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(54) **CONVEYING CYLINDER, METHOD FOR MANUFACTURE THEREOF, AND PUMPING EQUIPMENT WITH SAME**

(57) The disclosure discloses a conveying cylinder and a manufacturing method thereof, and pumping equipment comprising the same. The method for manufacturing the conveying cylinder comprises: forming a preliminary cylinder body by mechanical processing; electroplating the surface of the preliminary cylinder body for the first time, and then performing de-hydrogenation treatment on the coating to form a first chromium coating with a hardness of HRC58-60 and a thickness of 0.15-0.2mm; and electroplating the surface of the first chromium coating for the second time to form a second chromium coating with a hardness of HRC66-68 and a thickness of 0.15-0.2mm, namely, forming the conveying cylinder. By the method, the first and second hard chromium coatings of matched thickness and hardness are electroplated on the inner surface of the cylinder body to improve the wearing resistance of the whole conveying cylinder and the anti-falling off capability of each hard chromium coating, therefore, the service life of the conveying cylinder is prolonged.

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Description

Technical field of the invention

[0001] The disclosure relates to the field of construction of concrete, in particular to a conveying cylinder and a manufacturing method thereof, and pumping equipment including the same.

Background of the invention

[0002] The conventional conveying cylinders for viscous substances, such as concrete conveying cylinders, are mostly manufactured by taking plain carbon steel or low alloy steel as a matrix material, and directly electroplating a hard chromium coating of a certain thickness on the matrix material, so as to have a longer wearing life.

[0003] Such process of directly electroplating hard chromium is simple to operate but has the following defects: 1) with relatively low hardness, the base material, ordinary carbon steel or low alloy steel cannot support a high-hardness electroplating coating and may be deformed slightly when pressed by high-hardness particles to cause damage to the high-hardness electroplating coating; 2) the high-hardness hard chromium coating and a matrix are quite different in hardness and there is large stress on their joint surface, which causes the hard chromium coating to be inclined to fall off; and 3) the high-hardness hard chromium coating is relatively thick and has a lot of microcracks, which are easy to expand under stress in the using process, which causes the falling-off of partial hard chromium coating.

[0004] After the hard chromium coating falls off, concrete gravel directly flush a 45# steel matrix and thus the conveying cylinder is soon worn out and becomes invalid. Therefore, although the concrete conveying cylinder directly electroplated with the hard chromium coating surely has a certain service life, it may be replaced frequently due to the design of its electroplating coating and the matching problem between the electroplating coating and the matrix, so as to result in the waste of steel, equipment failure, increase of maintenance and the like.

[0005] In order to overcome the defects of the conventional conveying cylinders, researchers have made a lot of researches on methods for manufacturing a conveying cylinder, including the solution raised in the China patent No. 200810143572.X.

[0006] In the China patent No. 200810143572.X, a process for electroplating double chromium coatings on a conveying cylinder is disclosed, which has the following features: "f, applying forward current of 15-25A/dm^2 to an electroplating bath for 120 to 150min and electroplating milky chromium of 20 to 30 μm to form a conveying cylinder with a milky chromium coating; g, cooling the electroplating solution to 55 +/-2 °C by an electroplating bath cooling system; and h, raising the density of the current to 35-45A/dm^2 by a step current raising method, applying current for 420 to 450min and electroplating hard chromium of 280 to 300μm to form a conveying cylinder with a hard chromium coating." The conveying cylinder manufactured by the method is improved in corrosion resistance and adhesion to a certain extent, but its milky chromium, with low hardness, generally HRC45-55, and a thickness of only 20 to 30μm, cannot support the high-hardness hard chromium coating outside; and meanwhile, the high-hardness hard chromium coating is as thick as 280 to 300 μm, and the thicker the hard chromium coating is, the larger the internal stress in the chromium coating is, therefore, the hard chromium coating is still easy to fall off.

[0007] Under such circumstance, it is necessary to find a method for manufacturing a conveying cylinder with high surface hardness and wearing resistance and long service life.

