TECHNICAL PAPER

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1.Problems of the oil refining market

Today's world oil refining has an urgent and very complex problem in processing of heavy oil residues, tar and fuel oil. Heavy oil residues are an exceptionally complex multicomponent and polydisperse molecular weight mixture of high molecular weight hydrocarbons and hetero compounds that include, in addition to carbon and hydrogen, also sulfur, nitrogen, oxygen and metals.

The amount of heavy residues directly depends on the type of oil, as well as the technology of its processing. The tendency of exhaustion of high-quality oil and transition to deep heavy oil or other untapped fuel resources is evident, all this exacerbates the problem. When processing heavy oil, the proportion of tar reaches an unacceptably high level. The potential amount of heavy residues in oil, in most of the deposits, is from 20 to 55% of the mass of oil. However, the problem of utilization of the heaviest products (tar, heavy catalytic gas oils, etc. remaining after the primary and secondary processes) remains.

In case the refinery does not have the technology for specialized processing of heavy oil waste, than the waste is used as components for boiler fuel (furnace fuel oil). The processing of tar into boiler fuel is losing its relevance due to a significant tightening of environmental requirements for fuels (boiler fuel from oil residues of very low quality), and also because of the widespread gasification of power plants.

Another consumer of heavy oil residues is bitumen production, but it also does not allow to solve the above mentioned problem, mainly owing to seasonal demand of bitumen production and formation of tar in quantities exceeding the demand for them as a raw material for bitumen production.

Bitumen production is characterized by seasonal demand (in countries with a stable snow cover in winter), as well as the formation of tar exceeds the demand for them as a raw material for bitumen production.

In view of foregoing, increasing the efficiency of processing heavy oil residues into light oil products and raw materials of basic organic and petrochemical synthesis is a very urgent task for producing countries and consumers of petroleum products.

An increase in the depth of processing of oil residues is achieved by introducing into the scheme of the oil refinery secondary processes for the processing of heavy oil fractions (thermal cracking, catalytic cracking, hydrocracking, etc.).

However, most of these traditional approaches and solutions with many years of practical experience often prove to be insufficiently effective, complex or simply unacceptable and require huge capital investment. The use of fundamentally new technologies creates real prerequisites for obtaining qualitatively new results.

2.Papusha Rocket Technology

As a result of the transformation of Russian rocket and space technology on the basis of fundamentally new ideas, a new type of high-temperature, high-speed combustion was developed and brought to industrial use - transonic combustion (transonic combustion is included in the UN list under the name of the author, Papusha Rocket Technology (PRT)).

The essence of transonic combustion is translating the combustion process into the region of transonic flows, with the artificial initiation of wave processes and a controlled temperature regime (Fig. 1).

