

***The 22nd National Conference with International Participation
“New Cryogenic and Isotope Technologies for
Energy and Environment”
- EnergEn 2018 -***

Book of Abstracts

Vol. 1/2018

**Băile Govora, Romania
October 24-26, 2018**

ESHT 39-P	<u>Mariea Deaconu</u> , Ion Furtuna, Alice Dinu, Maria Mihalache <i>Studies On Hydrogen Interaction With Uranium Alloys</i>	82
-----------	--	----

CRYOGENIC TECHNOLOGIES

CRYT 1-O	<u>Silvano Tosti</u> <i>Pd-membranes applications from tritium separation to pure hydrogen production</i>	83
CRYT 2-O	<u>Petar Dalakov</u> , Maxim Kupriyanov, Jürgen Klier <i>The technological chain of enrichment of ³He</i>	85
CRYT 3-O	Vitaly Bondarenko, Iurii Symonenko, Dmytro Tyshko, <u>Borys Pylypenko</u> <i>Production of light gases stable isotopes by cryogenics method</i>	86
CRYT 4-O	Vitaly Bondarenko, <u>Artem Chyhrin</u> , Hlib Bashkirov <i>Cryogenic support of rectification units for the neon isotopes production</i>	88
CRYT 5-O	<u>Catalin Stelian Tuta</u> , Cristian Postolache, Aurelia Celarel, Constantin Cenusă, Viorel Fugaru, Mihail-Razvan Ioan <i>Characterization of gamma radiation fields emitted by ⁶⁰Co sources inside of the chambers for simulation of specific outer space conditions</i>	90
CRYT 6-O	<u>Ion Zabet</u> , Iulian Nita, Raluca Fako, Gratiela Maria Tarlea <i>Mathematical model of a heat exchanger working with different refrigerant fluids</i>	91
CRYT 7-O	<u>Sebastian Brad</u> , Alin Lazăr, Mihai Vijulie <i>Studies of cryogenic distillation equipments and process</i>	93
CRYT 8-P	<u>George Bubueanu</u> , Cristian Postolache, Viorel Fugaru, Catalin Stelian Tuta <i>Radiological characterisation of resulted materials from refurbishing of Tritium Laboratory</i>	94
CRYT 9-P	<u>József-Zsolt Szücs-Balázs</u> , Ștefan Bugeac, Codruța Mihaela Varodi, Claudia Lar, Mariana Cristina Marcu, Mihai Liviu Gligan <i>Experimental plant for carbon isotopes separation by carbon monoxide cryogenic distillation</i>	95

ISOTOPES OF HYDROGEN AND ITS APPLICATIONS

ISHA 1-O	Zhang Dongxun <i>Fabrication and hydrogen permeation of Al₂O₃/Er₂O₃ coating by MOD method</i>	96
----------	--	----

PRODUCTION OF LIGHT GASES STABLE ISOTOPES BY CRYOGENICS METHOD

Vitaly Bondarenko¹, Iurii Symonenko², Dmytro Tyshko³, Borys Pylypenko³

¹Moscow Bauman State Technical University, 2-nd Baumanskaya Str., 5, 107005, Moscow, Russia

²Cryoin Engineering, LTD, Mytna square, 1-A, 65026, Odessa, Ukraine

³Institute of Refrigeration Cryotechnology and Ecoenergetics n.a. V.S. Martynovsky, Dvoryanskaya Str., 1/3, 65082, Odessa, Ukraine

Corresponding author: dtishko@cryoin.com, Tel: +380972211942

Nature neon consists of three isotopic components (Table 1). In 1913, J. Thomson obtained first samples of neon isotopes by method of mass-spectrometry. Separation of ²⁰Ne and ²²Ne isotopic pair for laboratory and industrial purposes is also possible by thermal diffusion and chromatography methods. It is considered that neon is at the limit of the rectification method application, which is effective at the molecular weights less than 20. The rectification method is based on the concentration discrepancy of liquid and gaseous phase in a theoretical plate. However, deviations in the isotope components properties are hardly noticeable at the same temperature. The ratio of saturated vapors elasticities of the isotope pair ²⁰Ne – ²²Ne is shown at figure 1. At the neon rectification column work temperature $T_c = 28$ K, the separation coefficient α is close to one, and equals $\alpha=1,037$.