Summary of the invention

[0008] In order to overcome the defects of the prior art, the disclosure provides a method for manufacturing a conveying cylinder, by which a conveying cylinder with high surface hardness , wearing resistance and long service life is manufactured.

[0009] Therefore, the method for manufacturing the conveying cylinder includes the following steps: forming a preliminary cylinder body by mechanical processing; electroplating the inner surface of the preliminary cylinder body for the first time, and then performing de-hydrogenation treatment on the coating to form a first chromium coating with a hardness of HRC58-60 and a thickness of 0.15-0.2mm; and electroplating the inner surface of the first chromium coating for the second time to form a second chromium coating with a hardness of HRC66-68 and a thickness of 0.15-0.2mm, namely, forming the conveying cylinder.

[0010] Furthermore, the first electroplating includes the following steps: placing the preliminary cylinder body in electroplating solution and applying forward current of 45-50A/dm^2 at the temperature of 65 to 70 °C for electroplating for 240 to 300min to form a preliminary chromium coating; and performing de-hydrogenation treatment on the preliminary chromium coating to form the first chromium coating.

[0011] Furthermore, the de-hydrogenation treatment includes the following step: preserving the heat of the preliminary cylinder body subjected to the first electroplating in inert atmosphere at the temperature of 180 to 220 °C for 120 to 180min.

[0012] Furthermore, the method for manufacturing the conveying cylinder further includes performing surface activation treatment on the preliminary cylinder body before the first electroplating, and the surface activation treatment includes the following steps: placing the preliminary cylinder body in electroplating solution of 65 to 70 °C, keeping the temperature at 65 to 70 °C after the preliminary cylinder body is the same as the electroplating solution in temperature, and applying backward current of 50-55 A/dm^2 to perform surface activation treatment on the preliminary cylinder body for 30-60s.

[0013] Furthermore, the second electroplating includes the following steps: placing the preliminary cylinder body subjected to the first electroplating in electroplating solution, and applying forward current of 35-45A/dm^2 at the temperature of 50 to 55 °C for electroplating for 300 to 360min to form the second chromium coating.

[0014] Furthermore, when the first electroplating process includes the de-hydrogenation treatment, the method further includes the step of polishing the first chromium coating before the second electroplating.

[0015] Furthermore, the method further includes an after-treatment step after the second electroplating, and the after-treatment includes cleaning and accurately grinding the second chromium coating to make the surface roughness less than or equal to 0.4.

[0016] Furthermore, the same electroplating solution is used in both the first and second electroplating and is formed by mixing CrO_3 solution with the concentration of 230 to 260g/L and H_2SO_4 solution with the concentration of 2.3 to 2.8g/L in the ratio of 100:1.12-1.28.

[0017] Meanwhile, the disclosure further provides a conveying cylinder, which is manufactured by the manufacturing method above and includes: a cylinder body, a first chromium coating arranged on the inner surface of the cylinder body and having a thickness of 0.15-0.2mm and a hardness of HRC58-60, and a second chromium coating arranged on the inner surface of the first chromium coating and having a thickness of 0.15-0.2mm and a hardness of HRC66-68.

[0018] Meanwhile, the disclosure further provides pumping equipment, which includes the conveying cylinder above.

[0019] The disclosure has the following advantages:

By the method for manufacturing the conveying cylinder, the first and second hard chromium coatings of matched thickness and hardness are electroplated on the inner surface of the cylinder body to improve the wearing resistance of the whole conveying cylinder and the anti-falling off capability of each hard chromium coating, so that the service life of the conveying cylinder is prolonged.

[0020] According to the method for manufacturing the conveying cylinder, the first hard chromium coating is subjected to de-hydrogenation treatment to improve its hardness, so that the first hard chromium coating has good anti- falling off capability and can well support the second hard chromium coating.

Detailed description of the embodiments

[0021] It should be noted that what described below in detail are exemplary and intended to provide further understanding for the disclosure. All the technical and scientific terms used in the disclosure have the same meanings as that generally understood by those skilled in the art except as otherwise noted.

