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CRYOGENIC TECHNOLOGIES

ISOTOPES OF HYDROGEN AND ITS APPLICATIONS

PRODUCTION OF LIGHT GASES STABLE ISOTOPES BY CRYOGENICS METHOD

Vitaly Bondarenko[1], Iurii Symonenko[2], Dmytro Tyshko[3], Borys Pylypenko[3]

[1]*Moscow Bauman State Technical University, 2-nd Baumanskaya Str., 5, 107005, Moscow, Russia*
[2]*Cryoin Engineering, LTD, Mytna square, 1-A, 65026, Odessa, Ukraine*
[3]*Institute 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 ^{20}Ne and ^{22}Ne 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 ^{20}Ne – ^{22}Ne 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 α=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

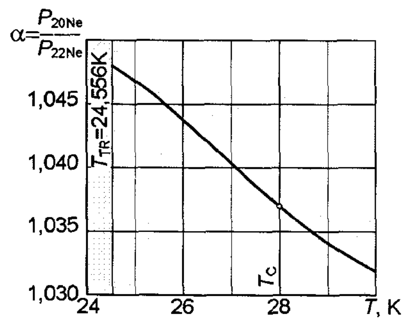

Figure. 1. The temperature effect on the separation coefficient of isotopes ^{20}Ne – ^{22}Ne

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 (from1.6 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 $^{20}Ne - ^{22}Ne$. The separation coefficient α for Hydrogen-Deuterium system is higher, and the boiling temperatures of H_2 and HD differ by almost two degrees.

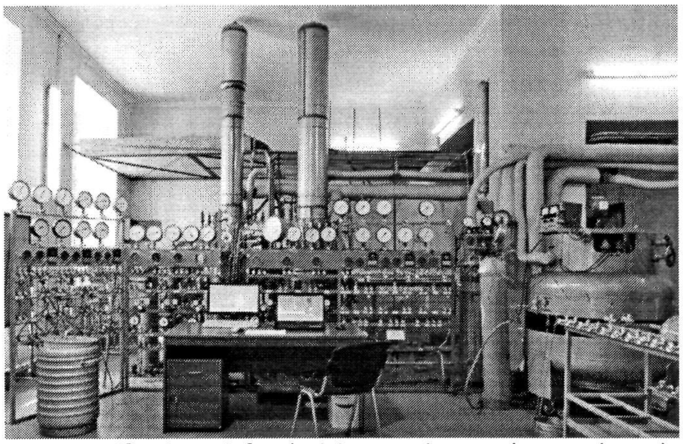

Figure 2. Rectification unit for obtaining neon isotopes by cascade method
(each vacuum case contains three separate rectification columns)

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*

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