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Development of control system of coating of rod hydraulic cylinders

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Abstract. In this article, requirements to materials of hydraulic cylinders and methods of eliminating the main factors affecting the quality of the applied coatings rod hydraulic cylinders. The chromium plating process - one of ways of increase of anti-friction properties of coatings rods, stability to the wear and corrosion. The article gives description of differences of the stand-speed chromium plating process from other types of chromium plating that determines a conclusion about cutting time of chromium plating process. Conducting the analysis of technological equipment suggested addressing the modernization of high-speed chromium plating processes by automation and mechanization. Control system developed by design of schematic block diagram of a modernized and stand-speed chromium plating process.

1. Introduction

Presently the hydraulic and pneumatic systems are used in a power supply [1–4] and land-reclamation, on all types of transport [5], in building, robotics [6], management [7], metallurgy and engineering [8]. Large attention at technical progress in an engineering must be spared to upgrading quality of mining machines, their reliability and longevity. Reliability enhancement – one of major tasks of modern metrology, that it is related to the continuous height of intensification of technological processes of mining, productivity enhancement of equipment and increase of the affecting him loading.

In the device of hydraulic cylinder, materials of contacting pairs, besides the required high durability, must possess good anti-friction properties at high enough speeds of recurrently - forward motion, by enhance able stability to the wear at a long friction. The details of power cylinders (a research object is a power hydraulic cylinder) make from corrosion-resisting materials or coated their surface the galvanic coating [9–11].

2. Attributes of anodic stand-speed chromium plating process

The chromium plating process provides this protection by providing of high stainless in such environments, as water, salt water and nitric acid. In order that to increase stainless of contacting surfaces, protect from corrosion and to recover threadbare or defective details the electrolytic chromium plating process of rod hydraulic cylinders is used [11, 12].

Quality of corrosion-resisting chromic surfaces is determined on next criterions:

- 1) their appearance;
- 2) coupling durability;
- 3) thickness of layer.

Considering that properties of chromic surface substantially depend on the mode of chrome-plating and not enough characterized by appearance of surface, it is expedient to carry out in practice control



on operations, watching out for operation of the anodic activation process and mode of chrome-plating (current density and temperature of electrolyte). For intensification of chromium plating process of rod hydraulic cylinders, it is necessary to apply the anodic stand-speed chromium plating process. The anodic-stream method of chromium plating process usually carry out in self-regulating electrolyte at a temperature from +55 to +66 °C (as marked higher this parameter must be controlled exactly).

Automation and mechanization of this process are used in heavy and harmful for a man productive terms, to increase the labor productivity and improve quality of electroplating rod hydraulic cylinders, also to remove ineffective hand labor. Therefore in modern terms on enterprises automatic operator galvanic lines (further – AOGL) are used [13–15].

Presently for the further decline of labor content of chromium plating process at providing of the required quality of coating perspective technology is technology of the anodic stand-speed chromium plating process in the stream of electrolyte at the set technological parameters. The distinctive of technological process of the stand-speed chromium plating process is that this process takes place at pumping of electrolyte through a workpiece-to-electrode with certain speed, pressure, temperature, current density and other parameters. Basic advantages:

- Speed-up deposition of chrome - to three $\mu\text{m}/\text{min}$.
- Irregularity deposition of chrome on a diameter – 10%.
- The healthy terms of labor by complete absence of open bath of electrolyte.

3. Modernization of the speed anodic stand-speed chromium plating process

The technological equipment of the stand-speed chromium plating process of period of 1980–90th years, applied on the enterprises of Republic of Kazakhstan, is characterized by the physical wear of basic equipment, physically and by the morally out-of-date element base of control system, which results operating trouble and low-grade coating. Scientific and technical modernization is therefore required this equipment. Essence of modernization of the speed anodic stand-speed chromium plating process consists in providing of new element base: introduction of programmable logical controllers (further – PLC) [14].

The schematic block diagram of modernized AOGL of the speed chrome-plating (Figure 1) include eight programmable logical controllers, automatic thermostat (further – AT), conveyor, personal computer (further – PC) and block of preparation of electrolyte. Conceptually all element base of control system subdivided into four basic working blocks:

- 1) A1 – control block of conveyor.
- 2) A2.1, A2.2, A2.3 – control blocks of current.
- 3) A3 – control block of pressure.
- 4) Block of preparation of electrolyte.