[0022] For those skilled in the art, to solve the problem that the hard chromium coating on the surface of the conveying cylinder is easy to fall off in the prior art, and prevent the hard chromium coating on the surface from falling off due to the overlarge internal stress on the joint surface, most of them may add a transition coating between the surface of the cylinder body and the hard chromium coating to reduce the internal stress therebetween.

[0023] The process for electroplating double chromium coatings on a conveying cylinder disclosed in China patent No. 200810143572.X in the background art is such as process that a milky chromium coating of 20 to 30μm is added between the surface of the cylinder body and the hard chromium coating to improve the adhesion therebetween; and by such method, although the corrosion resistance and adhesion are improved to a certain extent, the problem that the hard chromium coating is easy to fall off is still existed.

[0024] By a long-term study, the inventor finds that two hard chromium coatings which are formed on the surface of the cylinder body by rationally designing the thickness and hardness not only can improve the hardness of the surface of the conveying cylinder but also can effectively reduce the falling off phenomenon of the chromium coating on the surface.

[0025] In a typical implementation of the disclosure, a method for manufacturing a conveying cylinder includes the following steps: forming a preliminary cylinder body by mechanical processing, wherein the mechanical processing includes the steps of manufacturing the cylinder body by specifications, boring holes and roughly grinding; electroplating the surface of the preliminary cylinder body for the first time, and then performing de-hydrogenation treatment on the coating to form a first chromium coating with a hardness of HRC58-60 and a thickness of 0.15-0.2mm; and electroplating the surface of the first chromium coating for the second time to form a second chromium coating with a hardness of HRC66-68 and a thickness of 0.15-0.2mm, namely, forming the conveying cylinder.

[0026] In the implementation by the method for manufacturing the conveying cylinder, the first and second chromium coatings of the specified thickness are electroplated on the inner surface of the cylinder body to make the hardness

gradient among the three increase progressively and reduce the interface stress between two of them. The first chromium coating, with a hardness of HRC58-60 and a thickness of 0.15-0.2mm, is low in internal stress, fewer in cracks and high in adhesion with the cylinder body, and can support the second chromium coating as a bottom supporting layer to reduce the thickness of the second chromium coating; and the second chromium coating, with a hardness of HRC66-68 and a thickness of 0.15-0.2mm, has the capability of resisting the wearing of high-hardness gravels, and is thinner than the high-hardness chromium coating of 0.28-0.3mm of the ordinary concrete conveying cylinder and reduced obviously in internal stress and cracks. Therefore, the method improves the wearing resistance and anti-falling off capability of the conveying cylinder, so as to prolong the service life of the conveying cylinder.

[0027] The roughly grinding step requires that the surface roughness should be below 0.8, the inner diameter should be 0.6-0.8mm smaller than a product, the straightness should be less than 0.5 and the ovality should be less than 0.03.

[0028] The specific implementation for each step in the method for manufacturing the conveying cylinder will be given below, and is only intended to better illustrate the technical solutions of the disclosure instead of limiting the scope of protection of the disclosure.

[0029] In a specific implementation way, the first electroplating in the method for manufacturing the conveying cylinder includes the following steps: placing the preliminary cylinder body in electroplating solution, applying forward current of 45-50A/dm^2 at the temperature of 65 to 70 °C for electroplating for 240 to 300min, and then performing de-hydrogenation treatment on the electroplating coating to form the first chromium coating. The first chromium coating prepared by the specific implementation can meet the requirements of hardness of HRC58-60 and thickness of 0.15-0.2mm.

[0030] The electroplating chromium coating is rich in a large number of hydrogen atoms, which are solidly dissolved in the hard chromium coating to increase the hardness as well as the brittleness of the hard chromium coating; and in addition, the hydrogen atoms have gathering tendency and may loosen the hard chromium coating and form cracks when gathered to form hydrogen. The hydrogen atoms or hydrogen molecules in the chromium coating are removed by the de-hydrogenation treatment. The hardness of the chromium coating may be slightly reduced, but the toughness of the chromium coating is increased obviously, the internal stress in the coating is reduced, the adhesion strength with the matrix is improved, and the second hard chromium coating is well supported, so that the service life of the conveying cylinder is prolonged.

