

AIMBETOVA I.O.

**INDUSTRIAL WASTE OF
CHEMICAL - METALLURGICAL INDUSTRIES
CONTAINING RARE AND RARE EARTH METALS:
METHODS FOR OBTAINING PRIMARY
CONCENTRATES**

Shymkent, 2021

AIMBETOVA I.O.

INDUSTRIAL WASTE OF CHEMICAL - METALLURGICAL
INDUSTRIES CONTAINING RARE AND RARE EARTH METALS:
METHODS FOR OBTAINING PRIMARY CONCENTRATES

Shymkent, 2021

UDC 658.567.1 (075.8)
LBC 30.69 я73
А 26

Aimbetova I.O.

А 26 Industrial waste of chemical - metallurgical industries containing rare and rare earth metals: methods for obtaining primary concentrates. - Shymkent: «Алем», 2021. - 191 p.

Reviewers:

Mamyrbekova A.K. - Candidate of Chemical Sciences, Associate Professor of the Department of "Ecology and Chemistry", IKTU named after K.A. Yassawi.
Ismailov A.A. - laureate of the State Prize of the Republic of Kazakhstan, Doctor of Technical Sciences, Professor of M. Auezov South Kazakhstan University
Baigenzhenov O.S. - PhD, Associate Professor of K. Satpayev Kazakh National Research Technical University.

The monograph presents methods of processing technogenic waste to extract rare and rare-earth metals from them, forms of processing vanadium catalysts, procedures for obtaining concentrates of rare and rare-earth metals from various environ. Although the technology of securing metal concentrates makes it possible to increase the extraction of industrially important metals into primary productive materials, topical issues on the disposal of industrial waste are also partially considered.

The monograph is intended for engineering workers, technical and scientific workers engaged in the theory and practice of metallurgy and geoecology processes, processing of technogenic waste, and can also be used by students, master's students, and doctoral students of technical universities in the specialties: geoecology, metallurgy and chemical technology.

The monograph was published based on funds from the grant project AR09058456 (contract No. 57-KMU2 of 23.02.2021) and the grant of the Best Teacher of High School -2020.

Recommended for publication by the decision of the Senate of the International Kazakh-Turkish University named after K. A. Yassawi (Protocol No. 2 of 27.10. 2021.)

ISBN 978-601-08-1483-7



9 786010 814837

© Aimbetova I.O. 2021

CONTENT

NORMATIVE REFERENCES	4
DEFINITIONS, DENOTATIONS AND ABBREVIATIONS	8
INTRODUCTION	6
1 THE CURRENT STATE OF THE RARE-METAL AND RARE-EARTH INDUSTRY, TYPES OF PROCESSED RAW MATERIALS IN KAZAKHSTAN	11
1.1 Analysis of the condition of technogenic formations and their impact on the environment	17
1.2 A brief analytical review on technologies for the extraction of rare and rare-earth metals from technogenic wastes of the chemical and metallurgical industries	24
1.3 Physico-chemical analysis of technogenic wastes of the chemical and metallurgical industry for the content of rare and rare-earth metals, their phase composition	32
2 VANADIUM-CONTAINING TECHNOGENIC WASTE	55
2.1 Developed vanadium catalysts	57
2.2 Sorption technology for the production of ammonium metavanadate from used vanadium catalysts leaching solutions	61
2.3 Vanadium-containing slags	64
2.4 Method for obtaining vanadium pentoxide from pulp solutions of slag leaching	68
3 CONDUCTING RESEARCH ON THE EXTRACTION OF RARE AND RARE-EARTH METALS FROM TECHNOGENIC WASTE INTO PRIMARY PRODUCTIVE MATERIALS (ROUGH CONCENTRATES)	70
3.1 Technogenic waste of the uranium industry containing rare and rare earth metals	79
3.2 Phosphogypsum and agglomeration shop dust containing rare and rare-earth metals	85
3.3 A brief analytical review of the composition of technogenic waste from the uranium industry, and methods of extracting valuable components	97
3.4 Physico-chemical bases of extraction of rare and rare-earth metals from technological solutions	12
3.5 Obtaining rough concentrates from solutions of the uranium industry, containing rare and rare-earth metals	110
4 METHODS FOR THE DETERMINATION OF RARE AND RARE-EARTH METALS IN LIQUID AND SOLID SAMPLES	115
4.1 Method of determination of rare and rare-earth metals using mass separation with induction-coupled plasma	116
4.2 Conducting analytical studies to determine the content of admixtures in rough concentrates	137