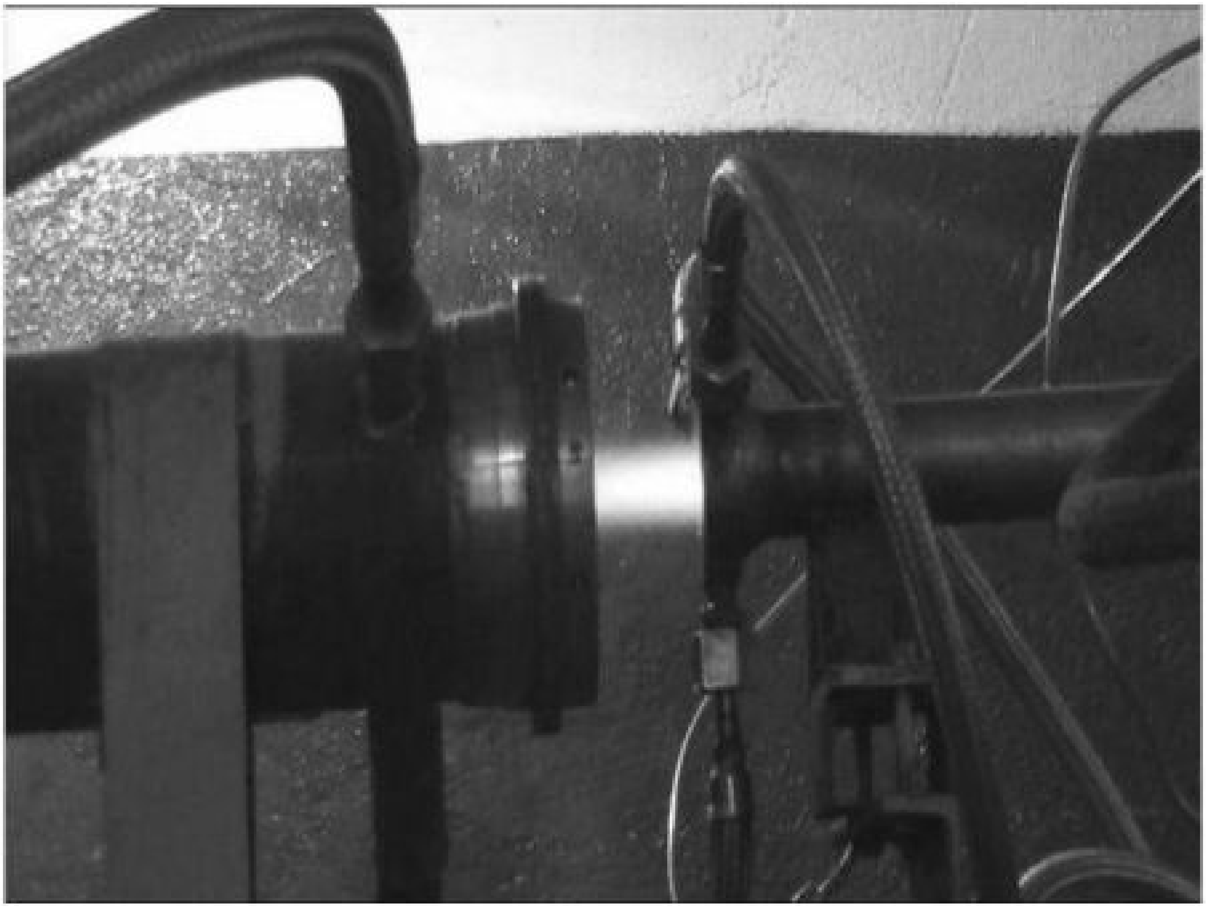


Fig. 1. transonic combustion stream (speed ~ 1000 m/s)

Organization of PRT does not present any fundamental and technical difficulties, just need to provide a critical pressure drop more than 1.6 times and a slight increase in the oxygen potential or initially high temperature of the reacting components.

Development of PRT allowed to provide a new high-temperature combustion process, first of all, stability of combustion, as it is fully isolated from external influence. High speed and dynamic of regulation of the working process parameters give effect of the high-speed stream on the processed substance, providing dispersion (up to the fragments of active radicals) from the almost ideal uniformity of the temperature and concentration fields, while providing wide regulation and control of the working process parameters.

The development, brought to industrial implementation (Annex 1 and 2), created a fundamentally new tool for thermochemical treatment of a wide range of processed substances, including heavy oil waste. Technical implementation of executive means is carried out based on high-tech products of rocket-space and aviation equipment (Fig. 2).

