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INDUSTRY APPLICATION OF THE COATINGS ON THE BEARING BUSH BY ELECTRO SPARK ALLOYING TECHNOLOGY

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Коротко представлено традиційний процес обробки та виробництва втулки підшипника ковзання. Досліджено, що при традиційному процесі спостерігається нерівномірний розподіл в антифрикційному шарі твердих частинок, які, крім того, є різними за розміром. Наявність підвищеного тиску в монокристалах великих частинок призводить до їх руйнування, що спричиняє пошкодження втулки підшипника, та підшипника загалом. Зменшення розмірів кристалів призводить зо збільшення межі зерен та збільшення невпорядкованості розташування атомів в них, що в підсумку може підвищити стійкість до деформації та забезпечити міцність та ударну в'язкість сплаву. Тому для поліпшення механічних властивостей підшипника необхідно очистити кристали і здійснити їх рівномірний розподіл. Формування покриттів на поверхні олов'яної бронзи, здійснено методом електроіскрового легування (ESA) із застосуванням як антифрикційного матеріалу срібла, міді, бабіту Б83 та оксиду графену (GO). Аналіз впливу процесу осадження на масообмін, шорсткість, товщину та трибологічні властивості сформованих покриттів досліджували за допомогою електронних ваг, тривимірного оптичного профілометру, скануючого електронного мікроскопа (SEM), спектроаналізатора дисперсії енергії (EDS), металографічної мікроскопії та трибометра. Результати показують, що сформовані покриття є щільними, зерна витонченими, рівномірно розподіленими між металургійним сплавом та підкладкою. Узагальнено та проаналізовано результати випробувань різних типів покриттів, визначено найкращу схему промислового застосування. Здійснено аналіз основного матеріалу, матеріалу покриття, технології обробки та технології формування покриття втулки підшипника, які впливають на якість продукції. Запропоновано нову екологічно безпечну технологію формування функціональних покриттів опорної втулки з олов'яної бронзи, детально описано етапи проектування, виготовлення, обробки, монтажу та дослідної експлуатації. До промислового впровадження запропоновано нову технологію, на базі методу електроіскрового легування, нанесення покриттів на втулку з олов'янистої бронзи, що мають переваги за показниками якості поверхні, антифрикційними характеристиками, підвищену стійкість до втоми, надійність та довговічність. Наведено деякі технічні пропозиції щодо нанесення покриттів на підшипники з олов'янистої бронзи.

Ключові слова: втулка підшипника, покриття, електроіскрове легування (ESA), промислове застосування, технічна пропозиція.

The traditional processing and manufacturing process of plain bearing bush is briefly introduced, but the hard particles are large or unevenly distributed, the pressure borne by a single crystal in the alloy is too large, and the crystal is cracked to cause the bearing Bush to be damaged. The finer the crystal, the more the grain boundaries and the more disordered the atomic arrangement, which can increase the deformation resistance and provide the strength and impact toughness of the alloy. Therefore, in order to improve the mechanical properties of the bearing, it is necessary to refine the crystal and make it distribute evenly. The running-in coatings on the surface of tin bronze that was formed by electro spark alloying (ESA) applying the antifriction material of silver, copper, Babbitt B83 and graphene oxide (GO). The analysis of deposition on mass transfer, roughness, thickness and tribological properties of the running-in coatings were investigated by electronic scales, 3D optical profilometers, scanning electron microscopy (SEM), energy dispersion spectrum (EDS), metallographic microscopy and tribometer. The results show that the running-in coatings are dense, grains refined, uniformly distributed and metallurgical fusion with the substrate. The test results of different running-in coatings were summarized and analyzed, and the best industrial application scheme is determined. The base material, coating material, processing technology and coating technology of bearing bush which affect the product quality are analyzed. A new environmental protection technology of constructing running-in coatings of tin bronze bearing bush is put forward, and the technical design, manufacture, processing, installation and trial operation are described in detail. The industrial application adopts *a new electro spark alloying of running-in coating technology on the tin bronze bearing Bush to realize the advantages of good surface comprehensive performance, excellent antifriction performance, strong fatigue resistance, high reliability, good durability. Finally, some technical suggestions for the application of running-in coatings process of tin bronze bearing are put forward.*

Key words: bearing bush, coating, electro spark alloying (ESA), industrial application, technical suggestion.

