GAS STORING IN MARTIAN ATMOSPHERIC ENVIRONMENT USING NIL DIFFUSION COVERING TECHNOLOGY. ***I. Nehéz[1], T. Varga[2], I. Darányi[2], Sz. Bérczi[3],*** Nehéz Balloon Project, H-8500 Pápa, Korona u. 13., Hungary (nehezimre@kabelszat2002.hu), [2]VTPatent Agency, H-1111 Budapest, Bertalan L. u. 20., Hungary (info@vtpatent.hu), [3]Eötvös University, Institute of Physics, Dept. G. Physics, Cosmic Materials Space Research Group, Budapest, Pázmány Péter sétány 1/a, Hungary.(berczi szani@ludens.elte.hu)

Summary: Nil Diffusion (ND) covering is used for long term storing of gases in Martian atmosphere. ND covering consists of several separated material layers treated with active isolation, with one or more separator spaces between the layers.

Background of the problem to be solved: Housing and long term storing of gases in isolated environment raise several basic problems, the significance of which is especially great in case of application on a Martian planetary surface far from the Earth.

The basic function of gas storing is to keep the stored gases for longer or shorter period in an isolated, separated environment for various applications, to ensure functioning of various research, measuring capsules, equipments, as well as proper storing of gases necessary for robotics planetary activities, in given case Martian surface ones. Also planned for later period during Martian human space travels to ensure human conditions of living.

Gas storing is a basic task at a long term space expedition to meet with industrial, technical demands as well as human requirements. For example storing pure O_2, H_2, N_2 or compounds, which are not identical with the atmosphere.

Parameters of the lower atmosphere on the Mars: Mainly consists of carbon dioxide (95%), further 2.7% nitrogen and 1.6% argon, furthermore additional components, among them 0.4% oxygen. The atmospheric pressure is 0.7-0.9 kPa, (depending on the season and radiation), density on the surface: 0.015 – 0.025 kg/m^3, on average 0.02 kg/m^3.

Basic issues of the gas storing: The loss of gas from inside towards outside. It results in the loss of the gas stored in the inner storing space.

- In planetary environments with atmosphere, gases from the outer atmophere penetrate to the storing space with partial diffusion.
- Gases in the storing space could mix and form compounds with gas of the outer atmosphere. The purity of the stored gas deteriorates due to this.
- The range of devices suitable for storing gas in a distant planetary environment is limited by size, thickness etc. So covering compactness which is easy to ensure on the Earth can not be ensured there. Only a few light shell structures can be applied as covering.

Liquefaction is a well-tried method under Earth conditions for storing and transporting gases, but in some planetary applications, for example temporary storing, in case of quick consumption or sudden storing of big quantity of gas liquefaction is not convenient. Liquefaction, respectively converting back to gas state needs a lot of energy, which is also unfavourable in case of planetary applications.

The efficiency of gas-sealing can be increased under Earth conditions by the increasing of the thickness of covering, respectively by applying several covering layers, or by using heavy container coverings, e.g. steel, nickel, chrom, etc. Increase of sealing capacity of gas-storing spaces results almost in every case the increase of the covering thickness and together with it the increase of their mass.

So we find the Nil-Diffusion covering of several layers, with active isolation technology, which results in the possible decrease of gas storing coverings beside keeping or even increasing gas-sealing capacity.

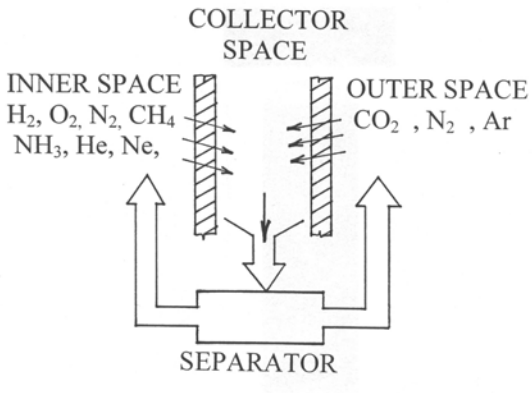

Fig. 1: The pricniple of the Nil-Diffusion covering utilized in the Martian atmosphere

The essence of the Nil-Diffusion covering with active isolation: Instead of one layer, two or more layers are applied in the covering, and between the layers there is at least one collector space. The task of the collector space is to separate the material layers of the covering and it is applied as a collector. The gases penetrating through the material layers of the inner and outer layers from any direction are removed and after selection they are sent back to their source space. The separation can take place with various well-known methods depending on the different gas compositions.

ND covering is the suitable technology for proper isolation of gas spaces. It has several layers and among them with the help of one or more border space layer is efficient storing of gases in the bordering space.