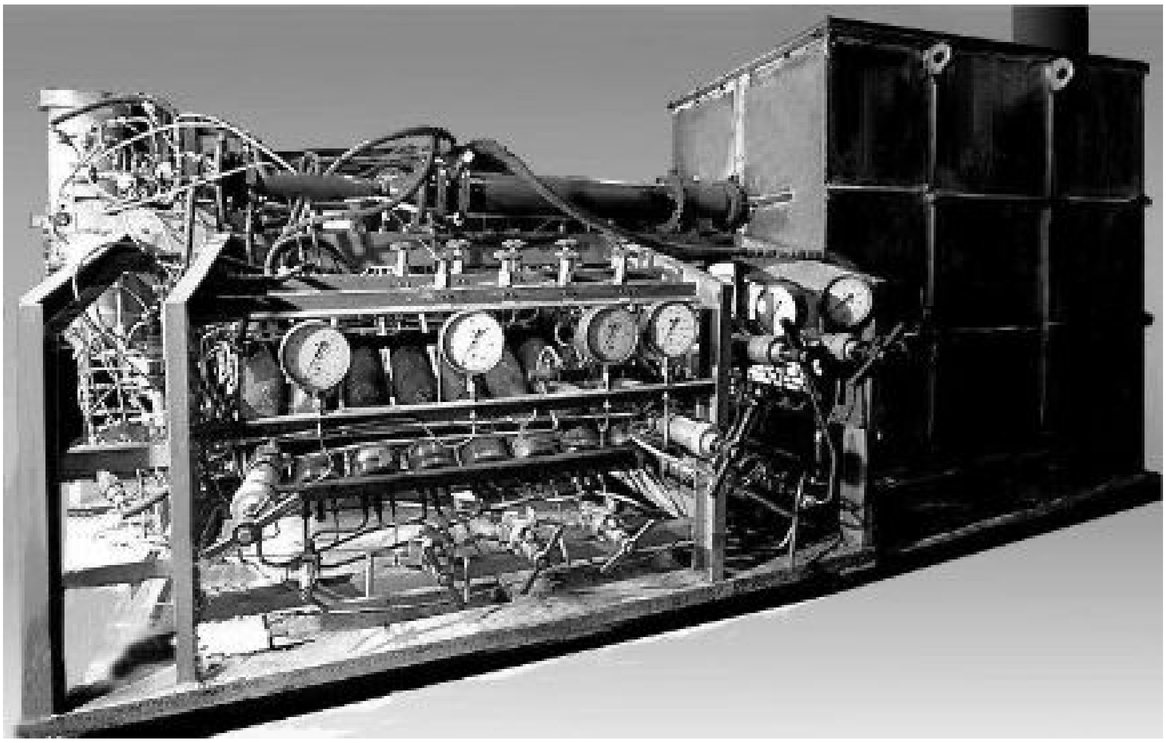


Fig. 2. Industrial module of transonic combustion installation based on a micro-rocket engine (4.5x2.0x1.8 m)

The development of PRT provides:

Efficiency: Combustion efficiency with a record high combustion completion rate up to 99.9999% meets the strictest national and international standards;

Universality: By the quantity of processed substances, the technology has no analogues in the world practice and includes the entire range of especially dangerous substances in the fuel and energy complex. The development of previously unclaimed fuels (such as high-ash, highly watered, low-calorie, etc.) is a huge potential.

Mobility: of the executive systems allows you to work directly at the locations of processed substances, excluding their transportation. It is possible to form mobile complexes of automobile, railway, air and water basing.

Environmental indicators (multiplay higher than traditional achievements), economical indicators (multiply cheaper),

operational indicators (mobility, which has no analogues) have reached or exceeded the world levels.

State and international recognition of achieved results is in Annex 3.

3. Testing of technology

In-depth processing of intermediate petroleum products, in particular, thermochemical processing of tar to produce fuel and petrochemical products is expansion of the practical implementation of PRT.

Based on previous experience (together with more than 1500 experimental and industrial plant inclusions), it is proposed to use the industrial introduction of transonic combustion for tar processing.

The dynamic implementation of the proposed innovative development guarantees the availability of scientific and methodological foundations used in rocket and space and aircraft engineering, high-quality design documentation carried out by representatives of the defense industry, the unique experimental base (Annex 6) and the experience of industrial application of transonic combustion for extreme conditions of neutralization highly toxic substances.

A series of tests were carried out at the transonic combustion installation. The tests showed destructive thermochemical decomposition of heavy hydrocarbons. A multifunctional semi-industrial module of a high-temperature transonic combustion plant was used to process a wide range of chemical substances.

To solve the problem of deep oil refining it was necessary to ensure the following:

- breaking of bonds of high-molecular hydrocarbon compounds (up to elemental state in hydrogen),

- displacement of the ratio of elements C and H to increase H, by introducing additional reagents.

The technical embodiment of such a solution is the organization of stable combustion at anomalously low values of $a \leq 0.2$ (oxidizer excess ratio). It is under such conditions that deep degradation of heavy hydrocarbons into light fractions (actually generation of synthesis gas) is carried out.

For real samples of heavy oil products (tar) (a real industrial sample of intermediate refined products - tar, presented by JSC SvNIINP (Novokuibyshevsk, Samara region) was tested (Annex 4), a series of installation tests was carried out.

Technologically, the organization of a stable combustion process at a ≤ 0.2 should be preceded by the obtaining of an oxidizing working medium necessary for the organization of high-speed, high-temperature combustion. To this end, a special gas generator (SG) was used, creating an active working gas flow at a velocity of ~ 1000 m / sec, a temperature of ~ 1000 °, containing a significant proportion of highly heated oxygen. Such parameters were achieved in an oxygen gas generator operating at an abnormally high a ≥ 5.

Thus, at the first stage of the technological process, a high-temperature working gas is produced in the HG by burning an insignificant part of the processed petroleum products, not in atmospheric air, but in a specially prepared oxidizing medium. To accelerate the active stream formed in the HG to transonic velocities, it is sufficient to provide a pressure drop of ~ 1.6 times. Introduced in such a flow processed substances under a powerful multifactorial action undergo in the reaction chamber (RK) radical physicochemical transformations. Adjustable levels of temperature and chemical composition in GG and RC are provided by maintaining an appropriate ratio of reacting components.