Introduction

The rotating parts of industrial machinery and equipment often work under the conditions of heavy load, high speed and high temperature, but they are also affected by corrosive and abrasive working environment [1-3]. Usually, the surface layer bears the largest load and is most affected by the external environment, so the performance of the surface layer directly determines the working life and stability of the parts [4-6]. Copper-based alloy bearing is widely used because of its excellent mechanical properties and thermal conductivity [7,8]. However, the analysis of its operation shows that the friction coefficient of bronze bearing is large, which is easy to wear the shaft, and its tribological characteristics become an obstacle to its further application [9-11].

The purpose of the industrial application is to manufacture a tin bronze bearing surface functional coating with good surface comprehensive performance, excellent antifriction performance, strong fatigue resistance, high reliability and good durability on the basis of previous research.

Materials and methods

Materials in the industrial application

Table 1 shows the elemental composition of the materials used in the industrial application.

Table 1 – The elemental composition of the materials used in the industrial application

Materials	Cu (%)	Ag (%)	Sn (%)	Sb (%)	P (%)	Others
Tin bronze	89.10	-	9.38	-	0.72	0.80
Silver	-	99.99	-	-	-	0.01
Copper	99.99	-	-	-	-	0.01
Babbitt	5.83	-	83.10	11.02	-	0.05

Table 1 gives that copper, tin, phosphorus and impurity content of the tin bronze Bush; The content of silver and impurity in silver electrode; Copper and impurity content in copper electrode; Sn, Sb, Cu and impurity content in Babbitt alloy electrode.

The content of Cu, Sn, P and impurity in tin bronze bearing bush is 89.10%, 9.38%, 0.72% and 0.80%, respectively.

The content of silver and impurity in the silver electrode is 99.99% and 0.01%, and the silver electrode has a diameter of 3 mm and a length of 100 mm.

The content of copper and impurity in the copper electrode is 99.99% and 0.01%, and the copper electrode has a diameter of 3 mm and a length of 100 mm.

The Babbitt alloy electrode contains 83.10% of tin, 11.02% of antimony, 5.83% of copper and 0.05% of impurities, and has a diameter of 3 mm and a length of 100 mm.

The tin bronze bearing bush and electrodes were polished with different types of sandpaper (400 #, 600 #, 800 #, 1000 #, 1200 #) in turn, and the surface roughness was about 1 μm. Before the electro spark alloying coating, the tin bronze bearing Bush and the electrodes were ultrasonically cleaned for 20 minutes in anhydrous alcohol at normal temperature to remove grease and impurities on the surface, and then the bearing Bush and the electrodes were dried by a blower at normal temperature.

Methods in the industrial application

Table 2 shows that electro spark alloying process parameters used in the industrial application.

Table 2 – The electro spark alloying process parameters used in the industrial application

Coatings	Voltage (V)	Capacitance (μF)	Efficiency (min/cm^2)
Ag	60	150	3
Cu	60	150	3
B83	30	90	4

Table 2 gives the detailed process parameters of voltage, capacitance and working efficiency used for silver electrode, copper electrode and Babbitt alloy electrode in electro spark alloying.

The parameters of the electro spark alloying process include voltage, capacitance, working efficiency, rotating speed and discharge frequency, and when the silver electrode is subjected to the electro spark alloying, the voltage is 60V, the capacitance is 150μF, the working efficiency is 3min/cm^2, the rotating speed is 2600r/min and the discharge frequency is 3000Hz.

When the copper electrode is alloyed by electro spark, the voltage is 60V, the capacitance is

150μF, the working efficiency is $3min/cm^2$, the rotating speed is 2600r/min, and the discharge frequency is 4000Hz.

