LONG LIFE AND LIGHT GAS BALLOONS WITH ACTIVE ISOLATION ENVELOPE FOR MARTIAN APPLICATIONS. ***I. Nehéz[1], Sz. Bérczi[2], T. Varga[3], I. Darányi[3], R. Cseh[3],*** [1]Nehéz Balloon Project, H-8500 Pápa, Korona u. 13., Hungary (nehezimre@kabelszat2002.hu), [2]Eötvös University, Institute of Physics, Dept. G. Physics, Cosmic Materials Space Research Group, Budapest, Pázmány Péter sétány 1/a, Hungary.(bercziszani@ludens.elte.hu), [3]VTPatent Agency, H-1111 Budapest, Bertalan L. u. 20., Hungary (info@vtpatent.hu)

Introduction: The most important issue in making long life balloons is the decrease the lost of inner gases so the prevention the diffusion through the envelope of the balloon. During designing the balloon sturctures for Martian environment the composition of Martian atmosphere and the Martian gravitation conditions should be especially taken into consideration [1]. An additional important factor in the Martian environment is the extreme temperature fluctuation, as well as the intensive cosmic radiation.

Aims: Creating long life balloons,

- for lifting - fixed or drifting (tranzo) balloons
- for gas storage (balloon containers, hose containers)

Additional aims are

- to keep both the full quantity of the gas in the balloon and keep it clean as well
- to ensure that the balloon structure is mechanically stable
- prevention of negative heat resistance (cold resistance) rigidity
- radiation-and UV resistance
- lightness (considering the intention to forward it to Mars or other planets)

Characteristics of the lower atmosphere on Mars: The atmosphere is very rare. It 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 value on the surface: 0.015 – 0.025 kg/m^3, on average 0.02 kg/m^3.

The Martian gas balloon structure must be created for an environment, which has significantly lower pressure, smaller density and essentially consists of carbon-dioxide.

The maximum temperature on Mars equator is +27°C, whereas the polar temperature low is -138°C. The composition of the atmosphere does not protect from UV or cosmic radiation. The temperature fluctuates between extremes depending on the radiation, medium value is about -50°C on the equator, which means, that the material of the balloon must have great negative heat resistance and radiation resistance.

It is not certain, that ordinary materials used in terrestrial conditions will be suitable among Martian conditions, because polymers used widespread become rigid influenced by extreme temperature, extreme cold. In given case new envelope materials should be developed, the current ones have to be modified so, that they can cope with the temperature range, respectively.

Under Martian conditions the gravity factor $g_M = 3.74\ m/s^2$ compared to that of the Earth $g_E = 9.81\ m/s^2$ resulting in the fact, that the weight force of an envelope of the same mass is smaller on Mars.

Summing up of issues:

An additional problem resulting from Martian conditions is, that a fast deterioration of the material of the envelope can be expected as the effect of UV and cosmic radiation. This can be decreased by the metallization of the outer surface of the envelope, but the deterioration of the material can not be decreased beyond a certain limit. The gas permeability of the envelope will increase as a result.

In case of lifting balloons an additional issue is, that due to the rare atmosphere the lifting power is substantially smaller, that is – compared to terrestrial conditions - the same lifting power can be gained by a much bigger volume and surface balloon only.

The essence of the nil-diffusion envelope (NDE) with active isolation: Instead of one envelope layer, several separating layers are applied in our balloons, and between the envelope layers there is at least one separating space (gas) layer. The task and aim of this separating layer space is to separate the material layers of the envelope. The separating layer space is applied as a collector space. The gases penetrating through the material layers of the inner and outer envelopes 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.

Specific Martian applications of gas ballons:

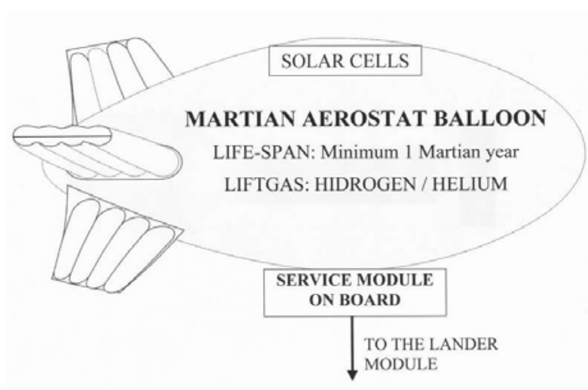

Fig. 1 Fixed, attached Martian balloon sonda (aerostat) for observation

Joining to the lander module or to the rover:

- the mass of a decreased weight balloon material, released from the landing unit or from a rover, can be optimized as ~200 kg – for balloon structure + useful load
- its size is ~ 30 m
- its shape is –sphere, melon, cigar

A part of the technical equipment can remain on the surface unit, only the absolutely necessary parts should be lifted.

