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Содержание

Энергетика 5
ВОПРОСЫ МЕТОДИКИ ВЫБОРА ОСНОВНЫХ ПАРАМЕТРОВ ТЕХНОЛОГИИ ДРОБЛЕНИЯ В ПРОЦЕССЕ ПЕРЕРАБОТКИ КАБЕЛЬНЫХ ОТХОДОВ 5
Цыпкина Виктория Вячеславовна
Иванова Вера Павловна
Исамухамедов Дилшод Нигматуллаевич
Турсунбаев Шерод Мурот ўғли
Каримов Шерод Эгамберди-ўғли

Энергетическое, металлургическое и химическое машиностроение 10
ОСНОВНЫЕ ТЕХНОЛОГИЧЕСКИЕ ПРОЦЕССЫ ЕСТЕСТВЕННОЙ СУШКИ ХУРМЫ (DIOSPYROS) 10
Курбанов Неъматжон Муродиллаевич
Файзуллаева Муаттар Фарходжон қизи
Дилшода Розикова Абдуллаевна
Хусанова Мавлуда Нурдиновна

Papers in english 14

Records 14
FUNDAMENTAL STRATEGY OF THE METHOD OF ACCOUNTING AND CONTROL 14
OF AUTOMATION AND TELEMECHANICS DEVICES
Baratov Dilshod
Elmurod Astanaliev

Computer science, computer engineering and management 18
AUTOMATION OF HIGH SPEED COMPUTER NETWORK CONTROL 18
Olimjon Toirov
Dmitriy Bystrov
Ixtiyar Ismailov
Murodali Akberdiev
Avazmamat Xuramov
DEVELOPMENT OF A WIRELESS WATER QUALITY MONITORING SYSTEM FOR WATER TREATMENT FACILITIES 23
Azamat Yusupov
Fayzulloh Salohiddinov
ORGANIZATION OF LABORATORY WORK ON «NUMERICAL METHODS IN THERMAL PHYSICS» IN THE CONTEXT OF ONLINE EDUCATION 27
Irina Berezovskaya
Maya Ryspaeva
Aruzhan Zhabaeva

Mechanical engineering and machine science 35
ISSUES OF INFLUENCE OF THE CONTENT OF SULFUR AND PHOSPHORUS IN WIRE ON THE PROPERTIES OF WELDED JOINTS 35
Khudaykulov Nurulla
Payazov Mirgiyas
THE METHOD OF GENERATING ADDITIONAL AIR POWER IN CENTRIFUGAL APPARATUS AND ITS EFFECT ON WORK QUALITY 39
Khudayarov Berdirasul
Ajargul Mambetsheripova
N. Abdiganieva
TECHNOLOGIES OF METAL STAMPING IN A SOLID-LIQUID STATE 45
Nargiza Makhmudova
EXPERIMENTAL STUDIES OF THE TECHNOLOGICAL PROCESS OF PROCESSING CONCAVE SURFACES OF COMPLEX SHAPES 48
Otabek Yusufjonov
Xojiakbar Ro’zaliyev
Axmadbek Maxmubek
Metallurgy and materials science

PERCUSSION ABRASIVE WEAR OF DROBILES ON WORKING DETAILS MADE FROM SOLID ALLOYS
Sarvar Parmanov
Shukhrat Shakirov
Kongratbay Sharipov
Sanobar Sadaddinova

HYDROMETALLURGICAL AND FLOTATION METHODS OF SLAG DEPLETION
Abdurashid Khasanov
Talant Sirozhov
Shahzoda Ulkurova
Mokhinabou Murtozaeva

Civil engineering and architecture

USE OF BASALT FIBER AND ITS OPPORTUNITIES
Nargiz Matchonova

Transport

THE MAIN FACTORS INFLUENCING THE FORMATION OF HARMFUL SUBSTANCES IN DIESEL ENGINES
Fakhriddin Sidikov
WAYS TO IMPROVE THE ENVIRONMENTAL PERFORMANCE OF DIESEL ENGINES
Fakhriddin Sidikov
ANALYSIS OF THE IMPLEMENTATION OF AN ECONOMIC MECHANISM TO ENSURE THE ENVIRONMENTAL SAFETY OF MOTOR VEHICLES IN THE CONDITIONS OF UZBEKISTAN
Fakhriddin Sidikov
PROBLEMS IN THE STUDY OF POLLUTION COMPENSATION AND THE EFFECTIVENESS OF ENVIRONMENTAL MEASURES
Fakhriddin Sidikov
ВОПРОСЫ МЕТОДИКИ ВЫБОРА ОСНОВНЫХ ПАРАМЕТРОВ ТЕХНОЛОГИИ ДРОБЛЕНИЯ В ПРОЦЕССЕ ПЕРЕРАБОТКЕ КАБЕЛЬНЫХ ОТХОДОВ

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ISSUES OF METHODOLOGY FOR SELECTING THE MAIN PARAMETERS OF CRUSHING TECHNOLOGY IN THE PROCESS OF PROCESSING CABLE WASTE

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Выбор параметров для дробильных установок является весьма сложным вопросом, т.к. в технологии дробления загружаемые в переработку отходы представлены в общей сложности загруженную смесь вероятностного характера [1, 2, 8]. Загруженная смесь в рабочую часть дробилки представляет собой соединение конструктивных элементов кабельного изделия, состоящих из различных по размеру и физической природе материалов констуктивных элементов кабельных отходов имеющие усредненно равные геометрические размеры. Данную смесь можно представить, как обобщенную модель, а именно систему с заданным параметрическим семейством распределений:

\[ F = \{ F(x, 0), \theta \in \Delta \} \]  \hspace{1cm} (1)

где, \( F \) – система, состоящая из загружаемых отходов кабельного производства, \( \theta \) – элементы системы.

Таким образом, рассматриваемая система \( G \) – это параметрическое множество, где единичный объем \( \theta \) загруженной смеси (кусок кабеля, провода), который является составной частью обобщенной модели – системы \( F \):

\[ (x) = \int F(x; \theta) dG(\theta) \]  \hspace{1cm} (2)

где, \( G(\theta) \) – распределение элементов единичной системы (подсистем); \( F(x; \theta) \) - параметрическое множество обобщенной системы с распределенными единичными системами.

Для удобства анализа смеси загружаемых в технологию отходов кабельного производства, необходимо систему \( G \) представить как случайные величины, имеющие параметрические распределения элементов конструкции кабельных отходов \( G(\theta) \).

Технологический процесс переработки отходов кабельного производства является емкой практической задачей механического переноса сложных систем детерминированного алгоритма [8, 9, 10], т.к. они характеризуют работу простой единичной системы, что облегчает решение задачи построения обобщенной модели системы с заданным параметрическим семейством распределений и делает невозможным этот процесс для детерминированного анализа из-за возникающих при переработке неразрешимых противоречий в реальном времени течении задачи.

В этой связи, использование в построении обобщенной математической модели процесса переработки отходов кабельного производства путем «рандомизированного» подхода является актуальным решением для поставленной технической задачи.
Рисунок 1. Детерминированный (а) и рандомизированный (б) алгоритмы описания технологического процесса переработки кабельных отходов в дробильной установке

Разработка рандомизированного алгоритма (рис. 1, б) основана на процедуре, основанной на случайном выборе правила, определяющего единичные составы обобщенной системы с распределенных подсистемах, представляющих собой элементы конструкции кабеля разных по массе и плотности.

Эта задача позволит исключить для системы управления процессом переработки большие массивы «перебора» возможных вариантов, алгоритмов, основанных на случайном выборе параметров системы, что позволяет за малый промежуток времени оптимизировать систему управления дробильной установкой: скорость вращения шнека в ограниченный временной промежуток, получение вероятностных результатов, оптимизация и минимизация негативного влияния систематической погрешности (ошибка модели). Алгоритмы подобного типа основаны на последовательной выборе, т. е. на случайном выборе параметров единичной подсистемы, когда детерминированная система выбора (рис. 1, a) определяет только один вариант некоторой случайной схемы распределения элементов входящих подсистем в обобщенную систему. Предлагаемая методика позволяет работать с "вероятностью успешным алгоритмом", который достигает оптимальный технологический результат работы системы управления дробильной установкой с возможным (вероятным) набором предлагаемых режимов работы дробильной установки [11, 12].

Необходимость решения данной технической задачи требует быстрого выбора логического пути в минимальный промежуток времени с помощью встраиваемого в систему управления технологического процесса "умного" блока, который позволит построить разные варианты решений для поддержания и принятия сигнала управления, выбранного на основе единичной системы (рис. 2). В свою очередь, обобщенной системой осуществляется процесс определения варианта «извлечения» необходимой информации, где решающим фактором выбора является время, зависящее от [11, 14]:
- объема информационных ресурсов входящих в ее состав подсистем;
- ограниченного количества вводных данных;
- разнообразия задействованных подсистем в обобщённой загружаемой системы с заданным параметрическим семейством распределений элементов входящих в подсистемы.

Быстродействие выполнения общей задачи исследования зависит от точности постановки задач для всех входящих подсистем [11, 12, 13, 14]. Сложный элементный состав кабельных отходов по массогабаритным параметрам и плотности, а также имеет большой разброс вариантов комбинаций состава возможных подсистем позволяет практически невозможным математически описать явления и процессы, протекающие в рабочей зоне дробильной установки.

Разработка обобщенной математической модели близкой к реальным процессам, которая обязательно должна учитывать включение различных "помех" позволяющих частично компенсировать неконтролируемые внешние возмущения, возможна только "рандомизированным" подходом, который обеспечит получение более точного математического описания процесса дробления загружаемой массы.

Теоретический подход решения данной задачи сводится к определению параметров реальной технологии и оптимизации процесса с целью построения обобщенной математической модели, учитывающей различные помехи, которые частично компенсируют "гробость", вызванную неконтролируемыми внешними возмущениями. Применение детерминированного подхода позволит поисков оптимального алгоритма, обеспечивающего высокое качество
оценки при учете статистических и динамических свойств помех, действующих в рассматриваемой системе.

Адекватность полученного результата оценивается не произвольными значениями системы, а определяется характеристиками (параметрами) технологии дробления, особенностями технологического оборудования (дробилки), свойствами и природой материалов подлежащих дроблению, а также их геометрическими параметрами.

При этом необходимо учесть влияние на результат условий проведения эксперимента, которые определяются наличием внешних сил, помех и т. п. возникающих в рассматриваемой системе – загрузочной смеси, при дроблении, а также особенностями работы технологического оборудования. Оценка результатов определяется неизвестным параметром элемента единичной системы $\theta^*$:

$$y_t = \theta^* u_t + v_t,$$

где: $u_t$, $t = 1, 2, \ldots, N$, входы (управления); $y_t$ – выходы системы.

Рисунок 3. Модель единичной системы (подсистемы)

Единичная система (рис. 3) представляет собой «черный ящик» имеющий входной $u_t$ и выходной $y_t$ сигналы.

Характеристикой системы является неизвестный параметр $\theta^*$, который складывается из характеристик загрузочной смеси и параметров технологического оборудования [8, 9, 10, 12, 13, 14]. Дробление сопровождается внешней помехой $v_t$, которая не зависит от «внутренних» процессов «черного ящика»: погрешность измерений, перепад температур окружающей среды, нестабильность напряжения сети и т.д.

Таким образом, основанием к применению рандомизированного метода в нашем случае является недостаточный объем информации о единичных подсистемах. Однако, не всю информацию по подсистемам, как параметры обобщенной математической модели необходимо учитывать, т.к. это усложняет вычислительную реализуемость процесса.

Достоинством применяемого рандомизированного алгоритма является тот факт, что его эффективность может быть оценена аналитическим методом.

Использование в нашем исследовании Метода случайного поиска строилось на работах Л.А. Растригина [5], Ю.А. Сушкова [6], А. Жилинская и А.А. Жиглявского [7], которые основывались на построении рандомизированных алгоритмов.

Представленная практическая задача по переработке кабельных отходов успешно решается рандомизированным методом, который имеет потенциал и ограничения рандомизации. Учитывая сложный состав загружаемых отходов кабеля оптимальным решением, является применение множественных входных параметров для обобщенной системы, состоящей из подсистем. Оценка уровня результатов строится на учете взаимного влияния множественных параметров, что увеличивает эффективность математического моделирования и подтверждает целесообразность применения рандомизированного метода.
Список литературы:
ОСНОВНЫЕ ТЕХНОЛОГИЧЕСКИЕ ПРОЦЕССЫ ЕСТЕСТВЕННОЙ СУШКИ ХУРМЫ (DIOSPYROS)

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АННОТАЦИЯ

Предложена технологическая линия для сушки хурмы. Проведены испытания с целью определения оптимального времени сушки. Определено, что на качество продукции и на время сушки фруктов и овощей существенно влияют температура и влажность среды, а также интенсивность массо- и теплообмена. Было подтверждено, что уменьшение влажности среды, способствующей интенсификации процессов сушки, позволяет получить качественную продукцию.
ABSTRACT

A technological line for drying persimmons is proposed. Tests were carried out to determine the optimal drying time. It has been determined that the quality of products and the drying time of fruits and vegetables are significantly affected by temperature and humidity, as well as the intensity of mass and heat transfer. The decrease in the humidity of the environment, which contributes to the intensification of the drying processes, which makes it possible to obtain high-quality products, has been confirmed.

Keywords: technology, drying, persimmon, bath, washing, conveyor, dryer, phenolic compounds, proanthocyanidins.

Введение. Хурма содержит витамины В₁, В₂, В₅, В₆, В₉, С, Е, К и А. Наличие физиологически активных веществ класса каротиноидов, танинов, флавоноидов, проантоцианидинов, катехинов, органических кислот превращает хурму в своего рода лечебный кладезь. Эти вещества способствуют нейтрализации свободных радикалов, снижают сердечно-сосудистый фактор риска (кровяное давление и холестерин), развитие рака, сахарного диабета, обладают антибактериальной и антиаллергической активностью, контролируют окислительные и воспалительные процессы, предотвращают деструкцию клеток и уменьшают риски развития хронических заболеваний.

Хурма также содержит другие вещества, такие как рибофлавин, калий, магний, фосфор, цинк, йод, кальций, фосфор, калий, магний, фосфор, цинк, йод, кальций, медь, железо, которые необходимы для мышечных сокращений, нормальной работы нервной системы, здоровой сердечно-сосудистой системы, для метаболизма аминокислот и углеводов, синтеза холестерина и нуклеотидов, роста костной и соединительной ткани, участвует в транспорте кислорода и окислительно-восстановительных реакциях, участвует в образовании тироксина, трийодтиронина, в процессах роста и дифференциации клеток всех тканей и органов, улучшает пищеварение, зрение, уменьшает кровяное давление и уровень холестерина, ускоряет обмен веществ и регулирует метаболические процессы, укрепляет кости, повышает иммунитет и когнитивную функцию мозга [1–6].

В фермерских хозяйствах Республики Узбекистан существуют трудности с сушкой хурмы в естественных условиях из-за отсутствия малых технологических линий с энергоутилизационными устройствами. Возможностями для выращивания овощей и фруктов, в том числе хурмы, достаточно, но сохранить и сбыть урожай проблематично. Поэтому сегодня спрос на малые сушильные устройства растет.

