УДК 621.926.5

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CAPACITY AND POWER EFFICIENCY DETERMINATION FOR CONCRETE MIXERS OPERATING IN CASCADE MODE

The paper contains a presentation of the concrete mixer operating in the cascade mode with their primary sides of the constructions. There is a description of their operating principle. Obtained dependencies are provided for determination of capacity and power expenditures of these machines.
The characteristic curves of concrete mixer's efficiency operating factors are given as of the specified work process-related parameters with identification of their rational values range. Practicability is specified as for the three-shaft concrete mixer and concrete mixer with gravity and forced action in the construction industry.
Key words: Three-shaft concrete mixer, power, concrete mixer, shoulder, torso, shaft, cascade mode.

Introduction. Low balancing capacity both at macro level and micro level is a major disadvantage in the work of the concrete mixers in operation. The working bodies in the existing horizontal-shaft mixers (single-shaft and twin-shaft) combine two operations: loadable components mixing and prepared concrete mixtures transportation to the unloading point from the machine casing. As a result, these mixing plants operate on a principle close to displacement, and mixing occurs mainly in the cross section of machine operating space, i.e. the volume, in which intensive mixing occurs, makes up a small part of the mixer, due to its low balancing capacity at the macro level. Low balancing capacity at the micro level stems from the fact that there is no sufficient destruction of small agglomerates consisting of the mortar component's particles [1-10].

Results. New approaches are required to enhance operating efficiency of the existing and working concrete mixers when creating these machines. From these positions, a group of concrete mixers brings itself to attention, which operates in the cascade mode, developed at the Department of mechanization of construction processes of the Kharkiv National University of Civil Engineering and Architecture.

This principle of concrete mixers operation allows to receive the highly-homogeneous mixtures of different assignment, in particular, fibre-concrete and polystyrol -concrete. The key point in this principle is in the following: there is cascade displacement of the mixture particles in the working space along the entire machine length of its case, which allows its axis motion when the coefficient of charge increased $K_{зо}$=0,7…0,75. The cascade operation mode of the mixing plant enables to apply two principles in the process of components mixing to full mixture readiness: gravitational and forced mixing. High degree of prepared mixtures homogeneousness in the cascade mode is reached due to the free sedimentation of the mixture particles from above the shoulders of the rotating case and following their forced lifting up by means of the shoulders of the inversely rotating horizontal shaft set in this case [11, 12].

This operation mode is peculiar for concrete mixers of new constructive solutions being granted with the Ukrainian patents. Three-shaft concrete mixer (Fig. 1 a) [13] and concrete mixer of gravitationally forced action (Fig. 1 б) [12, 14] have passed evaluation tests in factory environment. Their technical features are provided in the Table 1.

As compared to operating, the mixing plants, functioning in the cascade mode, as it is demonstrated by the conducted tests in factory environment, allow to:

– sufficiently decrease time for the process of mixture preparation and combine it with the activation process;

– lower specific quantity of metal, reduce dimensions;

– broaden the range of highly-homogeneous prepared mixtures.

The mixing efficiency has been assessed by the compression capacity indexes and degree of prepared mixtures homogeneousness. The machines (Fig.1) were used to prepare high-flow and low-slump concrete mixtures, fibre-concrete and self-consolidating mixtures, dry and with polystyrene fillers. The structural features of these machines are provided below.

Fig. 1. Concrete mixers operating in cascade mode a) three-shaft; b) with gravity and forced action

Table 1 - Technical feature of concrete mixers operating in cascade mode

Index	Three-shaft concrete mixer	Concrete mixer with gravity and forced action
Capacity, m³/ h	4.0...4.5	4.0...4.5
Upper limit size of filler, mm	10	10...20
Shafts rotating frequency, min^{-1}	47...65	50...60 15...20
Engine power, kW	5,5	4,0
Dimensions, mm: length width height	 1500 576 1200	 1400 600 130
Mixing plant mass, kg	380	140

Three-shaft concrete mixer (Fig. 1a) is equipped with a working body consisting of the lay-shafts set to an angle of 18^0 to the horizontal surfaces. The circuit diagram of this machine is provided on the Fig. 2 [11, 13, 15, 16], and its working body in the form of three lay-shafts on the Fig. 2 b.

