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Analysis and Solution of Oil Leakage from Silicone Sealed Oil Sump

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Abstract: With consumers' increasingly high requirements for cars, the engine three leakage problems have become the focus of consumers' attention, one of the common three leakage problems is the oil sump sealing surface leakage. Through the comprehensive analysis of the engine oil shell oil leakage problem model, we determine the root cause of the rubber coated oil shell, the small roughness combination of the body surface, make the surface oil storage glue combination to reduce the roughness of the oil shell, and increase the structure of the glue storage tank, and solve the oil leakage problem.

1. Introduction

The oil pan is the lower half of the crankcase, is an important part of the engine system, the role is to close the crankcase as the shell of the oil storage tank, to prevent impurities from entering, and collect and store the lubricating oil flowing back from the friction surface of the fuel engine, dissipate part of the heat, to prevent the lubricating oil oxidation. The main sealing methods of the oil shell are rubber gasket sealing and plane silicone sealing. Due to the excellent noise reduction performance of the cast aluminum oil shell and the low cost of a single silicone unit, it has been widely used. With the increasing demand of consumers for the engine, now the engine three leakage (oil leakage, water leakage, air leakage) problem has become the focus of attention, currently one of the most common three leakage problems is the oil pan sealing surface oil leakage problem. This paper analyzes the root cause of the oil leakage problem of the sealant surface adhesion, the surface wetting property, the oil pan plane structure, and the bolt tightening sequence, and confirms the improvement scheme, and finally confirms that the scheme is effective. This improvement experience provides reference methods and ideas for solving the problem of bad sealing oil leakage after the engine.

2. Current situation description

2.1 Confirmation of the oil leakage position

The engine cast aluminum oil pan of a certain type of engine is sealed with the binding surface of a certain type of silicone gel. In the process of small batch production test, 6 oil seepage phenomenon was found at the contact surface of the engine oil pan and the body, as shown in Figure 1. After disassembly, there is a bright belt (no sealant) in the local sealing area of the oil pan,

and the bright belt part is basically the same as the oil leakage part, as shown in Figure 2. Because the engine passes the reliability test, eliminates the design problems, from the engine production process of the investigation one by one, to find the root cause and solutions.

Figure 1: Oil leakage part

Figure 2: Oil leakage inspection of oil pan inspection

3. Analysis of the oil leakage causes in the oil pan

Silicone gel is a kind of liquid polymer material, before coating for a liquid viscous substance, can flow to form a sealing ring, completely filled with concave points, surface defects, scratches and uneven defects. But in fact, the sealing is restricted by various external factors such as micro vibration deformation of the surface, loosening of bolt torque, thermal expansion and cold contraction, and penetration of lubricating oil, which will make the oil pan and the binding surface of the body form for a long time, making the original static friction into dynamic friction. Any problem in the engine assembly process may lead to oil leakage problems. Only by fully understanding the principle of silicone sealing, can the oil leakage problem be fundamentally solved. For the oil leakage problem of flat surface silicone seal, the most important thing is to solve the problem of surface bonding[1].

3.1 Surface adhesion force analysis

Room-temperature cured rubber seals are sealed by adhesion rather than compression. Since the current machining methods cannot guarantee the absolute mirror surface of the flange surface, even if both sealed flange surfaces are the best machining surfaces, the microscopic study reveals that the contact area between the most refined parts is only 25% -35%, as shown in Figure 3. If the silicone can fill the gap between the two sealing flanges, and fit well, then the silicone can be 100% sealed. This requires that the adhesive of the contact surface must properly penetrate into the surface rough and completely wet the surface to form the sealing ring, and assembly within the specified time, make the sealing ring in the contact period of reliable bonding, glue line must meet the

requirements, stranded continuous does not allow interruption, in order to ensure the adhesion and contact area between the two materials. After on-site glue coating verification, all the glue coating process meets the process requirements.

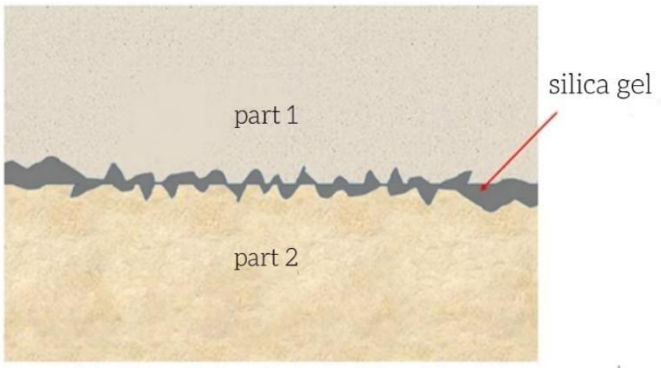

Figure 3: Microstructure of the sealing surface

3.2 Surface wetability analysis

Moisture refers to the process in which the gas on the surface of a solid (or liquid) is replaced by a liquid. It is the uniform spread of the liquid under the action of the intermolecular force on the solid surface, which is to evaluate the affinity of the liquid to a solid. The wetting of the liquid can be evaluated by the water droplet spreading test: by bringing a few pure drops of water to the cleaned surface on the poorly cleaned surface, the surface must be cleaned again. If the water flows on the treated surface, the wetting is ideal, as shown in Figure 4.