Such dividing into certain zones allows more exactly producing control on operations necessary in control system such chromium plating process of rods. By block A1 controls moving by the conveyor of object of chrome-plating (rod of hydraulic cylinder). Control blocks of current (A2.1, A2.2, A2.3) control power stream-lines electric current, the same is provide regularity of coating, removing or decrease fringe effect on the chrome-plated surface. Fringe effect is an unfavorable factor influencing on distributions of chromic coating. In addition, automatic control of power stream-lines is necessary for the exception of interruptions of current feeding in the chromium plating process, inasmuch as at the repeated galvanic plating shelling of chrome layer is possible. The block of preparation of electrolyte is straight related with automatic thermostat and accordingly with control block of pressure (A3). The block of preparation of electrolyte controls the temperature of electrolyte, because a defect (mat precipitates of chrome) will follow from the decline of temperature. This type of defect causes difficulties at polish of details.

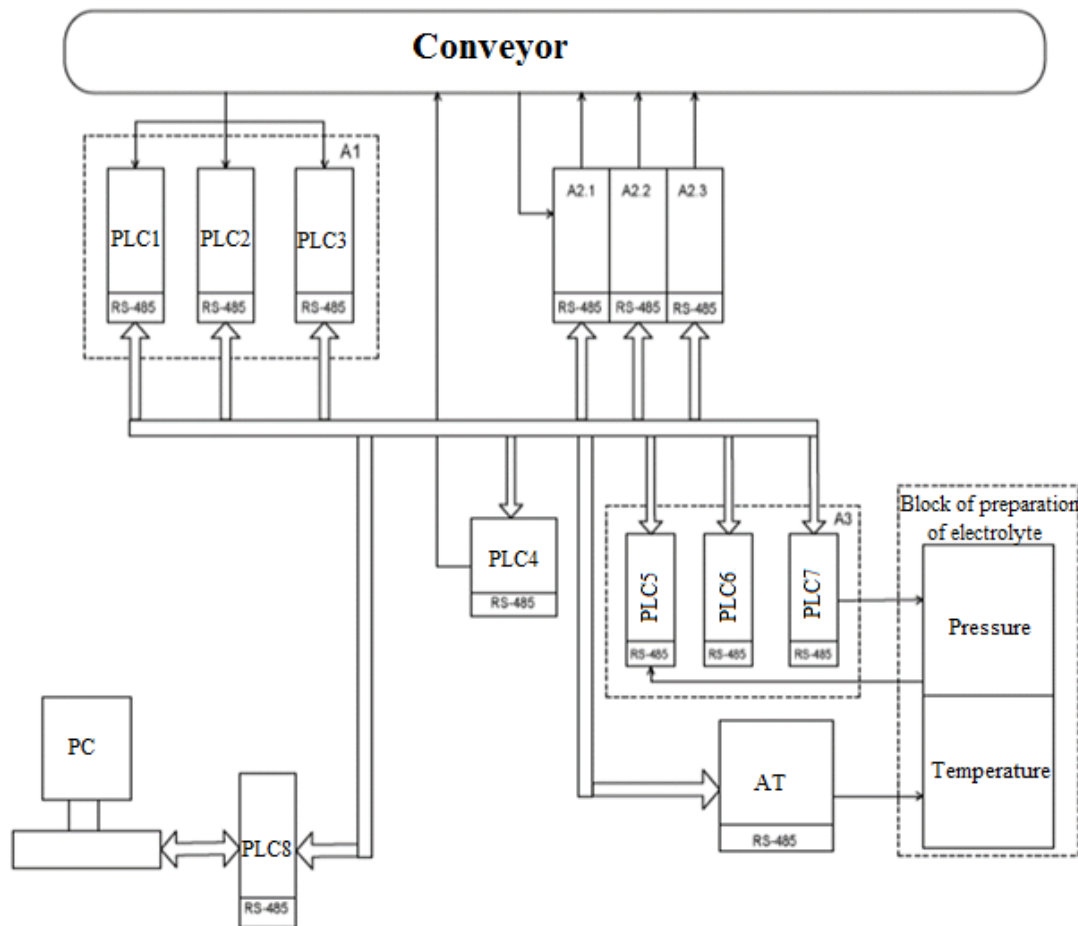


Figure 1. The schematic block control diagram of the chromium plating process of rod hydraulic cylinder.

The block of A3 include the controllers of PLC 5, PLC 6, PLC 7, that responsible for a control pressure and temperature of electrolyte (automatic thermostat maintain the standard temperature in a range from +55 to +66 °C) [10]. Controllers of PLC 1, PLC 2 and PLC 3 are designed to control conveyor. The controller of PLC 4 is necessary for realization of manipulations with the object of chromium plating process. The controller of PLC 8 is designed for connection with the personal computer. Programmable logical controllers are united inter se and with the personal computer by means of interface of RS – 485.

