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FINE SCREENING OF COAL SLURRY USING DRUM-TYPE AGGREGATES ON RUBBER DYNAMICALLY ACTIVE BELT SIEVES INTERACTING WITH NON-RIGID ELASTIC-STRESS SYSTEMS

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Abstract. A set of laboratory experiments was carried out to define regularities of fine screening and dehydration of coal slurry, using dynamically active belt sieve of a drum-type screen, and identify the rational operating conditions and design parameters of cleaner for dynamically active belt sieve openings to improve indicators of coal slurry sieving and dehydrating, which operation involves initiating centrifugal forces. To implement the laboratory-based program, a test bench was developed with the closed power supply cycle; laboratory drum-type screen, equipped with dynamically active belt sieve, and elastic non-rigid stress strained system for the forced cleaning of the openings, i.e. forced cleaning system «*Ramrod*» with a transport spiral. Moreover, certain methods were developed to carry out the research. The possibility to finely separate a liquid phase from the slurry-like mixture for the dynamically active belt sieve using forced cleaning system «*Ramrod*» with a transport spiral as a cleaner of its openings was evaluated. Relying upon the experimental results, the influence by the movable cleaner with a transport spiral was defined as well as the influence by design and technological parameters of the drum-type screen on the process of a liquid phase separation from coal slurry which grade is +0.5 mm. The experiments showed that high screening efficiency of coal slurry and low humidity percentage within the finished product result from the following: balanced ratio of the output in terms of input power; inclination angle of the screen drum; and frequency and rotation direction of the developed cleaner of dynamically active belt sieve openings creating such a moving mode of coal slurry through dynamically active belt sieve of the rotating screen drum, under which impact of initiating centrifugal forces operates maximally. The use of the developed screen hole cleaner of a drum screen with a conveying spiral allows you to effectively solve the problems of high-performance discharge of wet and clumping materials, which are classified in drum-type units. In this way, opportunities and prerequisites will be provided for the creation of equipment that combines the processes of preliminary dewatering and de-sludging by screening, as well as final dewatering on centrifuges.

Keywords: screening process efficiency, coal slurry, elastic-stress deformed «*Ramrod*» system with a transport spiral, drum-type screen, dynamically active belt sieve.

1. Introduction

Screening and dehydrating of slurry-like mixtures, obtained in operation schedules of wet preparation, are rather topical problems for a mining and processing complex branch. Among other things, fine screening and dehydrating are among the most important providing qualitative operation of equipment at preparation plants, and production of coal concentrate with the specified moisture content [1]. For the purpose, studies are carried out constantly; new screening approaches are developed; and innovative devices to improve screen operations are designed which will also favour the increase in slurry-like graded material dehydration [2].

Analysis of the available techniques has shown that the improved efficiency of fine screening process as well as dehydration level of the finished product needs new designs of sieves for drum-type screens and development of cleaners for their openings which make it possible to upgrade technological indicators of screening, dehydrating, and disintegrating of slurry-like mixtures. Abroad, following companies are engaged in the design and implementation of analogous equipment: Schenck, Uhde, Tip-Top, Stahlgruber, and Isenmann (Germany); Skega and Svedala (Sweden); Repifine, Trailer, and Derrick (USA); Furukawa and Mitsubishi (Japan); and Krush (Israel). In Ukraine, AHA-TEMC ltd and the M.S. Poliakov Institute of Geotechnical Mechanics of the NAS of Ukraine analyse screening, dehydrating, and disintegrating processes of slurry-like mixtures. Currently, mining and concentrating industry is applying such engineering devices based predominantly on operation of elastic screening surfaces (made from polyurethane and rubber). They are more efficient while being used and meet ever-increasing requirements for screening, dehydrating, and disintegrating facilities.

2. Methods

Theoretical studies [3] and experiments [4, 5], performed by researches from the M.S. Poliakov Institute of Geotechnical Mechanics of the NAS of Ukraine have helped separate and identify the impactful solution of the following technical problems, namely:

- design standard series of the specific rubber for dynamically active belt sieves (DABSs) aimed at fine screening and dehydrating of slurry-like mixtures with the prescribed 0.2–5 mm size;
- develop the specific sieving surfaces of the DABS type for drum-like screens, being of the standard design, applied for fine screening and dehydrating of slurry-like mixtures;
- design and develop non-rigid elastic-stress deformed system of the forced cleaning of the DABS opening which is able to influence actively the improvement of technological indicators of drum-like screeners.

The work idea is to use the movable elastic-stress deformed system with a transport spiral as a mobile cleaner for dynamically active surface of a sieving drum-like screener to upgrade technological parameters of screening, dehydrating, and disintegrating of slurry-like mixtures as well as sticky fine wet materials.

The purpose of the experiments is to improve technological indicators of screening, dehydrating, and disintegrating. The purpose is also to intensify graded material transportation owing to interaction between the transport spiral of the elastic-stress deformed system (i.e. movable cleaner of the drum-like screener) and dynamically active elastomers operating surface in its rotating operating body. In this context, attention is paid to identification of regularities of separation processes in terms of the specified size owing to reduced energy consumption and the number of the involved equipment.

3. Theoretical and experimental parts

The improvement of fine screening of slurry-like mixtures or wet fine prone to conglomeration material as well as increase in dehydration level of the final product, obtained with the help of such a mining and concentrating machine as drum-like screen, is rather topical problem, which depends upon numerous factors. Among other things, use of new, simple, and efficient technical devices (namely, cleaners for openings of sieves of drum-like screen) may become one of the key factors to achieve high and stable screening, dehydrating, and disintegrating processes as for coal slurries. In this regard, the main role within the processes belongs to interaction conditions between a dynamically active surface of a drum-like sieving screen and slurry-like mixtures, or the graded wet fine prone to conglomeration material, and the possibility to apply movable cleaner for the slotted openings of the dynamically active belt drum-like screen developed by researchers from the M.S. Poliakov Institute of Geotechnical Mechanics of the NAS of Ukraine. A movable cleaner of the slotted DABS openings, called as the forced cleaning system «*Ramrod*» with a transport spiral, and full-size drum-like screen, equipped with a drive and continuously controlled rotation frequency, are the key executive mechanisms of the test bench with the closed power supply cycle. The test bench is intended to implement the developed program analysing fine screening of coal slurry as well as dehydration degree of the finished product (Fig.1).

Figure 1 – Full-size drum-like screen with a working surface DABS within the test bench of the research

The mining and concentrating machine, having three duplex sieving sections, may be used as a dehydrating aggregate. Moreover, its structural and operational parameters involve its industrial application. The drum-like screen has following characteristics:

- output in terms of input power supply, t/hour up to 70;
- drum length, mm 4440;
- drum diameter, mm 1140;
- internal diameter of the drum throughout its working surface, mm 820;
- area of the drum working surface, m^2 8.2; and
- rotational frequency of the drum, rpm up to 40.

Coal slurry is a uniform mixture of solid and liquid components. Through pipelines, centrifugal pumps deliver it to a loading part of the screen drum. The research has applied rough (-5+0) mm grade coal being the solid component of coal slurry sized as +0.5 mm using DABS of the drum screen with granulometric composition of the rough coal shown in Table 1.