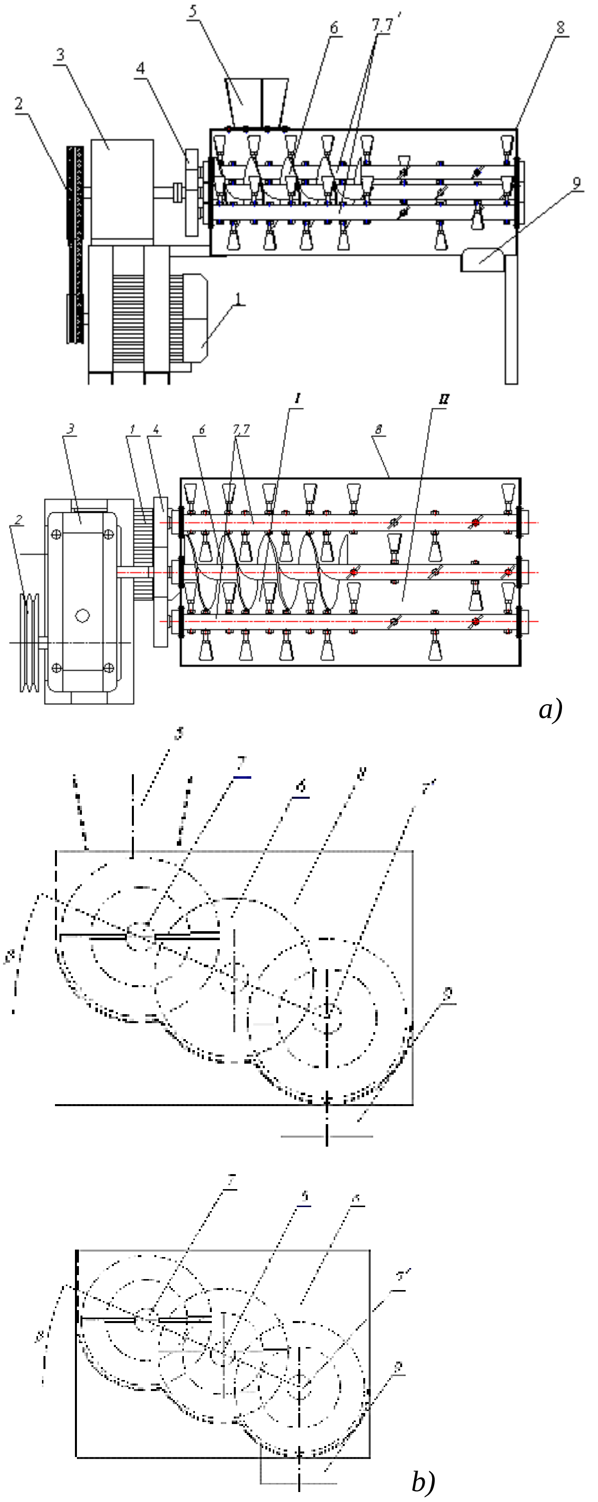


Fig. 2. Circuit diagram of three-shaft concrete mixer: a) three-shaft concrete mixer; b) shafts location in the mixing plant case; 1 – engine; 2 – V-belt transmission; 3 – reduction gear; 4 – open gear set; 5 – feed hopper; 6 – auger-type shaft; 7,7′ – top and bottom shoulder shafts; 8 – concrete mixer case; 9 – discharge sleeve

The shafts are installed at the angle of β vertically. The axes of all shafts are parallel in the horizontal plane.

The mixing plant operates as follows. Dry-weighed concrete materials – concrete. sand and crushed stone are fed to the left zone of the concrete mixer 8 through the feed hopper 5 being grasped by the shoulders of the top shaft 7 and partially mixing they got into the area of auger shaft action 6, from where the mixture components are drawn into the lower operation zone of the shoulder shaft 7' by means of the shoulders fixed on it. Apart from radial motion, the particles of dry concrete mixture are displaced longwise towards the mixing plant's discharge sleeve. Water is supplied to the right zone of the mixing plant and in a result of three shafts 6, 7, 7', there is a final mixing of the constituent mixture components along the crossing circle paths in the horizontal and vertical planes. Ready-made mixture is unloaded by means of shoulder shaft 7′ through the discharge sleeve 9 (Fig. 2. a, b).

The concrete mixer of gravitational and forced action (Fig. 3) [7-9, 11, 14] consists of a bowl shaped case with shoulders mounted to its inside surface, which are installed in rows on perimeter along all its length. Horizontal shaft is placed inside the case with its shoulders fastened on it down the circular helix. The mixing plant's case and shoulder shaft rotate contrariwise.

Thus, structural features of both gravitational concrete mixer and one of forced action as well are used in these machines.

The concrete mixer of gravitational and forced action functions as follows. Run on electric motor 1 through V-belt drive 2 passing torque moment to the reduction gear 5. In its turn, from the reduction gear shaft 5 through the coupling 7, the horizontal shaft 17, with shoulders 18 fastened on it, starts to rotate. Run on electric motor 3 through V-belt drive 4 passing torque moment to the reduction gear 6. Then, the torque moment from reduction gear 6 through the coupling 8 rotates the concrete mixer case 14 by means of chain transmission. The cover 15 is attached to the concrete mixer 14 overlapping charge-discharge machine hole and, if required, is opened or closed.