The ratio of the combustible and oxidizing elements in the mixture is selected in such a way that the passage of the reaction of the water gas supplying additional hydrogen is ensured. The thermal regime is provided at a temperature level of ~ 800 ok

The structural scheme of the organization of the proposed process is shown in Figure 3.

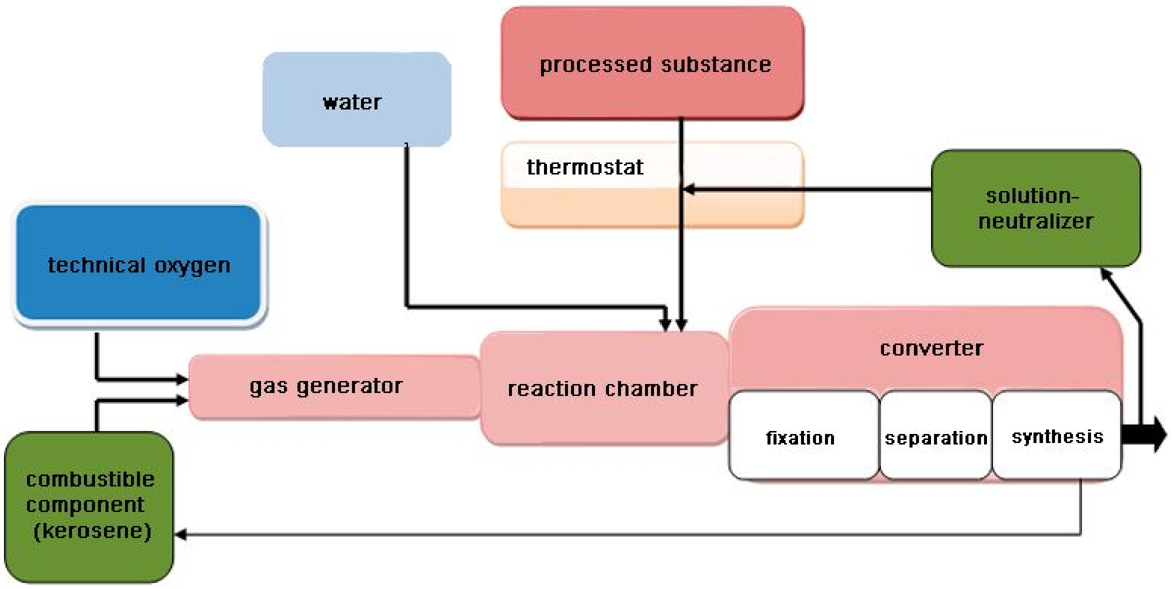


Fig.3 block diagram

With regard to oil refining, which involves a full cycle of extraction of light high-calorie fractions from heavy hydrocarbon compounds, it is possible to carry out a qualitatively new level:

- Deep destruction of high molecular compounds with formation of light fractions;
- Managed synthesis of new composite compounds;
- Fixation (hardening) of the resulting chemical components, with a cooling rate of up to 106 deg. / sec, which is two orders of magnitude higher than in traditional solutions.

In addition to the proposed solution for processing tar into light fuel oil, a significant expansion of the field of implementation in the oil and gas sector is expected in the following areas: utilization of huge accumulations of oil refinery waste - oil sludge accumulated in storage ponds, solving associated petroleum gases, etc.

4. Comparison with developments of competitors

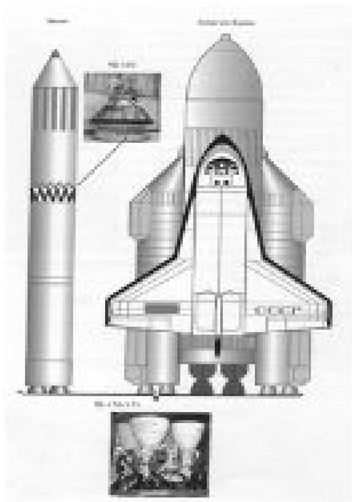
Identification of analogues. Mandatory requirements for joining the group of analogs			Developed technology - Transonic combustion	Thermal cracking
The name of the criterion, scale of quantification	Permissible boundaries of the values of the criterion			
	from. .	to …		
T,°C	400	1200	360-1100	400-750
Pressure, atm	1	120	5-100	1-70
The duration of the process, sec			less 0,05	0,5 - 119
Yield of the product: liquid phase upon degradation of tar,% weight,	0	100	30-60%	12-40%
Metal consumption			The sizes of the main executive unit length 4.5 m width - 1,8 m height - 2,0 m	diameter of the vacuum column 4 - 8 m

Conclusion				Is not an analog

Industrial use of PRT

As a result of the achievements in of Russian rocket and space technology on the basis of fundamentally new ideas, a new type of high-temperature, high-speed combustion was developed and brought to industrial use - transonic combustion.

