NEW NANO-TECHNOLOGIES FOR THE EXTRACTION AND USE OF HYDROCARBONS, BASED ON THE USE OF UNIVERSAL MODULES OF INDUSTRIAL DISINTEGRATORS/ACTIVATORS

Kulakov A.V.*

Corresponding Member of the Russian Academy of Sciences, Doctor of Physics and Mathematics – Dr. Sc. (Phys.-Math.);

Rantsev-Kartinvov V.A. **,

Candidate of Physics and Mathematics – Cand. Sc. (Phys.-Math.).

* Institute of Functional Economic Systems, Moscow, Russia

** Institute of Functional Economic Systems, Moscow, Russia

DOF: 10.31618/ajsr.2707-9864.2021.1.50.110

Abstract. UMolID/A, developed by the authors of this work, have unique technical characteristics (extremely high magnetic induction density, close to one hundred percent efficiency, low material consumption, reliability), which allows them to provide grinding of various materials up to nano-sizes for various fields of industrial production, chemistry and medicine. These unique characteristics of UMolID/A allowed to effectively use these disintegrators into proprietary technologies to produce cheap alkaline nano-cement/concrete, cheap and ecologically-safe wood concrete, diesel/fuel oil, local ash, clean processing of toxic heavy fuel oil, increasing the

References


final yield of light fractions of oil, further the standard process of cracking as mixers for high-quality suspensions in the oil, coal and construction industries and all this for the first time in the world to obtain fundamentally new and previously unknown materials and products, existing superior in quality and economy.

**Keywords:** Universal Modules Of Industrial Disintegrators/Activators (UMoID/A), alkaline nanocement/concrete, grinding of materials in UMID/A, new cheap efficient industrial nanotechnology, oil cracking, fuel suspensions, heavy fuel oil, cheap diesel fuel, nigrol

**Introduction**

In this paper, we analyze the possibility of using the world's first high-performance nano-technologies developed by us in the production and use of hydrocarbons (this article focuses on the oil industry), based on our patented Universal Modules of Industrial Disintegrators/Activators (UMoID/A).

UMoID/A[1][2][3], developed by the authors of this work, have unique technical specifications (extremely high magnetic induction density, close to one hundred percent efficiency, low material consumption, reliability), which allows them to ensure the grinding of various materials up to nano-sizes. The unique characteristics of UMoID/A allowed use of these properties, we developed the technologies for producing cheap alkaline nano-cement /concrete[1], modification of coal in a carbon nano-tube of new cheap efficient industrial nanotechnology, oil cracking, diesel/fuel oil, nigrol increase the final yield of light fractions of oil, later the standard process of cracking as mixers for high-quality suspensions in the oil, coal and construction industries , for environmentally friendly recycling of toxic heavy fuel oil with high sulfur content, and all this for the first time in the world to obtain fundamentally new previously unknown materials and products (based on the new nanotechnology [5],[4]) existing superior in quality and economy.

Since the UMoID/A blocks developed by us are optimized modules, their geometric parameters cannot be changed arbitrarily, i.e., it is impossible to change the pipe sections of its working area to increase, for example, the productivity of the machine, since this will lead to a sharp decrease in its economic indicators. The fact is that the price of obtaining a high value of the magnetic field strength in a large diameter pipe is very high. To increase the efficiency and intensification of any technological process with the use of UMoID/A, it is necessary to put the required number of UMoID/A modules in each technological chain sequentially, which, in fact, is equivalent to a corresponding increase in the total length of the active working zone of such a chain. In case of production necessity, in order to achieve high overall productivity, it is necessary to put in the technological scheme as many sequentially articulated UMoID/A in the form of parallel chains, as many times as it is necessary to increase the final output of the finished products of one such chain. Thus, the total machine in any technological process with the use of UMDoID/A modules is a series of parallel technological chains, each of which is a chain of separate UMDoID/A blocks connected in series.

To determine the required number of sequentially articulated UMDoID/A blocks for each technological process, it is necessary to initially loop the passes of the processed product on experience and monitor the change in its properties during each cycle. The number of successively articulated UMDoID/A is determined by the approximation to the saturation of this process. The number of parallel chains of such sequentially articulated UMDoID/A blocks is determined by the total required productivity of this process, based on the fact that each chain passes ~ 30 m³/hour of oil.

