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THE USE OF INFORMATION TECHNOLOGIES IN CALCULATING THE PRODUCTIVITY OF TECHNOLOGICAL EQUIPMENT FOR THE PRODUCTION OF CERAMIC PRODUCTS BASED ON MAN-MADE RAW MATERIALS

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Currently, a large amount of man-made waste has been stored on the territory of the Republic of Kazakhstan, which, by their chemical and mineral properties, are a serious raw material base for the production of building materials.

The quality indicators of raw materials affect not only the physical and strength characteristics of the finished product, but also the cost. In our study, we use man-made raw materials for the production of construction products, as additives to clay for the semi-dry method of producing ceramic products, since this method is less labor-intensive and does not require large financial investments. One of the most important characteristics of technological equipment is performance. Technological equipment for the production of construction products is represented on the market of Kazakhstan by leading foreign companies, including Chinese, Russian, Turkish, Spanish, Kazakh manufacturers are not included in this list. Technological equipment can produce products from a certain type of raw materials, for which such parameters as productivity, quality indicators of raw materials and others are indicated in the technical documentation. That is, when using technogenic raw materials as additives to the charge, it is not possible to determine productivity, for objective reasons. In this regard, the task of calculating the productivity of the technological line for the production of ceramic products using information technology is relevant.

As a software tool in the study, the program "Simulation model of a technological line for the production of construction products using industrial waste" is used, written in C++, in accordance with the principles of object-oriented programming. Performance calculations were performed for technological equipment Titanium 900-120 DHEX press, Titanium 80 D press. The presented program can be used by individual entrepreneurs not only to calculate productivity, output volume, but also to justify the choice of technological equipment for the production of ceramic products.

Keywords: modeling, information technology, programming language, program, technological equipment, productivity, ceramic products.

ТЕХНОГЕНДІК ШИКІЗАТ НЕГІЗІНДЕ КЕРАМИКАЛЫҚ БҰЙЫМДАР ӨНДІРІСІНІҢ ТЕХНОЛОГИЯЛЫҚ ЖАБДЫҒЫНЫҢ ӨНІМДІЛІГІН ЕСЕПТЕУ КЕЗІНДЕ АҚПАРАТТЫҚ ТЕХНОЛОГИЯЛАРДЫ ПАЙДАЛАНУ

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Қазіргі уақытта Қазақстан Республикасының аумағында өзінің химиялық-минералды қасиеттері бойынша құрылыс материалдарын өндіру үшін елеулі шикізат базасы болып табылатын техногендік қалдықтардың көп мөлшері жинақталған.

Шикізаттың сапалық көрсеткіштері дайын өнімнің физикалық және беріктік сипаттамаларына ғана емес, сонымен қатар өзіндік құнына да әсер етеді. Біздің зерттеуімізде біз құрылыс өнімдерін өндіру үшін техногендік шикізатты керамикалық бұйымдарды өндірудің жартылай құрғақ әдісі үшін сазға қоспалар ретінде қолданамыз, өйткені бұл әдіс аз еңбекті қажет етеді және үлкен қаржылық инвестицияларды қажет етпейді. Технологиялық жабдықтың маңызды сипаттамаларының бірі-
Өнімділік. Құрылыс бұйымдарын өндіруге арналған технологиялық жабдықты Қазақстан нарығында жетекші шетелдік компаниялар, оның ішінде қытайлық, ресейлік, түрік, испандық компаниялар ұсынады, қазақстандық өндірушілер бұл тізімде жоқ. Технологиялық жабдық шикізаттың белгілі бір түрінен өнім шығара алады, ол үшін техникалық құжаттамада өнімділік, шикізаттың сапалық көрсеткіштері және басқалары сияқты параметрлер көрсетіледі. Яғни, шихтаға, техногендік шикізатқа қоспалар ретінде пайдаланған кезде объективті себептер бойынша өнімділікті анықтау мүмкін емес. Осыған байланысты ақпараттық технологияларды қолдана отырып, керамикалық бұйымдарды өндірудің технологиялық желісінің өнімділігін есептеу міндеті өзекті.

