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Author: Mr. Kogan Ioann
NIICHIMMASH, Russian Federation, letyhxx@gmail.com

Dr. Alexandr Zheleznyakov
S.P. Korolev Rocket and Space Corporation Energia, Russian Federation, jeleznyakov@yandex.ru
Mr. Sergei Rukavitsin
NIICHIMMASH, Russian Federation, rukavicin@niichimmash.ru
Mrs. Elena Novoselova
NIICHIMMASH, Russian Federation, novoselova@niichimmash.ru
Mr. Alexey Yurgin
S.P. Korolev Rocket and Space Corporation Energia, Russian Federation, alexey.yurgin@yandex.ru
Mr. Artur Potemkin
S.P. Korolev Rocket and Space Corporation Energia, Russian Federation, a.potemkin@internet.ru
Mr. Yurii Butilkin
NIICHIMMASH, Russian Federation, Y_butylkin@niichimmash.ru

DEVELOPMENT STATUS OF A CARBON DIOXIDE REDUCTION SYSTEM "SPDU" FOR THE ISS

Abstract

Integration of a metabolic carbon dioxide utilization system into the Space Station life support system is a prerequisite for increasing cycle closure, reducing required onboard oxygen supply, and ensuring the feasibility of the long-term autonomous missions. This system will provide purification of the station's gas environment from carbon dioxide and its recycling to methane and water.

Carbon dioxide processing system "SPDU" consists of carbon dioxide concentration subsystem "BKDU" and carbon dioxide reprocessing subsystem "BGDU".

Currently, adsorption methods of air purification are the most proven in zero gravity conditions. During physical adsorption (used in "Vozdukh" and "CDRA" systems) dynamic CO2 capacity strongly depends of the incoming air humidity, because the physical sorption of water is more active than CO2. This requires pre-drying of the whole air stream and significantly deteriorates the mass-dimensional characteristics of the system.

This disadvantage is deprived by formation of carbonate compounds on solid chemosorbent in the presence of water vapor, which are breaking during thermal treatment with superheated steam. "BKDU" uses inorganic absorbent, resistant to mechanical stress, large number of cycles of sorption/desorption, completely safe for the crew, not polluting the gas environment with ammonia, amines and other harmful impurities.

"BKDU" is designed according to the 2 adsorber scheme and also includes: blower, steam generator, water treatment, cooling Interface, heat recovery and gas-liquid mixture separation units, gas analyzer and control unit.

The adsorbers operate in rotation with cycle up to 120 minutes at a gas flow rate of 30 m3/h and the concentration of CO2 in the cabin air of 0.25% vol. and above, providing extraction of up to 60 liters CO2 per hour with purity greater than 98%. Specific power consumption is less than 14 W/h/l CO2.

The "BKDU" subsystem works together with the "BGDU" subsystem - the single bed Sabatier reactor with an autothermal reaction mode with a specified temperature gradient along the catalyst bed length,

which makes its to achieve up to 96% of theoretically possible conversion rate. The reactor is placed in a capsule used as a heat insulation and a carbon dioxide accumulator, which ensures uniform flow of CO2 into the reactor. During the tests, when the "SPDU" and "Electron-VM" (water electrolyzer) systems function together, they able to return up to 47% of the water used for oxygen production into the cycle. The "SPDU" system has passed comprehensive tests and accommodated for installation and operation onboard the ISS.