Since the efficiency of UMDoID/A machines increases for finer grinding, it is advantageous to first use UMDoID/A in conventional mills (M), and only use UMDoID/A at the final stages of grinding.

The schematic diagram of the continuous industrial grinding shop based on the use of UMDoID/A should be as follows:

- The versatility and high efficiency of the Universal Modules of Industrial Disintegrators/Activators (UMoID/A is preconditioned by the multitude and activity of the processes occurring in its working area:
  a) unique ability to grind substances to units of nm;
  b) crushing by the "constrained blow";
  c) electromagnetic erosion;
  d) plasma exposure;
  e) ultrasound (when processed in a liquid medium);
  f) high energy density of magnetic induction in its working area (with B ~ 104 Gs, W~0.4 J/cm³ = 4 105 J/m³), B- magnetic field strength, W- magnetic induction energy density is hundreds of times higher than the energy density in the working areas of other similar devices;
  • almost one hundred percent efficiency;
  • low material consumption.

The UMoID/A design is schematically illustrated in Fig. 1.
A schematic diagram of a continuous industrial grinding workshop is illustrated in Fig. 2. Figure 3 illustrates a schematic sketch of a prototype model installation for the production of materials on an industrial UMM-P scale. The support of this device should allow changing the slope of this module, providing adjustment of the processed material passage speed through the module. Schematically, this device represents a serial joining of separate modules with two working areas also patented by the authors.
Fig. 2 The schematic diagram of a continuous industrial grinding workshop:

M – material pre-grinding mill
UMoID/A – material continuous industrial grinding modules.

Fig. 3 The schematic sketch of the UMoid/A prototype model installation.

Fig. 1. Schematic diagram of the continuous industrial grinding shop.
Here:
M – Material pre-grinding mill;
UMoID/A – modules for continuous industrial grinding of the material.

A full-scale industrial plant for continuous preparation of ANC for a large construction site should include a periphery for pre-grinding mills, preparation of crushed stone, sand, and at the final stage of the technology of the concrete mixer of the mortar unit. A full-scale installation should fully meet the need for the construction of the gas turbine engine.

1. New high-efficiency technology for the production of alkaline nano-cement

One of the most important applications of applications of UMoid/A is the technology of obtaining cheap (cheaper than Portland cement 4-5 times), extra heavy (up to 2000 kg/m²), resistant to seawater, alkaline nano-cement (ANC) without roasting clinker from the local metallurgical slag (LMS), mountain/volcanic rocks (MVR), based on the authors developed nano-technology[6],[7]. The role of the use of such NPCs in the implementation of research report is hard to overestimate. Indeed, they have remarkable structural properties (discussed in detail in the [1] so necessary in the construction industry), and enable large-scale construction method for 3-D printing based on the use of special liquid glass obtained at a cheap (developed by authors) nano-technology[2] without caking components, significantly increasing the strength of concrete and wood concrete and allowing to significantly reduce the process of "setting".

The calculation of the price and structural properties of such cements, as well as concretes and wood concrete prepared on their basis, are given naturally quite approximately. The main purpose of these calculations is to demonstrate the economic efficiency of using the developed nano-technologies.

Cost: a) 1 m³ of such cement concrete, stacked with basalt rebar is ~ EUR 60, which is 3 times cheaper than Portland cement, laid with steel reinforcement; b) 1 m² dwelling made from wood concrete on the basis of cement subject to the laying of the foundation, rebar slabs and urban communications is ~ EUR 50.
If a country needs cement for a year ~1·10⁸ t the transition of this country in the construction industry to ANC instead of Portland cement can bring additional revenue to the budget ~ 0.55·10¹⁰ EUR/year.

2. New high-efficiency nano-production technologies: gasoline, diesel/furnace fuel, nigrol

If you grind coal or heavy fuel oil in diesel fuel, then by selecting the appropriate concentration, you can get cheap diesel fuel that can be used in powerful diesels of small power plants or powerful ship/quarry diesels (quarry dump trucks, tractors, bulldozers, excavators, as well as helicopters, cargo ships and port tugs). Such diesel fuel is a fine suspension of fine coal in diesel fuel with a mass content of suspension particles up to (30-50)%. The preparation of this diesel fuel can be carried out in advance at special enterprises. However, the restoration of the homogeneity of such fuel and its additional activation should be carried out immediately before it is injected into the working cylinders of diesel engines. A specially designed miniature model of the UMoID/A for each type of such a specific diesel can be powered by a three-phase electric generator of the same diesel. The use of such fuel will allow to reduce the consumption of expensive diesel fuel by tens of percent. The preparation of a suspension of diesel fuel with a maximum concentration of finely ground coal in the UMoID/A gives a lubricating oil of the nigrol type, which is suitable for lubricating rubbing parts of machines and mechanisms. These last two described technologies will allow: to reduce the cost of buying diesel fuel and lubricants for high-power diesels by tens of percent, to increase their efficiency and to facilitate the maintenance of such equipment.