Зерттеуде бағдарламалық құрал ретінде объектіге бағытталған бағдарламалау қағидаттарына сәйкес ЕО тілінде жазылған ”өнеркәсіптік өндіріс қалдықтарын пайдалана отырып, құрылыс бұйымдарын өндірудің технологиялық желісінің имитациялық моделі” бағдарламасы қолданылады. Өнімділік есептеулері Технологиялық жабдыққа арналған Титан 900-120 DHEX Пресс, Титан 80 D пресс. Ұсынылған бағдарламаны жеке кәсіпкерлер өнімділікті, өнім көлемін есептеу үшін ғана емес, сонымен қатар керамикалық бұйымдарды өндіруге арналған технологиялық жабдықты таңдауды негіздеу үшін де қолдана алады.

Түйін сөздер: модельдеу, ақпараттық технологиялар, бағдарламалау тілі, бағдарлама, технологиялық жабдық, өнімділік, керамикалық бұйымдар.

ИСПОЛЬЗОВАНИЕ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ ПРИ РАСЧЕТЕ ПРОИЗВОДИТЕЛЬНОСТИ ТЕХНОЛОГИЧЕСКОГО ОБОРУДОВАНИЯ ПРОИЗВОДСТВА КЕРАМИЧЕСКИХ ИЗДЕЛИЙ НА ОСНОВЕ ТЕХНОГЕННОГО СЫРЬЯ

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В настоящее время на территории Республики Казахстан, складировано большое количество техногенных отходов, которые по своим химико-минеральным свойствам являются серьезной сырьевой базой для производства строительных материалов.

Качественные показатели сырья влияют не только на физические и прочностные характеристики готовой продукции, но и на себестоимость. В нашем исследовании мы для производства строительных изделий, используем техногенное сырье, в качестве добавок к глине для полусухого способа производ-ства керамических изделий, так как данный способ менее трудозатратен и не требует больших финан-совых вложений. Одним из важнейших характеристик технологического оборудования является производительность. Технологическое оборудование для производства строительных изделий, пред-ставлено на рынке Казахстана, ведущими зарубежными компаниями, в том числе китайскими, российскими, турецкими, испанскими, казахстанские производители в данном списке отсутствуют. Технологическое оборудование может производить продукцию из определенного вида сырья, для которых в технической документации указывается, такие параметры, как производительность, качественные показатели сырья и другие. Т.е., при использовании в качестве добавок к шихте, техно-генного сырья, не возможно определить производительность, по объективным причинам. В этой связи актуальна задача расчета производительности технологической линии производства керамичес-ких изделий с использованием информационных технологий.

В качестве программного инструмента в исследовании, применяется программа «Имитационная модель технологической линии производства строительных изделий с использованием отходов промышленного производства» написанная на языке С++, в соответствии с принципами объектно-ориентированного программирования. Расчеты производительности выполнены для технологического оборудования пресс Титан 900-120 DHEX, пресс Титан 80 D. Представленная программа может быть использована индивидуальными предпринимателями не только для расчета производительности, объема выпускаемой продукции, но и для обоснования выбора технологического оборудования для производства керамических изделий.

Ключевые слова: моделирование, информационные технологии, язык программирования, программа, технологическая оборудование, производительность, керамические изделия

Introduction. Clay has been used for centuries as a building material for the production of building products and household utensils. Currently, the qualitative composition of clay is regulated by ST RK 2652-2016 [1].

To date, the growth of ceramic construction products in Kazakhstan is more than 56% [2] with geometric growth, as the number of residential buildings, office and warehouse premises increases.

Plastic, semi-dry and rarely slip methods are used for the production of ceramic bricks [3].

The plastic pressing method is carried out from clay with a moisture content of 18-24%, on tape, screw presses.

Semi-dry and dry pressing methods use raw materials with a moisture content of 8-12 and 2-8%. Bricks, facade tiles, floor tiles, and paving slabs are formed in a semi-dry way. Knee-lever, rotary, and friction presses are used for pressing ceramic products.

The technological equipment for the production of ceramic products includes, equipment for the preparation of the charge uses the following types of equipment:

- vehicles used for the delivery and extraction of raw materials (dump trucks, excavators, bulldozers);
- receiving bins for raw materials;
- conveyors for feeding raw materials;
- rolling machines (disintegrators) carrying out grinding;
- pressing and forming equipment;
- Drying chambers;
- brick kilns [4].