The voltage, capacitance, efficiency, speed and frequency were 30V, 90μF, $4min/cm^2$, 2600r/min and 5000Hz respectively when the Babbitt alloy electrode was alloyed by electro spark.

Metallic silver is sometimes used for high load and high speed bearing shells because of its excellent mechanical properties, corrosion resistance and lubricity. The wetting angle between silver and copper is small, which is beneficial to strengthening the metallurgical bonding force between the coatings and is suitable for being used as a transition coating. The ε phase (Cu_6Sn_5) formed by soft metal Cu and Sn in tin-based Babbitt alloy is beneficial to improve the adhesion between coatings, and is also suitable for transition layer. Therefore, the surface of the tin bronze bearing is firstly subjected to the electro spark alloying silver coating, and then subjected to the electro spark alloying copper coating, and finally subjected to the electro spark alloying Babbitt alloy coating, so that the hardness of the material is gradually reduced, and the cracks on the surface of the material are also reduced. The angle between the electrode and the surface of the tin bronze bearing Bush is about 45 degrees, the swing amplitude from left to right is about 20 mm, and the moving speed of the electrode is about 2 mm/s. The alloying process was carried out at room temperature using argon (99%) as a protective gas at a flow rate of 0.2 L/s to protect the coating area from air.

The traditional technology of bearing bush machining

Bearing is made of copper alloy casting after machining, in order to improve its friction performance, often in the inner surface of the bearing pouring a layer of Babbitt alloy, pouring and then machining [12-14]. Usually, the traditional pouring process of Babbitt alloy bearing Bush is divided into five processes: cleaning of Bush tire, protection of Bush tire, hanging tin, alloy melting and pouring.

Cleaning of Bush tire

The Bush tire must be cleaned according to the following steps: before the tile tire is hung with tin, the oxide on the tin hanging surface must be checked, and the oxide must be eliminated. The rust can be removed by brushing with 10% hydrochloric acid, and then immersed in hot water at 75°C for cleaning after pickling. If oil or other dirt is found on the surface of the tile tire before hanging tin, it can be scrubbed with acetone solution, mechanical processing or electric furnace heating to ensure that the tin plating surface is clean. The surface to be hung with tin shall be evenly coated with a layer of zinc chloride solution before hanging tin to prevent oxidation.

Protection of Bush tire

Attention should be paid to the protection of the bushing: use asbestos mud to plug the process hole on the bushing to prevent the invasion of tin liquid when hanging tin and alloy liquid when pouring. A uniform layer of protective agent is coated on the surface which does not need tinning.

Hanging Tin

Tin is applied to the bronze bushing to ensure that the Babbitt adheres reliably to the bronze substrate. After the tile body is cleaned and protected, it shall be tin-hung immediately. The tin-hanging method can adopt the tin-bar coating method, which is simple and easy to operate. The specific process is as follows: Heat that tile body in a furnace or uniformly heating the back of the tile body to 320°C by use a welding gun, brushing the tile surface to be tin-coated by using a brush dipped with zinc chloride saturate solution, and then coating the tin-coated part by using a tin strip under the baking of flame. A good tin surface should be a uniform silver-white mirror surface, otherwise the part where the tin is hung should be removed immediately and the tin should be hung again.

Alloy melting

And preheat that crucible to about 200°C before smelting the Babbitt alloy. Removing dirt on the surface of the alloy ingot, putting the alloy ingot into a crucible, and carrying out slag removal treatment after the alloy is completely melted. Heat to about 420°C and refining with dehydrate ammonium chloride. The dosage of the ammonium chloride is 0.1% to 0.15% of the alloy liquid. If continuous pouring, it can be treated every 1 hour. Before pouring, that alloy liquid is evenly stirred for 5 minute, and then the slag is removed.