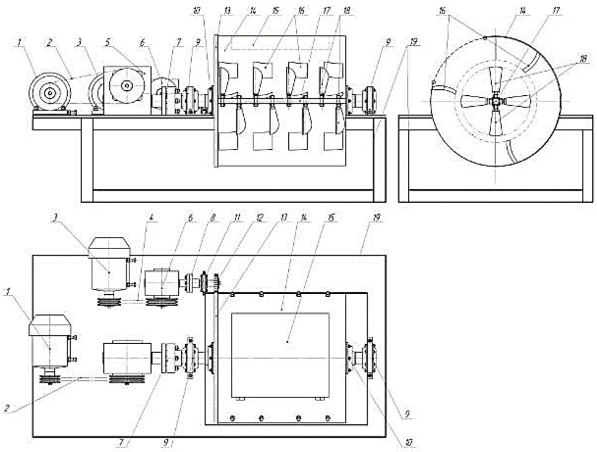


Fig. 3. Circuit diagram of concrete mixer of gravitational and forced action
1, 3 – electric motors; 2, 4 – V-belt drive; 5, 6 – worm reduction gearbox; 7, 8 – pin bush coupling; 9 – thrust rollers; 10 – bearing joints; 11 – star gear holder spring ; 12 – star gear; 13 – chain; 14 – case; 15 – cover; 16 – case shoulders; 17 – shaft;18 – shaft shoulders; 19 – concrete mixer frame

The primary components of the construction mixture are fed into the working space of the mixing plant with attached to it shoulders and rotating at this time horizontal shoulder shaft. When the case shoulders of the mixing plant rise the top part of the working machine space when rotating, the mixture particles freely come down from their surfaces getting into the shoulders of the rotating shaft being installed towards the case shoulders. The mixtures again, this time by force, fall dawn the shoulders of the rotating machine case from the shoulders of the shaft, and the process of their motion is repeated. This motion of the particles in the mixing plant's working space between left and right end walls ensures cascade mode of the machine.

Capacity and power are the principle operation factors of the above mentioned mixing plants.

For the three-shaft concrete mixer (Fig.1 a) these factors are defined as follows [15, 16]:

– capacity:

$$\Pi_{mex} = 3600 \cdot \frac{\pi}{4} \cdot (D^2 - d^2) \cdot b \cdot n \cdot z_{л} \cdot \sin\alpha \cdot \kappa_з^{ср} \cdot \kappa_в^{II}, \text{ m}^3\text{/h}, \quad (1)$$

where D – diameter over the end of centre shaft's shoulder rotation, m; d – centre shaft diameter, m; b – shoulder width, m; n – rotation frequency of centre shaft, c^{-1}; $z_л$ – quantity of centre shaft's shoulders; α – shoulder angle of attack, degree; $k_з^{ср}$ – mixing plant loading coefficient against centre shaft; $k_в^П$ – mixture reset coefficient in the right zone of mixing plant.

– power:

$$P = \left[\begin{array}{l} W_{11} \cdot n \cdot z_л \cdot к_{зап} + \dfrac{W_1 \omega}{2\pi} + \dfrac{W_3 \omega}{2\pi} + \\ + \dfrac{c_1 \rho_1 S_{ср}^3 \omega^3 k_з^{ср} Z_ш (D_ш^2 - d_ш^2)}{32\pi^2 k_в^1} + \\ + \dfrac{k_2 \pi c_1 \rho_1 x_1 \omega^3 f_1 Z_ш tg\alpha_{ср} \sin\alpha_{ср} (D_ш^5 - d_ш^5)}{80 k_в^1} \end{array} \right] \cdot \frac{\lambda}{\eta \cdot 1000}, \quad \text{kW}, \qquad (2)$$

where W_{11} – work spent on creation of concrete mixture components cascade motion from the top shaft to the action zone of centre shaft; $к_{зап}$ – filling space coefficient between the shoulders; W_1 – total energy spent for mixture components agitating by top shoulder shaft for one turnover; c_1 – tractive resistance coefficient when mixing dry components of the concrete mixture in direction to its motion around the circumference; ρ_1 – average density of dry mixture, kg/m^3; $S_{ср}$ – screw pitch over its mid-diameter, m; $Z_ш$ – quantity of shoulders on the centre shaft; $D_ш$ – screw outer diameter, m; $d_ш$ – centre shaft diameter, m; $k_в^1$ – mixture reset coefficient in the mixing plant left zone; $\alpha_{ср}$ – lead angle over the screw mid-diameter; W_3 – total energy spent for mixture agitation by bottom shoulder shaft per one turnover, J; λ – coefficient considering supplementary energy losses for internal friction of mixture particles and filler crushing; η – coefficient of mixing plant drive efficiency.

For the concrete mixer of gravitational and forced action (Fig. 1б, 3), capacity and power are defined in accordance with the following equations [15, 17]:

– capacity:

$$П_{техн} = \frac{1}{2}[\pi \cdot L_к (R_к^2 \cdot k - r_в^2) - \pi \cdot r_н^2 \cdot l_н \cdot z_н - \\ - z_1 \cdot b_1 \cdot h_1 \cdot c_1 - z_2 \cdot b_2 \cdot h_2 \cdot c_2] \cdot Z_Ц \cdot \rho_0, \qquad (3)$$

where $L_к$ – is a length of mixing pant case, m; $R_к$ – mixing plant case radius, m; k – coefficient considering mixture position with the case; $r_в$ – shaft radius, m; $r_н$, $l_н$, $z_н$– respectively radius, length of shaft shoulder roots and their quantity, m; z_1, b_1, h_1, c_1– respectively quantity, length, height and width of mixing plant case shoulders, m м; z_2, b_2, h_2, c_2 – respectively quantity, length, height and width of mixing plant shaft shoulders, m; $Z_Ц$ – amount of machine operation circles per hour; ρ_0 – average density of concrete mixture, kg/m^3.