Объекты и методы исследования. Известно, что внедрение малых производственных линий в пищевую промышленность и их развитие позволяют удовлетворить растущий спрос на сушеные фрукты и овощи. Одним из способов удовлетворения спроса на сушеные фрукты и овощи является интенсификация процесса сушки хурмы, экологичность и энергоэффективность основного технологического процесса. Причем безопасность пищевых продуктов имеет первостепенное значение в процессе сушки хурмы как на крупных сушильных предприятиях, так и в малых фермерских хозяйствах, осуществляющих процесс естественной сушки. Из-за периодичности процесса в технологических линиях с естественной сушкой особое значение приобретает получение сушеной хурмы с одинаковыми товарными показателями качества.

Результаты исследований показали, что разработка сушильного устройства исходя из потребностей, усовершенствований существующих и внедрение его в производство является одной из актуальных задач сегодняшнего дня.

Экспериментальная часть. Практические опыты проводили на предприятии ООО «Кукон Евро принт кошодаги Евро Пак мева ишлаб чиқариш корхонаси» на основе договора о кооперации. Эксперименты проведены в технологической линии, состоящей из высококачественных энергосберегающих аппаратов (рис. 1).
Для достижения цели разработали технологическую линию (схему) сушки хурмы (рис. 1). Сушильный аппарат (12) представляет собой изотермический шкаф, который состоит из вращающегося барабана с восходящим теплопроводом и верхним вытяжным аппаратом-кондиционером. Барабан имеет стальной сетчатый поддон и вращается со скоростью 1 об/мин. Температура входящего воздуха – 90 °С. Интенсивность потока регулируется термопарой, поддерживающей температуру внутри шкафа 80 °С. Верхний вытяжной аппарат-кондиционер способствует циркуляции горячего воздуха внутри шкафа. Время сушки составило 16 часов. Мощность линии составила 100 кг/час. Исследования показали, что в процессе естественной сушки хурмы основными недостатками являются ручной труд и длительность процесса сушки. Эти недостатки могут быть устранены обработкой хурмы на высокопроизводительной технологической линии с соблюдением всего технологического процесса.

Результаты и их обсуждение. Полученные образцы сушеной хурмы имели окраску от желтого до коричневого, с белым налётом сахаридов, упругой консистенцией, своеобразным запахом и сладким вкусом (рис. 2).

![Рисунок 2. Образцы фруктов]

Показано, что представленную технологическую линию можно приспособить под конкретную потребность фермерских хозяйств, производящих мультифруктовую продукцию, сохраняя качество получаемой продукции.
Список литературы:
FUNDAMENTAL STRATEGY OF THE METHOD OF ACCOUNTING AND CONTROL OF AUTOMATION AND TELEMECHANICS DEVICES

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ABSTRACT

The article considers the consequence of practical promotion of the computerized process of operation of railway automation and telemechanics devices: signaling, centralization and interlocking; the factors of the automated-executive section of the scheme are indicated; a theoretical form is designed, a modern innovative procedure is improved and the project properties of the automatic method are illustrated. The formation of an automated structure is examined and the method of running this system is explained.

АННОТАЦИЯ

В статье рассматриваются последствия внедрения в практику компьютеризированного процесса работы устройств железнодорожной автоматики и телемеханики: сигнализации, централизации и блокировки; указаны коэффициенты автоматизированно-исполнительного участка схемы; разработана теоретическая форма, усовершенствована современная инновационная процедура и проиллюстрированы проектные свойства автоматического метода. Рассмотрено формирование автоматизированной структуры и объяснен метод запуска этой системы.

Keywords: centralization and blocking devices, windows architecture, date of installation, scheme, program.

Ключевые слова: устройства централизации и блокировки, архитектура windows, дата установки, схема, программа.
The conventional process to automatize the computerized form operation of project documentation is that computer software improvement is gradually forced toward the background, as equal delicate alterations in the strategy of transportation and workflow base the necessity to reprogram the implementation and pass extra interval and currency. An outcome, there is no time to renovate requests positioned on proceeding situations and qualifications of railway transport. Actively developing formations connected to initiative automation demand numerous trained personnel due to high labor intensity. In addition, many qualified specialists in the field of automation are not growing fast enough [1,2,3,4].

At present, several technological means have reached the end of their service life or are approaching it (in indication projects, this is about a quarter of those in production). On purpose prevent further aging of devices, workers of the automation and transmissions economy will have to dramatically growth the pace of modernization of industrial means in the coming years. Meanwhile, newly improved and improved domestic and foreign system of electrical centralization, automatic blocking, dispatcher centralization on a microprocessor foundation should be introduced. Simultaneously, it is compulsory to switch to new modern service automations. The operation is to introduce the maintenance of appliances as much as probable due to technological development, to decrease the likelihood of a negative impact of the human factor on the procedure of establishing the trouble-free operation of scientific indications and, as a consequence, train safety is ensured [5,6,7].

The window construction of the computerized method contains of three stages: program window, system login and window types (fig. 1).

In an automated control system, the user is the most important process. It plays the role of an indication of input, output, search and grouping of material in relation to appliances. Custom windows should be simple, clear, and also ergonomic [8,9].

Let us consider in more detail the main window of the system, which is shown in fig.2. This window is logically divided into 5 parts: 1) the main window of the program, 2) the main menu of the program, 3) the toolbar, 4) the main field of the program, and finally 5) the device display field (DMS), divided into categories.
Adding a new workshop and station for the automation and transmission interspace is provided by the corresponding functions. You can call the list from the context menu of the design diagram. A list of information about all the devices located at the station can be viewed in separate sections. There are several processes of the method. One of them is a window for viewing expired fixtures [10,11,12].

Basic view of the system, replaceable fixtures is identified using the following icons:

Icon 🔄 - shows all appointments of a particular element.
Icon 🔄 - shows the main appliances of a distinct element.
Icon 🔄 - shows replacement devices (before the 30-day period expires).
Icon 🔄 - shows overdue (expired equipment) devices.

Replacing an expired appliance is transported in the “Replacing apparatus” window, which indicates the section, place, type, number, name accordingly the project, observation date, expiration period of device, appointment of removal, remaining service life and the sign of the appliance (fig. 3).

In the general communication section, when a specific device is selected from a particular element, the panel displays instruction concerning the appliance (pattern, serial number, manufacturer, name in accordance with the project, location, replacement season, period of establishment, time of removal of the appliance).

In this window, you can explore for appliances that are gathered in the database system. For example, in order to find a device, select the “Search” tab, the label of the project is written in the textbook field. After clicking the “Detect” button, the window shows the search results. Instrument reporting information can be printed from the print dialog section. In this window, you can configure print settings, preview [13,14].

Automated systems are also being developed in the field of railway automation, as a result of scientific research all manual labor will be converted into an automated system. This not only increases work efficiency but also allows for safe control of devices. All data of the devices is stored in an automated system and their status is constantly monitored. The automated system displays the data of the devices in the case of categories and automatically exchanges them in the database when they are replaced.
References:
AUTOMATION OF HIGH SPEED COMPUTER NETWORK CONTROL

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АВТОМАТИЗАЦИЯ УПРАВЛЕНИЯ ВЫСОКОСКОРОСТНОЙ КОМПЬЮТЕРНОЙ СЕТЬЮ

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ABSTRACT

It is known, that questions of management of the traffic in high-speed computer networks are solved on MAC - a sublevel of model of interaction of local area networks which reports, as a rule, are realized by means of program automatic devices. Thus existing reports, responding a principle of construction of the open systems, suppose the certain opportunities of updating. The same opportunities are incorporated to the structures of formats of the frame of data and the operating frame. All this allows in the certain limits, without essential change of the standard to modify separate reports. Using this feature of the organization of reports, below is offered one of the mechanisms increasing of efficiency reports FDDI.

1. Introduction

Transfer of the information to networks FDDI between logic objects of a MAC-sublevel of various stations it should be carried out in the form of the frame which formats with the instruction of fields are resulted in figure 1.

<table>
<thead>
<tr>
<th>PMB</th>
<th>NO</th>
<th>UK</th>
<th>AP</th>
<th>AO</th>
<th>INFO</th>
<th>KPK</th>
<th>KO</th>
<th>SK</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PMB</th>
<th>NO</th>
<th>UK</th>
<th>KO</th>
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</thead>
<tbody>
<tr>
<td>b)</td>
<td></td>
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<td></td>
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</tbody>
</table>

Figure 1. a) Format of the frame of FDDI data b) Format of the frame of a marker

PMB - the preamble in the frame serves for an establishment of original synchronization of the receiver and should consist, at least, of 16 symbols III (idling). In a status of relaying of station can dynamically change length of a preamble according to concrete requirements of synchronization. Each station should accept normally the frame with a preamble from 12 and more symbols I. [1]

The field NO is an initial field of any frame (data and a marker) and has two symboolical structure (IK).

Field UK defines type of the frame, length of fields AO and AP, and also operating functions of the frame, which format is represented on figure 2, and coding of field UK for various types of the frame of data and marker is resulted in table 1.

<table>
<thead>
<tr>
<th>C</th>
<th>L</th>
<th>F</th>
<th>F</th>
<th>Z</th>
<th>Z</th>
<th>Z</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>X</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
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<tr>
<td>1</td>
<td>X</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Table1.

<table>
<thead>
<tr>
<th>Bats of field UK</th>
<th>Type of the frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Fictitious the frame</td>
</tr>
<tr>
<td>1</td>
<td>The general marker</td>
</tr>
<tr>
<td>1</td>
<td>Dialogue the frame</td>
</tr>
<tr>
<td>1</td>
<td>Frame of the dispatcher of station</td>
</tr>
<tr>
<td>1</td>
<td>The address of following station (ACC)</td>
</tr>
<tr>
<td>1</td>
<td>Frames UDS (MAC)</td>
</tr>
<tr>
<td>1</td>
<td>Malfunction (NS)</td>
</tr>
</tbody>
</table>

Keywords: method of access, the frame, a format of the frame, a marker.

Ключевые слова: способ доступа, кадр, формат кадра, маркер.
2. HIGH SPEED TRAFFIC CONTROL

The field information (INFO) has parallel length which is limited by the maximal common length of the frame of 900 symbols, including four symbols of a preamble. The order of transfer of a field INFO is defined by logic objects UDS or ULZ, or the dispatcher of stations, and should not change during the transfer.

Field AP, AO are coded similarly to fields of frame UDS in local computer networks SHSD and KMD, and also can be either short, or long.

The field CSS - control sequence of the frame serves for detection of errors of transfer of the frame and supervises fields UK, AP, AO, INFO also is calculated on the basis of a standard forming polynomial of 32-nd station.

The field KO - a status of the frame consists of three and more symbols R or S, and can come to an end T. The format of field CK is shown on figure 3. Three first symbolical positions E, A and C fields CK are obligatory for each frame of data. [2]

![Figure 3. Format of field CK: E-bats «the error» is found out; A-bats «address is authenticated»; C-bats «frame is copied»; R-a symbol «a logic zero»; S-a symbol «logic unit»](image)

The station which is giving out in a ring the frame of data, installs symbol R in these positions. The station which has found out a mistake in the frame of data, identified AF as own address or copied the frame, establishes in positions E, A and C symbol S.

Essential additional services are services and primitives, allowing on the basis of the certain temporary parties to operate priority transfers.

Thus the important role is played by the dispatcher-subscriber of such system who cooperating with logic object of a MAC-sublevel and through it with dispatchers of other user's systems operates job of all network and in some limits adjusts character of loading and the traffic in a network. With this purpose it is expanded, in comparison with standard ISO 8802-5, a set of services and primitives, sold by them (table 2.) [3]

Primitives service as render a LLC-sublevel, and the dispatcher of user's system. In the first case they participate in management of the logic channel, in the second - allow to adjust (reconfigure) management of access to passing environment.

**Table 2.**

<table>
<thead>
<tr>
<th>Set of services and primitives, sold by them</th>
</tr>
</thead>
<tbody>
<tr>
<td>UDS_DATA confirmation</td>
</tr>
<tr>
<td>UDS_NUMBER inquiry</td>
</tr>
<tr>
<td>DISP_UDS_INITIALIZATION_PROTOCOL inquiry</td>
</tr>
<tr>
<td>DISP_UDS_INITIALIZATION_PROTOCOL confirmation</td>
</tr>
<tr>
<td>DISP_UDS_MANAGEMENT inquiry</td>
</tr>
<tr>
<td>DISP_UDS_CONDITION indication</td>
</tr>
</tbody>
</table>
The set of parameters of primitives are expanded in appropriate way. So, for example, primitive UDS_DATA the inquiry contains following parameters: Value_UK(1); Value_AP(1); SBD(1); Class service(1); Divider(1);…; Value_UK(I); Value_AP(I); SBD(I); Class service(I); Divider(I); Class marker. As it is specified above, the opportunity of updating is incorporated and in structure of a field of management the frame in which for this procedure reserves bats for developers and the future standardization.

In a network the mode of normal work and a mode of restoration of work of a ring are stipulated, by means of the last actually and adjustment of parameters of functioning of network FDDI is carried out.

The analysis of process of restoration of work of a ring to show, that with some additions and changes in work of the dispatcher of user’s system it is possible to organize management of the dataflow in a network [2]. The block diagram of algorithm management of the dataflow is shown on figure 4 [5].

At the certain divergence of the established size TTRT from user’s system desirable the dispatcher initiates a mode of adjustment of a network. With this purpose he makes active procedure of adjustment of a ring, forming inquiry about initialization of the report with the instruction of desirable parameters of management.

Having entered logic object MAC - a sublevel the given inquiry by means of transmitter MAC - a sublevel according to the report of restoration of a ring is passed following user’s system [6]. The inquiry about initialization of the report, having acted on corresponding user’s system is processed by receiver MAC - a sublevel. Then repeats standard procedure of restoration the work of a ring.

![Flowchart](image)

Fig.4. The block diagram of algorithm of management of the dataflow
3. CONCLUSION

Thus, the mode of reorganization of a ring depending on its status and intensity of streams can be realized. Considering a standard mode of restoration of work of a ring it is possible to read some delay of initialization connected with rivalry of user's systems, for an establishment of time TTRT. To increase efficiency of a mode of restoration the work of a ring it is possible due to formation on the basis of the reserved fields of management of the frame.

References:
DEVELOPMENT OF A WIRELESS WATER QUALITY MONITORING SYSTEM FOR WATER TREATMENT FACILITIES

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ABSTRACT

In this article, a system for monitoring water quality parameters based on a network of wireless sensors has been developed to improve the accuracy of measuring water quality in real time. The results show that the required parameters of the measurement accuracy are respectively, the measurement error of temperature, pH and DO, and the Maximum error of the dissolved oxygen value is 1.9%, 2.6% and 3.1%. The whole system works stable and reliable.

KEYWORDS: water quality monitoring, distributed wireless network, digital filtering algorithm, particle optimization algorithm; PID controller.

Introduction. Water resources are important and the basis for the development of the national economy and are associated with the security and standard of living of people. With the development of the economy of the Republic of Uzbekistan and the improvement of people's living standards, wastewater discharge is increasing day by day, and the wastewater treatment industry is facing huge challenges. The process of wastewater treatment is that the water after a certain treatment must meet the established regulatory standards and the water after treatment can be used in reservoirs [1-4].

Software Development. Transmission Control Center Base Station Programming The base station of the transmission control center is responsible for sending data from the data collection terminal to the remote monitoring system and adjusting the water temperature, DO and pH according to the instructions sent by the remote monitoring system. After turning on the central base station, the data is transmitted to the remote monitoring network and the receiving terminal. The data is sent to the central server for recording and analysis.