3. Production of various cements for the oil industry from local ash of mountain/volcanic rocks

One of the applications of the UMoID/A can result in the production of cheap (cheaper than Portland in 4-5 times), extra heavy (up to 2000 kg/cm²), resistant to sea water, alkaline nano-cement (ANC), which are obtained without calcination clinker from the local metallurgical ash (MMA), mountain/volcanic rocks (MVR), based on the authors developed nanotechnology. These cements make it possible to conduct large-scale construction of nano-concrete oil pipelines by the 3-D printing method, based on the use of a special liquid glass[3] obtained using a cheap (developed by the authors) nano-technology without sintering the components, which significantly increases the strength of concrete, and also allows to significantly reduce the process of "setting".

It is easy to show that the cost of: a) 1 m³ of this cement concrete, stacked with basalt reinforcement is EUR 60, which is 3 times cheaper than Portland cement, laid with steel rebar, ten times cheaper steel pipes, 3 times lighter than standard concrete and 3 times stronger than him.

4. Technology of pre-industrial processing of oil to increase the depth of its cracking

The UMoID/A can be used as a highly efficient oil pretreatment device before the standard cracking process, allowing for the creation of a cheap technology that increases the depth of oil cracking.

Further, since in the working area of the UMoID/A in some modes of its operation, long organic molecules are broken under the action of the processes occurring in it, the successive chains of such modules play the role of highly efficient devices for pre-processing oil before the standard cracking process. This allows the subsequent standard cracking process to increase the final yield of the light fraction of oil up to (1±5)% due to a corresponding reduction in the yield of its heavy component.

Modern oil plants process tens of millions of tons of oil a year. This means that the additional profit of such a plant from the use of the above proposed technology can amount to ~ (1±5) % of its annual profit, which, given the current prices for organic fuel, is a very large amount. Indeed, let's take at least one technological thread of such a plant, which gives - 10⁷ t =10⁴ l of gasoline per year. 1% of the additional performance of gasoline from this mass will be ~ 10⁶ liters, which is a significant profit for such a plant.

5. Highly efficient technologies for producing high-quality suspensions and various types of fuel

UMoID/A can be used as a high-performance mixer, allowing you to obtain high-quality, homogeneous suspensions of substances such as:

a) heavy fuel oil, diesel fuel for obtaining cheap boiler or diesel fuel of urban thermal power plants or powerful ship/quarry diesels (quarry dump trucks, tractors and excavators),

b) oil with chalk or clay as stable drilling fluids that do not settle for a long time, which can be prepared directly on the drilling rig and sometimes directly from the well rock.

The preparation of diesel fuel, which is a fine suspension of heavy fractions of fuel oil or coal in diesel fuel with a mass content of suspension particles up to (30-50)%, is carried out immediately before it is injected into the working cylinders. A specially designed UMoID/A model for each specific case can be powered by a three-phase electric generator of the same diesel engine. This will significantly reduce the cost of diesel fuel consumption for powerful mining dump trucks, drilling diesels and ship diesels, while increasing the power and efficiency of their work.

The patented structure of UMoID/A can be successfully used to obtain drilling fluids directly on the offshore drilling sites. Drilling fluids are a stable mixture of fine particles of chalk or clay that do not settle for a long time with oil. The efficiency of the UMoID/A in the drilling slurry production technology is almost 200 times higher than any other device in such a technology, this is due to the very high energy density in the working area of this unit. In fact, the required drilling slurry is obtained during the passage of its components through the working area of the machine, which is a part of a second. These suspensions are more stable than those obtained in ball mills at 200-hour activation, which is explained by the fact that UMoID/As are highly effective activators, because they contribute to the formation of charged rock particles in suspensions and the formation of fractal structures in their suspension.
Furnace fuel is a fine suspension of coal or heavy fuel oil particles in water. The preparation of such fuel makes it possible to significantly expand the possibilities of using coal/heavy fuel oil as fuel. The preparation of a suspension from diesel fuel and extremely finely ground coal in UMoID/A gives a lubricating oil of the nigrol type.