Pouring

There are two casting methods: static casting and centrifugal casting. Only the centrifugal casting process is described here. Before centrifugal casting, first check whether the centrifuge and its auxiliary equipment are in good condition. Place the bearing Bush between the driving and driven chucks with a preheated clamp, fasten it with bolts, and clamp it on the centrifuge. Seal the gap between the Chuck and the bearing shell with asbestos. The Bush shall be clamped and installed quickly to ensure that the temperature of the Bush body is not lower than 280°C before pouring, otherwise it is necessary to re-tin. The pouring temperature is about 420°C. And select the speed change grade of the centrifugal casting machine accord to the inner diameter of the bearing Bush. Install the runner, start the centrifuge, and pour a certain amount of alloy solution after the specified speed is reached. The alloy solution shall be injected smoothly, evenly and continuously. After that poured alloy is pour completely, the pouring is stopped for a while, then water is spray to the outer surface of the bearing Bush for cooling, and when the temperature is reduced to below 200°C, the water spraying is stopped and the machine is shut down. Carefully remove the bearing Bush, lightly hoist it in a furnace at about 100°C, and slowly cool it to room temperature.

The metallographic structure of Babbitt alloy should distribute uniform, dispersed and fine SnSb cubic crystals, and a small amount of rod-shaped, needle-shaped or punctiform crystals are allowed to exist. If the SnSb hard particles are large or unevenly distributed, the pressure borne by a single crystal in the alloy is too large, and the crystal is cracked to cause the bearing Bush to be damaged. The reason is that the interfacial area of single SnSb crystal increases and the matrix is fragmented, which reduces the strength and impact toughness. The larger the crystal is, the more uneven the distribution of the crystal is, and the larger the force applied on a single crystal, the more deformation and slip occur in the crystal, and the grain boundary is destroyed, so that the fatigue strength of the alloy is reduced and the alloy is ruptured. Only when the crystal of SnSb is fine and evenly distributed, can it have better carrying capacity. This is because the SnSb crystals on the matrix cause the distortion of the matrix lattice and increase the deformation resistance. The finer the crystal, the more the grain boundaries and the more disordered the atomic arrangement, which can increase the deformation resistance and provide the strength and impact toughness of the alloy. The distribution of Cu_6Sn_5 is also similar. Therefore, in order to improve the mechanical properties of the bearing, it is necessary to refine the crystal and make it distribute evenly.

The industrial application of new technology for constructing coatings

Influence of material on product quality

Bearing base material

Engineering and structural cast carbon steel, with high strength, plasticity and toughness, and low cost, suitable for heavy machinery used in the manufacture of parts to withstand heavy loads. The matrix material of the cast steel bearing shell is easy to be worn due to the adoption of a thin coating, and the bearing capacity is reduced due to the adoption of a thick coating, so that the cast steel bearing shell is easy to be fatigued and is suitable for light load and medium load.

In the actual work of the bearing, tin bronze bearing has good mechanical properties and thermal conductivity but slightly higher friction force. Tin bronze can effectively eliminate the heat generated by friction as a substrate material. Thus, there is need to provide for the bronze bearing pads with special coatings improving the running conditions. In the case of coating failure, the tin bronze substrate can continue to be used as a bearing with excellent performance, which is conducive to improving the stability and reliability of the system.

The Bearing base material is tin bronze QSn10-1 commonly used as Plain bearing material provided by Zhejiang Shenfa Bearing Co., LTD.

Coating materials

Soft metal silver is used in the design of bearings bearing high loads and high speeds and has good lubrication performance, mechanical properties and corrosion resistance. Silver and copper have very good wettability, which is conducive to improving the metallurgical bonding performance between metals during electro spark alloying. The silver can play a role in grain refinement, so that the strength and the hardness of the Babbitt alloy are improved. However, the performance of silver as anti-wear metal coating needs to be further improved. Therefore, based on the above factors, silver (Ag 99.99%) is suitable as the first transition coating material.

Pure copper is soft and has better wettability with silver. The copper in the coating can form ε-phase (Cu_6Sn_5) with the tin in the Sn-based Babbitt alloy, which is conducive to ensuring the metal bonding of the coating. Copper provides the preferential crystallization center, refines the grain size, and improves the microstructure and mechanical properties of the Babbitt alloy. So the copper (Cu 99.99%) is suitable for the second layer of transition coating material.