Table 1 – Granulometric composition of the rough coal

Size, mm	+5	-5+3	-3+2	-2+0.5	-0.5+0.315	-0.315+0.2	-0.2+0.1	-0.1
Solid, g	0.005	0.030	0.120	0.625	0.215	0.275	0.205	0.080
Solid, %	0.3	1.93	7.7	40.3	13.8	17.7	13.2	5

During the experiments, the coal density was 280-300 grams per litre, which corresponds to the ratio

$$T \div P = M_T \div M_P = (1 \div 3.6) - (1 \div 3.3) \qquad (1)$$

where M_T is solid component mass in the slurry; and M_P is liquid mass in the slurry.

Fig. 2 shown design of the elastic-stress rubber-rope cleaner of the slotted DABS openings of the experimental drum-like screen – a system of the forced «*Ramrod»* cleaning with transport spiral.

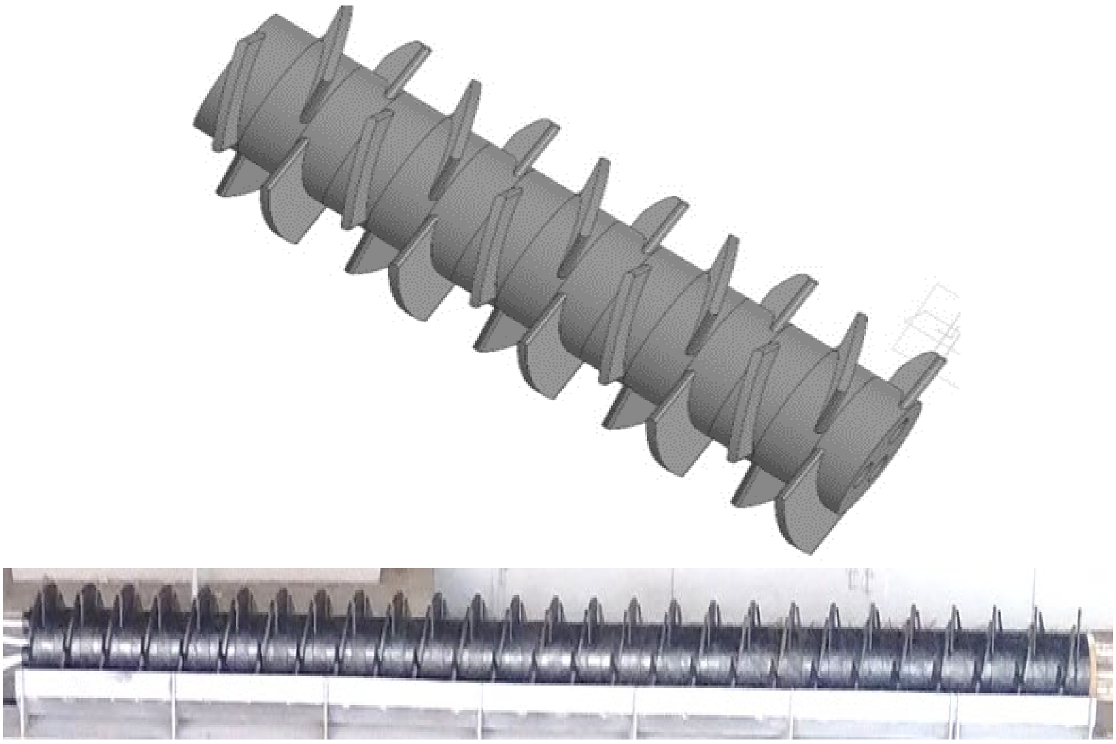
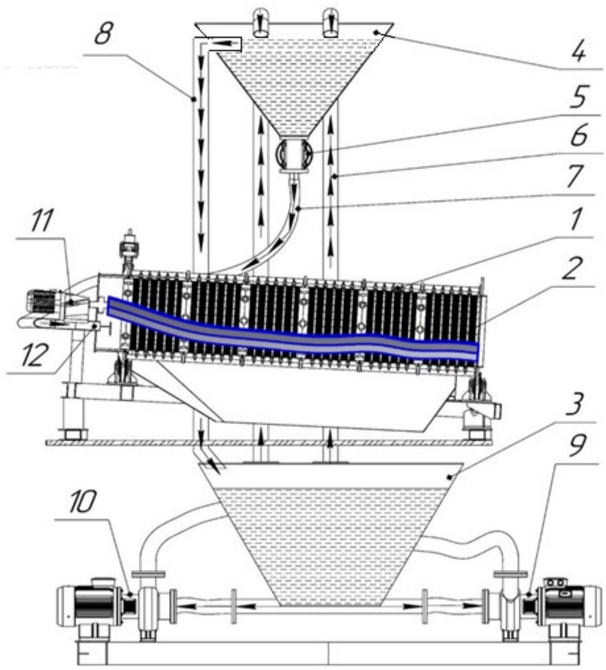


Figure 2 – Slot hole cleaner DABS - forced cleaning system «*Ramrod*» with a transport spiral and fragment of the assembled «*Ramrod*» rod

The «*Ramrod»* rod consists of elastic rubber stoppers being similar in shape and geometry. Throughout its longitudinal axis, it is compressed by means of four elastic bonds being metal cables. The elastic stoppers have two petals protruding in different directions. When the stoppers are assembled within the cleaner rod, they shape helical transport spiral at its smooth cylindrical surface. Moreover, each of the elastic stoppers, has one central and three side cylindrical locking flanges in coaxial relationship to which both central and three cylindrical locking notches are available. In this context, one central and three side cylindrical locking flanges as well as one central and three cylindrical locking notches have via round openings in their geometrical centres to mount compressive elastic bonds required to join the elastic stoppers in the non-rigid rubber-rope rod of the DABS cleaner of a drum screen. In addition, owing to the «*Ramrod*» rod design, while rotating, the guaranteed possibility to intensify impacting and scraping interaction with working the DABS surface of the drum-like screen, which provides contentious cleaning of the DABS openings. Fig. 3 explains arrangement of crucial components and mechanisms of the experimental closed power supply bench.

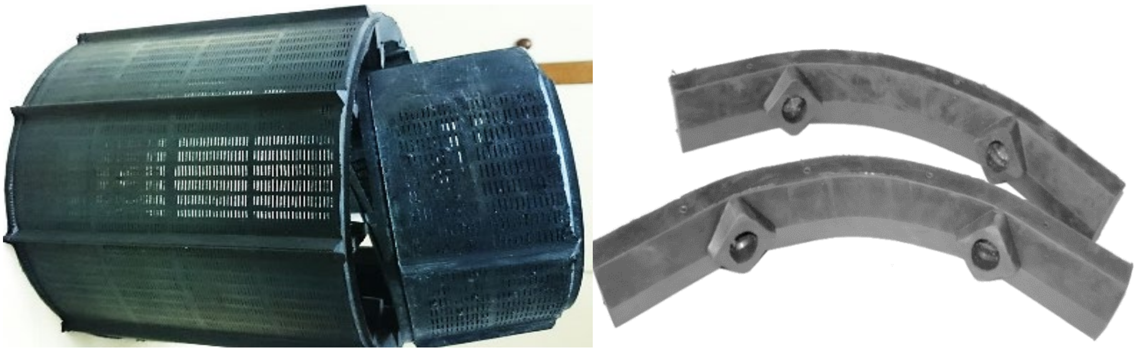


1 – drum-like screen; 2 is the forced cleaning system *Ramrod*; 3 – bottom tank; 4 – top tank; 5 – locking bar of the delivered material; 6 – pipeline to supply the material to a tank; 7 – pipeline to supply the material to a tank; 8 – overflow threshold pipeline; 9–10 – pumps; 11 – a drive of *Ramrod*; and 12 – loading device