[0031] Preferably, the de-hydrogenation treatment includes the following step: preserving the heat of the preliminary cylinder body subjected to the first electroplating in inert atmosphere, such as nitrogen, argon or ammonia decomposition atmosphere, at the temperature of 180 to 220 °C for 120 to 180min.These process parameters are favourable for discharging hydrogen in the preliminary chromium coating to make the hardness of the first chromium coating reach HRC58-60.

[0032] In a specific implementation of the disclosure, the method for manufacturing the conveying cylinder further includes performing surface activation treatment on the preliminary cylinder body before the first electroplating, and the surface activation treatment includes the following steps: placing the preliminary cylinder body in electroplating solution of 65 to 70 °C, keeping the temperature at 65 to 70 °C after the preliminary cylinder body is the same as the electroplating solution in temperature, applying backward current of 50-55A/dm^2, and performing surface activation on the preliminary cylinder body for 30-60s.The surface activation treatment for the preliminary cylinder body before the first electroplating is favourable for removing oxides on the surface of the preliminary cylinder body and electroplating the surface of the preliminary cylinder body to form the first chromium coating which is uniform and dense, and further improves the adhesion between the surface of the preliminary cylinder body and the first chromium coating.

[0033] In a specific implementation of the disclosure, the method for manufacturing the conveying cylinder includes the step of placing the preliminary cylinder body subjected to the first electroplating in electroplating solution, and the second electroplating includes the following step: applying forward current of 35-45A/dm^2 at the temperature of 50 to 55 °C for electroplating for 300 to 360min to form the second chromium coating. These parameters are favourable for forming the second chromium coating with a hardness of HRC66-68 and a thickness of 0.15-0.2mm, so as to prolong the service life of the manufactured conveying cylinder.

[0034] Preferably, in the method for manufacturing the conveying cylinder, when the first electroplating process includes the de-hydrogenation treatment, the method further includes a pre-treatment process before the second electroplating, and the pre-treatment process includes, polishing the first chromium coating. The polishing treatment can remove oxides and sundries on the surface of the first chromium coating so as to form the second chromium coating on the surface of the first chromium coating by electroplating.

[0035] In a specific implementation of the disclosure, the method for manufacturing the conveying cylinder further includes an after-treatment step after the second electroplating, and the after-treatment step includes cleaning and accurately grinding the second chromium coating, wherein the second chromium coating is accurately ground to make the surface roughness less than or equal to 0.4.

[0036] Preferably, the same electroplating solution is used in both the first and second electroplating and is formed by mixing CrO_3 solution with the concentration of 230 to 260g/L and H_2SO_4 solution with the concentration of 2.3 to 2.8g/L in the ratio of 100:1.12-1.28.The CrO_3 solution can be formed by placing CrO_3 in de-ionized water to be heated

to 50 to 60 °C.

[0037] Meanwhile, in a specific implementation of the disclosure, a conveying cylinder is further provided, which is manufactured by the method above, and includes, a cylinder body, a first chromium coating and a second chromium coating. The first chromium coating is arranged on the inner surface of the cylinder body and has a thickness of 0.15-0.2mm and a hardness of HRC58-60, and the second chromium coating is arranged on the inner surface of the first chromium coating and has a thickness of 0.15-0.2mm and a hardness of HRC66-68.

[0038] The first and second hard chromium coatings of matched thickness and hardness are electroplated on the inner surface of the cylinder body of conveying cylinder to improve the wearing resistance of the whole conveying cylinder and the anti-falling off capability of each chromium coating, therefore, the service life of the conveying cylinder is prolonged.