– power:

$$N_{СМ} = \frac{0{,}85 \cdot G_{см} \cdot h \cdot Z \cdot \omega_к + F_{тр.к} \cdot V_{абс.к} \cdot z_1}{\eta_к \cdot 1000} + \\ + \frac{\omega_в \cdot M_в + F_{тр.в} \cdot V_{абс.в} \cdot z_2}{\eta_В \cdot 1000}, \quad kW, \qquad (4)$$

where $G_{см}$ – is concrete mixture weight lifted under the action of frictional forces, N; h – vertical displacement coordinate of mixture mass in the case, m; Z – quantity of mixture circulations in the machine case; $\omega_к$ – angular velocity of mixing plant case rotation, c^{-1}; $F_{тр.к}$ – frictional force of material occurred when concrete mixture particle are displaced along the surface of the shoulder case of the mixing plant, H; $V_{абс.к}$ – absolute speed of mixture particles motion along the case shoulder, m/s; $\eta_к$ – coefficient of case drive efficiency; $\omega_в$ – angular velocity of shoulder shaft rotation, c^{-1}; $M_в$ – torque moment of shoulder shaft, N·m; $F_{тр.в}$ – frictional force occurred during concrete mixture particles motion along the shoulder surface, N; $V_{абс.в}$ – absolute speed of concrete mixture particles motion along the shoulder shaft, m/s; $\eta_в$ – coefficient of shaft drive efficiency.

The following indexes characterizing the operation of three-shaft concrete mixer are accepted:

– concrete mixture homogeneity (*f*, %);

– concrete mixer capacity (P, m^3/h);

– power expenditures for concrete mixture preparation, (P, kW);

– time required for concrete mixture preparation, (t, s).

The following is considered as factors influencing upon the concrete mixer operation:

– rotation frequency of the shafts (n, min^{-1})

– attack angle of the shoulders first zone (α_1, degrees);

– shoulder surface (form) area (S, cm²);

– water-cement ration (W/C);

– angle of working bodies position against the horizontal (β, degrees);

– quantity of shoulders (pcs);

– attack angle of the shoulders second zone (α_2, degrees);

The dependencies of operational efficiency factors of three-shaft concrete mixer on the above mentioned factors are demonstrated in the charts, Fig. 4-10.

Equations given above make it possible to define the rational values of basic operational parameters of the three-shaft concrete mixer when preparing low-slump concrete mixtures (P = 2-4 cm).

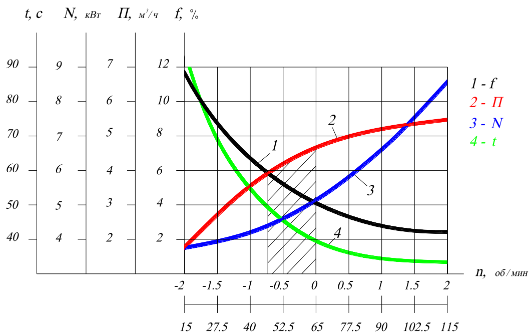


Fig. 4. Dependencies of concrete mixer's operational efficiency factors on rotational frequency of the working body

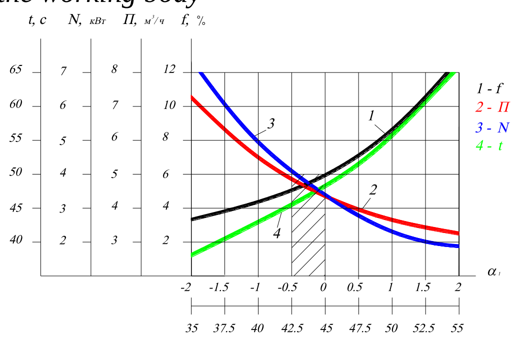


Fig. 5. Dependencies of concrete mixer's operational efficiency factors on a shoulders angle of attack in the left zone

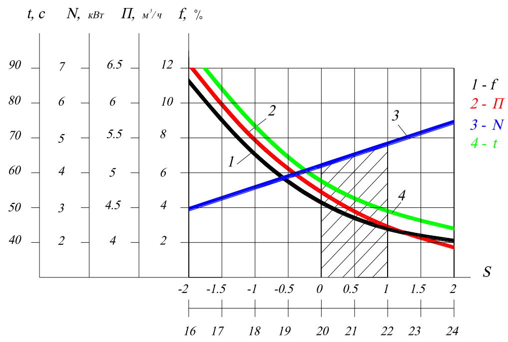


Fig. 6. Dependencies of concrete mixer's operational efficiency factors on the shoulder area