The overall performance of tin-based alloy is better than that of lead-based alloy, because the strength, hardness and corrosion resistance of tin-based alloy are obviously superior to that of lead-based alloy. Tin-based Babbitt is characterized in that hard phase particles are uniformly distributed on a soft phase matrix, the soft phase matrix enables the Babbitt to have very good embedding property, compliance and anti-seizure property, and after running-in, the soft matrix is concave inwards and the hard phase particles are convex upwards to play a supporting role, so that a micro gap is formed between sliding surfaces, and an oil storage space and a lubricating oil channel are formed which is particularly beneficial to the running-in at the early stage of operation, and Babbitt B83 is very suitable for operation as the coating material [15-17].

Graphene has been used to improve tribological property due to its extraordinary properties [18-20]. Graphene oxide (GO) is considered as a promising material for reducing friction and wear, owing to its structural features [21]. Therefore, adding the GO to the coatings is beneficial to improve the friction and wear properties of the surface. Graphene oxide was a dispersible solution of 4mg/ml with water as the solvent.

Influence of process on product quality

Processing technology of bearing bush

Because the inner surface of the bearing Bush and the journal are in clearance fit, when the shaft rotates at high speed, a pressure oil film is generated through the clearance between the two matched surfaces, so that the machine can work normally. The fit clearance and the inner surface roughness of the bearing shell are two important factors for the formation of the pressure oil film. Therefore, the roughness of the inner surface of the bearing Bush is required to be very high (Ra 0.1μm). It is difficult to obtain high precision inner diameter surface of the bearing.

Usually, the grinding and polishing process can be used for the machining of the inner arc surface with the surface roughness value of 0.1μm, but the inner surface material of the bearing Bush is a soft composite coating, and the abrasive particles will be embedded in the surface layer of the coating during polishing and grinding, which will not only fail to achieve the polishing effect, but also reduce the surface quality. If high-speed turning is used, residual area will be left on the machined surface, and high precision surface quality can not be obtained. By adopt that scraping process technology, the scraper blade scrapes the inner surface of the bear Bush alloy in one step in the width direction of the bearing Bush, theoretically, no residual area exists on the machined surface, and meanwhile, in the scraping process, the scraping cutter has an extrusion effect on the machined surface, so that the surface quality can be further improved. Therefore, for the processing of bearing running-in coating, the scraping process can be used to obtain high-quality surface roughness.

The inner and outer surfaces of the bearing Bush are roughly machined, and then the inner surface is finely machined, and then a running-in coating is deposited on the inner surface by electro spark, and the thickness of the composite coating is more than 200μm in order to provide enough machining allowance for subsequent processes. And then carry out fine grinding process on that outer diameter of the bearing Bush to achieve the surface roughness of Ra 0. 8μm. The semi-finish machining of the Bush coating is carried out by turning to remove the uneven surface layer and leave a finishing allowance. The finish machining (scraping machining) of the bearing Bush running-in coating is carried out on a special scraping machine tool. In order to ensure the precision requirement of the scraped surface, the secondary machining of rough and finish scraping is adopted. The purpose of rough scraping is to ensure the machining allowance of fine scraping to be uniform, and the appropriate thickness of alloy layer for rough scraping is about 50μm, so as to avoid leaving chatter marks on the scraping surface due to the large scraping thickness; And that thickness of the fine scrape is generally controlled to be 30μm. According to the above analysis, the processing route of the bearing shell is as follows: rough machining of the bearing shell, finish machining of the inner surface of the bearing, electro spark alloying of running-in coating, finish machining of outer diameter of bearing shell, semi-finish machining (turning) of bearing and finish machining (rough and finish scraping) of running-in coatings.

Coatings process

The coating process of electro spark alloying technology has an important impact on the deposition efficiency, cost, mass transfer, coating surface roughness, coating thickness, coating surface friction coefficient and so on. There are many process parameters of electro spark alloying, which can be summarized as follows:

Electrode material composition, density, microstructure, manufacture technique, shape, moving speed, specific deposition time, contact force, cycle number, deposition angle and other process parameter. Because of the great difference of resistivity, melting heat, thermal conductivity, ductility, wetting angle and other characteristics of materials, and considering the instability of electro spark alloying process, the influence of process parameters on the preparation and performance of coatings is uncertain.