The development was awarded by state Prize of the USSR in 1986.



Below to the left is the largest combustion chamber in the world (diameter - 5.5 m, length - 35 m, max flow rate - up to 10 tons per second, with 1000-fold CO reduction from 1000 to 1 kg / s.

The common complex is the base object of the space program "Energy - Buran" (currently operating) Khimki, Moscow region.

Stationary industrial complex for dehydration of dioxin-containing transformer oils.
132 tons of "sovtol-10" were disposed of, (class 1 of danger)
OAO Severstal, Cherepovets, Volgograd Region.

The work was awarded the Bardeen Prize in 2000.

Mobile complex, located in a 40-pound container.
Shikhany, Saratov Region 2002-2005.
In the field conditions, 37 special formulations (chlorine, fluorine, sulfur, and phosphorus-containing) were decontaminated with a record level of ecological safety

State and international recognition

The positive result was facilitated by the effective interaction of the leading creative organizations and state institutions with active participation of their leaders: in the OKB and the Research Institute (VP Glushko and VF Utkin), in scientific support of the Academy of Sciences of the USSR and the Russian Academy of Sciences (GI Marchuk and VE Fortov), in the ministries (VI, Danilov-Danilyan and AV Kvashnin). Favorable were contacts at the international level: UN Under-Secretary-General Klaus Töpfer and Marcel Boisar directly got acquainted with the project and the operating installation.

The results of the works were recognized and commended in Russia and abroad.

In the process of performing the work, intermediate results were discussed in the structures of the Academy of Sciences of the USSR and the Russian Academy of Sciences, the State Committee for Nature of the USSR and the Ministry of Natural Resources of the Russian Federation, specialized seminars and conferences, symposiums and exhibitions (for example, ITAR-TASS dated December 29, 1993).

In Russia in 2000, the positive conclusion of the State Ecological Expertise and the license for the works have been received. The technology and installations have been patented in Russia and several other countries:

-Patent of the Russian Federation, No.2240850 dtd 27.11.2004,

-Patent of Ukraine, No.83134 dtd 10.06.2008,

-Patent of Belarus Republic, No.11790 dtd 28.01.2009,

-Patent of India, No.239682 dtd 30.03.2010,

-Patent of the China, No.ZL200580010594.3 dtd 08.12.2010.

Relevant materials are included in the academic publication "The Security of Russia" (part II., Pp. 277-322, MGF "Znanie", M, 2003). The development was highly appreciated at a meeting of the Bureau of the Working Group under the President of the Russian Academy of Sciences on Risk Analysis and Security Problems conducted on April 25, 2006 under the leadership of Academician Frolov K.V. It was decided:

To approve the previously chosen direction of scientific research and experimental development of high-temperature controlled and controlled technology and technical systems for neutralizing super toxicants (including: the highest level of the processes of burning hazardous substances, ecological safety, economic and operational indicators, which corresponds to the level of modern world achievements or exceeds their).

an important property of the development is the possibility of creating mobile complexes that allow to work directly in the places where super toxicants are stored (excluding the need for complex transportation of particularly hazardous substances and wastes).