6. Integrated technology for the environmentally friendly processing of toxic heavy fuel oil with a high sulfur content

Many oil fields contain a large amount of sulfur, as a result of processing of which waste is obtained in the form of environmentally toxic heavy fuel oil with a high content of sulfur. The disposal of such fuel oil leads to severe environmental consequences. Therefore, the authors in this project offer an original and highly efficient technology for processing toxic heavy fuel oil with a high sulfur content, which is based on the use of the same patented UMoID/A devices.

The purpose of this technology is to obtain the maximum economic effect in the complex solution of two very important tasks:

1) elimination of waste from modern oil refineries of environmentally hazardous fuel oil with a high content of sulfur, as well as existing storage facilities of such fuel oil; 2) significant increase in the energy efficiency of gas furnaces used for annealing clinker of powerful cement plants.

A comprehensive solution to these problems through the application developed by the authors of the UMoID/A invariably leads to a significant economic effect. Indeed, modern technologies for the elimination of environmentally hazardous fuel oils are based on burning them in the atmosphere or plasma installations with subsequent neutralization or capture of sulfur/sulfur-containing compounds and, from an economic point of view, are ineffective. The cost of environmentally friendly elimination of such fuel oils in modern technologies, as already noted above, reaches EUR 65 per ton. On the other hand, in high-power clinker annealing furnaces at cement plants, expensive natural gas is used as the main fuel in modern conditions, which leads to a high cost of Portland cement.

Caloric content of environmentally hazardous fuel oil (per unit weight) almost two times less than the caloric content of gas. However, the use of these types of fuel oil in the form of furnace fuel due to their negative cost can have a very high economic effect. However, the high viscosity of environmentally hazardous fuel oils requires significant costs for the preparation of liquid fuel from them, which is supplied to the furnace by means of injectors. You can dilute such fuel oils with light fractions of petroleum products, but this significantly increases the cost of fuel.

Therefore, the authors of this project propose to use their patented UMoID/A for the preparation of furnace fuel from environmentally hazardous fuel oils, which allows you to prepare furnace fuel from these fuel oils with high efficiency immediately before introducing it into the working area of the furnace. A chain of modules from UMoID/A prepares a highly dispersed water emulsion with pre-known viscosity and caloric content. These fuel parameters for this type of environmentally hazardous fuel oil can be calculated analytically and adjusted in the course of appropriate laboratory studies. The content of environmentally hazardous fuel oil in the fuel emulsion can be adjusted up to (60-70)%. In practice, when operating cement kilns using the proposed technology, gas consumption can be reduced by 75 %, which will lead to a significant reduction in gas consumption and, consequently, to a significant reduction in the total cost of the final product. But the high content of sulfur in such furnace fuel significantly limits the scope of its application in terms of environmental indicators.

On the other hand, the use of such furnace fuel in clinker furnaces of cement plants leads to the release of sulfur-containing gases and should contribute to a more efficient aging of cement clinker with an improvement in the binding properties of the resulting Portland cement. Free calcium oxide (CaO), which is part of the clinker mixture, intensively binds sulfur-containing gases under annealing conditions and contributes to the formation of a binder in the form of gypsum. This process actually leads to the neutralization of sulfur from environmentally hazardous fuel oils and makes the use of such furnace fuel in cement clinker annealing furnaces from an environmental point of view justified.

So, the proposed technology is complex and economically highly efficient. The same technology can be used for annealing materials that are used to produce gypsum and building alabaster.

The implementation of this technology allows you:

a) create industrial high-performance complexes for the production of furnace fuel from environmentally hazardous fuel oil;
b) significantly increase the efficiency of obtaining finished products in the annealing furnaces of cement plants that produce Portland cement, construction gypsum/alabaster;
c) reduce gas consumption in high-capacity clinker kilns by up to 75 %, %;
d) resolve the issue of disposal of highly toxic waste from the oil complex.

This technology can also be used by some ceramic plants, if the composition of the shard of the products does not lead to the release of harmful impurities into the atmosphere, as well as at thermal power plants, which in this case will be able to consume heavy fuel oil with a high viscosity coefficient, but without the content of harmful impurities.

References


dated 05/10/2016