5	DEVELOPMENT OF MODES OF PURIFICATION OF ADMIXTURES IN ROUGH CONCENTRATES	140
6	DEVELOPMENT OF TECHNOLOGICAL REGULATIONS FOR THE USE OF MANGANESE ORE AS AN OXIDIZER FROM TECHNOGENIC WASTE FROM THE CHEMICAL AND METALLURGICAL INDUSTRIES.	149
7	PILOT-INDUSTRIAL TESTS	167
8	MAIN CHARACTERISTICS OF INDIVIDUAL REES AND THEIR FIELDS OF APPLICATION	179
	CONCLUSION	185
	LITERATURE	188

NORMATIVE REFERENCES

- GOST 25702.10-81. Rare metal concentrates. Method for determining the amount of rare-earth metals
- GOST 5905-73. Chrome metal
- GOST 24104-88. General-purpose laboratory scales and model scales
- GOST 24104. Laboratory scales. General technical requirements
- GOST 28165. Single-stage electric aquadistillator
- GOST 11125. Concentrated nitric acid, special purity
- GOST 10157. Argon, compressed or liquefied, of high purity
- TU 2633-039-44493179-00. Acetone, special purity
- GOST 12.0.004-79. Occupational safety standards system. Organization of occupational safety training for workers. General Provisions
- GOST 15150. Machines, devices and other technical products

DEFINITIONS, DESIGNATIONS AND ABBREVIATIONS

Leaching is a complex heterogeneous process of interaction of liquid reagents with a solid substance-ore.

Underground leaching is a technology based on the forced injection of aqueous solutions of inorganic compounds (sulfuric acid, etc.) into underground horizons, followed by pumping out a solution containing valuable elements for further processing.

Pulp is a heterogeneous mixture of water and solid mineral or technogenic particles.

The degree of conversion is the ratio of the amount of converted raw materials to the amount of introduced raw materials.

The product yield is the ratio of the amount of the product obtained to the amount calculated by stoichiometry.

REE – rare-earth elements

TPS – thermal power stations

AMD – analytical methods of determination

SLF – Shymkent lead factory

MPW – mining and preparatory work of a productive solution

ICPMSM – Inductively coupled plasma mass separation method

UL – underground leaching

DRS – dynamic reaction system

ETA – electrothermal atomization

LA – laser ablation

PS – productive solutions

RS – returnable solutions

HLP – hydraulic laboratory press

CP – chemically pure

SPE – solid-phase extraction

SPME – solid-phase matrix extraction

PFA – Perfluoroalkoxy Polymer

CIS – Commonwealth of Independent States

FDEC – full dynamic exchange capacity

INTRODUCTION

The mineral resource base for the production of rare refractory metals and rare-earth elements in Kazakhstan is large enough to create on its basis a mining and processing industry capable of meeting the domestic and export needs of new branches of technology.

The share of rare metal products in the global production of modern equipment is increasing. For example, a large proportion of rare, scattered, rare-earth, refractory metals are used as magnets, contacts, catalysts for complete fuel combustion, etc. For example, in the automotive industry, electrical engineering, and other modern high-tech industries.