Certain requirements for plasticity and moisture content are imposed on raw materials for the production of bricks in order to improve physical characteristics.

Since the production process of ceramic products is sufficiently debugged, and the composition of raw materials is known, the productivity of technological equipment is determined in a practical way, but factors affecting the flow of the technological process, changes in the composition of raw materials, changes in the working cycle are not taken into account, respectively, there is no scientific justification for calculating the productivity of that for various types of technological equipment.

Materials and methods. To calculate the productivity of technological equipment, the program ”Simulation model of a technological line for the production of construction products using industrial waste” is used [5], the algorithm of the program allows it to be used to simulate the performance of technological equipment of various types of construction products. The program is written in C++, using the principles of object-oriented programming.

Discussion of the results. The composition of the raw materials used for the production of ceramic products is described below.

Clay from the quarry of the deposit Near schools (Akmola region) was used for research fig. 1.

Bauxite sludge (Pavlodar Aluminum plant) fraction-1 (see fig.2), fly ash (Ekibastuz Gres -1) fraction- (see fig.3), metallurgical slag of Casting LLP fraction- 1 (see fig.4), river sand, fraction-1 (see fig. 5).

Figure 1 - Clay from the Ushkol quarry

Figure 2 - Bauxite sludge (Pavlodar Aluminum Plant) fraction-1

Figure 3 - Fly ash (Ekibastuz Gres -1) fraction-1

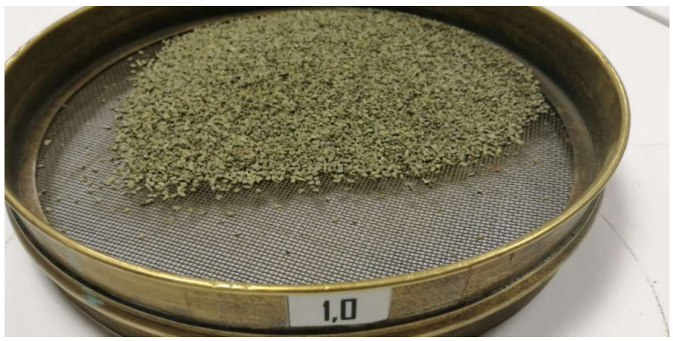

Figure 4−Metallurgical slag of Casting LLP fraction- 1

Figure 5 - River sand fraction- 1

The program allows you to simulate the operation of technological equipment for the production of various construction products, including ceramic ones.

Changes in the program related to the exclusion of the weight parameters ”cement”, various additives that are not part of the raw materials for the production of ceramic products, as well as the inclusion of the parameter ”clay” ensure that the model approximates the real technological process. [6]. The algorithm of the program is described in detail in [7].

Listing 1 shows a fragment of a program for calculating the productivity of technological equipment for the production of ceramic products based on man-made raw materials.

```
float Norm(float, float);
float ST[4];// list of events:
// ST[0]-  the end of the mixture formation by the z0 device and
   transfer to mixing
// ST[1]-  the end is mixing the mixture and pouring water z1
// and transfer semi-dry to the molding matrix
//  ST[2] - the end of the molding, the release of finished products z2
//  ST[3]- simulation interval in min 8*60=480 - one shift
Float Tt;// system time
class OA0// service class. a device that forms a dry mixture
{private:
public:
float Massa[NNp]; // the actual mass of the components of the mixture,
   case. value(+- dispenser error)
int ne;// the current number of the container to which the OA is
   connected, ne =0.1,...4
```

When calculating the productivity of the technological line for the production of ceramic products, the raw material ”clay” was used, the class OA1 was changed accordingly.

Listing 2 Class OA1 description program.

```
class OA1 // class-a maintenance apparatus that feeds clay and mixes
{ private:
 // Parameters OA:
public:
float tmixed;// mixing time
float dtmatrica;// the time of transfer of the mixture to the matrix
int sost;// 0- he is free and can take the mixture
            // 1 - the dry components have been transferred, the device
               is busy adding
            // add the clay to the mixture and mix before transferring
               the mixture
            // to the bunker, ordered the end time of the transfer
            // 2- simple, because it cannot transmit the mixture - the
               trace. OA is busy
            // 3 - simple, because no, the ingredient has run out (there
                is nothing to serve)
    //float massat; // the mass of the current charge transferred to the
        mixture.
 Float summamass; // the mass of the dry mixture in OA transferred to
    the mixture.
```

```
//float Sum;
Float och;
float proisv;
float gen1();
OA1();
Int Fobr();
Void display();
   };
```

Class OA2 ensures the formation of ceramic products.