Moisturidability analysis can be explained by the contact angle function. The relationship between the adhesive surface energy and the material is a direct function of the contact angle. Only when the surface energy of the adhesive is γ k is less than the surface energy γ k of the adhesive is γ s. Contact angle α refers to the angle between the junction of gas, liquid and solid. If α is <45°, the solid surface is hydrophilic, namely the liquid is easier to wetting the solid, the smaller the angle, the better the wetting performance; if α 90°, the solid surface is hydrophobic, that is, the liquid is not easy to moisten the solid and easy to move on the surface[2].

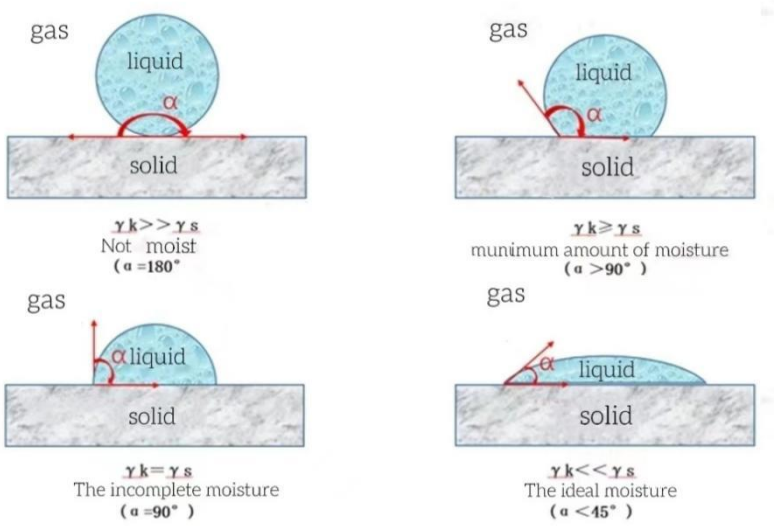

Figure 4: surface wetting comparison

After analysis, the adhesive surface cleaning enough is crucial to the successful sealing of

silicone gel. In order to obtain the optimal bonding effect, the appropriate surface pretreatment is necessary. The more thorough the surface cleaning, the stronger the adhesive adhesion is. After on-site glue verification, the combined plane is cleaned before coating, and the process meets the cleanliness requirements.

3.3 Flat structure analysis of the oil pan

Most technicians think that the brighter the plane processing of the oil pan is, the better. However, when the adhesive surface seal is used, applying the bolt during the sealing process reduces the amount of glue stored on the sealing surface. In addition to the longitudinal pressure transmitted through the bolt tightening, the silicone film is also affected by a piston box chamber pressure produces transverse force, due to vibration, temperature or pressure changes, impact, collision can move the sealing surface, but it is still classified as a static system. The silicone layer with the bright surface is purely static friction to resist the transverse pressure generated by the pressure in the box. The vibration of the engine in the process of operation and the penetration of the lubricating oil will form an oil film on the binding surface of the oil pan and the body for a long time, making the original static friction change into dynamic friction. The sealant on the smooth binding surface is affected by the pressure of the piston box, resulting in oil leakage problems on the binding surface[3].

Home and abroad on the engine cylinder block, pressure vessel and other high pressure strong combined surface, and the good results have been obtained. Based on this principle, the oil pan binding surface is processed into a mesh surface or add the rubber storage tank structure to match the original sealant for verification.

3.3.1 Seal Verification

Verification conditions: the bolt tightening torque remains the same, the control cleanliness before assembly, the rubber wires must meet the requirements, and the strands shall not be interrupted continuously, and shall be assembled within the specified time.

Seal face form: plane, mesh pattern, rubber storage tank

Methods: Realize effective glue storage by changing the sealing surface structure, and verify the sealing effect of different sealing surface structures:

A) Binding surface is sealed by plane structure, and the surface roughness is Rz16;

b) Flat seal is changed to cross mesh seal, the surface roughness is Rz25~Rz40;

c) Add rubber storage tank in the whole circle of the sealing surface, with tank width of 3mm and tank depth of 1mm;

Table 1 shows the validation results:

Table 1: Structural verification of different sealing surfaces

order number	Sealed surface structure	Test verification	Test quantity (table)	verification result	Can you draw lessons from
1	planar structure	Engine: 2-h run-in test	20	Oil seepage	deny
2	Net pattern structure		20	Do not seep oil	approve
3	Storage tank structure		20	Do not seep oil	approve

Conclusion: After the comparative verification of the sealing surface structure of the oil pan, the sealing of the combined surface is adhesive groove and mesh structure is better than the plane

structure, and the effective measures of the engine platform.

3.4 Analysis of other problems

Bolts are often used in groups in assembly connection, due to the special structure of thread teeth and the elastic interaction between the bolts, the bolt after tightening the bolt tightening force, different tightening sequence of connection quality, different assembly process on the bolt performance has different influence, which requires the oil pan bolt assembly sequence from the middle to both sides of cross symmetrical tightening. After checking in the field assembly process, the tightening sequence of the bolts meets the assembly process requirements.

4. Conclusion

This paper analyzes the detailed analysis of the oil leakage mechanism of the silicone sealing oil surface, and the surface adhesion, wetting, and plane of the oil surface structure, so as to find the real reason: because the sealing surface roughness is small, the sealing surface is too bright, and the storage quantity between the sealing surface is reduced. And confirm the improvement plan, and finally confirm that the improvement plan is effective.

Good sealing structure design is the most important factor to ensure the engine seal, and this technology is extended to the solution process of other three leakage problems, to provide a reference material for the study of sealing structure.

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