Figure 3 – Arrangement of crucial components and mechanisms of the experimental closed power supply bench

A three-sectional laboratory drum-like screen (1) of an industrial type, equipped with the DABS and *Ramrod* with a transport spiral (2) is the basis of the experimental closed power supply bench. The screen (1) can control rotational frequency of the drum as well as its inclination angles to a horizontal axis. Materiel is supplied to the screen (1) through a loading device (12) and pipeline (7) from a top tank (4). A locking bar of the delivered material (5) controls coal slurry amount, fed to the screen. Screening products get to a bottom tank (3) intended to accumulate them and mix with the input slurry carrier. Drain throat of a bottom tank (3) is connected with centrifugal pump tube assemblies (9–10) helping supply the slurry to a top tank (4) equipped with a damper, and pipeline (8) to drain the clarified liquid to a bottom tank (3).

Sieving surface of the laboratory drum-like screen is the DABS with the slotted openings with 0.5×6-mm section assembled using a set of the certain screening components, with ring bearing bodies, and rubber lining elements to protect fixing areas of sieving components shaping directly the DABS, and locating on the metal frame of the screen drum case.



a b

Figure 4 – Sieving component forming DABS (a) and rubber lining elements of places where DABS parts are fixed to the screen drum (b)

The experiments applied movable procedure to fix FCS *Ramrod* with a transport spiral. The procedure has made it possible to rotate the elastic-stress deformed system with the specified frequency and in the specified direction within the rotating screen drum. The idea of the obtained mobility of the developed executive mechanism is as follows. The matter is that the elastic-stress deformed system with a transport spiral is connected with a drive placed beyond the rotating screen drum, and fixed within the loading device frame, which cannot prevent from the sieving process. The developed design of such a fixing involves the use of a flexible petal clutch, transmission shaft, and gear motor with the control rotation frequency of input shaft. In turn, the motor rotates cleaner of the drum-like screener in any direction, i.e. either synchronously with the rotation direction or asynchronously. Moreover, changes in the drive rotation velocity help rotate the cleaner in such a way either exceeding rotation velocity of the screener drum or falling behind it.

Owing to structural features of the designed movable cleaner with a transport spiral, its rotary-percussion action is performed throughout the screener drum length resulting in elastic deformation of sieving the DABS components. The abovementioned is followed by intensive scraping and pushing influence on the DABS openings from the multi-directional petals of the constantly rotating helical transport spiral. Hence, the rotary-percussion effects clean wasty and littery DABS openings of the screen drum out of such hardly graded boundary grain-size categories of solid components of the coal slurry.

According to the developed methods of the experiments, two stages of the integrated research have been carried out using the DABS of the laboratory drum-like screen with a movable DABS cleaner, involving transport spiral, installed inside the screen drum. 30 rpm and 40 rpm indicators of its corrected rotation frequency N_S have been tested to identify efficiency of technological parameters for fine screening of coal slurry E as well as dehydration degree of the finished product W.

The decision has been made before the experiments to mount the screen drum at an angle of 10°. The structural parameter has been selected since during operation, 8°

drum axis inclination is optimal for the majority of industrial drum-like screen. Considering that there is an obstacle for the graded material transportation inside the screen drum and it is not required to reduce screening output indicators in terms of input power supply, inclination angle of the screen drum axis was increased additionally by two more degrees. Hence, its final option was 100.

The key difference between the two experimental stages is the fact that in case one rotational directions of the sieving screen drum surface and rubber-rope rod of its movable cleaner mismatch, i.e. they rotate with the specified frequencies in opposite directions relative to each other. In case two, they match rotating in a unidirectional mode. In this regard, rotational directions of a screen drum and sieving cleaner of its surface are assumed to identify visually and indicate from outside of unloading share of a drum if the drum rotates clockwise.

Complexes of the two experimental stages were carried out while varying the drum-like screen output in terms of input power supply Q and rotational frequency of the screen drum N where the variations meant the following:

- fourfold 3–4 rpm progressive growth of the screen drum rotation indicators N took place for each of the experiments, i.e. from 30 rpm up to 40 rpm. The growth has been represented definitely in the form of such a parametric series as 30-33-36-40 rpm; and
- each experiment involved gradual threefold 15–30 t/h increase in the efficiency indicators according to the output power supply Q, i.e. from 25 t/h up to 70 t/h. The increase has been represented definitely in the form of such a parametric series as 25-40-70 t/h.

According to the processing algorithm of the obtained results as for definition of technological indicators of coal slurry fine screening as well as a dehydration degree of the finished product for each of the experiments was following sequence of actions:

a) entering the textual information on the distinctive features of the mechanical system ‘Cleaner -drum-like screen’ in a special ‘Observation log’;

b) taking the required number of samples (i.e. 6 pieces) from the obtained product of coal slurry sieving;

c) weighing of each of the selected samples, and their subsequent dehydration, i.e. dewatering with the help of the specific drying equipment;

d) screening on fractions, and the obtained ‘dry’ material weighing;

e) use of Microsoft Office Excel software program to compile electronic Table of the obtained experimental findings and their following mathematical and analytical processing; and

e) use of Microsoft Office Excel software program to plot graphical dependencies for the calculated efficiency indicators of coal slurry fine screening as well as dehydration degree of the finished product subject to operating conditions of the mechanical system ‘Cleaner-drum-like screen’.

The proposed algorithm to process the obtained experimental results has helped calculate and identify the most adequate operating conditions for the mechanical system ‘Cleaner-drum-like screen’.

At stage one of the experiments, visual observations of the key executive mechanisms of the movable mechanical system ‘Cleaner-drum-like screen’ during their multi-directional rotation, have made it possible to identify such basic distinctions of the system operation:

- the graded material (i.e. coal slurry) was lifted up and jumped by a cleaner and a drum-like screen. Upon that, the unfixed end of the cleaner rod, and upon gradual increase in the screen drum rotation being 30-33-36-40 rpm, was lifted up and jumped periodically within in the lower left quadrant of unloading opening of the drum-like screen towards rotational direction of the screen drum. Namely, it achieved 60°–65° angles if technological load was 25 t/h; 65°–85° angles if technological load was 40 t/h; and 89°–90° angles if technological load was 70 t/h;

- a technological load, being 70 t/h, demonstrated pronounced ‘waterfall’ mode of coal slurry movement inside the screen drum as well as an effect of its liquid component overflow (transfer) through the arched central part of the DABS cleaner rod (Fig.5);

Figure 5 – Waterfall mode of the wet material movement inside the screen drum rotating with a frequency of 40 rpm

- while rotating with the specified 30 rpm and 40 rpm frequencies, the cleaner raised ‘barriers’ between solid and liquid components of the coal slurry inside the screen drum. Moreover, it was constantly cleared the clogged and cluttered the DABS openings;

- the cleaner accelerated the graded material delivery to unloading opening of the screen. In addition, the material was actively mixed and loosened by the rubber petals, shaping the helical transport spiral of its rubber-rope rod.