Listing 3 Class description program OA2.

```
class OA2  // The class is a service device that presses the mixture and
    delivers the finished product
{ private:
   // float massat; // the mass of the current mixture transferred to
      the molding matrix
 public:
float dtproduction;// time of transfer of finished products
 int sost;// 0- he is free and can take a ready-made mixture
            // 1 - I am busy with the transfer of finished products and
               ordered the transfer time
Float Sum;
Float vmatr; // the volume of the matrix, kg
 Int ki; // the number of products in the matrix
 Float summamass; // the mass of the mixture in OAO
Float vsego;// total mass of products
    OA2();
Float och;
Float gen();//Working cycle time
Void Fobr();//processing function
Void display();
  };
OA0 z0;
   OA1 z1;
   OA2 z2;


Float MassaKomp[NNp];
Float MassaKompSklad[NNp];
 // NNp=0- Clay, NNp=1-sand,NNp=2 - no, NNp=3- ash
//  NNp=4- metallurgical slag,  NNp=5-no,  NNp=6- bauxite sludge
 //  NNp=7 - no NNp=8 - no
Float smes[NNp]; // the percentage composition of the mixture
float MassaSmesy;// the planned total mass of the mixture,quantum,
   indivisible portion
float vsmes;// The volume of the mixer with the finished mixture
float massaprodution;
```

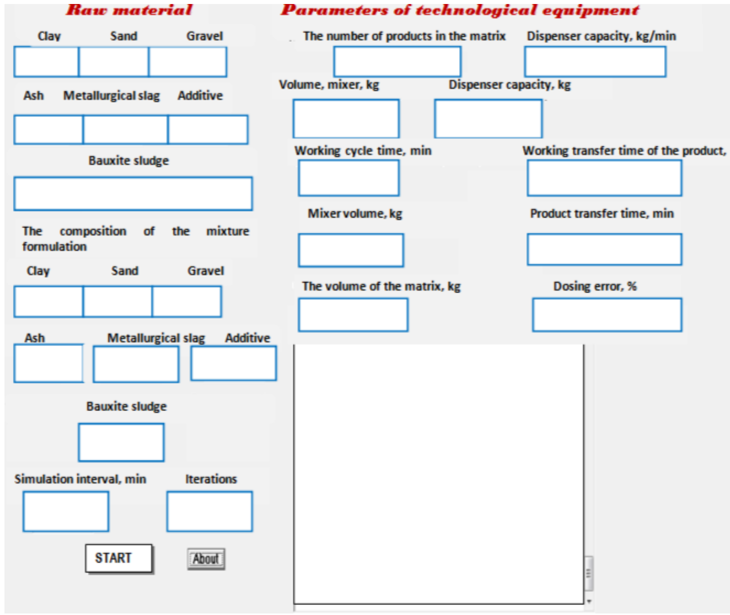

Figure 6 - Menu of the program for calculating the productivity of technological equipment for the production of ceramic products with additives of man-made raw materials

Fig. 6 shows the program menu for calculating the productivity of technological equipment for the production of ceramic products with additives of man-made raw materials.

The program menu shows 4 main parts:

1-raw materials in the warehouse of the enterprise;

2-the formulation of a mixture for the production of ceramic products, makes it possible to simulate production with various additives and volumes of artificial raw materials;

3-changing the parameters allows you to present the real picture of the technological process as adequately as possible, in a digital display of technical characteristics;

4-the simulation interval will allow you to calculate the performance of technological equipment most accurately by setting any number of iterations.

As it was presented above, a semi-dry production method was used in the study, it is assumed that the humidity of the mixture is 6-7%, while additional equipment for drying products is not required.

Technological equipment for calculating productivity is represented by Titanium 900-120DH EXpress brands Fig.7.