Tin bronze plain bearing pad surface roughness, cleanliness, shape, temperature.

Electrical discharge voltage, pulse current, energy storage capacitor, energy, frequency, discharge time, inductance and other power supply parameters.

The composition of gas environment and liquid environment, fluid properties, gas flow and mode, temperature and other environmental atmosphere of electric spark discharge.

Procedure for industrial application of bearing bush running-in coatings

Design, manufacture and preliminary machining of bearing bush

According to the actual operating conditions of industrial machinery design bearing size. Bearing bore diameter, length and initial radius clearance are very critical parameters in bearing design, which directly affect the bearing capacity, stiffness, bearing temperature rise and other aspects of performance.

The tin bronze bearing Bush blank is made by casting. After that tin bronze bearing Bush is roughly machine, the inner hole is left with 0. 5mm of machining allowance, and the inner hole is turning on a lathe within two hours before the electro spark alloying, wherein the rotating speed is about 120r/min, the feed amount is about 0.9mm, and the turning depth is 0.5mm. Before turning, the used tools, measuring tools and fixtures should be washed with alkali to remove oil stains, no lubricating oil or coolant should be added during turning, and the inner surface of tin bronze after low-speed processing should not contact with other objects. The inner hole of the tin bronze sliding bearing Bush blank shall be designed according to the drawing requirements, and the excircle shall be reserved with a machining allowance of 3~5mm.

Construction of running-in coatings on bearing bush surface

Before the coatings are deposited by electro-spark, the Tin bronze plain bearing bush is clamped by a bench, and the electrode material to be deposited is installed on the welding gun. Connect the power supply and argon to the electro spark alloying equipment, firmly connect the cathode power supply to the bench, and adjust the argon flow to prepare for the deposition of the coating.

The running-in coatings of the tin bronze bearing bush that were formed by alternately electro-spark deposition applying the antifriction material of silver, copper and Babbitt B83. Operate the control panel of the electro spark deposition equipment, and adjust the electrical parameters such as discharge voltage, energy storage capacitor and discharge frequency according to the parameters.

Travel speed in both cases was about 2mm/s, moving according to the small ring track or the broken line network track can ensure the corresponding pressure, as far as possible to ensure the stability of the discharge voltage and the arc stability of the workpiece surface, and the excellent quality of the sediment layer can be obtained. Deposition was carried out using a hand-held gun at room temperature with the argon gas (Ar 99%) protection (10L/min flow rate), which avoids contamination of the deposit zone by interstitial elements such as oxygen or nitrogen. And that work angle between the rotary electrode and the substrate is about 45 degrees.

The GO solution was applied to the surface of the specimens by manual pre-coating method, and then the specimens was dried by natural air, followed by the fifth layers with B83 electrode.

Post processing and treatment of bearing shell

The running-in coatings of the bearing bush is processed by scraping, namely the machined surface is finished by scraping on the whole width of the bearing bush at one time; and as the main deflection angle and the auxiliary deflection angle of a scraping cutter are both 0 deg during processing, theoretically, no residual area exists on the machined surface, and the influence of the main deflection angle and the auxiliary deflection angle of the cutter on the surface roughness is eliminated. At this time, the factors that affect the surface roughness of the bearing inner surface are the vibration in the scraping process, the straightness error of the blade and so on. If the stiffness of the scraping machine and the geometric parameters of the scraping tool are solved, the surface roughness of the Bush coatings after scraping can meet the mirror quality requirements.