The hookup of the stand-speed chromium plating process of rods (Figure 2) shows what control elements are involved on the certain stage of technological process for control of temperature and amperage. The technological process of chromium plating process of rod hydraulic cylinders contains positions of loading, unloading, depriving of fat, washing and chromium plating process. Control system by programmable logical controllers coordinates performance of separate operations of chromium plating process in time and in space. Intercommunication of this control system and the personal computer allows carrying out monitoring the stand-speed chromium plating process.

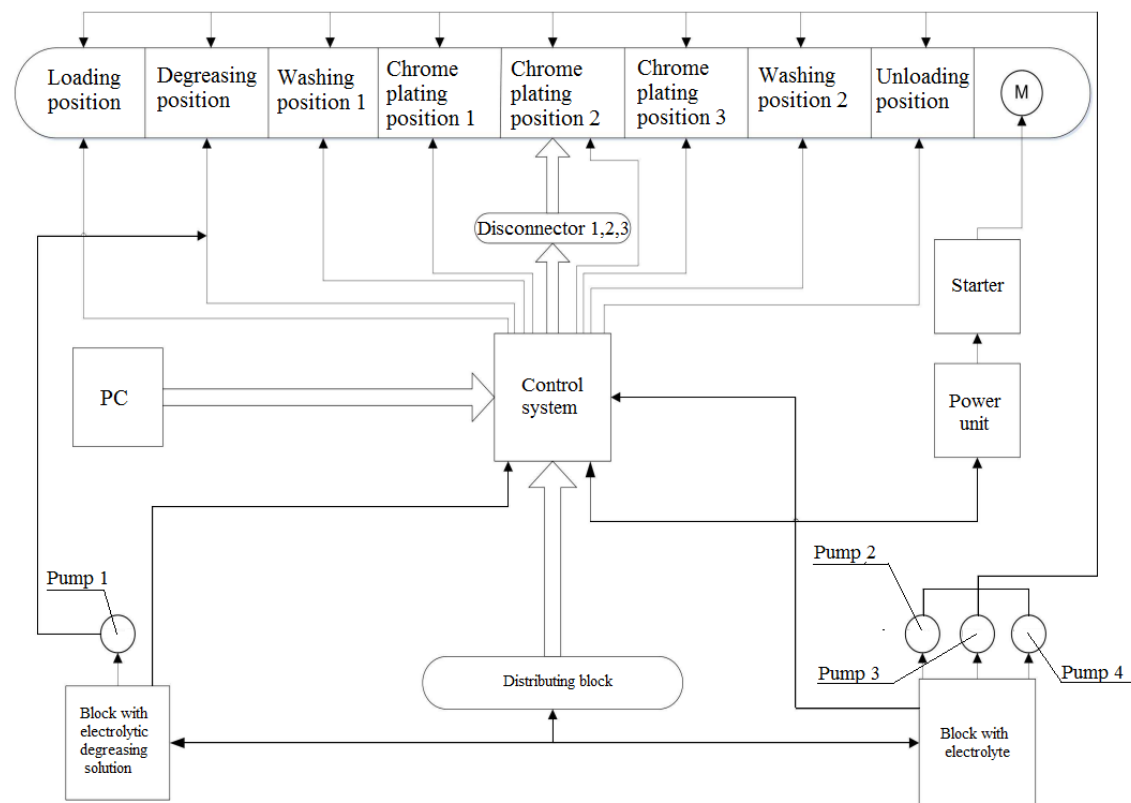


Figure 2. The hookup of the modernized stand of treatment the stand-speed chromium plating process of rods.

The chromium plating process of rods consists of next strict sequence: electrolytic degreasing (for details from high-strength steel possibly only chemical degreasing), washing, 3 positions of chrome plating, washing after chrome plating, drying and heat treatment [16]. By control block of conveyor rod of hydraulic cylinder passes all positions of the stand-speed chromium plating process. Positions of loading and unloading come true due to a programmatic logical controller 4, responsible for manipulations with the object of chromium plating process. Position of electrolytic degreasing is interrelated with a block in that there is electrolytic degreasing solution (depending on the type of steel composition of solution is determined). In addition, at co-operating with a distributing block the exactly that concentration of solution, that is necessary in accordance with technical documentation for rod of hydraulic cylinder, is given. The process of drying and heat treatment are produced not on the modernized stand, and after unloading position rod of hydraulic cylinder heads for other productive area (drying options, stoves) [17].

4. Summary

Thus, it is possible to do a conclusion on modernization of chromium plating process: realization of computer control the chromium plating process will allow to carry out monitoring at work of technological equipment real-time. The planned introduction of line of the stand-speed chromium plating process will allow shortening time of coating on 30...35 % as compared to an existent technological process. Reduction of time feasibly due to property of besieging of chrome (to three $\mu\text{m}/\text{min}$), that is main advantage of the stand-speed chromium plating process.

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