[0039] The cylinder body of the conveying cylinder generally adopts steel with a tensile strength of above 600MPa as the matrix material, such as 45# steel. Based on the disclosure, those skilled in the art can select a proper material for the cylinder body to manufacture the conveying cylinder provided by the disclosure.

[0040] Meanwhile, the disclosure further provides pumping equipment, which includes the conveying cylinder above. With the conveying cylinder above, the pumping equipment has longer service life.

[0041] The advantages of the conveying cylinder manufactured by the method for manufacturing the conveying cylinder provided by the disclosure will be further described below in conjunction with embodiments 1-3 and comparison embodiments 1-2.

Embodiment 1

[0042] The manufacturing method includes the following steps:

manufacturing a preliminary cylinder body: manufacturing a cylinder body by specifications, boring holes, and roughly grinding till the surface roughness of the cylinder body is 0.8, the inner diameter is 0.6mm less than the product, the straightness is 0.5 and the ovality is 0.03;
preparing electroplating solution: mixing CrO_3 with the concentration of 230g/L and H_2SO_4 with the concentration of 2.3g/L at the ratio of 100:1.12;
pre-treatment before electroplating: removing oil and rust for the conveying cylinder;
surface activation before first electroplating: preheating the electroplating solution to 65 °C, placing the conveying cylinder in an electroplating bath, and applying backward current of 50A/dm^2 for 30s for activation treatment after the conveying cylinder rises to 65 °C;
first electroplating: applying current of 45A/dm^2 at the temperature of 65 °C for 240min to form the first chromium coating with a thickness of 0.15mm and a hardness of HRC62;
de-hydrogenation treatment: placing the preliminary cylinder body with a preliminary chromium coating on the surface in a heating furnace at nitrogen protective atmosphere, heating to 180 °C, and preserving the heat for 120min to form the first chromium coating with a hardness of HRC60;
pre-treatment before second electroplating: polishing the inner surface of the first chromium coating to remove the oxides and sundries on the surface;
second electroplating: cooling the electroplating solution to 50 °C, applying forward current of 35A/dm^2 for 300min to form the second chromium coating with a thickness of 0.18mm and a hardness of HRC68; and
grinding and accurate grinding: taking the electroplated conveying cylinder out of the electroplating bath for cleaning, grinding and accurate grinding to make the surface roughness less than or equal to 0.4.

Embodiment 2

[0043] The manufacturing method includes the following steps:

manufacturing a preliminary cylinder body: manufacturing a cylinder body by specifications, boring holes, and roughly grinding till the surface roughness of the cylinder body is 0.8, the inner diameter is 0.6mm less than the product, the straightness is 0.5 and the ovality is 0.03;
preparing electroplating solution: mixing CrO_3 with the concentration of 260g/L and H_2SO_4 with the concentration of 2.8g/L at the ratio of 100:1.28;
pre-treatment before electroplating: removing oil and rust for the conveying cylinder;
surface activation before first electroplating: preheating the electroplating solution to 70 °C, placing the conveying cylinder in an electroplating bath, and applying backward current of 55A/dm^2 for 30s for activation treatment after the conveying cylinder rises to 70 °C;
first electroplating: applying current of 50A/dm^2 at the temperature of 70 °C for 300min to form the first chromium coating with a thickness of 0.17mm and a hardness of HRC60;

de-hydrogenation treatment: placing the preliminary cylinder body with a preliminary chromium coating on the surface in a heating furnace at nitrogen protective atmosphere, heating to 200 °C, and preserving the heat for 160min to form the first chromium coating with a hardness of HRC58;
pre-treatment before second electroplating: polishing the inner surface of the first chromium coating to remove the oxides and sundries on the surface;
second electroplating: cooling the electroplating solution to 55 °C, applying forward current of 45A/dm^2 for 360min to form the second chromium coating with a thickness of 0.18mm and a hardness of HRC67; and
grinding and accurate grinding: taking the electroplated conveying cylinder out of the electroplating bath for cleaning, grinding and accurate grinding to make the surface roughness less than or equal to 0.4.