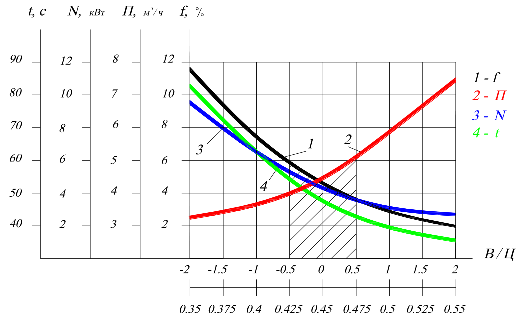


Fig. 7. Dependencies of concrete mixer's operational efficiency factors on the water-cement ratio

Homogeneity dispersion at the output makes up *f* = 5.2–7.3 %, concrete mixer capacity P = 4.2–4.8 m³/h, power consumption for concrete mixture preparation comprises N = 4.9–6.1 kW, mixing time t = 44–53 s. The homogeneity dispersion value of the concrete mixture samples in comparison with two-shaft concrete mixers used for preparation of low-slump concrete mixtures has improved to 2–4%. As expected, the power expended is reciprocally proportional to water-cement ratio of prepared mixture, i.e. the lower consistency of concrete mixture, the higher power consumption is.

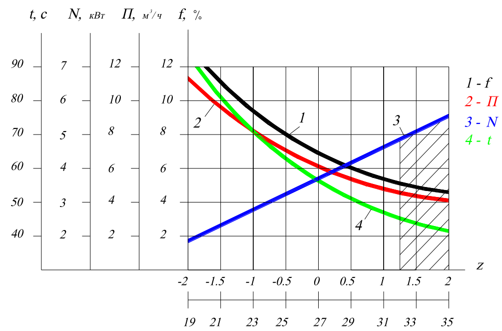


Fig. 8. Dependencies of concrete mixer's operational efficiency factors on the shoulders quantity

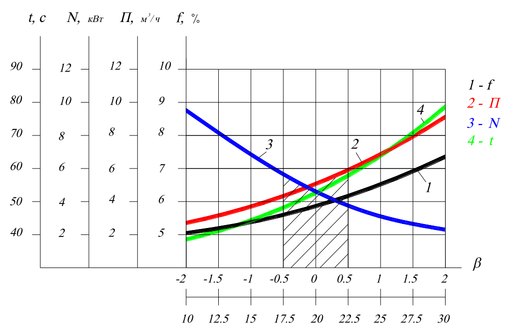


Fig. 9. Dependencies of concrete mixer's operational efficiency factors on slope angle of the working body

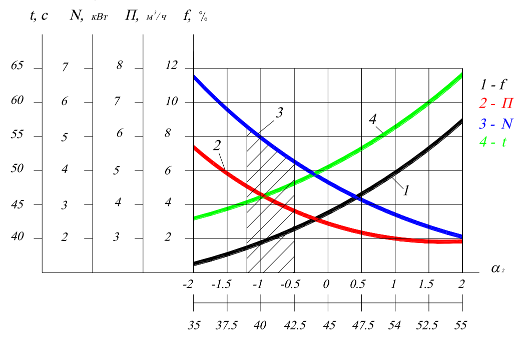


Fig. 10. Dependencies of concrete mixer's operational efficiency factors on a shoulder slope angle of the right zone mixer

From dependencies of the concrete mixer capacity on the water-cement ration it is seen that with its increase in the capacity rises steeply, what is explained by the mixture agility growth, internal friction force decrease and mixture components friction on the case surface of the mixing plant and working body of the concrete mixer. Under these circumstances, preparation time for low-slump concrete mixture makes up t = 44–55 s, whereas, in two-shaft concrete mixers time to prepare low-slump concrete mixtures comprises (P = 2–4 cm) t = 60–65 s. The most favorable conditions for three-shaft concrete mixer for preparation of low-slump concrete mixtures have been obtained under: working body rotation frequency to be n=47–65 rpm, attack angle of the left zone shoulders α_1=42–45°, the quantity of the shoulders z=32–35 pcs, slope angle of the working body against the horizontal planeβ=17–22°, water-cement ratio W/C=0.4–0.43, attack angle of the right zone shoulders α_2=39–42°, shoulders form (expressed via their area) S=20–22 cm².

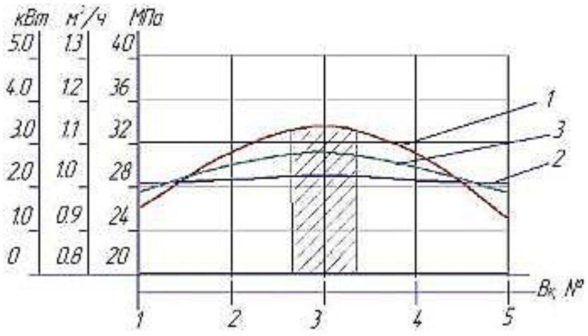
Rational process parameters for efficient operation of the concrete mixer of gravitational and forced action are defined in a result of multi-factor planned experimental set up. The following is accepted as indexes characterizing the operation of this concrete mixer:

- concrete compression capacity, ($R_{ст}$) MPa;
- concrete mixer capacity, (P) m³ / h;
- power expenditures for concrete mixture preparation process, (N) kW.
- The indexes of concrete mixer operation were defined under the following factors:
- installation diagram of the shoulders on the case ($B_К$)
- installation diagram of the shoulders on the horizontal shaft ($B_В$)
- rotation frequency of the case ($n_К$, min^{-1});
- rotation frequency of the shoulder shaft ($n_В$, min^{-1});
- space factor ($K_{зо}$)
- time to prepare mixture (t, s);
- water-cement ration (W/C).