Table 1. Isotope concentration in the nature neon

Isotope	Mass number	Concentration, %
²⁰ Ne	19,9924	90,48
²¹ Ne	20,9928	0,27
²² Ne	21,9914	9,25
Nature Neon	20,1797	100

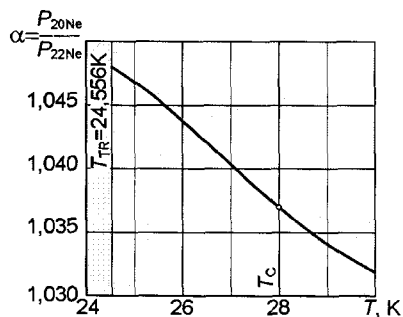


Figure. 1. The temperature effect on the separation coefficient of isotopes ²⁰Ne – ²²Ne

A considerable number of theoretical plates is required due to small values of the coefficient α . Consequence there is large height of the column contact space. Due to relatively small cross-section of such apparatus, their cryostatting at the temperature level 28 K is associated with considerable difficulties. The ratio of the column height to its diameter L/d is 600...800. It is very hard to transmit "cold" from condenser to the distant $L = 18$ along the channel with the diameter 30 mm even with the high-vacuum insulation and cooled screens. That's why, the height of

the column contact space is reduced up to 3...6 meters. Due to the insufficient separation factor, the secondary processing of the obtained fractions in the same column is practiced (Bondarenko et al., 2016). In the next variant, a consistent separation of neon is used in isotope columns cascade (Bondarenko et al., 2015).

The neon isotopes separations by rectification methods is very laborious and inefficient. It is necessary to decrease gas losses in the process sequences construction, because the energy costs for obtaining one normal liter of ^{20}Ne and ^{22}Ne are 50...500 MJ.

Several types of rectification columns with different sizes of contact space (from 1.6 mm to 2.2 mm) have been tested (fig. 2). The results of the studies can be used at the development of hydrogen isotopes rectification units. Despite the lower work temperature, the phase separation conditions of Hydrogen are better than conditions of isotope pair $^{20}\text{Ne} - ^{22}\text{Ne}$. The separation coefficient α for Hydrogen-Deuterium system is higher, and the boiling temperatures of H_2 and HD differ by almost two degrees.

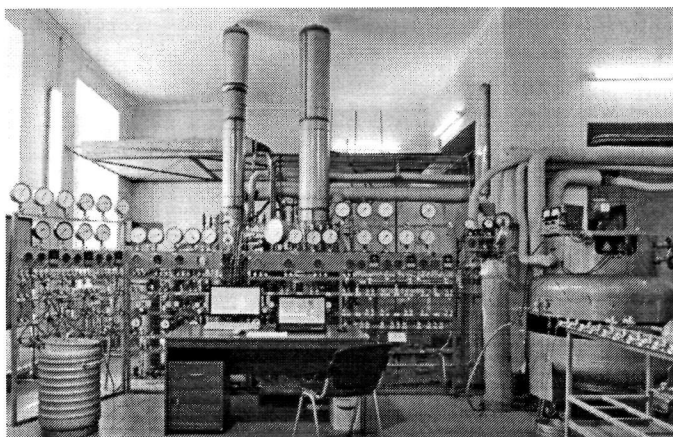


Figure 2. Rectification unit for obtaining neon isotopes by cascade method
(each vacuum case contains three separate rectification columns)

Despite the technological difficulties, rectification method makes it possible to obtain ^{20}Ne and ^{22}Ne with the concentration 99,995%. If ^{21}Ne is the target product, then this method doesn't have any alternative (Bondarenko et al., 2013).

Keywords: neon isotopes, rectification column, transfer unit, separation factor

References

- Bondarenko V. L., Symonenko I. M., (2015), *U.S. Patent No 9,168,467*. Assembly for separation gas mixtures in fractionating columns.
- Bondarenko V. L., Simonenko Yu. M., Tsvetkovskaya L. N., Matveev E. V., (2016), Separation of neon into isotope components by rectification method in a single column. *Industrial Gases*, 16(6):57-66
- Bondarenko V. L., Simonenko Yu. M., Diachenko O. V., (2013), Cascade units for neon isotopes production by rectification method. *Low Temperature Physics*, 39(5):617-622