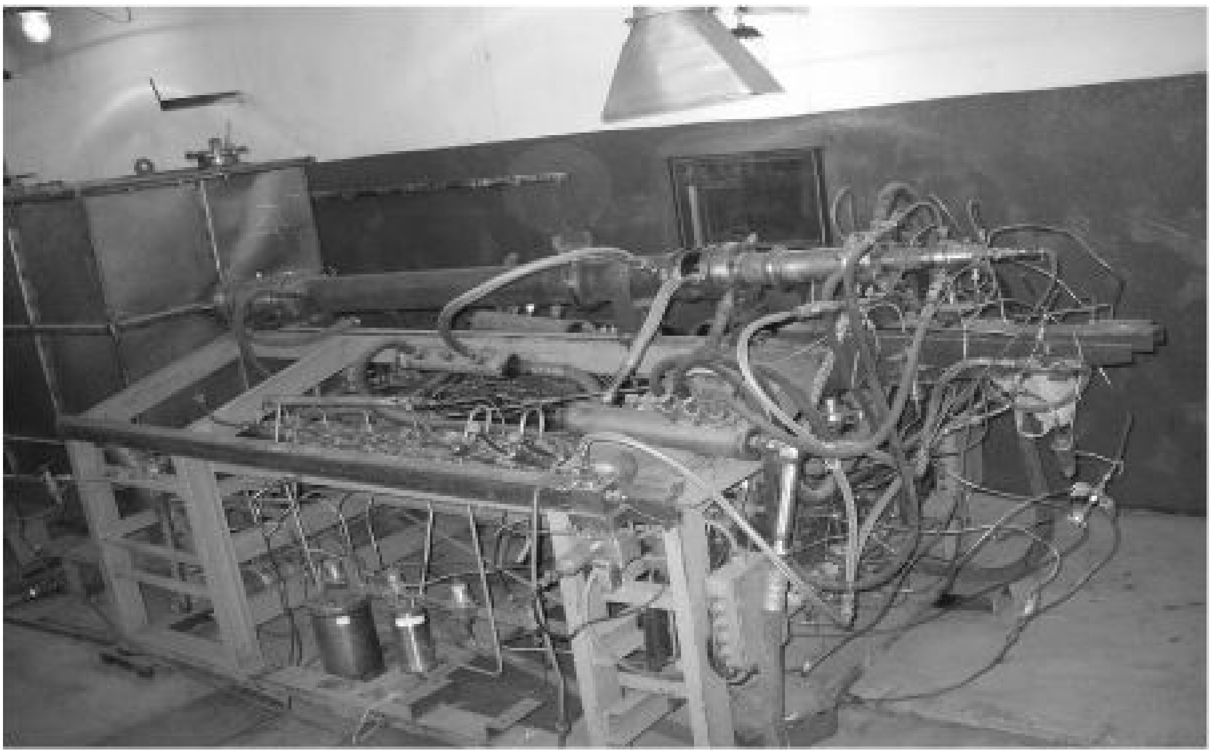
To recommend the developed technology and installation for wide industrial implementation in the largest megacities and industrial centers (including Moscow and St. Petersburg, Yekaterinburg, Chelyabinsk, etc.) at the facilities of the Ministry of Industry, Ministry of Defense, Ministry of Emergencies, Ministry of Transport, Rosprom, etc.

To provide for the creation of a basic facility for deep detoxication of super toxicants, at which (along with solving practical problems and accumulating experience of industrial implementation of new technology), scientific and project support will be provided for the implementation of international obligations declared by the Stockholm Convention, the Montreal and Kyoto protocols, etc.

In order to implement the development, the Government of the Russian Federation issued a resolution "On Priority Actions for

1996-1998 to Address the Waste Problem": No. 216 of 28 February 1996 and No. 1098 of 13 September 1996.

The development was published in the materials of NATO, UNEP, and was reported at the conference on the implementation of the Convention on the destruction of CW and the Stockholm Convention on POPs. At the largest environmental forum in Las Vegas "Environmental Technology for a Healthy World" in 1997, the development was awarded the highest award "For achievements in the development of technologies for the protection of the environment in the interests of all mankind." Development is also listed in the United Nations "Survey of Currently Available Non-Incineration PCB Destruction Technologies" (First Issue, August 2000) under the name of the author of "Papusha Rocket Technology". At the VII International Forum in Moscow in 2006, "High Technologies of the XXI Century" the development was awarded a diploma of the highest degree and a gold medal. In 2017, the development was awarded a special prize of the International Ecological Prize "Eco World".



Experimental installation of high-temperature high-speed incineration of JSC IA "TOS", Dolgoprudny, Moscow region

ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО
«СРЕДНЕВОЛЖСКИЙ НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЙ ИНСТИТУТ ПО НЕФТЕПЕРЕРАБОТКЕ»
(ОАО «СвНИИНП»)

Почтовый адрес: Российская Федерация, 446200, г. Новокуйбышевск, Самарская область, Главпочта
Место нахождения: Российская Федерация, 446200, г. Новокуйбышевск, Самарская область
Телефон: (846-35) 6-24-30. Факс: (846-35) 6-31-77. E-mail: sekr@svniinp.ru
ОКПО 00151911, ОГРН 1026303117510, ИНН/КПП 6330000352/633001001

УТВЕРЖДАЮ:
Технический директор
ОАО «СвНИИНП»
М.А. Панкратов
«___» ____________ 2012г.

ПАСПОРТ
Гудрон

ОАО «СНПЗ», цех №1 установка ЭЛОУ-АВТ-6
пробоотборник гудрона после Т-9
Масса НЕТТО:595,62 кг
Дата отбора проб: 02.06.2011г.
Дата проведения анализа: 07.-29.06.11г.