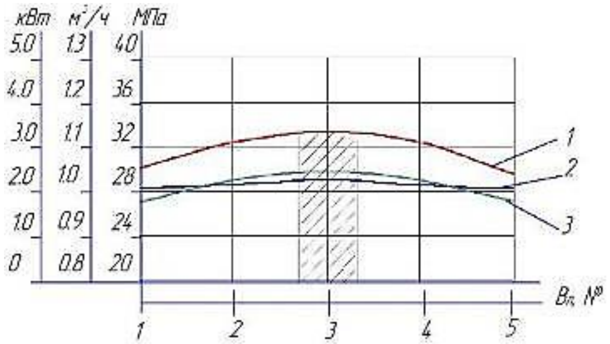
The dependencies of operational efficiency factors of the concrete mixer on the above mentioned factors are demonstrated in the charts, Fig. 11.

Analysing the characteristic curves (Fig. 11 a,b,c, d) it can be said that the nature of the curves attests to the fact that selected ranges of the investigated parameters are close to the conditions of preparation process of qualitative concrete mixtures. The numerical values of the characteristic curves of capacity and power expenditures from the space factor, time for mixture preparations and water-cement ratio practically coincide with the calculation data of these indexes as to previously mentioned theoretical dependencies. Discrepancy makes up not more than 3...5%.

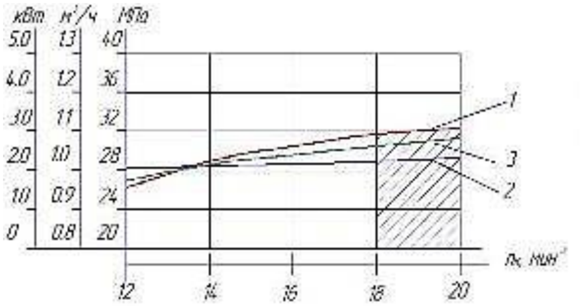
Rational process variables have been defined after conducting the experimental investigations.



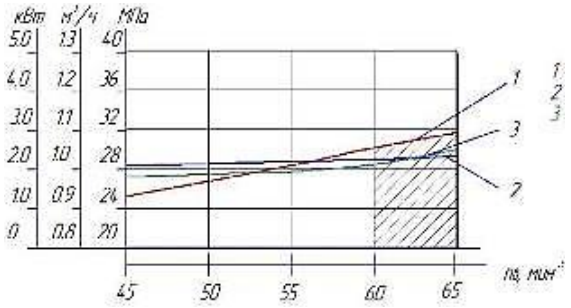
a) $n_к=16$ хв$^{-1}$; $n_в=55$ хв$^{-1}$; $К_{зо}=0.5$; $t=75$ с; $W/C=0.45$



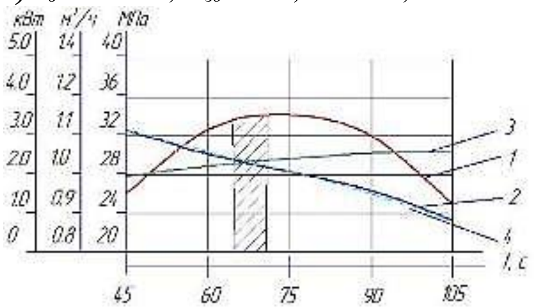
b) $n_к=16$ хв$^{-1}$; $n_в=55$ хв$^{-1}$; $К_{зо}=0.5$; $t=75$ с; $W/C=0.45$



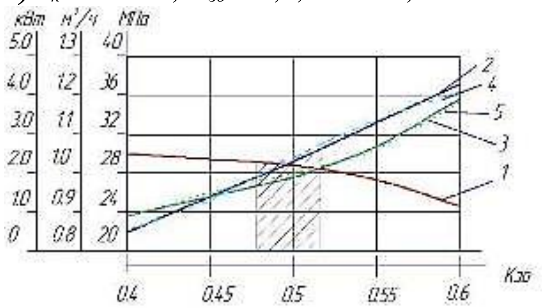
c) $n_в = 55$ хв$^{-1}$; $К_{зо} = 0.5$; $t = 75$ с; $W/C = 0.45$