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base station, each hardware port is initialized, and then the remote monitoring system is connected first [5]. Connection communication between the base station center and the remote monitoring system can only be initiated by the base station of the transmission control center, and its connection process is as follows: the user enters the unique identification code of the base station of the transmission control center into the remote monitoring system, waits for the central base station to send its own unique identification code, and matches them, and the connection is established correctly, otherwise the connection fails; After connecting to the remote monitoring system, the central base station starts transmitting data. In order to ensure the security of the system, the system is monitored [6-8].

**Wireless network settings for data transfer.** To ensure the efficiency and reliability of data transmission, it is necessary to establish a data transmission and reception network between the data collection terminal and the transmission control center, so that the base station of the transmission control center and the remote monitoring terminal can determine which collection terminal to send data to, and determine the exact search for faulty equipment in maintenance time. In order to achieve this function, by pre-programming the rules for each wireless transceiver module, a tag address is assigned, each time data is transmitted once to the tag address, the base station of the transmission control center and the remote monitoring system through the docking of the received data decoding, sender sensor address can be identified. For this purpose, National Instruments (NI) LabVIEW graphical programming is used. Using a graphical interface, users can query current and historical data through the monitoring system and set target standard water quality parameters.

![Figure 1. Block diagram of the base station software of the transmission control center](image-url)
The remote online monitoring system consists of a human computer interface (UI), a communication module and a database (DB). The function of the user interface is to provide users with a human-computer interface, the communication module is responsible for sending and receiving data, and the database is used to store the collected archive parameters. To save monitoring data for the system, you need to create a database [9-11]. NI provides LabVIEW with specific tools for connecting to a database: connecting to a database; which is implemented with this toolkit; connection between LabVIEW and the database. Install temperature tables, pH tables, and dissolved oxygen tables in the database to store relevant data.

**Figure 2. Block diagram of the base station software of the the block diagram of the communication connection**

**Measurement of water quality parameters.** To check the accuracy of measuring the water quality parameters of the designed system, the corresponding parameters of the same water body are measured simultaneously by a standard device and the designed system, and two measurement results are compared. The table of test results shows: actual temperature 23.5°C, measured value 23.8°C; Actual pH 7.2, Measured value 7.2. Measured at 8.3 mg/L actual dissolved oxygen. The maximum measurement errors for temperature, pH, and dissolved oxygen are 2.1%, 1.3%, and 3.6%, respectively.

To test the feasibility of the control method and the control accuracy of the system, 3 tests were carried out for temperature, pH and dissolved oxygen concentration. The test results for adjusting water quality parameters are shown in table 1.
### Table 1.

**Control Options**

<table>
<thead>
<tr>
<th>№</th>
<th>Measuring parameters before tuning</th>
<th>Parameters according to the standard</th>
<th>Actual correction value (Standard instrument measurement) / % of adjustment error</th>
<th>Adjustment time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature, °C</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>24</td>
<td>20</td>
<td>20,38, 1,9</td>
<td>0,73</td>
</tr>
<tr>
<td>2.</td>
<td>27</td>
<td>20</td>
<td>20,36, 1,8</td>
<td>1,03</td>
</tr>
<tr>
<td>3.</td>
<td>26,5</td>
<td>20</td>
<td>20,30, 1,5</td>
<td>0,98</td>
</tr>
<tr>
<td>pH, (increase)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>5,4</td>
<td>7,4</td>
<td>7,56, 2,2</td>
<td>0,36</td>
</tr>
<tr>
<td>2.</td>
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<td>7,4</td>
<td>7,59, 2,6</td>
<td>0,30</td>
</tr>
<tr>
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<td>5,9</td>
<td>7,4</td>
<td>7,56, 2,1</td>
<td>0,28</td>
</tr>
<tr>
<td>pH, (decrease)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>7,7</td>
<td>7,88, 2,4</td>
<td>0,37</td>
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<tr>
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<td>7,4</td>
<td>7,57, 2,3</td>
<td>0,47</td>
</tr>
<tr>
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<td>7,4</td>
<td>7,57, 2,3</td>
<td>0,55</td>
</tr>
<tr>
<td>DO, (mg/l)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>4,4</td>
<td>7,9</td>
<td>14, 3,1</td>
<td>1,8</td>
</tr>
<tr>
<td>2.</td>
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<td>7,9</td>
<td>8,13, 2,9</td>
<td>2,8</td>
</tr>
<tr>
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<td>6,7</td>
<td>7,9</td>
<td>8,12, 2,8</td>
<td>3,3</td>
</tr>
</tbody>
</table>

**Analysis of results.** Thanks to a comparative analysis of the measurement results of a standard instrument and the measurement results of the designed system, it can be seen that the error between them is very small, and the measurement accuracy meets all standards. After setting the WAN data transmission stability, the data collection terminal worked continuously for 72 hours, and the data transmission was stable. Analysis of the adjustment results can achieve the adjustment of temperature, pH and dissolved oxygen, and the maximum error of its adjustment is 1.9%, 2.6% and 3.1%, respectively. Adjusting the speed and accuracy can meet the needs of the wastewater treatment plant. The water quality results show that the system can adjust and control various water quality parameters, the adjustment speed is faster and more accurate than the manual adjustment method, the stability, accuracy and speed of the control system is better than the traditional manual adjustment method.

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ORGANIZATION OF LABORATORY WORK ON «NUMERICAL METHODS IN THERMAL PHYSICS» IN THE CONTEXT OF ONLINE EDUCATION

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Abstract
This study is devoted to the topical issue of efficient combustion of liquid fuels and the organization of laboratory work on the topic "Numerical Methods of Thermal Physics" as part of online training. The effect of Weber numbers on the processes of atomization and combustion of tetradecane was studied using the KIVA software package. The obtained results can be used to reduce costs in the development of fuels with certain characteristics that solve problems in the design of various technical devices, such as internal combustion engines, increase the efficiency of fuel combustion and reduce emissions.

Keywords: numerical methods, computer simulation, KIVA II, liquid fuel combustion, tetradecane, Weber number.

ОРГАНИЗАЦИЯ ЛАБОРАТОРНОЙ РАБОТЫ ПО ТЕМЕ «ЧИСЛЕННЫЕ МЕТОДЫ В ТЕПЛОФИЗИКЕ» В РАМКАХ ОНЛАЙН-ОБУЧЕНИЯ

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Аннотация
Данное исследование посвящено актуальному вопросу эффективного сжигания жидкых топлив и организации лабораторных работ по теме «Численные методы теплофизики» в рамках онлайн-обучения. Влияние чисел Вебера на процессы распыления и горения тетрадекана исследовали с помощью пакета программ KIVA. Полученные результаты могут быть использованы для снижения затрат при разработке топлив с определенными характеристиками, решающих задачи при конструировании различных технических устройств, например двигателей внутреннего сгорания, повышения полноты сгорания топлива и снижения выбросов.

Ключевые слова: численные методы, компьютерное моделирование, KIVA -II, горение жидкых топлив, тетрадекан, число Вебера.

Introduction

To date, KIVA-II is one of the computer programs that make it possible to study the flow of atomized liquid by numerical calculations, taking into account a number of phenomena that affect the combustion process in the combustion chamber [1, p. 265].

In addition to fossil fuels, energy sources include solar power, hydropower, wind power, and nuclear power. Energy produced on a large scale around the world is obtained by burning fossil fuels.

Prolonged and intensive use of such limited resources results in: 1) the gradual depletion of these resources; 2) an increase in the concentration of harmful substances in the atmosphere. Therefore, in our time it is necessary to look for ways to optimize the use of resources [2, p. 25].

The use of virtual laboratories solves many problems in teaching students when it is difficult to obtain the necessary equipment for research and when it is impossible to work offline [3, p. 29].

The numerical simulation method also takes into account other phenomena, such as molecular transitions, non-small chain chemical reactions, radiation, and heat transfer.

In this work, computational experiments on the combustion of tetradecane were carried out and the influence of high Weber numbers on its atomization and combustion in the combustion chamber was studied. Weber's numbers ranged from 4 to 8, through 0.5.

At a temperature of 300 K, liquid fuel is injected into the combustion chamber through a round nozzle located in the middle of the lower part of the chamber. The combustion chamber is a cylinder of 15 cm high and 2 cm in radius, filled with air at a temperature of 900 K and with the pressure of 32 bar.

The chemical kinetics of the combustion process of tetradecane is given below.

\[ 2C_{14}H_{30} + 43CO_2 \rightarrow 28CO_2 + 30H_2O. \]

Tetradecane is an organic compound of the alkane class. Tetradecane is found in petroleum products and is one of the components of diesel fuel. Under normal conditions, the substance is a colorless, flammable liquid, insoluble in water, but soluble in non-polar solvents.

Research results

Experiments on the study of the processes of injection and combustion of liquid fuels at various values of the Weber number correspond to the following results.

In Figure 1, tetradecane droplet sizes range from 1.02 to 7.65 µm. In this picture, one can see that the droplets are mainly collected at the bottom of the combustion chamber.

**Figure 1. Radial distribution of tetradecane droplets at time \( t = 1.5 \times 10^{-4} \) s. at \( We = 4.5 \)**
If the Weber number value is 6, the liquid fuel atomization is more efficient than the value shown in Figure 1, resulting in a higher and more intense combustion temperature, as shown below. The combustion process takes place in the combustion chamber, the radii of fuel droplets range from 0.645 to 7.095 microns.

![Figure 2. Radial distribution of tetradecane droplets at time $t = 1.5 \cdot 10^{-4}$ s. at $We = 6$](image2)

![Figure 3. Radial distribution of tetradecane droplets at time $t = 1.5 \cdot 10^{-4}$ s. at $We = 8$](image3)

![Figure 4. Dependence of the radius on the Weber number](image4)
Analysis of fig. 3 shows that the tetradecane droplet size ranges from 0.442 to 6.2 µm. For Weber numbers from 4 to 8, the drop sizes decrease. It can be seen in Figure 4.

As a result, as the Weber number increases, the inertial forces acting on the drops increase and deform the drops, leading to their destruction.

Figure 5. Tetradecane fuel concentration distribution at time $t = 6.36 \cdot 10^{-4} \text{ s. for We = 4.5}$

The fuel concentration is shown in fig.5. At the current value of the Weber number, the injection is less intensive, and as shown in the following figures, the fuel burns more efficiently than at higher values of the Weber number. The fuel concentration ranges from 0.05 to 0.7 g/g.

Figure 6. Tetradecane concentration distribution in fuel at time $t = 6.382 \cdot 10^{-4} \text{ s. for We = 6}$

The combustion zone in Figure 6 increases, which indicates the intensity of the combustion process. Fuel concentration values vary from 0.05 to 0.06 g/g. This indicates that the fuel is burning faster than in the previous Figure 5.

The fastest combustion in the range of 0.03-0.06 g/g and the corresponding minimum fuel concentration are shown in Figure 7.
**Figure 7. Time distribution of tetradecane concentration in fuel at time** \( t = 6.393 \cdot 10^{-4} \) s. for \( \text{We} = 8 \)

**Figure 8. Weber dependence on fuel concentration**

Fig. 9 shows the temperature distribution during combustion of tetradecane. Temperature values range from 756 K to 1418 K. Combustion covers a large part of the combustion chamber and occurs at intense and high temperatures, reaching a maximum value of 1418 K.

**Figure 9. Tetradecane temperature distribution at time** \( t = 6.36 \cdot 10^{-4} \) s. for \( \text{We} = 4.5 \) (T, K)
Figure 10. Tetradecane temperature distribution at time $t = 6.382 \cdot 10^{-4}$ s. for $We = 6$ ($T, K$)

Fig. 10 shows the temperature distribution during combustion of tetradecane. The temperature varies from 751 K to 1408 K. Most of the space of combustion chamber is involved in combustion. Combustion is also intense and occurs at high temperatures. The maximum temperature range in this figure 10 is larger than in figure 9 because of increased Weber number to 7 and improvements of the combustion characteristics.

Figure 11. Tetradecane temperature distribution at time $t = 6.393 \cdot 10^{-4}$ s. for $We = 8$ ($T, K$)

Fig. 11 shows the temperature distribution during combustion of tetradecane. The temperature value varies from 758 K to 1421 K.

Figure 12. Temperature dependence of the Weber number
The maximum temperature range in figure 11 is the largest compared to figures 9-10, moreover, it can be seen in figure 12. This is due to the improvement in the characteristics of the combustion process with an increase in the Weber number.

**Figure 13. Water vapor concentration at time** \( t = 6.36 \times 10^{-4} \text{s. for } \text{We} = 4.5 \)

Analyzing Figure 13, one can see that the concentration of water vapor takes values from 0.0013 to 0.019 g/g.

**Figure 14. Water vapor concentration at time** \( t = 6.382 \times 10^{-3} \text{s. for } \text{We} = 6 \)

Figure 14 shows that the concentration of water vapor takes values from 0.0012 to 0.0194 g/g.
Analyzing Figure 15, one can conclude that with an increase in the Weber number, the areas of maximum concentration of water vapor decrease, since the amount of water, which is the product of the reaction, decreases with a more efficient combustion process.

Water vapor concentrations range from 0.0014 to 0.021 g/g. Figure 16 clearly shows that these values are the maximum values.

Conclusion. As a result of studying and analyzing the results of computational experiments, one can draw the following conclusions:

An increase in the value of the Weber number from 1 to 8 leads to: an improvement in the atomization of liquid fuel, a rise in the spread of drops in the space of the combustion chamber, an increase in the area occupied by a temperature flame and temperature in the combustion chamber also rises.

At the optimal value We = 8, the fuel burns completely, while droplets reach a minimum size of 6.6 μm, the combustion chamber heats up to a maximum value of 1422 K, and a small amount of water is formed. With an increase in the Weber number above 8, no significant changes are observed.

The results obtained in this work can be used to reduce the cost of developing fuels with certain characteristics that solve the problems of designing various technical devices, such as internal combustion engines, increasing the efficiency of fuel combustion and reducing emissions.

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MECHANICAL ENGINEERING AND MACHINE SCIENCE

ISSUES OF INFLUENCE OF THE CONTENT OF SULFUR AND PHOSPHORUS IN WIRE ON THE PROPERTIES OF WELDED JOINTS

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ABSTRACT

In the article, the influence of the concentration of sulfur and phosphorus in the wire Св-08Г2С on the properties of welds welded in carbon dioxide is studied. Welding in a carbon dioxide environment is usually performed with Св-08Г2С wire. The standard limits the content of harmful impurities in it. The modern technical level of metallurgy makes it possible to produce this wire with less sulfur and phosphorus. In order to clarify the feasibility of such an increase in the purity of this material, in this work, the influence of the concentration of sulfur and phosphorus in the Св-08Г2С wire on the properties of welds welded in carbon dioxide was studied.

Keywords: carbon dioxide, harmful impurities, seam durability, crystallization crack, phosphorus and sulfur content, manganese content.

ВОПРОСЫ ВЛИЯНИЯ СОДЕРЖАНИЯ СЕРЫ И ФОСФОРА В ПРОВОЛОКЕ НА СВОЙСТВА СВАРНЫХ ШВОВ

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АННОТАЦИЯ

В статье исследовано влияние концентрации серы и фосфора в проволоке Св-08Г2С на свойства швов, сваренных в углекислом газе. Сварка в среде углекислого газа, как правило, выполняется проволокой Св-08Г2С. Стандарт ограничивает содержание вредных примесей в ней. Современный технический уровень отечественной металлургии позволяет выпускать эту проволоку с меньшим количеством серы и фосфора.