№ п/п	Наименование показателя качества	Значение	Методы испытаний
1	Плотность при 20°С, кг/м^3	992,7	ГОСТ 3900
2	Содержание серы, % мас.	2,91	ГОСТ 1437 (ГОСТ Р 51947)
3	Температура застывания, ^{0}С	Плюс 42	ГОСТ 20280
4	Фракционный состав, ^{0}С		ASTM D 5236
	НК-320°С	-	
	320 - 378 ^{0}С	1,662	
	378 - 458^{0}С	8,310	
	458 - 515^{0}С	14,958	
	515 - 520^{0}С	16,62	
5	Содержание углерода, %масс	83,94	Элементный анализ, проведенный на растровом электронном микроскопе JEOL JSM-6390A с энергодисперсионным рентгеновским спектрометром JEOL JED 2300
6	Содержание водорода, % масс	-	
7	Содержание азота, % масс	0,39	МВИ №40 св. об атт. № 224.12.02.04 4/2007
8	Групповой углеводородный состав % мас., в том числе:		Методика ГУП «ИНХП», г.Уфа Жидкостной хроматограф «Градиент - М»
	-парафино - нафтеновые углеводороды,	18,5	
	- ароматические углеводороды, % мас.	51,4	
	-Смолы	21,45	
	- Асфальтены	8,65	
9	Вязкость кинематическая, сСт		
	при 100°С	436,1	ГОСТ 33
	при 80°С	1422	ГОСТ 33
10	Коксуемость по Конрадсону, % вес.	5,88	ГОСТ 19932
11	Содержание никеля, ppm	58,9	МВИ
12	Содержания ванадия, ppm	160	ГОСТ 10364
13	Зольность, % мас.	0,232	ГОСТ 1461

ПДК паров углеводородов в воздухе рабочей зоны 300 мг/м^3.
Маркировка, хранение и транспортирование по ГОСТ 1510.
Меры безопасности при работе – использование СИЗ кожи рук, спецодежды спецобуви по ГОСТ 12.4.103 и ГОСТ 12.4.011.
Гарантийный срок хранения 1 год со дня изготовления.
Данные введены на основании испытаний, проведенных ОАО «СвНИИНП» в период с 07.06.11 г. по 29.06.11г.
Аттестат аккредитации № РОСС.RU.0001.515676 от 20 июля 2009г.

Начальник отдела В.А. Ясиненко
Дата выдачи паспорта: 13.02.12г.

УТВЕРЖДАЮ
Технический директор
ОАО «СвНИИНП»
_____________ М.А.Панкратов
«____» ___________ 2012г.

ПАСПОРТ БЕЗОПАСНОСТИ ПРОДУКТА

1. ИДЕНТИФИКАЦИЯ ПРОДУКТА И ФИРМЫ	
Название продукта	Гудрон
Химическое	Не имеет
Техническое название	Гудрон
Адрес производителя	ОАО «Сызранский НПЗ» 446009, Россия, Самарская область г. Сызрань, ул. Астраханская, 1
Адрес поставщика	ОАО «СвНИИНП» 446200,Россия, Самарская область, г. Новокуйбышевск, Главпочта Тел.8(84635) 6-24-30,35-9-86,35-9-60 Факс: 8(84635) 6-31-77
2. СОСТАВ И ИНФОРМАЦИЯ О КОМПОНЕНТАХ	
Название	**концентрация**
Углеводороды (конец кипения не ниже 375°С)	100%
3.ОБОЗНАЧЕНИЕ ОПАСНОСТИ	
Опасность для здоровья	Малоопасный продукт.
Опасность для окружающей среды	Пары не образуют взрывоопасных смесей с воздухом.
Пожароопасность	Не горючая жидкость.
4.МЕРЫ ПЕРВОЙ ПОМОЩИ	
Общая информация	При плохом самочувствии обратиться к врачу
Попадание на кожу	Обильно промыть загрязненное место теплой водой с мылом. В случае необходимости обратиться за медицинской помощью.
Попадание в глаза	Обильно промыть теплой проточной водой. В случае необходимости обратиться за медицинской помощью.
5. ПРОТИВОПОЖАРНЫЕ МЕРОПРИЯТИЯ	
Средства пожаротушения	Углекислый газ, распыленная вода, порошок ПСБ-3; в помещениях объемное тушение.
6.МЕРЫ ПО УСТРАНЕНИЮ СЛУЧАЙНОЙ УТЕЧКИ	Место разлива засыпать песком с последующим его удалением и обезвреживанием. Не допускать попадания вещества в водоемы, канализацию.
7. ОБРАЩЕНИЕ И ХРАНЕНИЕ	
Обращение	Помещения для работы должны быть