Figure 7 - Titanium Press 900-120 DHEX

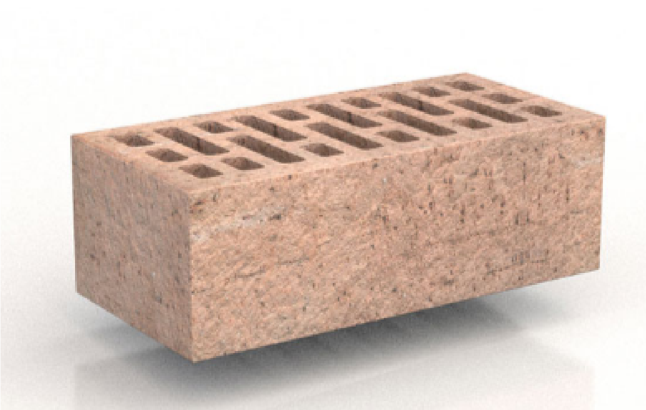

Figure 8 - Ordinary hollow ceramic brick

Figure 9 - Ordinary full-bodied ceramic brick

Let's calculate the productivity for 2 types of ceramic products, fig.8,9.

The technical characteristics of the processing line are indicated in the passport of the Titanium 900-120 hexagonal press :

The duration of the working cycle is 11-12 minutes;

The drive power is 90 kW.

The number of products is 16 pcs.

The weight of the product is 3.7 kg and 4.3 kg (calculated taking into account the additives of artificial raw materials).

The results of calculating the performance of the Titanium 900-120 hexagonal press are shown in Fig. 10;11.

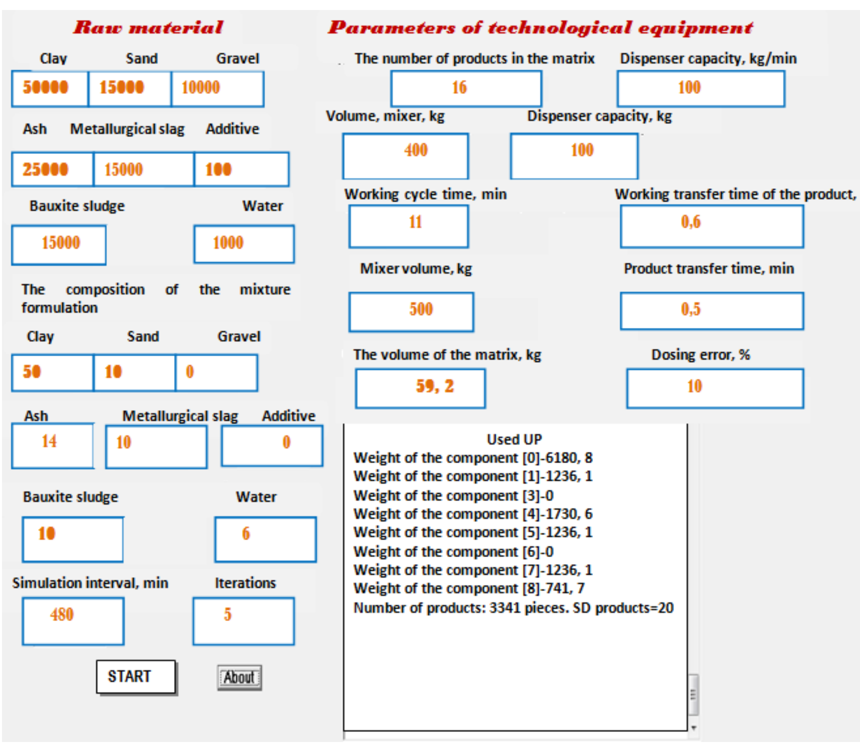

Figure 10 - Calculation of the productivity of technological equipment in the production of ordinary hollow ceramic bricks