Embodiment 3

[0044] The manufacturing method includes the following steps:

manufacturing a preliminary cylinder body: manufacturing a cylinder body by specifications, boring holes, and roughly grinding till the surface roughness of the cylinder body is 0.8, the inner diameter is 0.6mm less than the product, the straightness is 0.5 and the ovality is 0.03;
preparing electroplating solution: mixing CrO_3 with the concentration of 250g/L and H_2SO_4 with the concentration of 2.5g/L at the ratio of 100:1.20;
pre-treatment before electroplating: removing oil and rust for the conveying cylinder;
surface activation before first electroplating: preheating the electroplating solution to 68 °C, placing the conveying cylinder in an electroplating bath, and applying backward current of 52A/dm^2 for 30s for activation treatment after the conveying cylinder rises to 68 °C;
first electroplating: applying current of 47A/dm^2 at the temperature of 68 °C for 320min to form the first chromium coating with a thickness of 0.16mm and a hardness of HRC61;
de-hydrogenation treatment: placing the preliminary cylinder body with a preliminary chromium coating on the surface in a heating furnace at nitrogen protective atmosphere, heating to 220 °C, and preserving the heat for 180min to form the first chromium coating with a hardness of HRC59;
pre-treatment before second electroplating: polishing the inner surface of the first chromium coating to remove the oxides and sundries on the surface;
second electroplating: cooling the electroplating solution to 53 °C, applying forward current of 40A/dm^2 for 330min to form the second chromium coating with a thickness of 0.19mm and a hardness of HRC67; and
grinding and accurate grinding: taking the electroplated conveying cylinder out of the electroplating bath for cleaning, grinding and accurate grinding to make the surface roughness less than or equal to 0.4.

Comparison embodiment 1

Manufacturing method:

[0045]

manufacturing a preliminary cylinder body: preparing a cylinder body by specifications, boring holes, and roughly grinding till the surface roughness of the cylinder body is 0.8, the inner diameter is 0.6mm less than the product, the straightness is 0.5 and the ovality is 0.03;
preparing electroplating solution: mixing CrO_3 with the concentration of 250g/L and H_2SO_4 with the concentration of 2.5g/L at the ratio of 100:1.12;
pre-treatment before electroplating: removing oil and rust for the conveying cylinder;
surface activation before first electroplating: preheating the electroplating solution to 55 °C, placing the conveying cylinder in an electroplating bath, and applying backward current of 50A/dm^2 for 30s for activation treatment after the conveying cylinder rises to 55 °C; and
electroplating for an inner surface: applying current of 40A/dm^2 at the temperature of 55 °C for 480min to form a hard chromium coating with a thickness of 0.3mm;

Comparison embodiment 2

[0046] The manufacturing method is as follows: (embodiment 3 in China patent No. 200810143572.X)

a, preparing electroplating solution: mixing CrO_3 with the concentration of 220-250g/L and H_2SO_4 with the concen-

tration of 2.3g/L at the ratio of 100:1.12;
b, pouring the prepared electroplating solution 1 in an electroplating bath;
c, raising the temperature of the electroplating solution 1 in the electroplating bath to 70 °C to form electroplating solution 2 before electroplating;
d, placing a clean conveying cylinder in the electroplating solution in the electroplating bath and preheating the conveying cylinder to the temperature of the electroplating solution to form a conveying cylinder 3 to be electroplated;
e, applying backward current of 20A/dm^2 to the electroplating bath to perform reverse etching and corrosion removal to further remove sundries on the surface of the conveying cylinder and form a clean conveying cylinder 4 to be electroplated;
f, applying forward current of 20A/dm^2 to the electroplating bath for 150min to electroplate a milky chromium coating on the surface of the conveying cylinder and form a conveying cylinder 5 with the milky chromium coating;
g, cooling the electroplating solution to 55 °C by an electroplating bath cooling system without changing the magnitude of the current;
h, increasing the current by way of step increase to 40A/dm^2, keeping the current for 420min, and electroplating a hard chromium coating to form a conveying cylinder 6 with the hard chromium coating; and
i, taking the electroplated conveying cylinder out of the electroplating bath for cleaning to form a conveying cylinder 7 with the milky chromium coating and the hard chromium coating.