	снабжены обменной приточно-вытяжной вентиляцией с механическим побуждением. Избегать попадания на кожу и в глаза. Запрещается курить, есть, пить во время работы с веществом. Использовать средства индивидуальной защиты.
Хранение	Емкости для хранения должны быть защищены от статического электричества. Запрещается хранить совместно с кислотами, баллонами с кислородом и другими окислителями.
8. КОНТРОЛЬ ЗА КОНТАКТОМ С ВЕЩЕСТВОМ И ЛИЧНАЯ ЗАЩИТА	
Технические мероприятия	Не курить и не принимать пищу на рабочем месте. Обеспечить подходящую вентиляцию. Тщательная очистка и стирка спецодежды.
Индивидуальные средства защиты:	
Защита дыхательных путей	В аварийных ситуациях следует использовать фильтрующие противогазы с коробками марки А и БКФ, шланговые противогазы типа ПШ-1 или аналогичные в соответствии с ГОСТ 12.4.034.
Защита рук	Использовать защитные рукавицы, мази и пасты.
Защита глаз	Во избежание попадания в глаза носить плотно сидящие защитные очки.
Защита кожи	Использовать спецодежду для защиты от нефти и нефтепродуктов, непромокаемые фартуки, комбинезоны со специальной пропиткой, кожаную обувь.
9. ФИЗИЧЕСКИЕ И ХИМИЧЕСКИЕ СВОЙСТВА	
Физическое состояние	вязкое вещество
Цвет	черный
Фракционный состав, ^{0}С:	
НК-320°С	-
320 - 378 ^{0}С	1,662
378 - 458^{0}С	8,310
458 - 515^{0}С	14,958
515 - 520^{0}С	16,62
Вязкость кинематическая, сСт	
при 100°С	436,1
при 80°С	1422
Плотность при 20°С	992,7 кг/м^3
Температура застывания	Плюс 42°С
Коксуемость по Конрадсону, % вес.	5,88
Содержание никеля, ppm	58,9
Содержания ванадия, ppm	160
Зольность, % мас.	0,232
10. СТАБИЛЬНОСТЬ И РЕАКЦИОННАЯ СПОСОБНОСТЬ	
Продукт стабилен при соблюдении рекомендованных условий обращения и хранения.	
11. ИНФОРМАЦИЯ О ТОКСИЧНОСТИ	

Попадание на кожу	Может вызывать раздражение кожи
Попадание в глаза	Раздражает слизистую оболочку, вызывает отек слизистой.
12. ИНФОРМАЦИЯ ПО ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ	Является малоопасным продуктом, по степени воздействия на организм относится к 4 классу опасности
13. РЕКОМЕНДАЦИИ ПО УНИЧТОЖЕНИЮ ОТХОДОВ	Отходы собирать в отдельные закрытые металлические емкости и направлять на регенерацию или использовать в качестве сырья для нефтеперерабатывающих предприятий.
14. ТРЕБОВАНИЯ К ТРАНСПОРТИРОВКЕ	Тару не кантовать. Избегать розливов и утечек.
15. ИНФОРМАЦИЯ ПО ОБОЗНАЧЕНИЯМ	
Фазы безопасности	S: 16-20/24/25-36-61 – Беречь от огня – не курить, при использовании не пить и не принимать пищу, избегать контакта с кожей, избегать попадания в глаза, использовать соответствующую защитную одежду, избегать попадания в окружающую природную среду.

Зав. отделом №5 **В.А. Ясиненко**
Зав. лабораторией №10 **И.Н. Канкаева**

СОГЛАСОВАНО:
Гл. специалист по охране труда **Ю.А. Морозов**

Calorific value of tar

1. as per ISO 8217

highest - 42,35 МДж/кг, lowest - 40,10 mJ/kg.

2. as per ASTM D 4868

highest - 42,10 МДж/кг, lowest - 39,84 mJ/kg.

ICO sources

Website papusha.io / personal account lk.papusha.io
Twitter https://twitter.com/Papusha_ICO
Facebook https://www.facebook.com/Papusha-Rocket-tech
GitHub https://github.com/PRTICO/PapushaTokenSale
Telegram https://t.me/prt_chat

Please feel free to ask any question via mail@papusha.io