Ключевые слова: углекислый газ, вредные примеси, стойкость швов, кристаллизационная трещина, содержание фосфора и серы, содержание марганца.
Research methodology. The influence of sulfur and phosphorus on the properties of the welds was studied during automatic welding in carbon dioxide of steel Cr 3 using experimental wires of the Ca-08Г2C type with different sulfur and phosphorus contents, manufactured at the PWI. E.O. Paton.

To obtain wires with a low concentration of phosphorus, carbonyl iron was used in the smelting of ingots of steel Св-08Г2С. The amount of sulfur was reduced by electroslag melting of ingots of this steel under АНФ–7 flux. The content of sulfur and phosphorus was increased by introducing iron sulfide and Ferrophosphorus into the mixture of experimental melts. Seven batches of experimental wires with 0.007÷0.035% S and 0.011÷0.037% P were tested. At the same time, commercially manufactured Св-08Г2С wire was tested. The wires were tested when welding steel Cr 3 δ = 20 mm of the following composition: 0.17% C, 0.44% Mn, 0.16% Si, 0.18% P and 0.033% S.

The weld metal was subjected to chemical analysis, studies on resistance to crystallization cracks and mechanical tests. Welding was carried out with wires with a diameter of 2 mm at direct current of reverse polarity in the mode: I_{cв}=400÷420 A, U=33÷35 V, V_{cв}=20 m/h, Q_{co2}=1200 m3/h.

The resistance of welds against crystallization cracks was determined by a method based on the static bending of butt specimens during welding [1]. Butt specimens were made from plates 160x120x20 mm in size with a beveled edge at an angle of 30° and a bluntness of 4 mm. Samples were collected without a gap using tacks, welding was performed on a copper lining. The maximum strain rate of the sample \( \nu_{kr} \) at which cracks have not yet appeared was taken as the criterion for the resistance of welds to hot cracks. The presence of cracks was visually detected by the fracture of the seam.

The effect of the phosphorus concentration in the wire on the mechanical properties of the weld metal was determined from the results of tests of tensile and impact specimens. For this purpose, plates made of steel Cr 3 δ =20 mm were butt welded with a V-shaped groove at an angle of 60°. Welding was carried out on an automatic machine in four or five passes until the groove was filled. From the middle layers of the weld metal, discontinuous specimens of type II and impact specimens of type IV (ГОСТ 6996-66) were cut out. The notch on the impact specimens was applied along the critical section from the side of the upper rollers.

Research results. The chemical composition of the experimental wires and the results of testing the weld metal made with these wires for resistance to crystallization cracks are given in Table 1. For comparison, the composition and test results of Ca-08Г2C wire of industrial production (wire №. 8) are also indicated there.

Figure 1 shows the dependence of the resistance of the weld metal against crystallization cracks on the sulfur content in it. This dependence was obtained for welds with 0.12-0.14% C, 0.30-0.40% Si and 0.90-1.10% Mn. It indicates a significant influence of the sulfur concentration in the joints on their resistance to crystallization cracks. So, with a decrease in the amount of sulfur in the wire from 0.034 to 0.007%, the resistance of welds against crystallization cracks more than doubles.

Table 1.

<table>
<thead>
<tr>
<th>№ wire</th>
<th>C, %</th>
<th>Mn, %</th>
<th>Si, %</th>
<th>P, %</th>
<th>S, %</th>
<th>( \nu_{kr} ), mm/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.10</td>
<td>1.79</td>
<td>0.92</td>
<td>0.037</td>
<td>0.034</td>
<td>2.93</td>
</tr>
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<td>2</td>
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<td>0.89</td>
<td>0.035</td>
<td>0.025</td>
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</tr>
<tr>
<td>3</td>
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<td>2.13</td>
<td>1.00</td>
<td>0.022</td>
<td>0.023</td>
<td>4.00</td>
</tr>
<tr>
<td>4</td>
<td>0.08</td>
<td>1.93</td>
<td>1.00</td>
<td>0.011</td>
<td>0.022</td>
<td>4.53</td>
</tr>
<tr>
<td>5</td>
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<td>2.00</td>
<td>1.20</td>
<td>0.018</td>
<td>0.021</td>
<td>4.53</td>
</tr>
<tr>
<td>6</td>
<td>0.11</td>
<td>1.95</td>
<td>1.20</td>
<td>0.022</td>
<td>0.008</td>
<td>4.83</td>
</tr>
<tr>
<td>7</td>
<td>0.11</td>
<td>2.11</td>
<td>0.92</td>
<td>0.012</td>
<td>0.007</td>
<td>5.91</td>
</tr>
<tr>
<td>8</td>
<td>0.09</td>
<td>1.72</td>
<td>0.88</td>
<td>0.021</td>
<td>0.019</td>
<td>4.00</td>
</tr>
</tbody>
</table>
The seams were welded on steel with a high sulfur content (0.032%) in a mode that provides an increased proportion of the base metal in the weld metal. Obviously, the effect of the sulfur concentration in the wire on the resistance of the welds against solidification cracks can be even stronger if the proportion of the base metal in the weld is reduced or steel with a lower sulfur content is used. However, it should be noted that all the given data refer to welds with a small amount of carbon (up to 0.14%). It is known that an increase in the ratio of manganese and sulfur concentrations prevents the formation of crystallization cracks only at a certain limiting carbon content in the metal. With a larger amount of carbon, a decrease in the sulfur concentration or an increase in the manganese content in the metal no longer gives a positive effect [2].

In Table 2 shows data on the composition of the metal of multilayer welds welded with experimental wires. Tensile and impact samples were made from these welds to determine the effect of phosphorus content on impact strength at various temperatures. Chips for chemical analysis were taken from the metal of impact samples after their testing.

Table 2.

<table>
<thead>
<tr>
<th>№ wire</th>
<th>C</th>
<th>Mn</th>
<th>Si</th>
<th>S</th>
<th>P</th>
</tr>
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<td>1,72</td>
<td>0,33</td>
<td>0,032</td>
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<td>0,025</td>
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<td>0,09</td>
<td>1,54</td>
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<td>0,11</td>
<td>1,76</td>
<td>0,35</td>
<td>0,024</td>
<td>0,019</td>
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</tbody>
</table>

The mechanical properties of the metal of welds made with experimental wires are indicated in Tab. 3. As can be seen, the phosphorus content within the studied limits, without significantly affecting the strength and ductility of the weld metal, significantly affects its impact strength. So, when welding with experimental wires № 3-8, providing the content of P < 0.020% in the weld metal, the impact strength is much higher than when using wires № 1 and 2, in which the concentration of this element is more than 0.020%. Phosphorus has a particularly strong effect on the impact strength of the weld metal at low temperatures. So, when welding with wires № 4 and 7, which guarantee the phosphorus content in the weld metal is less than 0.015%, the impact strength at -70°C was 8.6 and 7.8 kg•m/cm², respectively. According to this indicator, the seam was superior to the base metal.

Figure 2 shows the dependence of the impact strength of multilayer welds on the concentration of phosphorus. As can be seen, the effect of phosphorus content on impact strength is greatest at low temperatures. So at -70°C and the presence of 0.018% phosphorus in the weld metal, the value of an < 3 kg•m/cm². It should be noted that all data on the effect of phosphorus concentration on impact strength refer to welds with a low carbon content (up to 0.14%).

As follows from, a decrease in the concentration of phosphorus increases the impact strength of the weld metal only when the carbon content is not higher than a certain limit [2].
### Table 3.

Mechanical properties of the metal of welds made with experimental wires

<table>
<thead>
<tr>
<th>№</th>
<th>Wire</th>
<th>( \sigma_0 ), kg/mm²</th>
<th>( \sigma_t ), kg/mm²</th>
<th>( \delta ), %</th>
<th>( \psi ), %</th>
<th>( au ), kg·m/sm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>28,1</td>
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<td>26,4</td>
<td>62,3</td>
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<td>14,7</td>
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<td>28,3</td>
<td>60,8</td>
<td></td>
<td>13,4</td>
</tr>
</tbody>
</table>

**Findings.**

1. With a relatively low carbon content (up to 0.14%), a decrease in the amount of sulfur in the welding wire significantly increases the resistance of the weld metal against crystallization cracks. Reducing the phosphorus content in the welding wire significantly increases the impact strength of the weld metal at low temperatures.

2. Wire Ca-08Г2C with a low content of sulfur and phosphorus (<0.02% S and <0.02% P) can be recommended for welding critical metal structures in carbon dioxide.

**References:**

THE METHOD OF GENERATING ADDITIONAL AIR POWER IN CENTRIFUGAL APPARATUS AND ITS EFFECT ON WORK QUALITY

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ABSTRACT

The object of research is the process of increasing the initial rate of flat application of mineral fertilizers by throwing them from the pneumomechanical apparatus.

Because the aerodynamic properties of mineral fertilizer grains vary, after they are discharged from the centrifugal apparatus, a process of fractionation is observed according to the properties of the sails during free movement in the air. This process cannot be reversed with an existing decentralized disk apparatus. As a result, the possibility of improving the quality of mineral fertilizers on the field surface is limited.

A new type of pneumomechanical apparatus scheme was developed, developed and field tests were carried out using a method of critical study of the technological processes of centrifugal apparatus in existing and patent information materials and the combination of structural elements in a single working part and the rules of classical mechanics. A mathematical expression was derived and calculated that took into account the formation of additional airflow and the change in the relative velocity of the fertilizer grains relative to it under its influence.

The centrifugal pneumomechanical device is designed to increase the initial speed by simultaneously performing two functions, the first - the throwing of mineral fertilizers, the second - creating an additional air flow and directing it behind the thrown fertilizer grains.

The proposed centrifugal pneumomechanical apparatus ensures that component fertilizers of different sizes, shapes and densities are spread evenly over the field surface.
АННОТАЦИЯ
Объектом исследования является процесс повышения начальной нормы плоского внесения минеральных удобрений путем выброса их из пневмомеханического аппарата.
Поскольку аэродинамические свойства зерен минеральных удобрений различны, после их выгрузки из центробежного аппарата наблюдается процесс фракционирования по свойствам парусов при свободном движении в воздухе. Этот процесс нельзя обратить вспять с помощью существующего децентрализованного дискового устройства. В результате возможности улучшения качества минеральных удобрений на поверхности поля ограничены.
Разработана схема пневмомеханического аппарата нового типа, разработаны и проведены полигонные испытания методом критического изучения технологических процессов центробежного аппарата в существующих и патентных информационных материалах и совмещением конструктивных элементов в единой рабочей части и нормами классической механики. Получено и рассчитано математическое выражение, учитывающее образование дополнительного воздушного потока и изменение относительной скорости движения зерен удобрения относительно него под его воздействием.
Центробежное пневмомеханическое устройство предназначено для увеличения начальной скорости за счет одновременного выполнения двух функций, первая - разбрасывание минеральных удобрений, вторая - создание дополнительного воздушного потока и направление его за выбрасываемыми зернами удобрения.
Предлагаемый центробежный пневмомеханический аппарат обеспечивает равномерное распределение по поверхности поля составных удобрений разной крупности, формы и плотности.

Keywords: mineral fertilizers, centrifugal pneumomechanical apparatus, additional air flow, initial velocity, fertilizer application.

Ключевые слова: минеральные удобрения, центробежный пневмомеханический аппарат, дополнительный поток воздуха, начальная скорость, внесение удобрений.

1. Introduction
Taking into account the specific natural climate and soil conditions of the republic, grain is sown mainly in autumn. Feeding it begins in early spring. Taking into account the fertility of the soil and its other physical and mechanical properties, the condition of the grain in the spring, 600-800 kg of ammonia, phosphorus and potassium mineral fertilizers are applied per hectare.
All types of granular and crystalline mineral fertilizers, which are given to feed grain around the world, are made by mass spraying.
The object of the study is to increase the initial velocity of mineral fertilizer grains in the flat distribution on the field surface by throwing them from the pneumomechanical apparatus and to analyze the results obtained.
Typically, the technological process of mass spraying of mineral fertilizers on the field surface with centrifugal devices is divided into three stages, each of which is analyzed separately. Among the processes, the free movement of the fertilizer grains in the air after being thrown from the centrifugal apparatus is more affected by the uneven scattering.
This is because the grains of fertilizer are divided into fractions based on the coefficients of sail. This means that the ability to control the quality of mineral fertilizers is a factor that does not depend on the technological process of the centrifugal disk apparatus. Therefore, the issue of influencing the initial rate of disposal of fertilizer grains from the technological processes of the centrifugal disk apparatus and thereby reducing their uneven scattering is relevant to the study.
60-65% of all mineral fertilizers are applied to the soil by mass fertilization, which requires maintenance of the specified amount (100-1000 kg / ha) and strict adherence to the entire surface of the cultivated area depending on.

In the world practice, centrifugal disk, centrifugal pendulum, centrifugal rotor, centrifugal circular apparatus are used for mass application of mineral fertilizers.
In world practice, for the mass application of mineral fertilizers on the field surface, various types of centrifugal disk workpieces of different types have been developed [1,3,6,7,8,9,10,11,12,13,14]. However, they are designed to sprinkle granular simple or complex fertilizers. It is recognized that this type of workpiece does not meet the agro-technical requirements when spraying mixtures consisting of several simple mineral fertilizers, the granules of which vary in shape, density and size [1,2,3,13,14].
Based on the above, the aim of the study was to improve the quality of work by spraying mineral fertilizers of different grain sizes with a centrifugal apparatus, affecting their initial velocity at the disc.
The task of the study was to improve the technological process of the centrifugal apparatus by creating an additional air flow and to ensure a smooth application of fertilizers on the field surface.

2. Bipolar transistor radiation degradation model
Conducted on the basis of 30 years of research and analysis of patent information and methods of analysis of the results and the rules of classical mechanics, devoted to the design and technological process of all types of centrifugal disk apparatus for spraying mineral fertilizers and their mixtures around the world.
In this case, the shape of the blades in the centrifugal apparatus for high-quality spraying of mineral fertilizers and their mixtures of different shapes, sizes and densities and their placement on the disk, important elements in the design of additional air generating devices were selected and combined into one working part.
3. Comparative analysis of radiation hardness of the current mirrors on bipolar transistors

Many years of scientific, theoretical and experimental research have shown that the main reason for uneven application of mineral fertilizers of different shapes, sizes and densities across the field surface is that mineral fertilizer grains break down into fractions during their movement in the air after being thrown from the apparatus. As a result, fertilizer grains with a low volatility coefficient fall to the ground at a longer distance, while those with a high volatility coefficient fall to the ground at a shorter distance. As a result, small aggregates and large-sized fertilizers are sorted in the middle of the working width of the unit.

This means that if the mixture contains a large amount of large-scale fertilizer, the amount of fertilizer at the edge of the aggregate working width is denser than at the middle, creating a basis for uneven spraying of the mixture on the components. It follows that it is possible to solve the scientific and technical problem by ensuring the long-distance fall of fertilizer grains with high volatility coefficients and by this method ensuring the proximity or uniformity of the landing distance of different volatile fertilizer grains in the fertilizer [1,2,3,14].