At stage one of the experiments, visual observations of mechanisms of the movable mechanical system ‘Cleaner-drum-like screen’ during their one-directional rotation, have made it possible to identify the following:

- the graded material (i.e. slurry) was lifted up and jumped by a cleaner and a drum-like screen influenced by centrifugal force field. Upon that, the unfixed end of the cleaner rod, and upon gradual increase in the screen drum rotation being 30-33-36-40 rpm, was lifted up and jumped periodically within the lower left quadrant of unloading opening of the drum-like screener towards rotational direction of the screen drum. Namely, it achieved 450 - 50° angles if technological load was 25 t/h; 55°–75° angles if technological load was 40 t/h; and 80°–85° angles if technological load was 70 t/h;
- a helical transport spiral of the cleaner cleared away constantly the DABS openings from their sticking and blinding with wet particles of the coal slurry. Nevertheless, the process decelerated significantly the graded material movement to unloading opening of the screen drum;
- a cleaner distributed rationally a movable layer of the graded material inside the screen drum preventing from its potential accumulation.

It has also been defined the maximal raising boundaries of the unfixed rod end of the DABS cleaner within the lower left quadrant of unloading opening of the drum-like screen in terms of unidirectional and multi-directional rotations direction of the key executive mechanisms of ‘Cleaner-drum-like screen’ system (Fig.6). The difference between the maximum raising indicators of the unfixed rod end turned out to be minor in terms of the abovementioned rotations, i.e. 5° (while being 85° under unidirectional rotations).

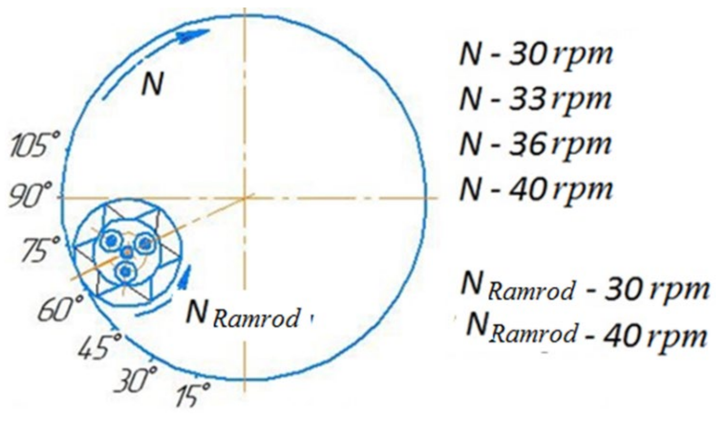


Figure 6 – The maximum raising boundary of the unfixed end of the cleaner rod within the lower left quadrant of unloading opening of the sieve under multi-directional rotations of cleaner and the screen drum

After the two experimental stages, analysing the operation of the mechanical system ‘Cleaner-drum-like screen’, terminated and the obtained results were processed, technological indicators of fine screening process of the finished product of coal slurry E, sized as +0.5, were identified. Microsoft Office Excel program has been applied to make calculations using the known formula [6]

$$E = \left|(\beta - \alpha)\cdot(\alpha - \theta)\cdot 10^4 \div \alpha \cdot (100 - \alpha)\cdot(\beta - \theta)\right| \%, \tag{2}$$

where α is undersize amount in the input material (%); β is undersize amount in the minus material (%); and θ is undersize amount in the plus material (%).

In addition, technological dehydration parameters of the finished fine screening product of the graded coal slurry (W) have been defined. Moreover, relying upon the weight of samples, they have been calculated using formula [7]

$$W = \left[(M_w - M_d)\cdot 100 \div M_w\right] \%, \tag{3}$$

where M_w is wet sample mass; and M_d is dry sample mass.

4. Results and discussion

Figures 7–10 demonstrate graphically dependencies of the obtained dehydration indicators of coal slurry sized as +0.5 mm W and its screening efficiency E upon the specified productivity values in terms of input power supply Q, and rotational frequency of the drum-like sieve N under multi-directional rotations of the mechanical system 'Cleaner-drum-like screen' where rotational frequency was 30 – 40 rpm.

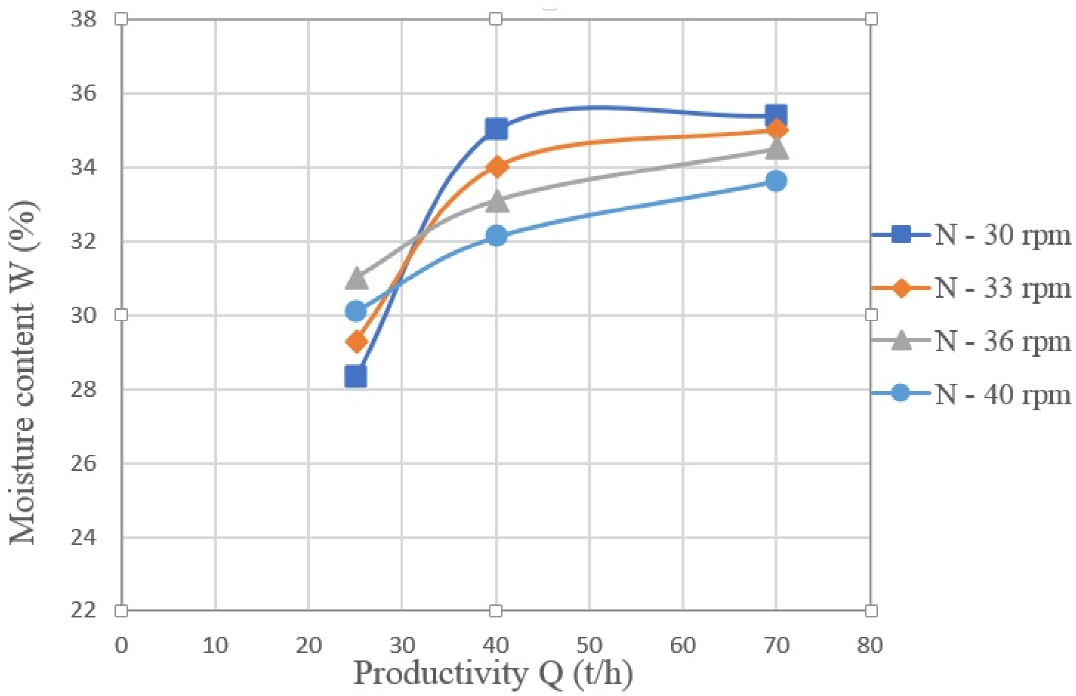


Figure 7 – Dependence of dehydration indicators of the finished product obtained from the graded slurry W upon the efficiency in terms of input power supply Q under multi-directional rotation of a cleaner and a drum-like screen N if rotational frequency of the cleaner is 30 rpm