The rare-metal chemical industry uses metals that are the basis of structural materials (radio electronics, europium for highly efficient absorbing elements, gadolinium, and erbium for the production of uranium-gadolinium uranium-erbium fuels). In addition, some elements accompany uranium and thorium in the processing of ores (rhenium, scandium) and are included in the technological chain of processing raw materials and obtaining nuclear-clean materials. The industry's demand for nonferrous, rare, and rare earth metals is constantly increasing since their use largely determines the development of Kazakhstan's strategic, scientific, and technical base. However, the use of known methods for obtaining these metals from traditional sources of raw materials does not fully meet the ever-increasing volumes of their use. Therefore, the task of developing new effective methods for extracting rare and rare-earth metals from unconventional sources of raw materials and technogenic low-concentration waste from metallurgical and chemical industries is urgent.

The chemical industry's complex (multicomponent) ores and technogenic wastes containing rare and rare-earth metals are characterized by complex material composition. The possibility of industrial development of such ores depends not only on the quantitative content of valuable components in the ores but also on the technological methods of extracting valuable components during mining, processing, and metallurgical processing of ore raw materials. The material composition of ores and the possibility of their industrial development are found in testing and laboratory research.

At the current level and scale of consumption of natural raw materials, the importance of full use and involvement of secondary material resources in social production is of paramount importance. The role of this factor is especially great when assessing the economic efficiency of the national economy in its various sectors, including industrial waste, agriculture, and substandard natural minerals.

Technogenic waste from chemical and metallurgical industries is a valuable raw material for extracting rare and dispersed metals. Although rare metals are becoming popular today, they are contained in various ores, where their share is very small, in tenths, hundredths, sometimes in thousandths of a percent. Therefore, their extraction can be profitable only in combination with base metals. This is now also an important area for researchers. Japan is the leader among

- 84 Palant A.A. Metallurgiya reniya / A.A. Palant, I.D. Troshkina, A.N. Chekmarev. – M.: Nauka, 2007. – 298 s.
- 85 Redkie i rasseyanny'e e'lementy': Khimiya i tekhnologiya: V 3 kn. 3. / Pod red. S.S. Korovina. – M.: MISIS, 2003. – 440 s.
- 86 Chamtr R / Recovery of rhenium associated with copper ore // Hufnusz. 1989. N 3/4. P. 19 – 22.]
- 87 Mikhajlichenko A.I., Mikhlin E.B., Patrikeev Yu.B. Redkozemel'ny' metally'. – M.: Metallurgiya, 1987. – 232 s.
- 88 Dyatlova N.M., Temkina V.P., Kolpakova I.D. Kompleksny'. – M. Khimiya, 1970. – 417 s.
- 89 (Khimicheskie e'lementy' v organizme cheloveka. Spravochny' materialy'. / Pod obshhej redakciej L. V. Morozovoj. — Arkhangel'sk: Pomorsk gosudarstvenny'j Universitet im. M. V. Lomonosova, 2001. — S. 16-17. — 44 : — 100 e'kz.)
- 90 (John Emsley. Nature's building blocks: an A-Z guide to the element — US: Oxford University Press, 2001. — P. 442-443. — ISBN 0-19-850341-5.)
- 91 Zayavka 59-450 yaponii. MKI SO117/00, Opubl. 06.01.1984
- 92 Akinc Mufit, Sordelet Daniel. Preparation of yttrium, lanthanum cerium and neodymium basic carbonate particles by homogeneous precipitation Advanced Ceramic Materials. – 1987. – Vol.2 (3A). – P. 232-238.
- 93 Rasmussen M.D. Effect of spray drying on the sintering of Y2O3. American Ceramic Society Bulletin. – 1985. – Vol. 64(2). – P. 314-318.
- 94 Norby T. Electrical conductivity and defect structure of Y2O3 as function of water vapour pressure // Journal of American Ceramic Society. – 1984 – Vol.12. – P. 786-791.
- 95 Takagi K. Epitaxial growth of neodymium sesquioxide films on calcium fluoride by a reactive-evaporation method // Journal Applied Physic. 1987. – Vol. 61 (3). – P. 1030-1033.