According to the research conducted by the authors, in order to increase the initial velocity of fertilizer grains with a large volatility (sailing) coefficient from the disk, it is possible to direct additional air flow and ensure their disposal over longer distances [2,3,14].

This requires that the technological work of the centrifugal apparatus is not limited to the application of mineral fertilizers, but also has the ability to generate additional air flow at once, as well as theoretically and experimentally based. As a technical solution to these problems, a centrifugal apparatus was developed with improved technological work process and corresponding design (Fig. 1), [2,3,14].

The proposed centrifugal pneumomechanical apparatus consists of a flat horizontal disc 1, logarithmic coil-shaped blades 2 fixed to the upper side, and devices for generating additional air flow 3 mounted on the lower side (Figure 1).

Flat disc with a diameter of 600 mm 1. The height of the paddles is 50 mm. At the bottom of the disc 1, on each paddle 2, is placed a device that generates one additional air, respectively (Fig. 1 a, b).

From the moment when the mineral fertilizer grains are thrown from the pneumomechanical apparatus at the initial speed under the influence of centrifugal force, the second phase of their movement, i.e. free movement in the air, begins. During this period, they begin to be affected by additional airflow.

In the second phase of the study, the following was accepted: - the force of the additional air is directed horizontally; - the velocity and direction of the air flow are the same on the cross-sectional surface of the outlet; - The initial velocities and directions of all fertilizer grains thrown from the shovels are the same. The additional air flow coming out of the outlet of the device, the movement during which it expands in proportion to the distance to the hole, pushing the fertilizer grains in the air with it. Taking into account the distance-dependent decrease of the additional air flow rate [4,5] and the relative movement of the fertilizer grains relative to it, as well as the change in velocity, the authors obtained the following expression,

\[ \dot{x} = \pm k \left( \frac{0.48V_x}{ax} + \dot{x} \right) \]  

(1)

where the distance traveled by the additional air stream along the axis, m;
- \(V_x\) - initial velocity of additional air flow, m/s;
- \(k\) - coefficient of air resistance;
- \(V_x\) - initial velocity of additional air flow, m/s;
- coefficient of turbulence of the \(a\)-flow, \(a = 0.07-0.14\);
- \(x\) is the distance from the air outlet of the device, m;
- \(d\) is the diameter of the outlet, \(d = 0.043\) m2.
(1) the “+” sign in the expression; The “-” sign is used in cases.
(1) is an expression of the second order differential equation, which was calculated by the following values in the Runge-Kutta-Felberg automatic step numerical method: \( k = 0.184-0.265, \ V_х = 50.0-110.0 \ m / s \); the initial throwing velocity of the fertilizer grain is \( V_0 = 25 \ m / s \), the free fall acceleration is \( g = 9.8 \ m / s^2 \) [1.14].

Under the influence of additional air flow, the initial velocity of the fertilizer grains at the outlet changes. This is because the value of the additional airflow velocity is on average 3-4 times higher than the velocity at the time of application of mineral fertilizers from the apparatus, and the directions of movement are also parallel. Based on the results of the calculations, Figure 2 shows the change in the velocity of the fertilizer grains under the influence of the additional air flow.

As can be seen from Figures 2 a, b, the initial velocity of the fertilizer grain was 25 m/s, while after additional air flow, its velocity was 42 m/s (Fig. 2 a), 53 m/s (Fig. 2 b) and 70 m/s (Fig. 2 c). This can be explained by the fact that the force of the additional air flow gives impetus to the fertilizer grains. From the analysis of the graphs, it can be seen that over time the rate of additional air flow decreases rapidly, while that of the fertilizer grain is relatively slow. However, the fertilizer grain had a significantly higher velocity than the initial velocity at the time of discharge from the pneumomechanical apparatus. This is why their throwing distance is large, which allows the machine to increase the working width.

\[ R = mk_u u^2 \]  
(3)

where \( m \) is the mass of fertilizer grain, kg; \( k_p \)-fertilizer grain sailing coefficient, 1 / m; \( u \) is the relative velocity of the fertilizer grain, \( m / s \). The equation of motion of fertilizer grains in the XOU coordinate system in a resistive environment is as follows [1.9,14].

\[ x = \frac{v_y^2}{g} \ln \left( \frac{v_0 g t}{v_y^2} + 1 \right) \]  
(4)

\[ y = \frac{v_y^2}{g} \ln \left( ch \frac{g t}{v_y} \right) \]  
(5)

where \( x \) is the distance traveled by the fertilizer grains along the axis, m:

\( v_y = h \) - distance traveled by fertilizer grains along the ou axis, m.

\( v_y \) is the volatile velocity of the fertilizer grain, \( m / s \).

Once the mineral fertilizer grains are released from the effect of the additional airflow generated in the apparatus, the third phase of their movement begins.

In the third phase, it was assumed that the wind speed in the environment was less than 5 m/s.

Resistance of the medium to the fertilizer grain [4, 5, 6].

\[ R = mk_u u^2 \]  
(3)

Given that, the following expression was formed,

\[ e^t = \left( \frac{y g}{v_y^2} \right) = ch \frac{g t}{v_y} \]  
(7)

(7) by performing mathematical operations on the expression,

\[ t = \frac{v_y}{g} \left( \frac{y g}{v_y^2} \pm \sqrt{\frac{2 y g}{v_y^2} - 1} \right) \]  
(8)

(8) Substituting the value of \( t \) into (3),

\[ x = \frac{v_y^2}{g} \ln \left( \frac{v_0}{v_y} \left( ch \frac{g t}{v_y} \right) \right) + 1 \]  
(9)

(9) The initial velocities of the expression fertilizer grains were calculated from the values \( v_0 = 18-30 \ m / s \), \( v_y = 12 \ m / s \), and \( g = 9.8 \ m / s^2 \), and the connection graphs shown in Figures 3 and 4 were constructed.

Figure 2. Additional air flow and fertilizer grain
1, 2- additional air flow and fertilizer grain velocities respectively Figure 2. Graphs of change of fertilizer grain initial velocity at additional air flow rate 50 (a), 75 (b) and 100 m/s (c)

Solve equation (5) with respect to time \( t \) and put it in equation (2). For this

\[ ch = e^t + e^{-t} \]  
(6)

\[ e^t = \left( \frac{y g}{v_y^2} \right) = ch \frac{g t}{v_y} \]  
(7)

(7) by performing mathematical operations on the expression,

\[ t = \frac{v_y}{g} \left( \frac{y g}{v_y^2} \pm \sqrt{\frac{2 y g}{v_y^2} - 1} \right) \]  
(8)

(8) Substituting the value of \( t \) into (3),

\[ x = \frac{v_y^2}{g} \ln \left( \frac{v_0}{v_y} \left( ch \frac{g t}{v_y} \right) \right) + 1 \]  
(9)

(9) The initial velocities of the expression fertilizer grains were calculated from the values \( v_0 = 18-30 \ m / s \), \( v_y = 12 \ m / s \), and \( g = 9.8 \ m / s^2 \), and the connection graphs shown in Figures 3 and 4 were constructed.
Figure 3 shows a graph of the change in the distance traveled by the fertilizer grain depending on the volatile (critical) velocities.

From Figure 3 it can be seen that the distance traveled increases with the increase in the critical velocity of the fertilizer grain along the bubble curve.

This situation can be explained by the fact that the higher the volatility rate of the fertilizer grain, the less the effect of the environment that resists it. Considering that the volatile velocity of fertilizer grains varies in a large 1.5–15.5 m/s depending on their size, when the volatile velocity is 8–10 m/s, the distance covered by them is in the range of 8.6–11.2 m.

Figure 4 shows a graph of the change in the distance traveled by the fertilizer grain depending on the initial velocity.

It can be seen from Figure 4 that as the rate at which the fertilizer grain enters the resisting medium increases, it is observed that the distance covered by them increases in a view close to the bubble curve. This situation is explained by the fact that the initial speed of the fertilizer grain is large, it can overcome the resistance force exerted by the environment at a certain distance.
4. Conclusion

Based on the results of theoretical research, the following conclusions were made:
1. Improving the quality and application of mineral fertilizers on the field surface by improving the working process and design of the centrifugal disk apparatus, ie by installing logarithmic shovels on the upper side and a device that creates additional air flow at the bottom.
2. The initial velocity of the generated additional air flow is 3.0-4.5 times greater than the initial velocity of mineral fertilizer grains and the direction is parallel, which allows to increase the initial velocity of fertilizer grains by 1.5-3.0 times.
3. Direct parallel flow of additional air flow in accordance with the trajectories of fertilizer grains in the air, reducing the process of separation into different fractions based on their aerodynamic properties, ensuring that they fall to the same distance and, as a result, evenly sprayed.

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TECHNOLOGIES OF METAL STAMPING IN A SOLID-LIQUID STATE

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ABSTRACT

The article considers the advantage of the technology over traditional forging, which is to reduce the power of the equipment and the possibility of obtaining not simple shaped forgings such as bushings, covers, flanges, gears, etc., complex shapes, with good surface quality and high-precision geometric dimensions.

Keywords: microstructure metal thixotropy technology metal suspension temperature deformation hydraulic press stamping.

In the technology of tikso — and re-stamping, the advantages of liquid stamping are preserved and taken into account and its disadvantages are eliminated due to a significant change in the microstructure of the metal: a spherical (globular) microstructure is formed instead of a dendritic one.

This structure is formed by a special effect on the crystallizing metal, during the formation of a solid-liquid suspension in the temperature range between the liquidus and solidus lines, that is, at a temperature below the melt line and above the solidification line. Considerable interest in the new technology of solid-liquid stamping is caused by the discovery of the thixotropy property of metal suspensions with a globular microstructure (M.C. Flemings, 1978).

The thixotropy effect is the ability of metal suspensions with a globular microstructure in a solid-liquid state to significantly reduce the resistance to shear deformations, which allows the metal to fill complex shapes of die cavities with insignificant specific force.

The novelty of the developed technologies lies in the fact that the forming processes are carried out in the solid-liquid state of the metal on blanks in which the globular microstructure of the primary crystallizing phase is pre-prepared.

This requires the development of new schemes for the organization of technological processes in procurement industries.

They should provide for the impact on the metal, during the casting process by various means that prevent the formation of a dendritic microstructure with subsequent stamping (re-stamping) or hardening (preservation of the globular microstructure), reheating to the formation of a solid-liquid phase (suspension) and deformation in stamps on CNC hydraulic presses, or on specialized hydraulic presses (thix-stamping).

Thixotechnologies are characterized by a simultaneous increase in the strength and plasticity of the forging material. And when cooled to a suspension temperature with a solid phase content of more than 90%, it is characterized by plasticity and deformation resistance similar to hot volumetric stamping. Forgings stamped in this way have high quality and increased reliability, significantly improved processability criteria.

In foreign companies, in production conditions, a two-stage stamping is used: 1) production of primary billets with a globular microstructure in metallurgical
production (enterprise, workshop, site): melt, magneto-hydrodynamic mixing of the melt in the mold to obtain a globular microstructure, rolling and hardening of profiles; 2) cutting of a solid billet of the desired size at a machine-building enterprise, subsequent heating it to the temperature of a solid-liquid state (suspension) and shaping stamping.

All metal waste can be returned for remelting to a metallurgical enterprise (workshop, site) TL is the temperature of the liquidus line, TS is the temperature of the solidus line, and fs is the relative proportion of the solid phase in the solid-liquid suspension.

Some advantages of the technology of thixo-stamping: the ability to stamp casting alloys, to obtain forgings of complex-shaped shapes with high dimensional accuracy, to obtain shaped forgings in one transition, high material utilization, reduction of energy costs during deformation, reduction of subsequent machining.

In practice, defects such as liquation, porosity, and clamps may appear. Insufficient knowledge of the issue of the appearance of these defects is a possible obstacle to the widespread use of thixing in industry. When developing an appropriate process management system, it is necessary to increase its stability. Thus, it is necessary to conduct systematic studies of the flow of the material and the appearance of liquor defects, porosity, and clamps in the process of thixing.

Reheating the metal to a solid-liquid state is a particularly important step in the process of thixing. Its purpose is to obtain a homogeneous solid-liquid state of the workpiece with a precisely controlled solid-phase content from globular-shaped particles evenly distributed in the liquid phase with a lower solidification temperature. It is the heating temperature that determines the quantitative content of the solid phase in the workpiece. The purpose of heating is to obtain a specific temperature uniformly over the entire section of the workpiece, lying within the limits between the solidus and liquidus lines. The state of the microstructure of the workpiece before stamping depends on the correctness of the choice of this temperature, the uniformity of its distribution over the cross-section of the workpiece, as well as the total heating time, that is, the degree of manifestation of the thixotropy effect.

When choosing the heating temperature, use the graph of the dependence of the liquid phase content on the temperature at the maximum and minimum silicon content for the A356 alloy (Fig. 2).
The lower limit of the heating temperature should lie above the inflection point on the graph, in this case, the alloy will be guaranteed to be in a solid-liquid state. The upper limit of the heating temperature is determined experimentally. To determine it, it is necessary to be guided by the following criteria: the workpiece should not lose stability, the duration of the thixotropy test should be in the range of time sufficient for transporting the workpiece to the stamp, the mass loss of the workpiece due to separation of the liquid phase should be less than 15%.

To determine the readiness of the workpiece for thixing, it is necessary to use a thixotropy test. Immediately after heating, the workpiece is cut with a knife and the time during which the workpiece is effortlessly subjected to this procedure is fixed. According to the time of the thixotropy test, the degree of "readiness" of the workpiece can be set, during this time the workpiece can be transported from the heating device to the stamp. The process of stamping forgings made of aluminum alloy A356 begins with a minimum solid phase content of ~ 50%. The material during the stamping process must also be in a solid-liquid state, and the stamp must be heated to at least 250° C. To avoid possible leakage of material from the die cavity, stamping should be carried out in closed dies. Currently, there are no recommendations and standards for the design of stamps for the process of stamping. Based on our experience of experimental work, it is recommended to assign internal slopes according to the standards adopted for GOSH, GOST 7505-89 (due to the danger of forging sticking on the inner surface as a result of thermal shrinkage), external stamping slopes 0..2 ° (significantly less than for GOSH). Internal radii of rounding according to the standards of GOSH, GOST 7505-89, external 0..2 mm. It is necessary to lubricate the stamps with a lubricant. When stamping forgings from A356, boron nitride (BN) or graphite in a dispersed state is usually used.

Bibliography:
EXPERIMENTAL STUDIES OF THE TECHNOLOGICAL PROCESS OF PROCESSING CONCAVE SURFACES OF COMPLEX SHAPES

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ABSTRACT

The aim of the dissertation was to improve the existing production technology. As a result of the research, the technological process of machining the body part of increased complexity "Corpus" in the conditions of serial production on technological equipment with numerical control has been improved.

Based on the plans for surface treatment of the part, a starting technological process was developed and illustrations of the processing route were made. Appropriate equipment and process equipment selected.

Ключевые слова: vacuum ring, pvb, cellulose, eva, tpu, silicone rubber, nitrate.

ЭКСПЕРИМЕНТАЛЬНЫЕ ИССЛЕДОВАНИЯ ТЕХНОЛОГИЧЕСКОГО ПРОЦЕССА ОБРАБОТКИ ВОГНУТЫХ ПОВЕРХНОСТЕЙ СЛОЖНОЙ ФОРМЫ

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АННОТАЦИЯ

Целью дисsertации было усовершенствование существующей технологии производства. В результате исследований усовершенствован технологический процесс механической обработки корпусной детали повышенной сложности «Корпус» в условиях серийного производства на технологическом оборудовании с числовым программным управлением.