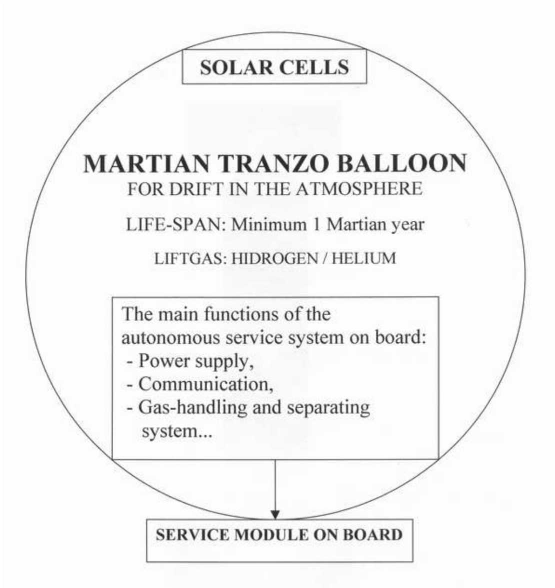

Fig 2. Drifting, not fixed Martian balloon sonda for observation (tranzo)

It is possible to release from the Mars surface, or applied as a sonda landing from orbital course. It would be possible to make a durable drifting balloon, for which it would not be necessary to land on the surface, but it would be blown right at entering the atmosphere (it can join to an existing NASA project). Its long term operation has been made possible by the application of the active isolation technique we use in the multi-layered balloon envelope.

Balloons for gas storing purposes: It is suitable to store different gases without loss in a clean way by setting up such balloon on Mars surface. The mechanical stability of the envelope can be increased, but the weight of the envelope can not represent an obstacle. Its advantageous design is a cylinder form, closed by cones at the ends. Its size is determined (and limited) by the mechanical stability of the balloon material.

Issues of practical applications on Mars: Practical aspects suggest that we choose different materials for the outer envelope layer, and for the internal envelope layer of the balloon. Among several reasons this solution comes from the different requirements for the different (inner and outer) layers. For example in the case of the outer layer UV and radiation resistance is important, whereas in case of the inner envelope layer the increased gas stopping capacity is important, which does not actually goes together with proper UV resistance.

The gas-physics and gravitation issues of lifting and their correlation with the properties of the surrounding atmosphere:

- theoretical lifting capacity, its determination, useful load
- for various filling gases, e.g. Hydrogen, Helium
- balloon volume, balloon surface, lifting power table, other charts
- optimums gained from the above requirements.

Physical conditions of back floating of lifting balloon in Martial atmosphere: shape, shape factor, reaction to wind flux, (Balloon should keep its shape), necessity of inner space with over-pressure, increased diffusion as a consequence of over-pressure (this can be stopped by the active isolation).

From the point of view of the shape as well as of the envelope: the self-load spherical shape is the most favourable surface (and surface/volume rate). Shape factor of this form is unfavourable, because it is sensitive, when effected by winds. Therefore in the case of attached applications the drop shape of lateral direction, or discus shape, or wing-profile can be considered as well. In case of wing-profile, beside static lifting power, dynamic lifting power can produce increasing lifting capacity and resistance to wind.

In case of a drifting (tranzo) balloon, which travels in the atmosphere, shape factors have no importance. In case of steering it is important to have a shape favorable from aerodynamic aspects, e.g. a drop shape.

Joining to possible scientific and space research programs on Mars: Survey of atmosphere in situ: composition, radiation, dust, flux, wind velocity, wind direction, observation of the surface from near the surface, high point, antenna, radar for communication, (e.g. multifunctional high point), gas storage.

Advantages: In the Martian environment separation of mixed gases (CO_2, Hydrogen, Helium) is much easier than among Earth conditions. CO_2 diffused into the envelope does not create an explosive compound with hydrogen lifting gas and their separation is easier. Diffusing of minimum oxygen present in Martian atmosphere can be practically prevented by active separation, and diffusion of nitrogen present in the atmosphere in a small amount can not cause problems either.

The presence of H_2O ice on Mars gives the possibility of avoiding the delivery of hydrogen which is intended to be used as lifting gas on Mars. It can be produced in situ and as a by-product oxygen is also available from this separation process.

Balloons of long life can be made, because due to partial diffusion, the gas diffusing from outside can not get to the inside of the balloon, or in an insignificant extent only, so filling of the inside of the balloon with outside gases is prevented this way.

Diffusion rate from inside is also insignificant, because the gas escaping from inside is a fed back effect. This problem is solved by a considerably increased gas-sealing, gas-storing capacity of balloons provided with nil-diffusion envelope as well as significant lengthening of their useful life and possibility of application. This feature is absolutely crucial in case of extraterrestrial, Martian or other planetary application.

References: [1] Formisano, V. (1987): Aerosols in Martian Atmosphere and Natural Dust Observation (AMANDO). Proposal for the Mars orbiter balloon and rover to study the Martian atmosphere, its thermal content, and its interaction with the soil. Abstract, http://adswww.harvard.edu/.