Aimbetova Indira Orazaliyevna

INDUSTRIAL WASTES OF CHEMICAL AND METALLURGICAL INDUSTRIES CONTAINING RARE AND RARE EARTH METALS: METHODS FOR OBTAINING PRIMARY CONCENTRATES

Computer processing

Signed to the press 11.11.2021. Format 6084 1/16. Offset printing. Volume 11.9 printed sheets
Circulation 300 copies. Order no. 186/2021. Publishing house «Alem».

e-mail: science@ayu.edu.kz

tel: +7 777 717 0111

MKTU named after H.A. Yasawi, 2021

ISBN 978-601-08-1483-7



9 786010 814837

УДК 658.567.1 (075.8)

ББК 30.69 я73

A26

Aimbetova Indira Orazgalievna

Industrial waste of chemical - metallurgical industries containing rare and rare earth metals:
methods of obtaining primary concentrates

ISBN 978-601-08-1483-7



Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті
Ғылым комитеті №2 мәжілісінің
ХАТТАМАСЫНАН КӨШІРМЕ

Түркістан қаласы

21.10.2021 ж.

Сағат: 16:30

Өткізілетін түрі: онлайн

Сілтеме:

<https://zoom.us/j/2219572850?pwd=d3pqVTZadFk5QitSVkJOYjRGSFtGQT09>

идентификатор: 221 957 2850, пароль: 6811

Регламент:

Негізгі мәселелер үшін – 10 минут

Әр түрлі мәселелер үшін – 3-5 минут

Қатысқандар:

ҒК төрағасы – Ошибаева А.Е.

ҒК мүшелері: факультет декандары, декан орынбасарлары, ҒЗИ/ҒЗО директорлары, Ғылым департаментінің директоры, бөлім басшылары және ғылыми жоба жетекшілері.

Күн тәртібі:

Әр түрлі мәселелер:

3. Монографияларды Сенатқа ұсыну:

3.1. Аймбетова И.О. «Промышленные отходы химико-металлургических производств, содержащие редкие и редкоземельные металлы: способы получения первичных концентратов» (Industrial waste of chemical-metallurgical industries containing rare and rare earth metals: methods for obtaining primary concentrates) / ағылшын тілінде. (74,44% түпнұсқалылық).

Шешім:

Жаратылыстану ғылымдары факультеті Биология кафедрасының қауымдастырылған профессоры, техн.ғ.к. И.О. Аймбетованың ағылшын тіліндегі «Промышленные отходы химико-металлургических производств, содержащие редкие и редкоземельные металлы: способы получения первичных концентратов» (Industrial waste of chemical-metallurgical industries containing rare and rare earth metals: methods for obtaining primary concentrates) (74,44% түпнұсқалылық) атты монографиясы Ғылым комитетінің шешімімен Сенатқа ұсынылсын.

Комитет төрағасы

Мәжіліс хатшысы



А.Ошибаева

Ж.Ахметова

**Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті
2021-2022 оқу жылындағы кезектен тыс Сенат мәжілісінің**

№2 ХАТТАМАСЫНАН ҮЗІНДІ

Түркістан қаласы

15 қараша 2021 жыл

Сағат – 15:00

Дүйсенбі

Онлайн

Қатысқандар: сенат мүшелері, «Жоғары оқу орнының үздік оқытушысы – 2021» конкурсының үміткерлері, «Жастар саясаты» департаментінің директоры міндетін атқарушы Даркембай Аружан және студенттік ректор, Халықаралық қатынастар мамандығының 3-курс студенті Мустафа Санжар Ышин

Күн тәртібінде:

2. Әртүрлі мәселелер:

2.4. Университет ОПҚ-ның дайындаған монографияларды бекітіп баспаға ұсыну туралы (*Баяндамашы: Сенат хатшысы Куралбаева Алия Ахметкаримовна*)