Bear bush scraping process is completed by scraping once in that width direction of the bearing bush, the scrape force is large, in order to prevent vibration generated during scraping and influence the roughness of the scraping surface, in addition to sufficient rigidity of the arbor shaft, the fit clearance between the arbor shaft and the sliding bearing in the supporting seat is also very important. Before scrape, that bearing bush is place in a semicircular arc fixture for positioning and clamping, the extending amount of the scrape blade (namely the depth of the scraper) is adjusted, the machine tool is started, the cutter bar shaft rotates, and the scraper blade finishes scraping and machining the inner surface in one step in the width direction of the bearing bush. And when that scrape is finished, the brake has brake effect on the motor, so that the blade is stopped above the fixture seat, the bearing bush is taken out, and the scraping process is finished. In order to improve the scraping surface roughness, the bush scraping process is divided into two processes of rough scraping and fine scraping, and the corresponding cutter is also divided into rough scraper and fine scraper. The rough skiving tool and the fine skiving tool are different in material, geometry angle and so on.

Installation and commissioning of bearing shell

Clean it up during installation, and there should be no sundries, so as not to affect the surface of bearing bush or lubrication system. The installation standard shall be strictly implemented in the installation process of the bearing bush, so that the installation measurement dimensions shall meet the specification requirements. Special attention shall be paid to the assembly clearance between the journal and the bearing bush shall meet the requirements.

After the lubricating oil is filled, the idle running test is carried out for 1 hour in total, and the external temperature of the bearing bush is detected at any time. After the idling operation test, carry out the on-load test with a load of 10N for 3 hours, and check the external temperature of the bearing bush at any time.

According to the analysis of load test data, the operation of tin bronze bearing with running-in coating is stable, and the temperature of bearing is normal. After the test operation, it is found that the surface scratch of the bearing bush is not obvious and the wear is slight. From the overall situation, the operation of the bearing Bush is stable and reliable.

The operating characteristics of the running-in coatings are such that it can withstand short term damage under lubricating oil dynamic conditions without seizure and at relatively high temperatures, and it has very good fatigue properties under rated load conditions.

Technical suggestion on application of running-in coatings technology

Guarantee the coatings quality of bearing bush

The coatings quality of the bearing directly affects the service life of the bearing. Before the deposition of bearing bush, clean the oil stain and oxide skin on the surface of the Bush tire, and carry out acid washing. The deposition should be careful and serious. The deposition process parameters should be well controlled to ensure that the coating is closely combined with the tile tire and the alloy grains are uniform and meticulous.

Ensure the machining accuracy of bearing bush

In the aspect of machining, it is necessary to properly formulate the processing technology, use high-precision processing machine tools, select the clamping position, and control the coaxiality of the bearing bush and the dimensional accuracy of the working surface.

Improving the installation quality of bearing bush

The bearing Bush needs to be scraped manually when it is installed. The quality of the bush scraping affects the installation accuracy of the shaft, and also affects the service life of the bearing Bush. The top clearance, side clearance and bush mouth clearance of the bearing bush shall meet the installation technical requirements. The side clearance and tile mouth clearance can be measured with a feeler gauge. The top clearance must be measured by the method of encapsulating and pressing lead. The accuracy of the measured data can be ensured only by tightening the screw of the tile cover. If these three parameters can not meet the requirements of installation technical conditions, the bearing bush may be glued during the test run.

*Ensure **reliable** lubrication of bearing bush*

Lubrication is the key in the process of using bearing Bush, and the lubricating oil should be selected reasonably. The viscosity of lubricating oil should be matched with the clearance of bearing Bush, and it is not appropriate to change the viscosity of lubricating oil casually when the clearance of bearing bush is unchanged. The temperature and flow of lubricating oil should meet the needs of heat dissipation of bearing bush, which can take away the heat generated by bearing bush and ensure the stability of bearing bush temperature. The lubricating oil shall be clean to avoid impurity blocking the oil way or scratching the surface of the bearing bush.

Conclusions

In the industrial application, silver, copper and Babbitt alloy running-in coatings were coated on the surface of tin bronze bearing by electro spark alloying process. The tin bronze bearing Bush coated with the running-in coating has the advantages of good surface comprehensive performance, excellent antifriction performance, strong fatigue resistance, high reliability and good durability.

NOTES

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