

THE 11TH INTERNATIONAL CONFERENCE ON

CRYOCRYSTALS AND QUANTUM CRYSTALS

TURKU, FINLAND - 18-24 AUGUST 2016

The 11th International Conference on Cryocrystals and Quantum Crystals (CC2016) is organized in Turku, Finland by the Department of Physics and Astronomy, Wihuri Physical Laboratory, and Congress Office of the University of Turku. Conference Chairs are Prof. Kalle-Antti Suominen and Dr. Sergey Vasiliev.

The Conference on Cryocrystals and Quantum Crystals (CC) dates back to 1979, when the first national USSR meeting dealing with cryocrystals and quantum crystals was organized in Viljandi, Estonia by V.G. Manzhelii (Verkin Institute for Low Temperature Physics and Engineering NASU) and A.F. Prikhot'ko (Institute of Physics NASU). The subsequent biannual meetings were held in Kharkov (Ukraine), Almaty (Kazakhstan), Donetsk (Ukraine) and Odessa (Ukraine).

Since the Almaty meeting in 1995 the CC Conference had acquired international status becoming an important international forum for presenting new results on physics and chemistry of atomic and molecular solids. The great merit in achieving of this goal belongs to Prof. Vadim Manzhelii and Prof. Horst Meyer, the co-chairs of the first International CC-1995.

The next two CC conferences were held in Poland, in Polanica Zdrój (September 1997) and in Szklarska Poręba (August 2000). The venues of the next CC conferences were Freising (Germany) in 2002, Wrocław (Poland) in 2004, Kharkov (Ukraine) in 2006, Wrocław (Poland) in 2008, Chernogolovka (Russia) in 2010, Odessa (Ukraine) in 2012 and the last meeting was held in the city of Almaty (Kazakhstan).

The scope of CC is wide, including, but not limited to:

- thermodynamic and mechanical properties of cryocrystals and quantum crystals
- order-disorder phenomena
- optical and neutron spectroscopy of cryocrystals
- high-pressure studies of cryocrystals and quantum crystals
- charged species in cryocrystals and quantum crystals
- phenomena at the surface of quantum fluids and solids
- impurity-helium condensates
- matrix isolation in cryocrystals
- ultrafast dynamics in crystals
- crystalline and amorphous films, nanoscale systems
- supersolid state
- new emerging materials
- technological applications and instrumentation

CC-2014 is a forum where ideas on various aspects of the physical, chemical and technological properties of solidified gases and other relevant materials are discussed and where top experts in the field meet.

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The organizers of CC11 wish to thank the following organizations for their contribution:

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Cryoin Engineering Ltd.

Academy of Finland, project 260531

C07 PURIFICATION AND EXTRACTION OF RARE GASES BY FREEZE OUT METHOD

Bondarenko V. L.¹, Symonenko Iu. M.², Chigrin A. A.³

1Bauman Moscow State Technical University, Russia, 2Institute of Refrigeration, Cryotechnology and Ecoenergetics n.a. V.S.

Martynovsky, Ukraine, 3Cryoin Engineering, LTD, Ukraine

artemon_2006@mail.ru

In the coming decade there is expected a steady growth in the global consumption of rare gases. Plants with relatively low productivity join a list of suppliers of krypton-xenon concentrate. Under these conditions, operation of large plants for the enrichment of Kr and Xe mixture is not always justified.

We have developed alternative methods of krypton and xenon enrichment from a poor mixture directly in the places of its extraction. We have created a cryogenic freezer Xe, which allows using a product with xenon content of less than 0.02% as initial feedstock. We get xenon with no less than 99.5% purity at the outlet of the unit.

Freezeout (desublimation) is used in the technologies of rare gases extraction, along with adsorption and condensation methods for separating mixtures. Similar to the adsorption, this method is cyclical and requires energy for periodic cooling of the unit up to operating temperatures TC. TC level is selected in such a way as to provide selective absorption of a valuable product (or impurities). Separation of an individual component occurs when the partial pressure of this component in the mixture is above the phase transition pressure of the substance.

By way of example, let us consider the use of a freezer for extracting xenon from the low-potential flows. Such mixtures are obtained in air separation plants equipped with krypton columns. Kr-Xe concentrate has more than 98% oxygen. Other components include: nitrogen \approx 1.5%; methane 0.2 ... 0.3%; krypton <0.2% xenon and <0.02%. A major obstacle to the processing of the mixture is the threat of liquefaction of oxygen. For this reason, when using N₂ as a refrigerant (Tc = 78 K), the operating pressure maintained in the freezer is at the level of P_z \leq 22 kPa.

At these operating parameters the first four mixture components (O₂, N₂, CH₄ and Kr) remain in a gaseous state. They leave the apparatus, practically, without changing their concentration. Only xenon at 85 K reaches the crystallization conditions. In the process of transition to the solid state, the partial pressure of Xe in the mixture and the equilibrium temperature are reduced. At the output at Tc = 78 K, not more than 16% of the initial content of xenon remains in the mixture. Thus, for the accepted conditions, for the degree of extraction of xenon is about 84%.

In addition to the named example, freezing out process, as an alternative to adsorption, finds application in the separation of neon helium mixture and helium purification. For obtaining 99.995% purity helium at P_z = 0.2 MPa, temperature TC = 13K is required. In many plants for processing gas concentrations, freezers are used for absorption of high-boiling impurities. Nitrogen vapors with temperature Tc = 100 ... 150K are used as a refrigerant. This method allows almost complete removal of moisture and CO₂ from the mixture, which can adversely affect the performance of low-temperature separators.

During the testing of freezer prototypes, we studied the effect of frost on the temperature and the concentration of the effluent flow. To reduce thermal resistance between the refrigerant and the mixture, we used an effective finning of the channel on the gas stream side.