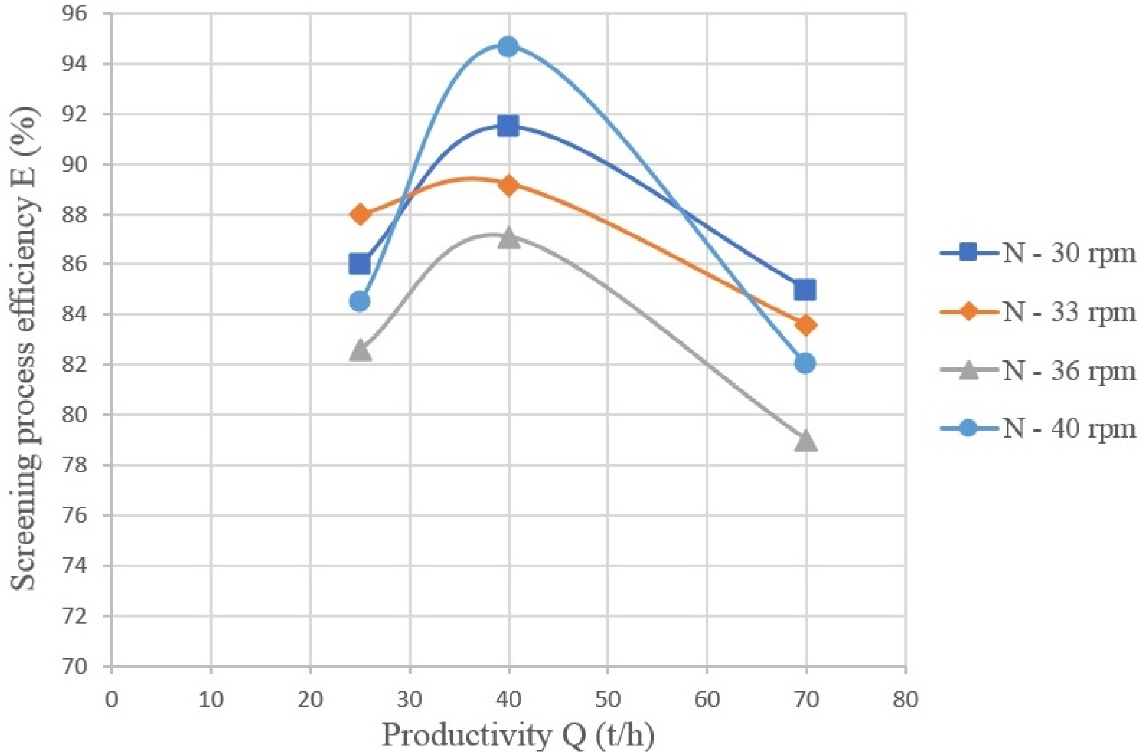


Figure 8 – Dependence of the screening efficiency indicators of the finished product obtained from the graded slurry E upon the productivity in terms of input power supply Q under multi-directional rotation of a cleaner and a drum-like screen N if rotational frequency of the cleaner is 30 rpm

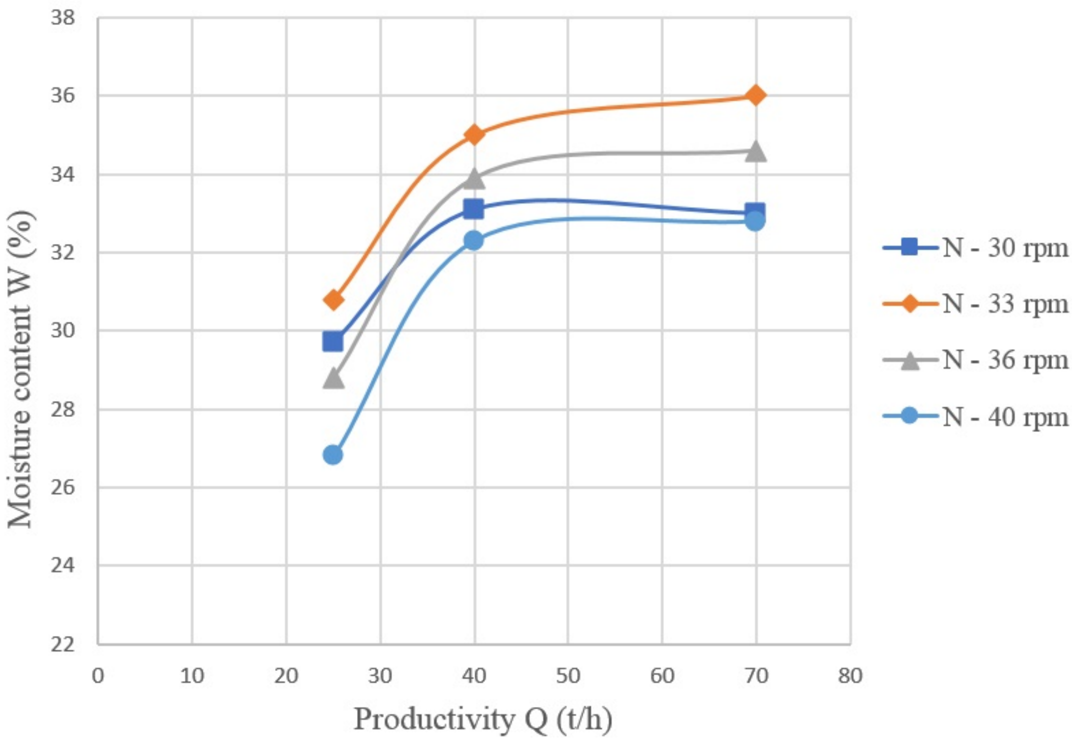


Figure 9 – Dependence of dehydration indicators of the finished product obtained from the graded slurry W upon the efficiency in terms of input power supply Q under multi-directional rotation of a cleaner and a drum-like screen N if rotational frequency of the cleaner is 40 rpm