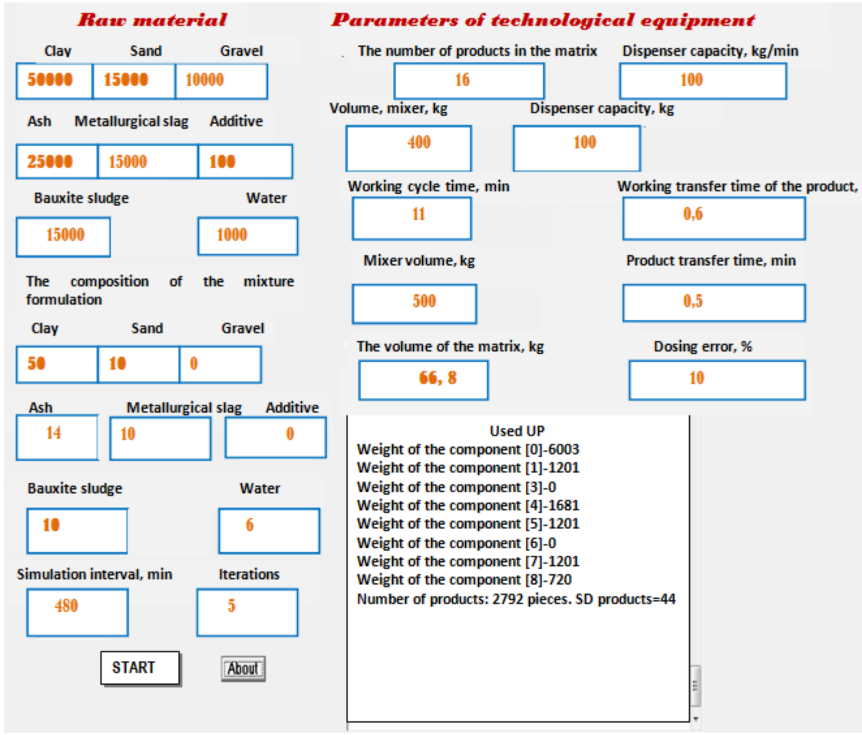

Figure 11–Calculation of the productivity of technological equipment in the production of ordinary full-bodied ceramic bricks

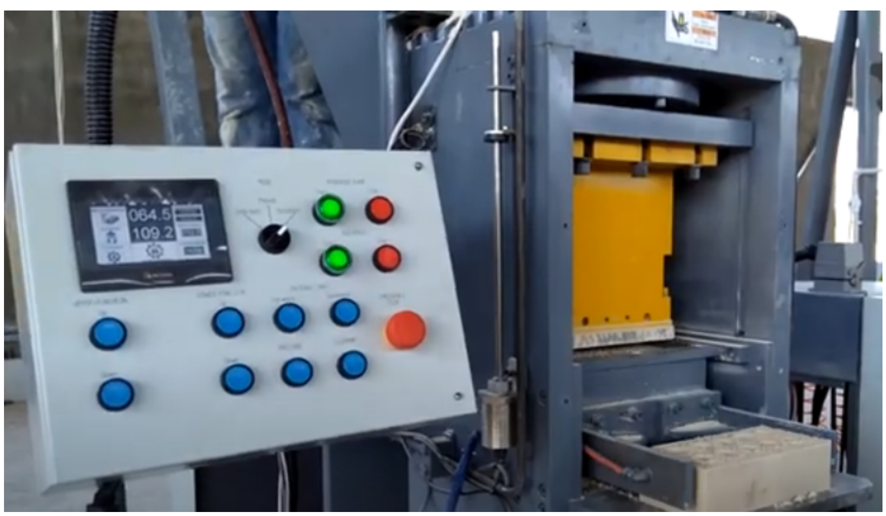

Figure 12 - Titanium 80 D Press

Similar calculations of the performance of technological equipment are calculated by the program for the Titanium 80D press fig.12.

The technical characteristics of the processing line are given in the passport of the Titanium 80D press:

The duration of the working cycle is 2-3 minutes;

The drive power is 15 kW.

The number of products is 1 pc.

The calculation of the productivity of the Titanium 80D press for two types of ceramic bricks is shown in Fig. 13;14.