Comparison embodiment 3

[0047] The manufacturing method is as follows: the electroplating parameters and steps are as mentioned in comparison embodiment 2, wherein the first chromium coating has a hardness of HRC50 and a thickness of 0.10mm; and the second chromium coating has a hardness of HRC68 and a thickness of 0.30mm.

Performance test

[0048] The wearing resistance, cracking rate and service life of the conveying cylinders manufactured in embodiments 1-3 and comparison embodiments 1-3 are tested, with the test results shown in Table 1.

[0049] The method for testing the adhesion of a coating is a bending test according to international GB/T5270; and the measurement standard depends on the bending amount of cracks and falling off generated by bending.

[0050] The method for testing the cracking rate is to observe and calculate the number of cracks passing through a straight line of 1mm under an optical microscope, and the measurement standard is that the more the cracks passing through the straight line of 1mm are, the larger the brittleness or internal stress of the coating is.

[0051] The method for testing the service life is to measure the capacity of pumped concrete, and the measurement standard is that the larger the capacity of pumped concrete is, the longer the service life is.

Table 1

	Adhesion of coating	Cracking rate	Service life
Embodiment 1	Excellent	40-50 cracks/mm	100,500 stere
Embodiment 2	Excellent	40-50 cracks/mm	98,400 stere
Embodiment 3	Excellent	40-50 cracks/mm	99,200 stere
Comparison embodiment 1	Normal	90-100 cracks/mm	63,800 stere
Comparison embodiment 2	Good	60-70 cracks/mm	76,500 stere
Comparison embodiment 3	Good	60-70 cracks/mm	78,400 stere

[0052] It can be seen from Table 1 that each performance of the conveying cylinders manufactured by the embodiments 1-3 is obviously better than that in the comparison embodiments 1-3.Specifically:

The comparison embodiment 3, not belonging to the prior art, is only put forward for proving the advantages of the method for manufacturing the conveying cylinder provided by the disclosure, and is the most approximate to the solution provided by the disclosure compared with the comparison embodiments 1 and 2.It can be seen from Table 1 that each performance of the conveying cylinder manufactured in comparison embodiment 3 is better than that in comparison embodiments 1 and 2, but worse than that in embodiments 1-3Thus, by the method for manufacturing the conveying cylinder provided by the disclosure, two chromium coatings are prepared at the same time and the

hardness and thickness of the two chromium coatings are controlled in a certain range, so that the conveying cylinder prepared by the method is excellent in performance and low in cracking rate, so as to have longer service life.

[0053] The above are only preferred embodiments of the disclosure and not intended to limit the disclosure. For those skilled in the art, various modifications and changes can be made in the disclosure. Any modifications, equivalent replacements, improvements and the like within the spirit and principle of the disclosure shall fall within the scope of protection of the disclosure.

Claims

1. Method for manufacturing a conveying cylinder, comprising a step of forming a preliminary cylinder by machining, **characterized by** further comprising steps of:

   making a first electroplating on inner surface of the preliminary cylinder body, and then performing de-hydrogenation treatment on the coating to form a first chromium coating with a hardness of HRC58-60 and a thickness of 0.15-0.2mm; and
   making a second electroplating on the inner surface of the first chromium coating to form a second chromium coating with a hardness of HRC66-68 and a thickness of 0.15-0.2mm, such that a conveying cylinder is formed.

2. The method according to claim 1, **characterized in that** the first electroplating comprises steps of:

   placing the preliminary cylinder body in electroplating solution and applying a forward current of 45-50A/dm^2 at the temperature of 65 to 70 °C for electroplating for 240 to 300min to form a preliminary chromium coating; and performing de-hydrogenation treatment to the preliminary chromium coating to form the first chromium coating.