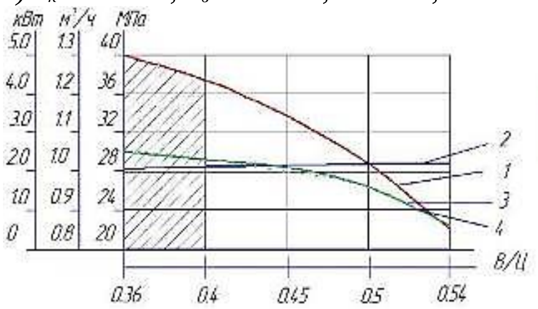
d) $n_к = 16$ хв$^{-1}$; $К_{зо} = 0,5$; $t = 75$ с; $W/C = 0.45$



e) $n_к = 16$ хв$^{-1}$; $n_в = 55$ хв$^{-1}$; $t = 75$ с; $W/C = 0.45$



f) $n_к =16$ хв$^{-1}$; $n_в = 55$ хв$^{-1}$; $К_{зо} =0,5$; $W/C =0.45$



h) $n_к = 16$ хв$^{-1}$; $n_в = 55$ хв$^{-1}$; $К_{зо} = 0.5$; $t = 75$ с

Fig. 11. Dependencies of concrete mixer's operational efficiency factors of the concrete mixer with gravitational and forced action:
a) installation diagrams of the shoulders on the case; b) installation diagrams of the shoulders on the horizontal shaft; c) case frequency rotations; d) shoulder shaft frequency rotations; e) space factor; f) time for mixture preparation; g) water-cement ration; 1 – $R_{ст}$; 2 – $П$; 3 – N; 4 – $П_{теор}$; 5 – $N_{теор}$

The most favorable conditions for three-shaft concrete mixer for preparation of low-slump concrete mixtures have been obtained under: working body rotation frequency to be n=47–65 rpm, attack angle of the left zone shoulders α_1=42–45°, the quantity of the shoulders z=32–35 pcs, slope angle of the working body against the horizontal plane β=17–22°, water-cement ratio W/C=0.4–0.43, attack angle of the right zone shoulders α_2=39-42°, shoulders form (expressed via their area) S=20-22 cm².

In case of the concrete mixer of gravitational and forced action, the water-cement ratio W/C = 0.36 ÷ 0.4 is to be considered as the recommended range for qualitative low-slump concrete mixtures, which ensures compression capacity of the cube concrete test specimen Rсж = 37 ÷ 40 MPa, production factors – П = 1.1 ÷ 1.2 m^3/h and power – N = 1.95 ÷ 2.5 kW.

The indexes of the cube concrete test specimen as for compression capacity in a result of performed investigation when using identical concrete mix proportions prepared in the concrete mixer of gravitational and forced actions in the concrete mixer of ELBA Company [10], have demonstrated higher efficiency of the concrete mixer. Thus, cube concrete test specimen moulded on the mixtures being prepared in this machine, in comparison with the specimen moulded on the factory mixtures, are

– 35…40 % higher for the concrete grade C30, class B22,5, at concrete flow P3;

– 10…15 % higher for the concrete grade C35, class B25, at concrete flow P4;

In order to obtain concrete grade C30 class B20 at concrete flow P4, the time for concrete mixtures is shortened to 10…15 % [17].

Conclusions. Thus, the investigation results on the concrete mixers operating in the cascade mode have shown their efficiency and practicability in large-scale implementation in the construction, both in individual structural design and technological equipment set as well for the conditions of the construction site.

For these purposes it is possible to use the obtained ranges of the rational work process-related parameters as for concrete mixtures preparation in the cascade mode machines.

REFERENCES:

1. Бауман В.А. Механическое оборудование предприятий строительных материалов, изделий и конструкций / В.А. Бауман, Б.В. Клушанцев, В.Д. Мартынов. – М.: Машиностроение, 1981. – 32 с.
2. Емельянова И.А. Современные строительные смеси и оборудование для их приготовления. Учеб. пособие / И.А. Емельянова, О.В. Доброходова, А.И. Анищенко. – Х.: Тимченко, 2010. – 146 с.: ил., табл.
3. Назаренко І.І. Машини для виробництва будівельних матеріалів / І.І. Назаренко. – К.: КНУБА, 1999. – 488 с.
4. Хмара Л.А. Бетоносмесительные заводы и установки (конструкции, технические характеристики, расчет). Учебное пособие / Л.А. Хмара, А.С. Шипилов, Ю.В. Хвостенко, А.А. Бутенко. – Днепропетровск, ООО «ЭНЭМ», 2008. – 464 с.
5. Огиевич В.А. Современные автоматизированные бетоносмесительные установки цикличного и непрерывного действия /В.А. Огиевич, М.А. Титов. – М., 1962. – 73 с.
6. Саленко Л.Н. Разработка вибрационного оборудования бетоносмесителей принудительного действия для обработки цементобетонных смесей: дис. … канд. тех. наук: 05.05.02 / Л.Н. Саленко. – Полтава, 2004. – 174 с.
7. ELBA-WERK Maschinen-Gesellschaft. – [Электронный ресурс]. – Режим доступа: http://www.elba-werk.com/ru/produkte/mischer/index.php?navid=9
8. US Patent № 832 722; 09.10.1906. Mixing-machine. / Roy Cunningham, John McPherson. № 832 722; 09.10.1906.
9. Societa Italiana Costruzione Macchine (SICOMA). – [Электронный ресурс]. – Режим доступа: http://www.sicoma.ru/twin-shaft.html
10. ELBA-WERK Maschinen-Gesellschaft. – [Электронный ресурс]. – Режим доступа: http://www.elba-werk.com/ru/produkte/mischer/index.php?navid=9
11. Бетоносмесители, работающие в каскадном режиме. Монография / И.А. Емельянова, А.И. Анищенко, С.М. Евель, В.В. Блажко,О.В. Доброходова, Н.А. Меленцов. – Харьков: Тим Паблиш Груп, 2012. – 146 с. ил., табл.
12. Пат. №101953 С2, МПК (2013.01) В28С 5/20. Спосіб приготування будівельних сумішей / Ємельянова І.А., Блажко В.В., Аніщенко А.І. Україна. – № а2009 13497; Заявл. 24.12.09; Опубл. 27.05.13, Бюл. № 10 –2 с.: ил.
13. Пат. №74444 С2, МПК 7 В28 С5/14. Змішувач для приготування будівельної суміші. / І.А Емельянова, А.М. Баранов, В.В. Блажко, В.В. Тугай; Украъна – № 20031213023; Заявл. 30.12.03; Опубл. 15.12.05, Бюл. № 12 – 2 с.: ил.