На основании планов обработки поверхности детали был разработан стартовый технологический процесс и выполнены иллюстрации маршрута обработки. Подобрано подходящее оборудование и технологическое оборудование.

Ключевые слова: vacuum ring, pvb, cellulose, eva, tpu, silicone rubber, nitrate.
Machining on wholesale imalnyh modes may produce ditsu without additional adaptive devices on CNC machines, if the control program is designed with varying na - parameters of the cutting speed and feed. But as modern CAM the system - we do not take into account changes in the geometric parameters of the cutting area, the development of UP with frame adjustment will be possible only "handed - hydrochloric," which is unacceptable when a large amount of control frames.

In addition to establishing the optimal cutting conditions, at the stage of developing the cutting tool, it is necessary to take into account the effect of the cutting force on the pressing of the tool, setting the necessary correction for its geometric dimensions. As parameters optimization process surround frezerova - Nia were chosen and form error performance surface finish.

In an experimental study of the volumetric milling process, it is necessary to consider the following technological parameters:

- cutting modes;
- geometric parameters of the chip formation zone;
- geometric parameters of the tool.

To ensure the highest forecast accuracy of the output characteristics, as factorial designs when constructing models, designs close to D - optimal [69] were used for three variable parameters, the design matrix of which is presented in Table

At each point of the factor space, five experiments were carried out, the planning involved speed, feed, cutting depth, the range of factors is given in section 3.2. Defining display patterns change - teley process and the solution of optimization carried out with the use - vaniem algebraic polynomial of the second degree.

Technical characteristics of the machine 6B52F3.

Experimental studies were carried out on a 6B52F3 three-coordinate vertical milling machine with a SIEMENS 802 CNC system .

![Figure 1. Vertical milling machine with CNC 6B52F3](image1)

Experiments to determine the geometric parameters of the cutting zone on CNC machines

Below is a fragment of the control program for Z = -50 mm, as well as geometric and calculated values for a parabola (Figure 3.2), the branches of which are directed along the Z axis, and the plane is rotated from the XZ plane by 28.5 °.

![Figure 2. Parameters of the control program for Z = -50 mm](image2)

The rack display shows the following information:
- the actual value of XYZ, (position);
- section of the program, for the actual position of the tool;
- often the spindle rotation - S;
- feed F.

Once in software is required baking was introduced by definition block division arc radius circumference surface treated in councils - a block ( . Figure 3.4), by definition, previously has been inserted optionally-governing program - CLOSED plots (2.19).

A 3D model of a spherical surface was built in UNIGRAPHICS CAD .

![Figure 3. Spherical surface programming](image3)

R 1 - radius of the cutter trajectory, R 2 - radius of the machined surface

The developed control programs for various parameters of the preliminary allowance, the radius of the tool sphere, and the radius of the machined surface were tested on a CNC machine.

At sites "wall" machine practiced by moving the feed frame MA1 S = 500 mm / min, when approaching a previously unprocessed area remescheniya perfected on frame MA2 feed S = 250 mm / min.

The experiments revealed , and the possibility that the systems councils Lenia CNC machines allow to define portions approximation instru - ment to previously untreated zone, and the feed switch in the "bottom" mode is made at a height of 0.1-0.3% of the diameter of the milling cutter that enables predot - repair the breakage of the tool.

Conclusions

The experiments carried out by the automatic determination of the geometry - empirical treatment zone parameters and previously untreated areas of the
ICU - the theme of the NC confirm the theoretical expression developed in the WTO - Roy chapter.

Allowance for error processing allows to influence the geometric parameters of the formed linear dimensions and change the trajectory inst - ments to compensate for the error parameter, which greatly increases the accuracy finishing processing volume of the concave spherical surfaces of complex shape cutters.

Bibliography:
METALLURGY AND MATERIALS SCIENCE

PERCUSSION ABRASIVE WEAR OF DROBILES ON WORKING DETAILS MADE FROM SOLID ALLOYS

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УДАРНО-АБРАЗИВНЫЙ ИЗНОС ДРОБИЛЕЙ НА РАБОЧИХ ДЕТАЛЯХ
ИЗ ТВЕРДЫХ СПЛАВОВ

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ABSTRACT

This article describes the impact-abrasive wear of abrasive particles from a hard alloy under the action of a flow of particles during ore crushing, the angle of impact of abrasive particles, the initial size of abrasive particles, the initial size of abrasive particles, the initial concentration of abrasive particles, the moisture content of the crushed material, the number of abrasive particles dedicated to laws.
АННОТАЦИЯ

В данной статье описаны ударно-абразивный износ абразивных частиц из твердого сплава под действием потока частиц при дроблении руды, угол удара абразивных частиц, исходный размер абразивных частиц, исходный размер абразивных частиц, исходная концентрация абразивных частиц, влажность измельчаемого материала, количество абразивных частиц, посвященных законам.

Keywords: a crusher, a finger, the working capacity, Energy dispersive X-ray spectroscopy, scratched areas, abrasive particle.

Ключевые слова: дробилка, палец, работоспособность, энергодисперсионная рентгеновская спектроскопия, поцарапанные области, абразивная частица.

Introduction

One of the main factors influencing the efficient, uninterrupted and high-quality operation of ore crushers used in mining and metallurgical enterprises is the impact resistance of the parts directly involved in the crushing of the ore to impact abrasive wear [1-2]. Therefore, in most cases, the working parts of the crushers (knives, fingers, hammers, etc.) are made of WC-Co based hard alloy. The main reason for this is that the wear resistance of hard alloys in one WC-Co group is higher than the wear resistance of other types of materials [3-4]. However, it is still difficult to conclude that WC, Ti-based hard alloys fully meet the modern requirements for the wear resistance and cost of materials used by mining companies. Because one of the main problems in solving this problem is that the improvement of the operational properties of WC, Ti based hard alloys often leads to an increase in the cost of their production [5-6].

In our opinion, one of the most optimal ways to improve the operational properties of WC, Ti-based hard alloys, especially impact abrasive abrasion without increasing the cost of production, is to study their abrasive mechanism and adapt the physical and mechanical properties of hard alloys to operating conditions. In this paper the results of a study on the mechanism of impact abrasive crushing that occurs in the working parts of ore crushers made of WC-Co based hard alloy is presented.

Object and method of the research

In order to study the mechanism of impact abrasive wear of tungsten carbide cobalt hard alloy, in the “Selective smelting unit” of the Central Mining Administration of JSC “Navoi Mining and Metallurgical Combine” found 94% WC A finger detail made of a hard alloy containing + 6% Co was selected. A picture of a finger grinding ore in a crusher for 110 hours is shown in Figure 1.

Object and method of the research

In order to study the mechanism of impact abrasive wear of tungsten carbide cobalt hard alloy, in the “Selective smelting unit” in the assembly “Central Mining Administration of JSC "Navoi Mining and Metallurgical Combine " made a finger detection of 94%WC+6%Co hard alloy of “CEMCO” and “BARMAK” crushers used in crushing ores containing rare metals. A picture of a finger grinding ore in a crusher for 110 hours is shown in Figure 1.

The finger is 232 mm long and 38.1 mm in diameter, 6 pieces are placed between the rotor of the crusher and the lining plates, the working capacity of the crusher averages 220 t/h, while the total working resource of the fingers is 110 hours. During ore grinding, the average depth of the surface on one side of the finger that was eaten was 8 mm, while the mass of the finger before eating was 3.8 kg and the mass after eating was 2.09 kg. The abrasive absorption of the material was 2.36 t/g.

The chemical and granulometric composition of the ore crushed in the crusher is given in Tables 1 and 2.

Table 1.

<table>
<thead>
<tr>
<th>Elements</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>TiO₂</th>
<th>CaO</th>
<th>MgO</th>
<th>Na₂O</th>
<th>K₂O</th>
<th>MnO</th>
<th>S₂O₂</th>
<th>Su, Pb, Zn</th>
</tr>
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<tbody>
<tr>
<td>%</td>
<td>72,9</td>
<td>14,0</td>
<td>4,61</td>
<td>0,69</td>
<td>1,4</td>
<td>1,9</td>
<td>0,53</td>
<td>2,3</td>
<td>0,05</td>
<td>1,61</td>
<td>0,011</td>
</tr>
</tbody>
</table>
Table 2.

<table>
<thead>
<tr>
<th>Particle size in ore, mm</th>
<th>+5</th>
<th>-5…+20</th>
<th>-20…+50</th>
<th>-50…+150</th>
<th>+150…-250</th>
<th>+250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of ore, %</td>
<td>2,9</td>
<td>7,3</td>
<td>52,1</td>
<td>28,1</td>
<td>6,9</td>
<td>2,7</td>
</tr>
<tr>
<td>Average hardness of ore particles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4…6 (According to the Moos scale)</td>
</tr>
</tbody>
</table>

To study the abrasive abrasion process that occurs in hard alloys, samples measuring 15x10x5 mm were cut from the abrasive surface of the finger using a diamond disk and the areas were photographed using SEM-EVO MA 10 (Zeiss, Germany) scanning electron microscope.

**Results and discussions**

Pictures 2, 3 and 4 show the magnification of x100 to x1000 times using SEM - EVO MA 10 (Zeiss, Germany) scanning electron microscope of different areas of the surface exposed to impact abrasive wear on the finger.

**Figure 2.** Macrostructure of the abrasive worn surface of a hard alloy, x100:
- a - scratched; b - solidified abrasive particle; s - stained areas

During the analysis of the structure of the surface subjected to abrasive wear, there are three categories of areas (Fig. 2, a, b, c) that differ from each other in terms of their origin on the surface: a - scratched areas; b - abrasive particle areas penetrated into the solid alloy base and s - black stained areas of unknown origin were identified.

An image of a particle piercing the surface of a hard alloy is shown in Figure 3.

**Figure 3.** Pictures of scratched area: a - scratched area of different degrees; b - punctured abrasive particle; c - the abrasive particle adhering to the surface
At different magnifications of the abrasive worn surface of the finger (Fig. 3), the particle immersed in the body of the hard alloy and its mark left during immersion are clearly visible (b). It can also be seen that the surface of the particle is partially melted and a portion of it flows to the side and sticks to the material (c). An energy-dispersion X-ray spectroscopy was performed in the area to determine if the particle flowing from the particle belonged to it. The results are shown in Figure 4.

According to the results of the analysis, the particle and the adjacent part of it showed that the origin of the products between the cracks is the same. In addition, the image clearly shows cracks of different sizes and shapes on the surface around the particle (Figure 4). A structural analysis of the surface perpendicular to the eroded surface was performed to determine the origin of the eroded surface and how deep they were (Figure 5).

Structural analysis of the perpendicular surface to the impact abrasive worn surface showed that the scratches themselves and adjacent lines (Fig. 5, a) have a transverse dimension of 25 ... 50 μm, length 250 ... 350 μm, depth 200 ... 300 μkm were found to be cracks. In the areas of the cracks close to the eroded surface, the tungsten carbide grains were broken, and at the lower ends, the crack passed along the cobalt binder between the carbide particles. This indicates that the crack was caused by a large impact on the material.

**Conclusion**

According to the results of the study, the mechanism of impact abrasive abrasion on the surface of the finger part of the crusher made of tungsten carbide cobalt hard alloy is a complex process and it consists of at least three stages occurring simultaneously. In the first stage, the surface of the hard alloy begins to crack on the surface under the influence of a series of blows by large pieces of ore; The second stage begins with the increase in the amount of cracks in the surface unit, in which the ore fragments begin to knock the amount of material in the micro-volume from the body of the solid alloy with their blows; in the third stage, the crushed ore particles continuously grind the surface of the hard alloy.
References:


HYDROMETALLURGICAL AND FLOTATION METHODS OF SLAG DEPLETION

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ABSTRACT
"Almalyk MMC" is one of the largest industrial enterprises of the Republic of Uzbekistan, in addition, it is focused on the production of exported products. As a result of many years of processing of copper concentrates of the copper smelting plant AMMC, more than 7 million tons of waste slag of copper production have been accumulated. At present, part of the old slag from the Copper smelter is processed at AMMC CCF-2 by the flotation method and copper, gold, and silver are recovered. Analysis of the current state of slag processing technology shows that the most preferable for involving slags in processing and obtaining iron from them is the low-temperature reduction technology with subsequent magnetic separation of the metallized phase from the non-magnetic fraction.

АННОТАЦИЯ
«Алмалыкский ГМК» является одним из крупнейших промышленных предприятий Республики Узбекистан кроме того, оно ориентировано на выпуск экспортируемой продукции. В результате многолетней переработки
Slag hydrometallurgy is used only at the Gatsila plant (India), where it replaced flotation, since the latter did not give satisfactory results in the extraction of nickel and cobalt [1]. Melting slag in suspension, containing, %: 1.76 Cu; 0.23 Ni; 0.19 Co; 33.6 SiO₂, are leached with a solution of ferric chloride, the FeCl₃ consumption is 5 times higher than the stoichiometric one. Slag size -0.053 mm, leaching time - 6 h, extraction into solution, %: 54 Cu; 77Ni; 44 Co. It is planned to use this method also at the plant "Khetri" for a mixture of flash smelting slags and converter slags. At other enterprises, either slag flotation or their electrothermal depletion is used. Technical indicators of flotation of converter slags, depending on their composition, are given in Table 1.1.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Copper content</th>
<th>extraction</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slag</td>
<td>Concentrate</td>
<td>Tails</td>
</tr>
<tr>
<td>Krasnouralsky MMC (converter)</td>
<td>3-6</td>
<td>9-15</td>
<td>0,5-0,7</td>
</tr>
<tr>
<td>Software “Balkhashmed” (converter)</td>
<td>1,58-1,6</td>
<td>16</td>
<td>0,17</td>
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<td>Almalyk MMC (converter)</td>
<td>2,07</td>
<td>25,7</td>
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<td>Almalyk MMC (OFF)</td>
<td>2,21</td>
<td>13,8</td>
<td>0,94</td>
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<td></td>
<td>2,05</td>
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<td></td>
<td>1,82</td>
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<td></td>
<td>1,71</td>
<td>8,8</td>
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</tr>
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</table>

Good indicators of slag flotation are achieved only when they are slowly cooled. This is due to the fact that in slowly cooled slags sulfide particles have a particle size of 0.015-0.04 mm, in normally and rapidly cooled slags their particle size is much smaller. However, slowly cooled slags have greater abrasiveness and hardness. At foreign plants, slag flotation is carried out in separate workshops with higher quality structural materials for grinding equipment. At the enterprises of the CIS, where slag flotation is carried out together with ore, there are difficulties with equipment wear, so slow cooling is not used. Almalyk MMC carries out flotation of converter slags together with ore and separately with SOF AMMC in an amount of up to 30% of its mass. Extraction of copper is 80-85% [4]. Converter slag flotation is used in almost all copper plants using autogenous processes, since the removal of converter slag improves the performance of the main smelters.

The flotation of slags with a high copper content from the Noranda process (Canada) is characterized by a high copper content in the tailings [5]. This is due to the need to obtain super-rich concentrates with a copper content of 40-60%. Flotation is mainly carried out by converter slags, in some cases flash smelting slags.