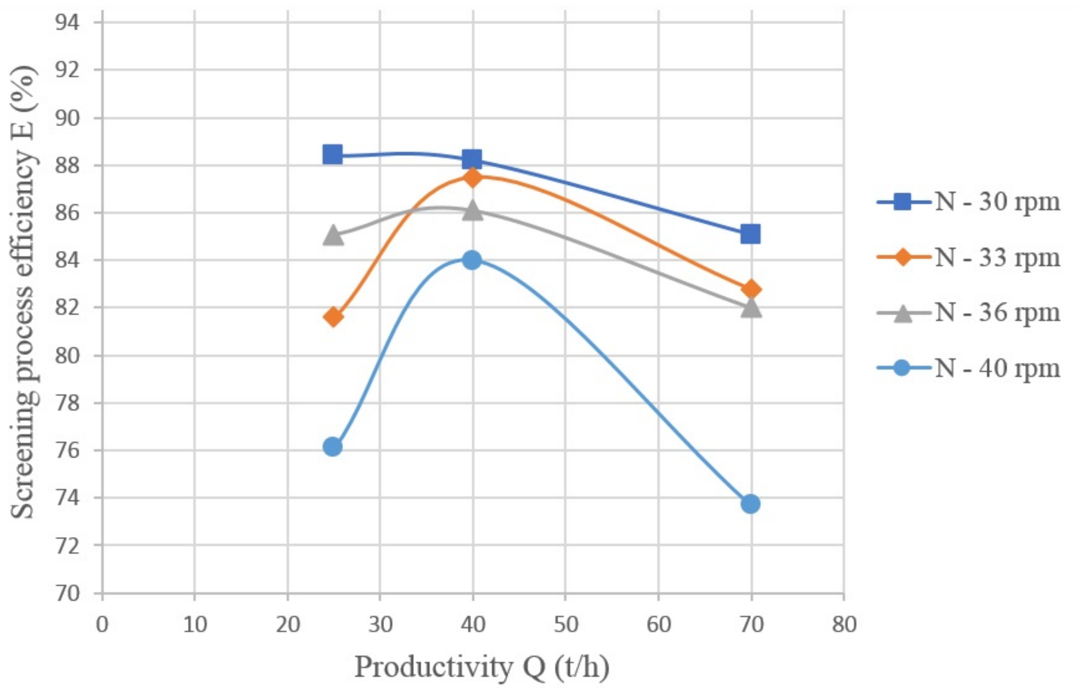


Figure 10 – Dependence of the screening efficiency indicators of the finished product obtained from the graded slurry E upon the productivity in terms of input power supply Q under multi-directional rotation of a cleaner and a drum-like screen N if rotational frequency of the cleaner is 40 rpm

According to Fig.7, under $\alpha_d = 10^0$ inclination angle of the screen drum axis and such technological parameters as N = 30 rpm being the drum rotation frequency, and Q = 25 t/h being the screen efficiency in terms of input power supply, the obtained minimal dehydration indicator of the finished product W is 28.3%.

According to Fig.8, under $\alpha_d = 10^0$, and such technological parameters as N = 40 rpm being the drum rotation frequency, and Q = 40 t/h being the screen efficiency in terms of input power supply, the obtained maximal efficiency indicator of the slurry fine screening in terms of the finished product E is 94.7%.

According to Fig.9, under $\alpha_d = 10^0$ inclination angle of the screen drum axis and such technological parameters as N = 40 rpm being the drum rotation frequency, and Q = 25 t/h being the screen efficiency in terms of input power supply, the obtained minimal dehydration indicator of the finished product W is 26.8%.

According to Fig.10, under $\alpha_d = 10^0$, and such technological parameters as N = 30 rpm being the drum rotation frequency, and Q = 25 t/h being the screen efficiency in terms of input power supply, the obtained maximal efficiency indicator of the slurry fine screening in terms of the finished product E is 88.4%.

Figures 11–14 represent graphically the dependencies of the obtained dehydration indicators of the finished product sized as +0.5 mm of the slurry W, and its screening efficiency E upon the specified productivity values in terms of the input power supply Q, and rotation frequency of the drum-like screen rotation N under unidirectional rotations of the mechanical system ‘Cleaner-drum-like screen’ where the cleaner rotation frequencies are 30 and 40 rpm.

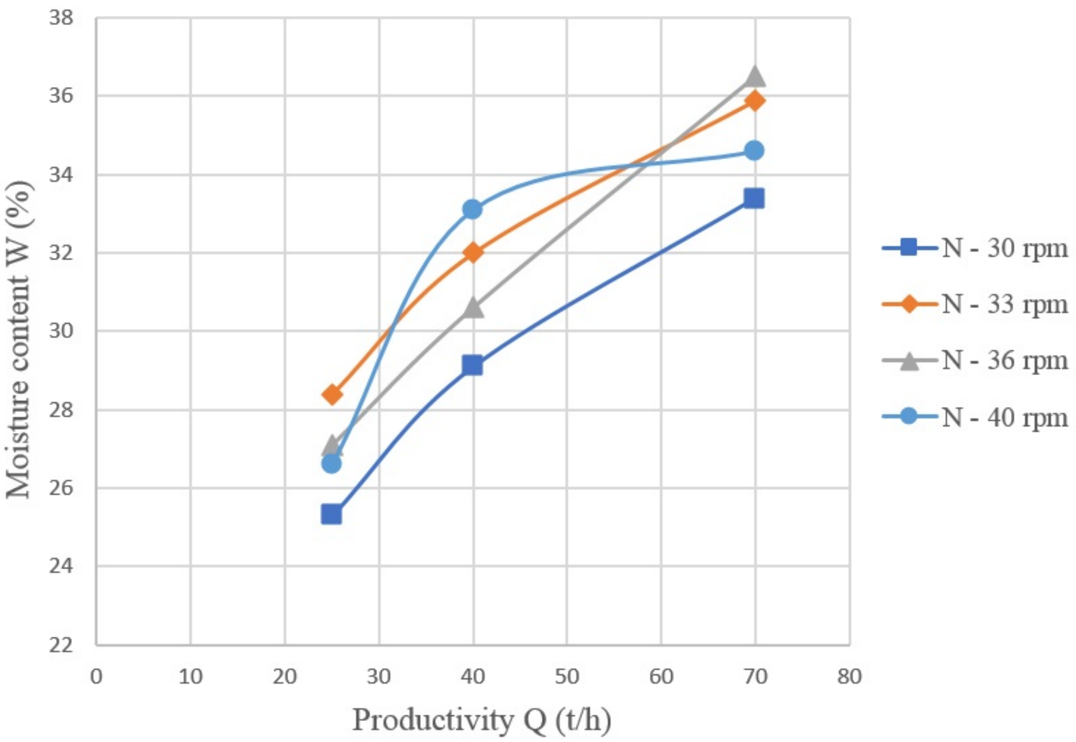


Figure 11 – Dependence of dehydration indicators of the finished product obtained from the graded slurry W upon the efficiency in terms of input power supply Q if rotation frequencies of a cleaner and a drum-like screen N coincide with 30-rpm cleaner rotation frequency