Examples for use of ND technology for long life Martian fixed balloons as well as drifting balloons have been made known in our earlier publications [1,2]. Regarding ND technology and balloon structure there are valid US and EPC patent applications.

In these cases [1,2] the mass of the covering was a determining factor from that point of view, that a balloon structure being able to rise and float under Martian conditions had to be produced. Its measurement and mass were limited and there were other aspects of transportation as well.

In our paper the main aim is to ensure gas sealing as efficient as possible, respectively storing as big quantity of gas as possible, respectively ensuring the rate of mass/volume of the gas with proper efficiency values. It is especially important in case of storing of bigger volume, e.g. oxygen necessary for human stay, or other gases necessary for industrial, technological processes, in case of storing propellant gases.

Possible applications of ND gas storing: The Martian atmosphere is different compared to that of the Earth: on the gas composition, pressure, density, temperature and its changes, static charge, dust of micro particle size, UV and cosmic radiation.

Under Martian conditions ND technology makes possible the use of relatively light, thin coverings with achieving proper gas sealing efficiency. Application of metal, steel covering is not necessary, respectively it arises in special cases only. Big volume storing can be solved with light ND covering of small mass of thin polimers.

Possible Martian emplacements of the gas storing units are widespread. Depending on the stored gas and on proper anchoring the size of the gas storing unit can be as big as necessary. It can be deposited in the surface formations optionally. Under extreme temperature fluctuations it is especially important, that during gas storing flexible spaces are applied, as temperature fluctuations of 100-120 ºC may cause considerable fluctuation in gas volume.

Practical considerations: The advantage of using ND covering appears on those places, where there is an outer atmosphere. In such places there is a partial diffusion from the outside atmosphere towards inside. Application of ND covering in case of several stored gases taking into consideration Martian atmospheric environment: Outer gas CO_2 abt. 95%, inside stored gas: H_2, O_2, N_2, CH_4, ammonia, noble gases etc.

Depending on the stored gas, a covering structure of one, two, or three space layers is applied, and the gases diffusing into the covering space layers are separated by active isolation and fed them back to their resources.

This makes possible a very effective gas storing on the long term, which is especially suitable for using in space vehicles, space devices on planetary surfaces far away from the Earth, especially on the Mars. Under Martian conditions the following additional aspects could occur: UV and cosmic radiation-proof in case of installment on open surface, and resistance to thermal fluctuation.

Preferable realizations, implementations: The gas storing unit to be realized under Martian conditions can be of any shape in case of proper anchoring, placement, preferably: cylinder, semi-cylinder, spherical, half-sphere, ellipse-like, any other, partly arch-like space shape, balloon stabilized by some mechanical structure, anchored.

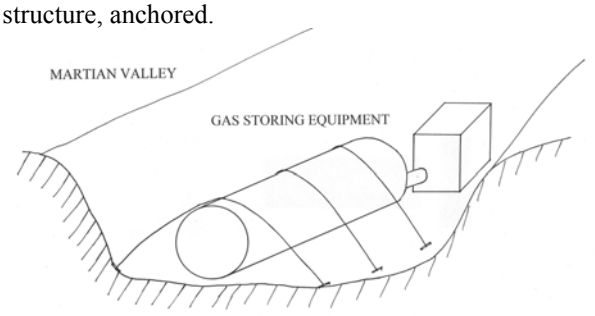

Fig. 2: Application of the Nil-Diffusion covering for gas storing on the Martian surface

It is necessary, that the gas storing unit is properly stabilized, e.g. fixed to the ground or to some object, and in given case provided with some solid covering and is installed. The covering of the gas storing unit can be stiffened if necessary, because of partly pressure resistance, partly structural stability.

The outer shape factor of the gas container realized and installed on Martian surface is important from the point of view of winds and fluctuations near the surface. It is preferable to apply a streamlined shape nesting into the landscape as well as possible. During the first expeditions such surface applications should be definitely used.

Measurements: as per demand, a few 1,000 - 10,000 m^3. The bigger, the more economical because of the gas cleaning technologies to be applied together.

Advantages of the Nil-Diffusion covering: pure gas storing for long term applications, small covering mass to be transported, great, almost perfect gas storing capacity, easy installation, easy re-installation, respectively transportability, gas storing capacity can be increased as per demand.

References:

[1] I. Nehéz et. al.: Theoretical questions of the application of the light and long life gas balloons in Martian and planetary atmospheres. 37 LPSC 2006 (#1703) [2] I. Nehéz et. al.: Long life and light gas balloons with active isolation envelope for Martian applications. 37 LPSC 2006 (#1719),