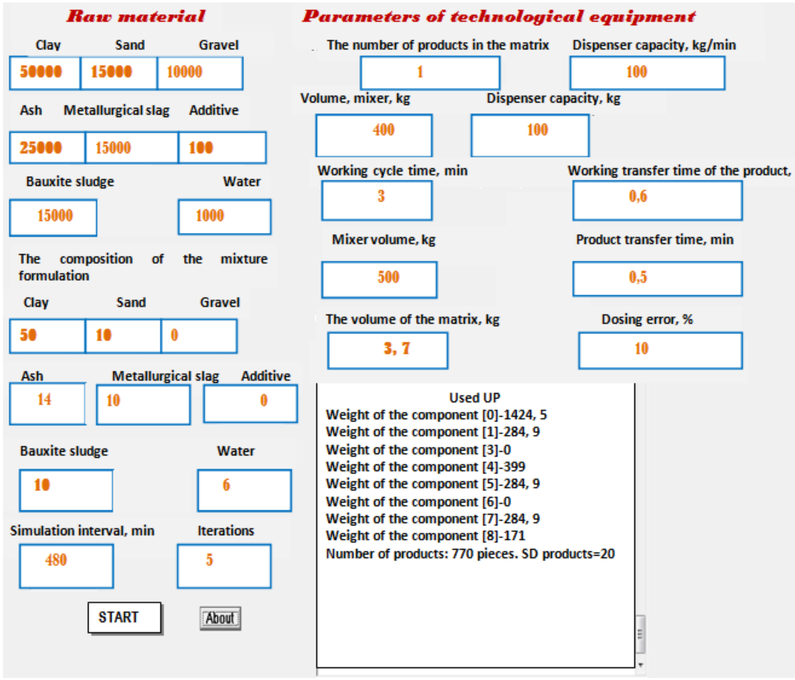

Figure 13 - Calculation of the productivity of technological equipment in the production of ordinary hollow ceramic bricks

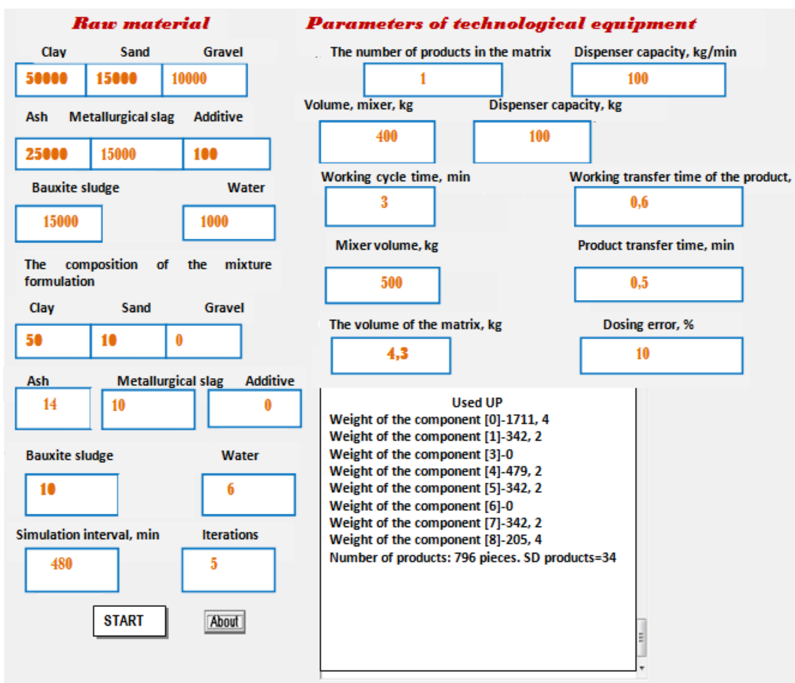

Figure 14–Calculation of the productivity of technological equipment in the production of ordinary full-bodied ceramic bricks

Conclusion. The developed program allows you to:

1) perform calculations of the productivity of technological equipment for semi-dry and dry methods of forming ceramic products, for various types of molding matrices;

2) provides an opportunity to control the volume of raw materials in the warehouse;

3) determine the calendar plan for the production of ceramic products;

4) flexibly respond to changes in the technological parameters of the production process.

The program can be useful both for technologists of enterprises producing construction products, and for individual entrepreneurs with a limited number of technological equipment and a small volume of production.

Existing developments related to simulation modeling are mainly related to solving logistical problems, describing components and strategies, and discrete events in particular [8-10], which today opens up the possibility of wider use of all information technology capabilities for the practical implementation of engineering calculation tasks.

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