The chemical composition of converter slag entering the flotation processing and the form of finding copper, as well as the results of converter slag flotation at some foreign plants are given in Table 1.1. The Balkhash copper smelter (Kazakhstan) processes imported concentrates along with its own raw materials; The largest suppliers (more than 10.0 thousand tons of concentrate per year) are Erdenetshky (Mongolia), Nikolaeovsky, Dzhezkazganshky, Ushalsky and Tishinsky mines. As of December 1, 2006, 36,737 thousand tons of copper slags were stored in the slag dump with reserves of 472,306 tons of copper in them, with an average content of 0.80%. Slag output varies from 336 to 727 thousand tons per year; the copper content in them varies from 0.7 to 0.87%. The main parameters of slag dumps (as of January 1, 1995): length - 1 km, height - 20 m, occupied area - 49 hectares, density - 3.4-3.5 t/m³, volumetric weight 3.2-3.5 t/m³. Chemical composition, %: Cu-0.41-0.50, Pb-0.16-0.23, Zn - 0.4-1.5, Fe - 30-40, SiO₂ - 38-42, Al₂O₃ - 6-12, CaO-12-14, Re-0.00005, Mo-0.01-0.02, Au-0.1-0.4 and Ag - 4-6 g/t. The slags are not toxic, the admixture of

Keywords: slag, burning, concentration, flotation, waste.

Ключевые слова: шлак, обжиг, концентрат, флотация, отход.
As is 0.02-0.04%, and it is bound into insoluble compounds with iron and calcium. Mineral composition: glass-50-80%, anorthite 1-10%, magnetite, copper sulfides. Stocks of metals in slags (as of 1997): Cu - 156 thousand tons, Au - 12.4 kg, Ag - 0.16 tons, Mo - 0.006 thousand tons, Pb - 0.06 thousand tons, Fe - 10.8 thousand tons. In terms of iron content (25-30%), they are close to iron ores. Due to the admixture of certain alloying metals (tungsten, nickel, cobalt, etc.), steel is obtained by reducing iron. There is experience in the extraction of iron at the Balkhash Mining and Metallurgical Complex. Here, the flotation method was developed and a feasibility study has been drawn up for the processing of dump slags from a medical plant. A technology has been developed and a feasibility study has been drawn up for the processing of slag at existing facilities due to some reduction in the processing of poor off-balance ores from the Koungrad open pit. With an annual volume of slag processing of 1200 thousand tons with a copper content of 0.53%, the output of concentrate should be 28.9 thousand tons with a copper content of 15%. There are proposals for the processing of slags from the Balkhash plant by the cementation method using carburized cast iron, which allows the most complete extraction of non-ferrous, rare and noble metals and iron. Crushed stone and slag can be made from depleted slags. Pilot tests for the processing of copper-smelting slags by the flotation method were carried out back in the 70s. Then the extraction of copper into concentrate was 70%. With separate processing of copper smelting slag, the extraction of copper into concentrate can reach 90%. The proposed capacity of the enterprise is 1 million tons of slag per year. In 1995, during the flotation enrichment, an additional 26.2 thousand tons of copper concentrates were obtained from 304.8 thousand tons of processed slags. Since 1990, complex processing of slag from copper-smelting production with the production of copper and iron concentrates has been carried out by the TVETMET enterprise, later by the Kazakh-American joint venture Kznyzhetai. The Dzhezkazgan copper smelter processes copper concentrates from the Dzhezkazgan concentrator, as well as imported and imported raw materials. Share of own concentrates is 90-95%.

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CIVIL ENGINEERING AND ARCHITECTURE

USE OF BASALT FIBER AND ITS OPPORTUNITIES

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ABSTRACT

There are described the possibilities of creating unconventional materials, targeted functional paintings, and value-added products through the use of basalt raw materials in this article. The article is devoted to the prospects for creating functionally oriented products, innovative composite materials aimed at localizing and creating additional value and research on the use of basalt.

Keywords: basalt, basalt fiber, roving, cord, twisted reinforced roving, woven, bedding, knitwear, sleeve, composite.

Introduction. Decree of the President of the Republic of Uzbekistan of 2019 Resolutions PQ-4277 of April 10 "on additional measures for the organization of the development of fiberglass, fiberglass products, composite materials, energy-saving heating equipment and modern energy-saving systems"[1], PQ-4198 of February 20, 2019 "On measures for the radical improvement and integrated development of the Building Materials industry"[2] are aimed at further development of the production of building materials, increasing the range of modern building materials based on local raw materials and secondary resources. Special attention is expected to be paid to the use of basalt fiber.

Literature review. In the world, basalt was first used as a filler for concrete foundations, in the formation of railway tracks, and then continuous basalt fibers were obtained, from which specific threads, woven fabrics, semi-finished products and composites reinforced with them quickly penetrated aircraft construction, shipbuilding and other industries. At the beginning of the XXI century, with the advent of several new enterprises in Russia, Austria, China, Ukraine, the production and use of basalt fiber has further improved[3].

It has been established that, according to the resistance of crystalline structures to intense mechanical stress, basaltic silicates are arranged in the following order: hydro silicates -> framework aluminosilicates (plagioclases) - chain silicates (pyroxenes) - orthosilicates (forsterite). The low mechanical resistance of hydro silicate is explained by the presence of large interplanar distances along which the destruction of the structure begins. The greater stability of pyroxenes than plagioclases indicates that the chain framework is more mechanically resistant than silicon-aluminum[4].

D.D. Dzhigiris, M.F. Makhova conducted research on the production of basalt fibers, as well as on their practical application[5-7].

According to F.M. Rozanov and L.A. Chernikina[8], complex indicators of the structure of the fabric take into account the ratio of filling the base and back, this factor takes into account the type of weaving, changes in cross-sectional shape and the size of the threads in the fabric. With their help, the filling ratio is defined as the ratio of the actual filling of the tissue to the maximum level.
A.A. Kurbanov studied the structural parameters of basalt rocks and recommended the production of filter materials from their fibers [9]. According to the analysis of the scientific literature, one-sided (unidirectional), two-sided (biaxial), three-way (triaxial) or multilayer fabric obtained from reinforced basalt fibers is also deposited. The above-mentioned textures, used for special purposes, were the result of the interaction of specialists from several industries, which allowed us to obtain relatively inexpensive innovative products, such as various non-traditional (sports goods, some parts of cars and motorcycles, boat and boat hulls, parts with a complex profile, various construction panels, heat, sound insulation and refractory materials, building structures, wind wings). At the same time, in most cases, there are no cases in the literature when basalt fiber can be observed even in production processes that violate environmental requirements, and the enterprise can become a source of environmental pollution [5]. There fore, along with the expansion of the range of basalt fiber and products made from it, the improvement of production technology is also an urgent issue today.

"Paraffin emulsion", which is a multicomponent water-based dispersion containing paraffin, stearin, vaseline, transformer oils, OC-20 preparation, DTSU fasteners and water, is one of the most common surfactants in the textile industry.

Surfactants are used in the manufacture of complex filaments of various compositions intended for the production of various reinforcing materials from basalt fibers. The main dangerous and harmful factors in the preparation of surfactants are physical (electric shock) and chemical (poisoning through the skin) if the concentration norm is not observed.

**Theoretical research.** «Uzmetkombinat» JSC in Bekobot, Tashkent region (7-8 thousand tons), «Mega Invest Industrial» LLC in the Forish district of Jizzakh region (1-1.5 thousand tons) and «Elektroizolit» LLC in Tashkent (0.2 - 0.25 thousand tons) associated its activity with basalt. JV LLC "Mega Invest Industrial" manufactures a range of products from basalt fiber: rebar, mesh, geogrid, geotextile, roving, fiber.

“Geobasalt” LLC was established in December 2020. The company produces corrosion-resistant, durable geonets made of basalt fibers (600, 1200, 2400 tex). The new geosynthesis, in contrast to the metal mesh, does not require corrosion resistance and dryness, lies flat on the surface, is safe to use, can be easily cut with construction scissors, does not lose the strength of alkaline concrete, conducts little heat, and provides high adhesion when using special alloys, allows [10].

The aforementioned enterprises of the country produce building materials from basalt stone, such as basalt fiber, fiberglass, high heat-retaining slabs, composite reinforcement, composite mesh. However, today’s need is to strengthen theoretical and practical research on the use of this type of raw material in the production of textile and composite materials. It is aimed at creating a classification related to the production and use of continuous basalt fibers, as well as the development of basalt fibers in this area and the creation of not only textiles, but also new types of shaped products, and the improvement of existing technologies.

**Results and discussion.** If we look at world experience [4], firstly, the chemical composition of basalt is mainly: SiO2 - 45-60%, Al2O3 - 12-19%, Fe2O3 and FeO - 5-15%, Na2O - 6-12% MgO - 3-7%, TiO2 - 0.9-2%, Na2O and K2O - 2.5-6% and other compounds -2-3.5%. This is a natural raw material, more ready for fiber than glass.

Secondly, the strength of basalt fiber is several times higher than that of other similar fibers, that is, in accordance with the existing dimensions of the diameter of elementary fibers: 5.0 microns - 215 kg / mm²; 6.0 microns - 210 kg / mm²; 8.0 microns - 208 kg / mm²; 9.0 microns - 214 kg / mm²; 11.0 microns - 205 kg / mm².

Thirdly, basalt fabrics and products have high strength, non-flammable and flammable, maintain their integrity up to +980 ° C, are resistant to electromagnetic radiation, moisture, corrosion, resistant to chemical influences (acidic, alkaline media and salts) and have electrical insulating properties. Compared to fabrics and products made of glass yarn, their tensile strength is more than 25%, the operating temperature range is from -260 ° C to + 820 ° C (maximum + 980 ° C).

The following table shows the general characteristics of basalt fabrics. Characteristics of basalt fabrics

<table>
<thead>
<tr>
<th>Code</th>
<th>Type of weaving</th>
<th>Density, g/m²</th>
<th>Thread diameter, μm</th>
<th>Width, mm</th>
<th>Thickness, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>BWP200</td>
<td>Plain</td>
<td>200</td>
<td>9</td>
<td>1000</td>
<td>0.18</td>
</tr>
<tr>
<td>BWP200</td>
<td>Plain</td>
<td>200</td>
<td>13</td>
<td>1000</td>
<td>0.19</td>
</tr>
<tr>
<td>BWP700</td>
<td>Plain</td>
<td>700</td>
<td>13</td>
<td>1000</td>
<td>0.53</td>
</tr>
<tr>
<td>BWP900</td>
<td>Plain</td>
<td>900</td>
<td>13</td>
<td>1000</td>
<td>0.82</td>
</tr>
<tr>
<td>BWT350</td>
<td>Twill</td>
<td>350</td>
<td>13</td>
<td>1000</td>
<td>0.25</td>
</tr>
<tr>
<td>BWT750</td>
<td>Twill</td>
<td>750</td>
<td>13</td>
<td>1000</td>
<td>0.75</td>
</tr>
<tr>
<td>BWU200</td>
<td>Unidirectional</td>
<td>200</td>
<td>9</td>
<td>1000</td>
<td>0.11</td>
</tr>
<tr>
<td>BWU300</td>
<td>Unidirectional</td>
<td>300</td>
<td>13</td>
<td>1000</td>
<td>0.16</td>
</tr>
<tr>
<td>BWU400</td>
<td>Unidirectional</td>
<td>400</td>
<td>13</td>
<td>1000</td>
<td>0.18</td>
</tr>
</tbody>
</table>
At the joint venture of “Mega Invest Industrial” LLC, the largest sample was taken from basalt yarn treated with a special surfactant with a linear density of 85 tex, which was made in the form of an experimental sample wrapped in a single-needle sock of the “Soosan 604” automatic machine [11].

**Conclusion and Recommendations:** The conditions of a cluster development system, which require innovation, industry and intersectoral knowledge, require a comprehensive study of world experience, the production of basalt fibers, the creation of functional fabrics and products, the production of functional composite materials and their targeted use in cooperation with experts in related fields. Effective innovative cooperation, in-depth research, and analysis of scientific databases will accelerate innovation processes and ensure economic growth.

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2. Resolution PQ-4198 “on measures for radical improvement and integrated development of the construction materials industry” of February 20, 2019.
THE MAIN FACTORS INFLUENCING THE FORMATION OF HARMFUL SUBSTANCES IN DIESEL ENGINES

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ABSTRACT

Products of incomplete combustion and partial decomposition of fuel (carbon oxides, hydrocarbons and soot) are formed due to general or local oxygen deficiency. The determining factors for their formation are: fuel composition and quality; excess air ratio, uniformity of the macrostructure and optimum microstructure of the operating mixture.

Keywords: carbon monoxide, hydrocarbons, nitrogen oxides, combustion, excess air ratio.

Fuel composition and quality. Fuel quality mainly has a direct influence on the content of both regulated and unregulated toxic components in the exhaust gases. The content of sulphur and its compounds in exhaust gases (mainly in the form of particulate matter) is proportional to the sulphur content of the fuel. Increasing the share of cyclic and polycyclic aromatic hydrocarbons in the fuel increases the smokiness of exhaust gases. The effect on NOx emission is directly manifested through organic nitrogen compounds in the fuel.

The effect on the reduction of all toxic emissions obtained by improving the fuel quality is quite obvious and is in the range of 10-20%.

Excess air ratio. In diesel engines, the overall excess air ratio determines the particulate (soot) and hydrocarbon content in the exhaust gases, but has little effect on the CO concentration. A clear increase in incomplete combustion products and soot formation is only observed when the excess air ratio is less than 1.35-1.40.

Increasing the air charge pressure (e.g. by increasing the supercharger degree, using a two-stage supercharger) entails a reduction in carbon monoxide and soot.
particles emissions. The effect of increasing pressure on nitrogen oxides is ambiguous, as on the one hand the excess air ratio increases, reducing NOx emissions, and on the other hand the temperature of the air at the cylinder inlet increases, increasing nitrogen oxide emissions.

*Reducing the air charge temperature* (e.g. by using a charge air cooler) by every 10 °C, can reduce the specific NOx emissions by about 10% [4].

*The resistance of the intake and exhaust systems* influences the air charge pressure and temperature. The valves are normally opened by a cam follower with a constant cam profile, and the valve lift law is not optimal at engine operating conditions other than nominal. The current trend is to replace conventional mechanical timing mechanisms with electromagnetic, hydraulic or electro-hydraulically actuated systems. Caterpillar, for example, uses Variable Valve Actuation (VVA) on the C13 and C15 diesel engines.

*The aerodynamics of the air charge*, i.e. the characteristics of the mixture formation process, depend on the geometry of the intake valve and duct.

*The size of the over-piston gap* determines the volume of the flame-extinguishing zone at the piston position near TDC, i.e. determines the emission of incomplete combustion products, mainly hydrocarbons.

*The geometry of the piston side surface* determines the amount of oil entering the combustion chamber from the cylinder walls. This parameter determines the emissions of hydrocarbons, carbon monoxide and soot particles.

*Increasing the compression ratio* results in higher combustion temperatures and combustion products, higher NOx emissions and lower CH emission.

*Type of mixture formation*. In case of film mixing, the smallest quantity of CO, CH and soot particles in exhaust gases is observed; in case of volumetric mixing, the smallest quantity of nitrogen oxides is observed.