Ашық дауыс беру нәтижесінде СЕНАТ ҚАУЛЫ ЕТЕДІ:

2.4. Жаратылыстану ғылымдары факультеті Биология кафедрасының қауымдастырылған профессоры, техн.ғ.к. И.О.Аймбетованың ағылшын тіліндегі «Промышленные отходы химико-металлургических производств, содержащие редкие и редкоземельные металлы: способы получения первичных концентратов» (Industrial waste of chemical-metallurgical industries containing rare and rare earth metals: methods for obtaining primary concentrates) (74,44% түпнұсқалық) атты монографиясы бекітіліп, баспаға ұсынылсын.

Сенат төрайымы

Сенат хатшысы



Ж.Темірбекова

А.Куралбаева



АНТИПЛАГИАТ
ОБНАРУЖЕНИЕ ЗАИМСТВОВАНИЙ

СПРАВКА

о результатах проверки текстового документа
на наличие заимствований

Международный Казахско-Турецкий
университет

ПРОВЕРКА ВЫПОЛНЕНА В СИСТЕМЕ АНТИПЛАГИАТ.ВУЗ

Автор работы: Айымбетова Индира
Самоцитирование
рассчитано для: Айымбетова Индира
Название работы: INDUSTRIAL WASTE OF CHEMICAL - METALLURGICAL INDUSTRIES CONTAINING RARE AND RARE
EARTH METALS: METHODS FOR OBTAINING PRIMARY CONCENTRATES
Тип работы: Монография
Подразделение:

РЕЗУЛЬТАТЫ

■ ОТЧЕТ О ПРОВЕРКЕ КОРРЕКТИРОВАЛСЯ: НИЖЕ ПРЕДСТАВЛЕНЫ РЕЗУЛЬТАТЫ ПРОВЕРКИ ДО КОРРЕКТИРОВКИ

ЗАИМСТВОВАНИЯ	21.14%	ЗАИМСТВОВАНИЯ	21.14%
ОРИГИНАЛЬНОСТЬ	74.44%	ОРИГИНАЛЬНОСТЬ	74.44%
ЦИТИРОВАНИЯ	4.42%	ЦИТИРОВАНИЯ	4.42%
САМОЦИТИРОВАНИЯ	0%	САМОЦИТИРОВАНИЯ	0%

ДАТА ПОСЛЕДНЕЙ ПРОВЕРКИ: 21.10.2021

ДАТА И ВРЕМЯ КОРРЕКТИРОВКИ: 21.10.2021 12:37

Модули поиска: ИПС Адилет; Библиография; Сводная коллекция ЭБС; Интернет Плюс; Сводная коллекция РГБ; Цитирование; Переводные заимствования (RuEn); Переводные заимствования по eLIBRARY.RU (EnRu); Переводные заимствования по eLIBRARY.RU (KkRu); Переводные заимствования по Интернету (EnRu); Переводные заимствования по Интернету (KkRu); Переводные заимствования (KkEn); Переводные заимствования издательства Wiley (RuEn); eLIBRARY.RU; СПС ГАРАНТ; Модуль поиска "АЯУ"; Медицина; Диссертации НББ; Перефразирования по eLIBRARY.RU; Перефразирования по Интернету; Патенты СССР, РФ, СНГ; СМИ России и СНГ; Шаблонные фразы; Кольцо вузов; Издательство Wiley; Переводные заимствования

Работу проверил: Садыкова Айгул Дуненбаевна

ФИО проверяющего

Дата подписи: 21.10.2021

Подпись проверяющего



Чтобы убедиться
в подлинности справки, используйте QR-код,
который содержит ссылку на отчет.

Ответ на вопрос, является ли обнаруженное заимствование
корректным, система оставляет на усмотрение проверяющего.
Предоставленная информация не подлежит использованию
в коммерческих целях.