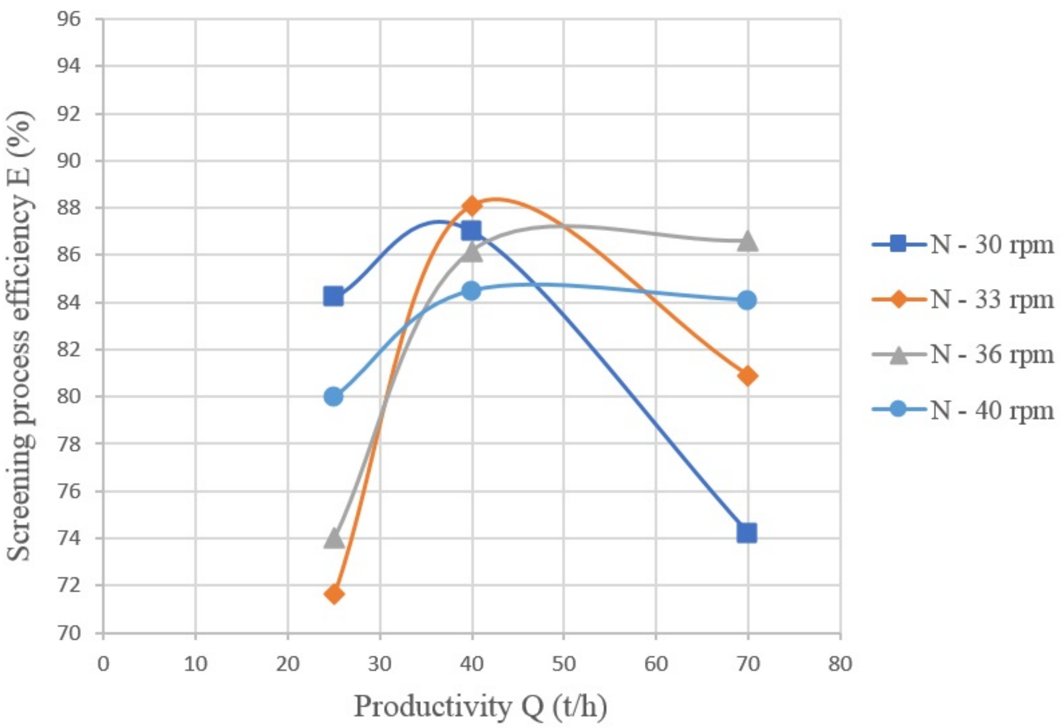


Figure 12 – Dependence of the screening process efficiency of the finished product obtained from the graded slurry E upon the efficiency in terms of input power supply Q if rotation frequencies of a cleaner and a drum-like screener N coincide with 30-rpm cleaner rotation frequency

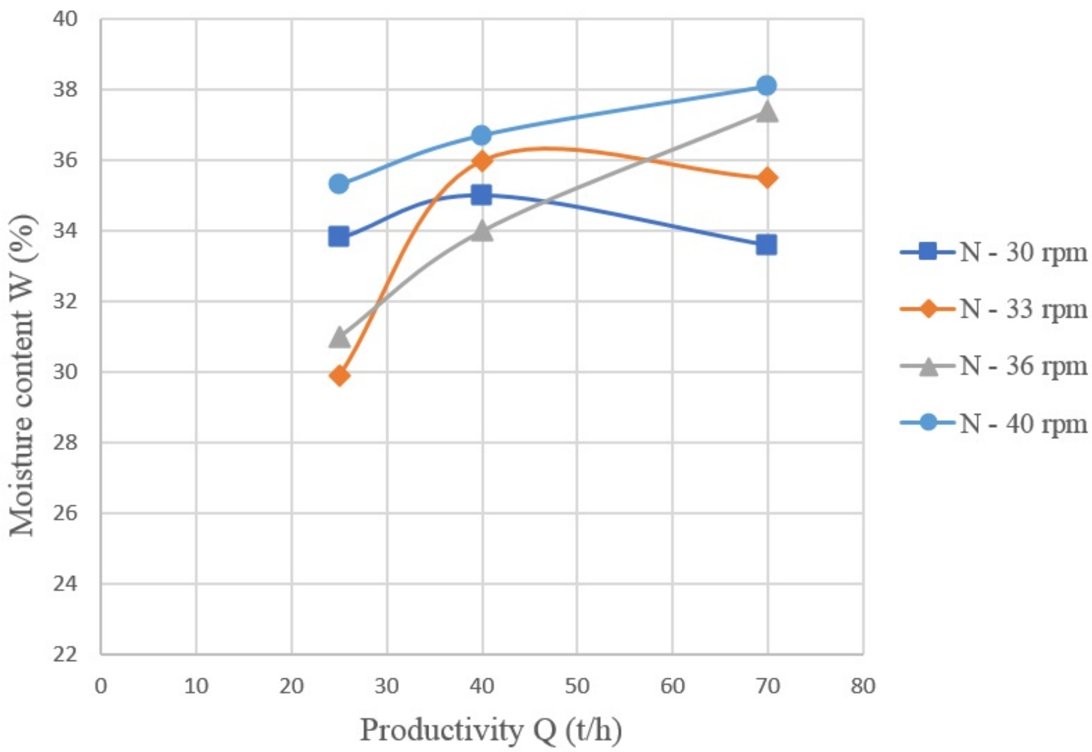


Figure 13 – Dependence of dehydration indicators of the finished product obtained from the graded slurry W upon the efficiency in terms of input power supply Q if rotation frequencies of a cleaner and a drum-like screener N coincide with 40-rpm cleaner rotation frequency

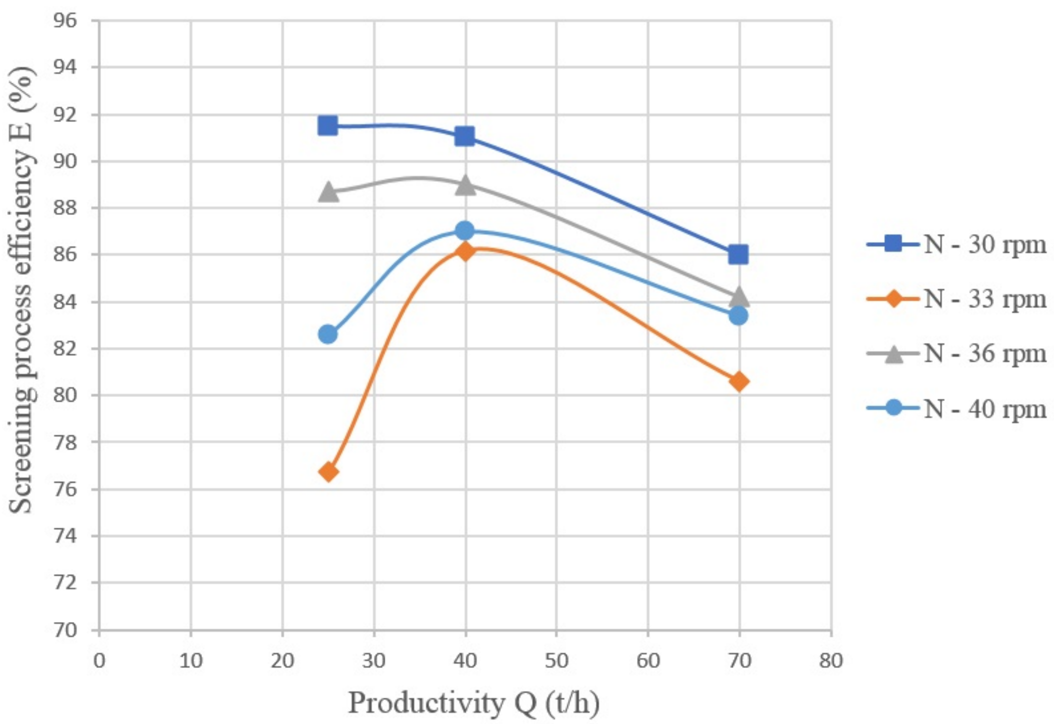


Figure 14 – Dependence of the screening process efficiency of the finished product obtained from the graded slurry E upon the efficiency in terms of input power supply Q if rotation frequencies of a cleaner and a drum-like screener N coincide with 40-rpm cleaner rotation frequency

According to Fig.11, under $\alpha_d = 10^0$ inclination angle of the screen drum axis and such technological parameters as N = 30 rpm being the drum rotation frequency, and Q = 25 t/h being the screen efficiency in terms of input power supply, the obtained minimal dehydration indicator of the finished product W is 25.3%.

According to Fig.12, under $\alpha_d = 10^0$, and such technological parameters as N = 33 rpm being the drum rotation frequency, and Q = 40 t/h being the screen efficiency in terms of input power supply, the obtained maximal efficiency indicator of the slurry fine screening in terms of the finished product E is 88.1%.