14. Пат. №101773 С2, Україна. МПК (2013.01) В28С 5/20. Змішувач для приготування будівельної суміші / Ємельянова І.А., Блажко В.В., Аніщенко А.І.; Україна. – № а2012 03562; Заявл. 26.03.12; Опубл. 25.04.13, Бюл. № 8 –2 с.: ил.
15. Методические указания к выполнению лабораторной работы на тему «Определение основных показателей, характеризующих работу бетоносмесителей, работающих в каскадном режиме» для студентов специальностей 7.05050315 та 8.05050315 «Оборудование химических производств и предприятий строительных материалов». / Составили: И.А. Емельянова, В.В. Блажко, А.И. Анищенко – Харьков: ХНУСА, 2016. – 29 с.
16. Блажко В.В. Трехвальный бетоносмеситель для приготовления малоподвижных бетонных смесей: дис. … канд. тех. наук: 05.05.02 / В.В. Блажко. – Харьков, 2007. – 164 с.
17. Аніщенко А.І. Розробка бетонозмішувача гравітаційно-примусової дії для приготування бетонних сумішей різної рухливості: автореф. дис. … на здобуття наук. ступеня канд. тех. наук: спец. 05.05.02 / А.І. Аніщенко. – Харків, 2013. – 20 с.

Емельянова И., Блажко В., Анищенко А., Доброходова О., Гордиенко А. ОПРЕДЕЛЕНИЕ МОЩНОСТИ И ЭНЕРГОЭФФЕКТИВНОСТИ ДЛЯ БЕТОНОСМЕСИТЕЛЕЙ, РАБОТАЮЩИХ В КАСКАДНОМ РЕЖИМЕ. В статье представлено описание конструкции бетоносмесителя, работающего в каскадном режиме. Показаны принципы работы его составных частей. Получены зависимости для определения мощности и энергозатрат этих машин. Приведены характерные кривые рабочих коэффициентов эффективности бетоносмесителя в отношении заданных параметров рабочего процесса с указанием их рационального диапазона значений. Практичность определяется как для трехвального бетоносмесителя и бетоносмесителя с гравитацией и принудительным воздействием в строительной отрасли.

Ключевые слова: трехвальный бетоносмеситель, мощность, бетоносмеситель, плечо, корпус, вал, каскадный режим.

Ємельянова І., Блажко В., Аніщенко А., Доброходова О., Гордієнко А. ВИЗНАЧЕННЯ ПОТУЖНОСТІ І ЕНЕРГОЕФЕКТИВНОСТІ ДЛЯ БЕТОНОЗМІШУВАЧІВ, ЩО ПРАЦЮЮТЬ У КАСКАДНОМУ РЕЖИМІ. У статті представлено опис конструкції бетонозмішувача, що працює в каскадному режимі. Наведено принципи роботи його складових частин. Отримано залежності для визначення потужності і енерговитрат цих машин. При-ведені характерні криві робочих коефіцієнт ефективності бетонозмішувача щодо заданих параметрів робочого процесу із зазначенням їх раціонального діапазону значень. Практичність визначається як для трехвального бетонозмішувача і бетонозмішувача з гравітацією і примусовим впливом в будів-котельної галузі.

Ключові слова: трехвальний бетонозмішувач, потужність, бетонозмішувач, плече, корпус, вал, каскадний режим.

УДК 628.16

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МЕТОДИ ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ ЗМІШУВАННЯ ВОДИ З РЕАГЕНТОМ НА ОЧИСНИХ СПОРУДАХ ВОДОПОСТАЧАННЯ

Наведено аналіз існуючих технологічних і конструктивних методів підвищення ефективності змішування води з реагентом на очисних спорудах водопостачання та їх недоліки. Показані переваги розробленої конструкції перегородчастого змішувача.

Ключові слова: водопостачання, змішувачі, ефективність, реагент, вода.