3. The method according to claim 2, **characterized in that** the de-hydrogenation treatment comprises the following step:

   preserving the heat for 120 to 180 min at the temperature of 180 to 220 °C in inert atmosphere.

4. The method according to claim 2, **characterized by** further comprising performing surface activation treatment to the preliminary cylinder body before the first electroplating, wherein the surface activation treatment comprises the steps of:

   placing the preliminary cylinder body in the electroplating solution of 65 to 70 °C, keeping the temperature at 65 to 70 °C while the preliminary cylinder body gets the same temperature as the electroplating solution and applying backward current of 50-55 A/dm^2 to perform surface activation treatment to the preliminary cylinder body for 30-60s.

5. The method according to any one of claims 2-4, **characterized in that** the second electroplating comprises the steps of:

   placing the preliminary cylinder body subjected to the first electroplating into electroplating solution, and applying forward current of 35-45A/dm^2 at the temperature of 50 to 55 °C for electroplating for 300 to 360min to form the second chromium coating.

6. The method according to claim 5, **characterized by** further comprising a step of polishing the first chromium coating before the second electroplating.

7. The method according to claim 1, **characterized by** further comprising a step of post-treatment after the second electroplating, wherein the after-treatment step comprises:

   cleaning the second chromium coating and accurately grinding the same to make the surface roughness less than or equal to 0.4.

8. The method according to claim 1, **characterized in that** electroplating solution used in the first and second electroplating is same and is formed by mixing CrO_3 solution with the concentration of 230 to 260g/L and H2S04 solution with the concentration of 2.3 to 2.8g/L in the ratio of 100:1.12-1.28.

9. A conveying cylinder, **characterized in that** the conveying cylinder is manufactured by the method according to any one of claims 1-8, comprising:

a cylinder body;
a first chromium coating being provided on the inner surface of the cylinder body and having a thickness of 0.15-0.2mm and a hardness of HRC58-60; and
a second chromium coating being arranged on the inner surface of the first chromium coating and having a thickness of 0.15-0.2mm and a hardness of HRC66-68.

10. Pumping equipment **characterized by** comprising the conveying cylinder according to claim 9.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/080615

A. CLASSIFICATION OF SUBJECT MATTER

see the extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C25D, F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, CNPAT, CNKI: cylinder, plating, electro+, chrom+, two, second, twice, hydrogen, remov+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101418458 A (LOUDI ZHONGXING HYDRAULIC PART CO., LTD.) 29 Apr. 2009 (29.04.2009) see description, page 3, line 9 to page 5, line 1	1-10
A	CN 1804144 A (ZHANG, Xicheng etc) 19 Jul. 2006 (19.07.2006) see the whole document	1-10
A	JP 4350193 A (TEIKOKU CHROME KK etc) 04 Dec. 1992 (04.12.1992) see the whole document	1-10
A	EP 0330722 A1(ELCA SRL) 06.Sep. 1989(06.09.1989) see the whole document	1-10

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 Apr. 2012(12.04.2012)	03 May 2012(03.05.2012)
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10)62019451	Authorized officer ZHANG, Min Telephone No. (86-10)62084136

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/080615

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2003106216 A (NIPPON PISTON RING CO LTD) 09 Apr. 2003 (09.04.2003) see the whole document	1-10

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2011/080615

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 101418458 A	29.04.2009	None	
CN 1804144 A	19.07.2006	None	
JP 4350193 A	04.12.1992	None	
EP 0330722 A1	06.09.1989	BR 8901046 A	24.10.1989
		IT 1215985 B	22.02.1990
		AT 72587 T	15.02.1992
		EP 0330722 B	12.02.1992
JP 2003106216 A	09.04.2003	None	

Form PCT/ISA /210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/080615

Continuation of : second sheet A. CLASSIFICATION OF SUBJECT MATTER

C25D 5/14(2006.01) i

F04B 53/16(2006.01) i

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 200810143572X **[0005] [0006] [0023] [0046]**
- GB T5270 A **[0049]**