According to Fig.13, under $\alpha_d = 10^0$ inclination angle of the screen drum axis and such technological parameters as N = 33 rpm being the drum rotation frequency, and Q = 25 t/h being the screen efficiency in terms of input power supply, the obtained minimal dehydration indicator of the finished product W is 29.9%.

According to Fig.14, under $\alpha_d = 10^0$, and such technological parameters as N = 30 rpm being the drum rotation frequency, and Q = 25 t/h being the screen efficiency in terms of input power supply, the obtained maximal efficiency indicator of the slurry fine screening in terms of the finished product E is 91.5%.

Henceforth, to improve operation by the mechanical system ‘Cleaner-drum-like screen’, it is proposed to use flexible bellow coupling as a connector between elastic cleaner rod and its controlled drive instead of the traditional petal coupling. The reason is that the former is aimed at the torque transfer with the possibility to compensate arising misalignment and prevent from radial beat of the output shaft of the reduction motor. Moreover, to control operational efficiency of the structural components, forming the mechanical system ‘Cleaner-drum-like screen’ it is proposed to monitor periodically both density and granulometric composition of the graded input solid material, i.e. slurry. The abovementioned will help respond quickly under potential changes and correct an operating schedule of the mining and processing equipment if required.

5. Conclusions

The experiments, carried out using the developed bench of the closed power supply cycle, and laboratory industrial drum-type screen with continuous delivery of input material, equipped with the DABS as well as the forced cleaning system «*Ramrod*» with a transport spiral having ‘active’ (i.e. movable) type of its fixing to the drum-time screen frame, have made it possible to identify the following. Regulation of structural parameters (i.e. inclination angle of the screen drum axis) as well as operating conditions (i.e. slurry density; rotation frequency of the screen drum; and efficiency in terms of input power supply) may help achieve rational technological indicators of sieving, dehydrating, and disintegrating of the slurry-like mixtures.

It has been defined that the higher frequency of the screen drum frequency is the more arising centrifugal forces influence on the graded material. Moreover, they also favour active dewatering of the obtained product, and improve the efficiency of the screening process. In addition, the experiments have demonstrated high cleaning

DABS degree owing to the use of mobile elastic-stress deformed system of the forced cleaning. Among other things, the mentioned transport spiral helps preserve the initial DABS clear area, which results in the improved sieving, dehydrating, and disintegrating indicators.

The cleaner with a transport spiral, intended to clear away openings of surfaces of sieving drum-like screens, mounted with the possibility to regulate its rotations within industrial screeners as part of manufacturing chains of preparation plants within the new mechanical system ‘Cleaner-drum-like screen’ is recommended for industrial use in a mode of multi-directional rotating movements of the abovementioned executive devices. Namely, the experiments, carried out in the mode of multi-directional rotating displacements of executive devices within the ‘Cleaner-drum-like screen’ system, have helped understand the following:

- to obtain more than 90% efficiency indicators of fine screening of coal slurry, it is required to provide the use of the identified rational structural and technological parameters of its operation: α_d = 10° inclination angle of a sieve drum; w = 30 rpm rotation frequency of DABS; N = 40 rpm rotation frequency of the screen drum; and Q = 40 t/h efficiency in terms of input power supply; and
- to obtain less than 30% dehydration indicators of plus (i.e. the finished) product of coal slurry, it is required to provide the use of the identified rational structural and technological parameters of its operation: α_d = 10° inclination angle of a sieve drum; w = 40 rpm rotation frequency of DABS; N = 40 rpm rotation frequency of the screen drum; and Q = 25 t/h efficiency in terms of input power supply.

It is necessary to assemble the cleaner with a transport spiral into a single elastic rod using similar mutually fixed rubber components being elastic stoppers stringing on three transverse metal ropes equidistant from each other and from the central rope, and making elastic-stress deformed state of the rod (where tension of the transverse ropes should be analogous) while pulling the ropes. Moreover, camber state of the shaped elastic rod should be excluded, and its resistance to bending deformations should be achieved. In addition, linear deformation indicators of the rubber rod of the cleaner along its longitudinal axis should be 4.2–4.6% of its initial length.

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ТОНКЕ ГРОХОЧЕННЯ ВУГІЛЬНИХ ПУЛЬП В АГРЕГАТАХ БАРАБАННОГО ТИПУ НА ГУМОВИХ СИТАХ ДИНАМІЧНО АКТИВНИХ СТРІЧКОВИХ, ЯКІ ВЗАЄМОДІЮТЬ З ЕЛАСТИЧНИМИ ПРУЖНО-НАПРУЖЕНИМИ СИСТЕМАМИ

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Анотація. Проведено комплекс лабораторних досліджень, який дозволив встановити закономірності тонкого грохочення і зневоднення вугільної пульпи на ситі динамічно активному стрічковому барабанного грохота і виявити раціональні режимні і конструктивні параметри очищувача отворів сита динамічно активного стрічкового, який слугує для покращення показників грохочення і зневоднення вугільної пульпи, і який в своїй роботі використовує виникаючі відцентрові сили. Для виконання розробленої програми лабораторних досліджень створений експериментальний стенд з замкнутим циклом живлення, з лабораторним барабанним грохотом, оснащеним ситом динамічно активним стрічковим і пружно-напруженою деформованою системою примусового очищення отворів сита динамічно активного стрічкового – система примусового очищення «Шомпол» з транспортуючою спіраллю, а також розроблена методика проведення даних досліджень. Наведено результати експериментів, в ході яких оцінювалася можливість високоякісного виділення рідкої фази з пульпоподібної суміші на ситі динамічно активному стрічковому, з використанням в якості очищувача її отворів системи примусового очищення «Шомпол» з транспортуючою спіраллю. На підставі виконаних експериментальних досліджень, встановлено вплив даного рухомого очищувача з транспортуючою спіраллю, а також вплив конструктивних і технологічних параметрів барабанного грохота на процес відділення рідкої фази з вугільної пульпи, яка класифікується по крупності +0,5 мм. Експериментальні дослідження показали, що високі показники ефективності процесу грохочення вугільної пульпи і низький відсоток вологи в отриманому готовому продукті, забезпечуються раціональним співвідношенням продуктивності по вхідному живленню, кутом нахилу барабана грохота, а також частотою та напрямком обертання розробленого очищувача отворів сита динамічно активного стрічкового, що створює такий режим руху вугільної пульпи по даному ситу барабана грохота, що обертається, при якому максимально задіяний вплив виникаючих відцентрових сил. Використання розробленого очищувача отворів сита барабанного грохота з транспортуючою спіраллю дозволяє ефективно вирішувати проблеми високопродуктивного вивантаження вологих та схильних до злипання матеріалів, які класифікуються в агрегатах барабанного типу. Таким чином будуть забезпечені можливості та передумови для створення обладнання, в якому поєднуються процеси попереднього зневоднення і знешламлювання грохоченням, а також остаточного зневоднення на центрифугах.

Ключові слова: ефективність процесу грохочення, вугільна пульпа, пружно-напружена деформована система «Шомпол» з транспортуючою спіраллю, барабанний грохот, сито динамічно активне стрічкове.