*Fuel injection torque*. The formation of pollutants in diesel engines is significantly influenced by fuel injection timing, determined by the angle of crankshaft rotation to the upper dead center (θinj). Late injection shifts the end of the combustion process beyond the expansion phase to the beginning of exhaust, with the result that the amount of incomplete combustion products in the exhaust gas increases.

Increase in θinj has a favorable effect on unburned hydrocarbons content, but causes a sharp increase in nitrogen oxides emission. The latter is explained by the fact that as θinj increases the ignition delay period increases, which, in turn, leads to an increase in the share of cycle fuel, which has undergone pre-ignition preparation and burns at a high rate. This causes an increase in maximum cycle pressure and temperature, naturally leading to increased nitrogen oxide emissions.

*Atomizer geometry* determines the character of fuel jets development: their quantity, opening angle, dispersion of fuel droplets, range. The volume of the sub-air well determines the effect of fuel flow after the main injection, which leads to increased emission of hydrocarbons.

*Engine operating mode*. Increase in load on the diesel engine, compensated by increase in a cycle fuel supply, leads to growth of the maximum pressures and cycle temperatures, accordingly, to increase in NOx concentration in exhaust gases, increase in fuel evaporation time, that entails increase in concentration of products of incomplete combustion [5].

The general pattern of formation of toxic components in diesel exhaust gases is an increase in incomplete combustion products (CO, CH and soot) as the load increases (figure 1.1), when the excess air ratio decreases from 6-8 units at idle to 1.4-1.6 at nominal power mode.

Exhaust gases of diesel engines contain only about 0.1 % (by volume) of CO at idle, the concentration of which increases as the average effective pressure rises up to 0.2 % at full throttle.

![Figure 1.1. Dependence of the exhaust emission content of a diesel engine on load [1]](image)
Therefore, the highest amount of hydrocarbons (up to 0.8 g/m3) is registered at low loads and idle running of diesel engines. Minimum CH emissions occur at pe=0.4-0.6 MPa and at full fuel supply, due to the local oxygen deficit in the diffusion combustion zones, the CH concentration increases again.

The increase in soot emissions is even more significant with increasing load. A sharp increase in smoke-ness, starting from pe=0.4-0.5 MPa, is explained by deterioration of mixture formation processes, change in total and local excess air ratios and slowing down of diffusion stage of combustion against the background of increasing temperature in the flame zone.

References:
WAYS TO IMPROVE THE ENVIRONMENTAL PERFORMANCE OF DIESEL ENGINES

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ABSTRACT
As the diesel exhaust gases contain small amounts of carbon monoxide and unburned hydrocarbons in their normal technical condition, the main focus is to reduce emissions of nitrogen oxide and particulate matter - soot. Excessive presence of oxygen in exhaust gases does not allow neutralization of NOx as it is done in gasoline engines.

Keywords: diesel, exhaust gases, nitrogen oxides, combustion, excess air ratio.

As the diesel exhaust gases contain small amounts of carbon monoxide and unburned hydrocarbons in their normal technical condition, the main focus is to reduce emissions of nitrogen oxide and particulate matter - soot. Excessive presence of oxygen in exhaust gases does not allow neutralization of NOx as it is done in gasoline engines. In this case it is required to introduce additional reducing agents, for example, ammonia (NH₃) which complicates the engine significantly. Therefore NOx reduction directly at fuel combustion is predominant. To this end, the workflow organization of diesel engines is adjusted by:
• optimization of the timing and energy characteristics of fuel injection, ensuring the best possible charge micro- and macrostructure, as well as the lowest possible ignition delay;
• optimizing the vortex motion of the air charge;
• improving the design of diesel engines for water injection into the intake system;
• use of water-fuel emulsions;
• application of exhaust gas recirculation.

In general, the techniques listed aim to start the combustion process as close to the upper dead center as possible with the shortest possible ignition delay period.

A complex programme of changing the fuel injection timing is recommended, depending on the crankshaft speed, load and engine thermal condition. When running a cold engine at idle, it is advisable to increase the fuel injection advance angle with increasing crankshaft speed in order to avoid "white" smoke with high hydrocarbon content. However, after the engine warms up, the value of θinj should decrease by about 10 degrees of crankshaft rotation. When the "hot" engine is working under loading, the program of changing the moment of fuel injection has a completely different nature: θinj must decrease with increasing speed and load modes of the diesel engine from idle to 800-1200 rpm and remain at the level of 5-6 degrees of crankshaft rotation after the upper dead center at high rpm. Such programmes are implemented with the aid of electronic fuel management systems.

In addition to the starting point of fuel injection, the formation of harmful substances is influenced by the duration of injection. If the injection is too long, the last fuel portions are injected directly into the "hot" combustion products and are heated with a lack of oxygen. The result is an increase in incomplete combustion products and an increase in soot particle emissions. Therefore, in modern diesel engines the injection duration is reduced to the technically possible 20-30° rotation of the crankshaft.

A reduction in injection duration is achieved by significantly increasing the injection pressure (p_{inj}). Increasing p_{inj} has a positive effect on atomization fineness, allowing optimization of the fuel jet microstructure and the charge macrostructure and thereby reducing exhaust gas smokiness (figure 1.1).
In connection with this, in modern diesel engineering there is a very clear tendency to increase $p_{\text{inj}}$ up to 100-120 MPa. There are variants of fuel equipment, having injection pressure up to 180 MPa and more. Optimization of charge vortex motion. The charge vortex motion, together with the fuel jet parameters, significantly affects the macro-structure of the fuel-air mixture. As shown by experiments (Figure 1.2) [1], there is a well-defined vortex intensity at which both emissions of incomplete combustion products (CO, CH, C) and specific fuel consumption are minimized. However, in this case there is an increase of nitrogen oxides emission.

Improving the design of diesel engines. The main design methods for improving the environmental safety of diesel engines are:  
• increase in the ratio of piston stroke to cylinder diameter;  
• reduction of the piston volume above the piston;  
• filling the gap between the cylinder liner and the head with a gasket made of heat-resistant synthetic materials;

- reduction in the piston flameband; conversion to four-valve timing systems.

Injection of water into the intake pipe. Water injection into the intake system also has a positive effect on the environmental performance of diesel engines. Under these conditions, the water vapour acts as inert ballast, having little effect on the ignition delay. Reduced charge temperature and a decrease in free oxygen concentration cause a decrease in NOx emission. It was found [2], that addition of 6% (by weight) of water to the air entering the cylinder allows to reduce concentration of NOx in exhaust gases by 50% (figure 1.3).

Application of water-fuel emulsions. An emulsion is a system consisting of two liquid phases, one of which is dispersed as 0.1-100 µm droplets (dispersed phase). The liquid in which the droplets reside is called the dispersed medium. Water-fuel emulsions can be direct (fuel droplets in water) and inverse (water droplets in fuel). However, most studies [3 etc.] show that application of water-fuel emulsions with high water content decreases the concentration of nitrogen oxides in exhaust gases. Thus, with 20 % water in emulsion the content of nitrogen oxides decreases by 30-40 %, and with 40 % water - by 100 %, making 6-8 thousand ppm. In addition, with 20 % water in the emulsion, the concentration of CO decreased by 33 %, and with 40 % water by 66 % and is at 0.1 %. It was also found that the presence of water in the fuel reduces soot formation, preventing the coagulation of its molecules into large agglomerates.

Nevertheless, the prospects for water injection and the use of water-fuel emulsions are not uncontroversial, as they entail many problems. They require a water reserve (up to 20-30 % of the fuel stock). There are difficulties in preparing water-fuel emulsions and ensuring their stability over time, as water is released from the fuel over time and settles to the bottom of the fuel tank.
Figure 1.4. Schematic diagram of an exhaust gas recirculation system

References:


ANALYSIS OF THE IMPLEMENTATION OF AN ECONOMIC MECHANISM TO ENSURE THE ENVIRONMENTAL SAFETY OF MOTOR VEHICLES IN THE CONDITIONS OF UZBEKISTAN

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ABSTRACT

The article analyses current problems of ecologically safe operation of automotive machinery. The concept of ecological safety in the economic sphere is described. The issues of complex assessment of the state of the atmosphere in urban conditions are considered. It is revealed that the currently available economic mechanism of ecological safety of automotive machinery in the region needs improvement.

At present, the issue of ensuring environmental safety in all sectors of the economy has become particularly acute.

In cities, road transport has a huge impact on the state of atmospheric air and the environment, which, in turn, is an integral part of environmental systems.

With the widespread growth of population in cities and, as a consequence, the increase in the number of private cars, as well as public transport, road transport has become one of the most adverse environmental factors for the urban environment and public health.

In this context, an urgent problem today is the development and implementation of measures to improve the urban environment and increase the ecologically safe operation of road transport.

Improving the quality and identifying the main economic methods for creating a mechanism that can ensure the environmentally safe operation of road transport is the aim of this study.

Close attention needs to be paid to measures that can be aimed at improving the economic efficiency of reducing the negative impact of the transport system.

In today’s realities, particular attention is paid to innovative transport development. Innovation oriented to economic benefits can bring additional income, both to the country as a whole and to the regions in particular.

The principle of encouraging the application of measures for environmental sustainability should form the basis for economic impacts on innovation.

For the time being, there are no unambiguous economic impact options for maintaining a safe environment. A combination of such mechanisms is inevitable, as specific technologies, activities and types of production are important.

The use of natural resources is both general and regional in nature. Economic activity and the damage it causes are manifested in the territory of a particular region. Therefore, zoning is necessary for the formation of an economic development mechanism.
Such a development model, which takes into account ecological and other specific features of the region is able to ensure a relative balance between ecology and economy, sustainable ecological, economic and social development.

One of the priority tasks of ensuring the stable development of the country's territories is to create a mechanism that can ensure environmental security. It is the ultimate goal of this mechanism, to save natural resources from depletion, and to significantly reduce harmful emissions into the environment.

Environmental safety is a set of properties, states, processes and actions of various objects, which directly or indirectly do not lead to material damage (or threats of such damage) to the economic environment and to individuals.

Specific normative values have been identified for the concentration of various pollutants and their combinations, at which ecological systems are able to maintain their properties and the so-called ecological equilibrium is not disturbed.

In order to determine how the economic mechanism to ensure environmental safety in road transport operation functions and develops, it is necessary to consider in dynamics the cause-effect relationships.

This method makes it possible to assess the current environmental and socio-economic situation, but also its development in the future.

Two major socio-economic issues are currently determining the main directions for the improvement of the automotive power plant:

- rational use of fuel of oil origin, including its replacement by alternative energy carriers;
- reduction of the harmful environmental impact of motor transport.

The demands of the international community to limit emissions of exhaust substances harmful to public health and the environment from vehicles and to conserve energy resources have led to the emergence of modern developments of new power plants powered by new, environmentally friendly fuels.

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ПРОБЛЕМЫ ПО ИЗУЧЕНИЮ КОМПЕНСАЦИИ ЗА ЗАГРЯЗНЕНИЕ ОКРУЖАЮЩЕЙ СРЕДЫ И ЭФФЕКТИВНОСТЬ ЭКОЛОГИЧЕСКИХ МЕРОПРИЯТИЙ

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ABSTRACT

The article analyses current problems in the study of compensation for environmental pollution and the effectiveness of environmental measures.

Transport companies are constantly working to reduce environmental pollution. Environmental protection activities are aimed at improving the environmental friendliness of stationary and mobile sources of emissions.

Stationary sources are easier to equip with devices that ensure efficient cleaning of pollutants: special technical solutions have been developed to capture particulate matter and gaseous emissions. On vehicles, such devices are of limited use because they increase the weight, require additional space on the rolling stock and are expensive to produce.

In order to motivate enterprises to implement environmental protection measures at both stationary and mobile emission sources, economic leverage and incentives from the state are needed. The amount of pollution charges imposed on enterprises and organizations should be high enough to stimulate their efforts to develop effective pollution reduction measures and carry out environmental protection measures.

The modern payment system is based on the methodology for determining the economic efficiency of the implementation of environmental measures and the assessment of the economic damage caused to the national economy by environmental pollution.

Efficiency of carrying out measures on environment protection should be evaluated from the point of view of nature, society and individual enterprise.

With properly constructed system of payments, the option, which is the most effective from the point of view of enterprises, should provide the bigger effect for the nature and society as a whole.

The environmental, or nature effect, is a reduction in the amount of pollution.p

This damage is expressed in the loss of part of the national income due to increased morbidity, reduced longevity, reduced ability to work and other factors.

The economic effect for an enterprise is determined by the increase in its profits due to the reduction in payments to environmental authorities as a result of environmental protection measures.

Economic efficiency is calculated by measuring the economic effect obtained and the cost of pollution reduction measures.
Pollution fee is a form of compensation for economic damage from emissions of pollutants into the environment. Fees are levied for the following types of harmful impacts on the environment:

- emission of pollutants into the atmosphere from stationary and mobile sources;
- discharge of pollutants into surface and underground facilities, waste disposal;

In accordance with the approved procedure, two types of basic rates of payment for emissions of 1t of pollutants into the atmosphere have been established:

- o for emissions, discharges of pollutants, waste disposal, other types of harmful impact within permissible limits (at the level of maximum permissible emissions MPE and maximum permissible discharges MPD);
- o for emissions, discharges of pollutants, waste disposal, other types of harmful impact within the established limits (temporarily agreed emission TAC and temporarily agreed discharge TAC).

Payments in excess of the established emission or discharge limits are levied at five times the amount of the GHG (GWP).

Pollution charges are a form of economic compensation for emissions and discharges of pollutants into the natural environment, which compensates the costs of compensating the impact of emissions and discharges of pollutants and encourages the reduction or maintenance of emissions and discharges within the established limits. These payments also compensate for the costs of designing and constructing environmental protection facilities.

Payments for environmental pollution are made

- at the cost of products, works and services for actual emissions within permitted norms and limits;
- from the profits of natural users for exceeding the actual emission limit value.

The fee for emissions of pollutants into the atmosphere by DP within the permitted limits by mobile sources may be calculated:

a) at the rates of payment set per 1 tonne of fuel combusted (if data on the amount of fuel consumed is available);

b) the rates of payment stipulated for stationary sources of pollution for emission of 1 ton of pollutants (if there is no data on the amount of fuel consumed but there is reliable information on the mass emission of pollutants);

c) on the rates of annual fee for emissions by one vehicle (if data on the amount of fuel used and the mass of pollutants emitted are not available).

If exhaust gas neutralization systems are used on vehicles, a reduction coefficient is applied in payment calculations: for motor vehicles using unleaded petrol and gas fuel - 0.05, for other vehicles - 0.1.

Payments for allowable emissions of pollutants into the atmosphere of technically serviceable vehicles complying with applicable standards and manufacturer's specifications are determined by the following formula

\[ P_{tr} = \sum_{j=1}^{J} Y_e \cdot T_e \cdot K_e \cdot K_a \]

where \( P_{tr} \) - payments for allowable emissions of pollutants into the atmosphere from mobile sources, \( Y_e \) - specific payments for allowable emissions of pollutants generated from the use of 1 ton of j-th type of fuel, sum/t (Table 1); \( K_e \) - coefficient of environmental situation and environmental significance of the atmosphere in a given region; \( K_a \) - indexation coefficient of pollution charges.

The main regulated pollutants for mobile sources are carbon and nitrogen oxides, hydrocarbons, carbon black, lead compounds and sulphur dioxide.

Reference:
