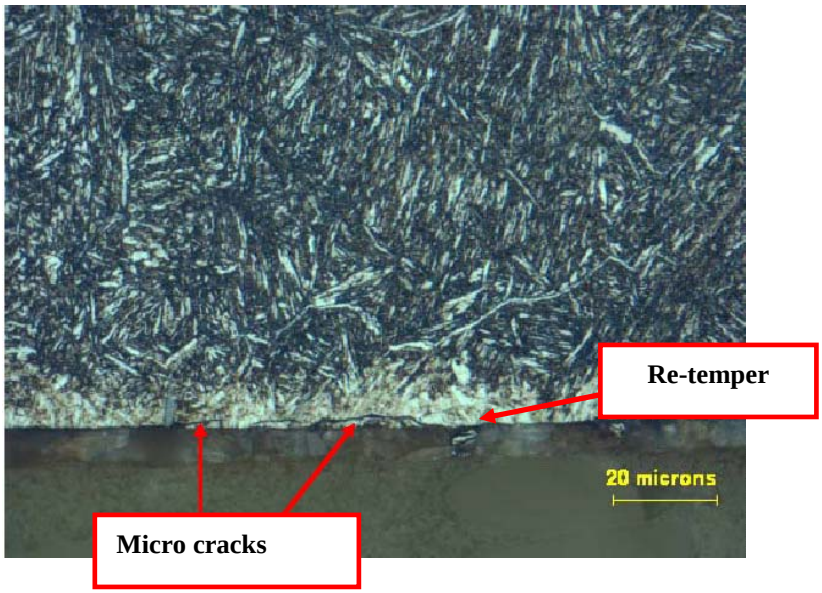

Figure 7. Areas with micro cracks and re-temper (15µm). (arrows)

3. CONCLUSIONS AN RECOMENDATIONS

The failures this component was caused by fatigue cracks that beginning in the micro cracks provoked by grinding in the valve hole surface. In this case it was recommended the verification of the cooling grinding parameters as well as should be periodically inspected as for burning and re-temper of the manufacturing process.

4. REFERENCES

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