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Theoretical justification of reducing soil adhesion to the surfaces of the excavator working body at creation underground infrastructure

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Abstract

It is proposed method of passive cleaning of the excavator working body from adhering soil that practically does not require additional energy. Theoretical studies of the surface temperature effect of the working body on the stickiness of cohesive fine-grained soils of different fractions are made, on the basis of which the calculation is made, and temperature regimes required to prevent adhesion are defined. The proposed design is recommended to be implemented in all types of shovels to improve the operational performance and, as a consequence, reduce the cost of earthworks.

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Keywords: **excavation work, adhesion, soil, excavator, bucket, temperature, performance, energy efficiency, resistance to digging, the idle, exhaust gas**.

1. Introduction

Experience of operating machinery shows that the development of wet soils (especially at cold temperatures) sticking and freezing of soil on the working bodies significantly decreases the performance of the machines. Downtime of shovels associated with cleaning buckets, reaches 5-10% of shift time (depending on operating conditions). Resistance to digging significantly increases because of the adhered layer of soil, which leads to higher loads on all drive types. There is a need in the design of earthmoving equipment to lay additional strength to all the

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details involved in [1, 2, 3]. Part of the thrust force of the internal combustion engine is consumed for overcoming the resistance forces of the soil to digging, which ultimately leads to increased fuel consumption. Performance degradation occurs in part because of the reduction of useful capacity of the scoops due to incomplete discharge. All this reduces the quality of work performed. The total loss of operational performance average is about 20%.

2. Objects, methods, and results of research

It is revealed that the main factors affecting the intensity of the buildup and subsequent freezing of cohesive soils, is their humidity and low temperature working surface earthmoving equipment. Theoretical studies for the quantitative and qualitative assessment of the adhesion processes intensity during excavation works at various environmental conditions are Produced [4, 5].

Theoretical studies of the effect of surface temperature of the working body on the stickiness of cohesive fine-grained soils of various grades are also produced. On their basis was calculated and the necessary temperature regimes for prevention of adhesion are determined.

It is proposed a possible design of the excavator bucket, allowing to use the energy of exhaust gases of an internal combustion engine for heating the contact surface. The proposed design does not require additional energy, will greatly enhance operational performance and reduce the cost of excavation.

During the development wet cohesive soils, especially at temperatures

+3...-10 °C, there is an intensive buildup of soil to the bucket [6, 7]. the amount of adhering soil reduces the volume of the bucket 11... 12% during the work in the summer in 45 min (figure 1).

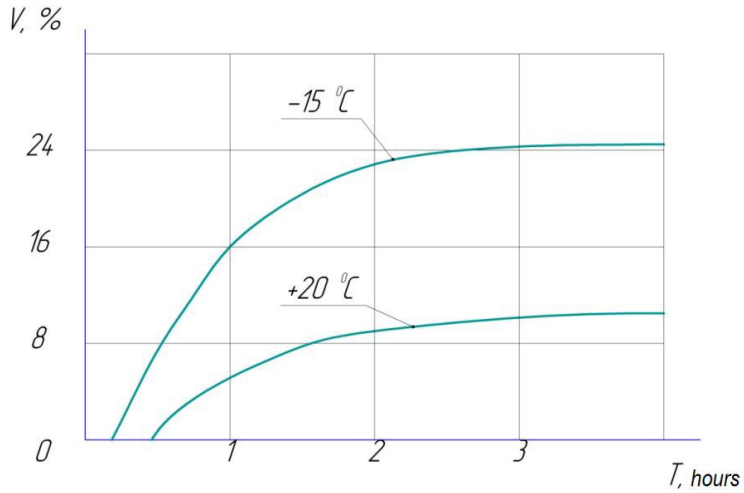

Fig. 1. Icrease of the buildup of dispersed cohesive soils in the bucket depending on the time and ambient temperature.

The study of the physical essence of the adhesion and freezing process of clayey soils to the working surface showed [8] that a complete unloading of the soil occurs when the bonding strength...480 550 kPa. The decrease in the bonding strength (adhesion) of different clay soils in their critical humidity to the specified value occurs when the metal surface is heated to 70...75 °C.

The structural energy relations of water changes with heat exposure , with possible transition of bound water to free, with decrease of viscosity and surface tension of the pore moisture. The process of drying the contacting layer of the soil occurs at a higher temperature, which contributes to the rupture of adhesion bonds (capillary component of the adhesion force is the main component for cohesive fine-grained soils).