Industrial robot Ural 1 for the oil and gas industry

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Abstract. Ural industrial robots have been developed for diagnosing oil and gas pipelines and inspecting reservoirs. The developed industrial robot is designed to collect information on remote objects of the oil and gas industry in difficult geographical conditions using sensors for various purposes. Monitoring the condition of pipelines and examine reservoirs for the presence of hydrogen sulfide without the direct involvement of a person will improve the safety of these operations and reduce the cost of their implementation. The article describes the design features, technical characteristics and main advantages of the developed industrial robots with an internal combustion engine and an electric motor.

1. Introduction
The oil and gas industry is one of the main components of the Russian economy [1]. The development of energy is facing a number of environmental problems, which are becoming increasingly acute, since the oil and gas industry is one of the most environmentally hazardous industries. The problem of environmental pollution in the oil and gas industry is especially relevant in our time. The oil and gas industry is one of the most powerful nature-transforming economic formations of the Russian Federation, and the problem of making environmental decisions on it constantly exists. Work at mining and processing facilities is associated with increased responsibility, strict requirements for safety and environmental protection. In recent years, most enterprises, in order to combat oil pollution, create links or workshops to deal with the consequences of accidental oil spills, equip them with modern technologies and environmental equipment, both domestic and foreign production. Unfortunately, the equipment of Russian manufacturers does not stand out in terms of high performance, reliability, and most importantly, a wide range of products.

In Russia, an extensive network of pipelines is located in the extreme north, tundra, as well as in oilfield areas with difficult traffic, in places dangerous to human life [5, 11]. Deposits form on the walls of process pipelines over time. This process does not depend on the method of operation of the system and leads to a decrease in its throughput and the occurrence of emergency situations [3]. Pipeline systems also require a set of measures aimed at preventing the destruction of welded joints of pipelines, since when a pipeline ruptures, oil is lost, and environmental damage is noticeable. To localize problem areas, pipeline diagnostics are carried out. To date, this procedure is not automated. To improve human security and ensure the reliability of oil and gas facilities, automation of technological processes is actively used [6]. The intensification of production, improving the quality and reducing the cost of production is possible due to the automation of technological processes based on modern technology. Monitoring the condition of pipelines and examining oil reservoirs for the...
presence of hydrogen sulfide without the direct participation of a person will improve the safety of these operations and reduce the cost of their implementation [2]. In an effort to increase efficiency and reduce the cost of production, companies seek to automate it, which in turn led to the use of industrial robots. The relevance of developing a special robot is justified by the fact that at present there is a significant number of pipelines and reservoirs in operation; damage and destruction of components of which can lead to loss of life, serious economic losses and detrimental effects on the environment.

The Ural industrial robot is the latest technology that provides the ability to transfer information from a pipeline or tank to a control point in real time. This technology includes a large number of measurements and controls that optimize the operation of these oil and gas facilities. The Ural industrial robot enables extremely accurate analysis of the pipeline state. Based on a detailed analysis of the information received, conditions are created that are suitable for the full operation of the pipeline network, which, in turn, reduces production costs.

The need for personnel to visit an extended network of oil and gas pipelines disappears, all the necessary data is recorded directly on a computer. Thus, employees are less at risk and have more time for the quality of other important production tasks. Important advantages include the general availability of information about the state of the pipeline for all employees working in the same company. This extends the optimization of production processes and allows the team to work together.

2. Materials and methods
The purpose of the work is the development of technical documentation for the design and creation of a prototype of the Ural portable mobile platform with remote control for inspection of tanks and pipelines. Tasks for the implementation of the project:

1. Development of technical specifications.
2. Creating a preliminary design of an industrial robot.
3. Technical design of an industrial robot.
4. The prototype of the robot Ural 1.

Particular attention is directed to the transport and logistics tasks of the model for the possibility of operation in extreme weather conditions and areas of difficult patency. Therefore, the developed model is created on a tracked platform. The main part of research is aimed at the invention of new technologies for the chassis of tracked vehicles.

3. Results and Discussion
A multifunctional industrial robot Ural 1 (Figure 1) was developed on a track platform for collecting information on remote objects of the oil and gas industry in difficult geographical conditions, for diagnosing with the use of sensors for various purposes for the presence of external defects in the oil and gas pipeline, inspecting reservoirs, and performing work in places dangerous to life person. The main technical characteristics of the industrial robot Ural 1 are presented in Table 1.
Figure 1. Ural 2M prototype

Table 1. Main technical characteristics of the industrial robot Ural 1

| Mass of Ural 1 model [kg] | 10.7 |
|--------------------------|------|
| Motor type               | Heater plug |
| Motor class              | Class 15 |
| Motor displacement [cm³] | 2.5 |
| Fuel                     | Nitromethane |
| Dimensions (length, width, heigh) [cm] | 85 x 55 x 45 |
| Suspension clearance [cm] | 18 |
| Maximum speed in 1 gear [km/h] | 6 |
| Maximum speed in 2 gear [km/h] | 12 |

The developed mobile platform is simple, has no complex mechanical and electrical components. Light weight and dimensions ensure ease of transportation of the robot. The model has a high potential for operation in the oil and gas industry, as it provides the ability to install any equipment and sensors. Details of the tracks are made of aluminum p-shaped profiles, which ensures the smallest mass and the highest adhesion to the surface. Due to the large clearance of the suspension, high cross-country ability and the ability to overcome difficult geographic areas, such as operation in wetlands [4, 7], are ensured.

The design of the model enables operation both on a solid surface and on water. Ural 1 has full waterproofing and is equipped with an air cushion, which allows controlling the robot in areas with no contact with a solid surface [8]. Equipping the model with a generator provides the longest running time. The model is equipped with external light devices that allow it to be operated in the dark or in conditions of limited visibility [9, 10].

The model has a six-channel remote control FS-CT6B with an automatic start system. Depending on the type of work performed, sensors for various purposes can be installed on this platform. Depending on production tasks, the Ural industrial robot can be equipped with a gas analyzer, temperature and humidity sensors, a GoPro camera and First Person View (FPV) system. Received and processed information from devices is displayed on the monitor in the form of various diagrams.
A special effect is achieved when using the FPV system, which consists of a camera, transmitter and video receiver, with virtual-reality glasses.

Also, an industrial robot Ural 2M with an electric motor and an upgraded running gear (table 2) was developed. The model allows in the field to perform a quick and not time-consuming replacement of the technical part of the model, namely, changing the drive with an internal combustion engine to an electric motor.

Table 2. – Main technical characteristics of Ural 2M industrial robot with an electric motor

| Characteristic                      | Value          |
|------------------------------------|----------------|
| Motor type                         | two collector motors |
| Motor class                        | electric motor RC370 - HSP58033 |
| Dimensions (length, width, heigh) [cm] | 85\times55\times45 |
| Suspension clearance [cm]          | 18             |
| Maximum speed in 1 gear [km/h]     | 8              |
| Maximum speed in 2 gear [km/h]     | 17             |

It is planned to consider the possibility of using this model in geological exploration activities.

4. Conclusion

Automation of diagnostics of the state of oil and gas pipelines and inspection of oil reservoirs using industrial robots Ural 1 and Ural 2M, equipped with sensors for various purposes, enables the collection of information at remote objects of the oil and gas industry in difficult geographical conditions and work in places dangerous to human life. Comprehensive control of parameters in the process of diagnostics of the pipeline transport of oil and gas will increase economic efficiency and production safety. The model has great potential for operation in the oil and gas industry, as it provides the ability to install any equipment and sensors.

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