Energy gas storages for high protected landscape

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INTRODUCTION

It is known, that it is necessary to use such energy sources in high protected areas, which would not have a negative impact on the environment. For this purpose is suitable renewable energy sources that have zero emissions, such as solar collectors or photovoltaic cells. All these resources have a fundamental one drawback - not a source of energy all the time. Therefore, it is necessary for them based energy storage. For this purpose is suitable energy gases storage. For energy storage gases are usually used high volume underground tanks (Klepáč, 2009) or above ground pressure tanks including tanks for storage of liquid gases (Bailey & Fearn, 1964; Khurana et al., 2006; Seo & Jeong, 2010).

The main disadvantage of such devices it is that they must be classified as explosive and they are subjects to the rules for working in hazardous environments, including increased demands on the materials. The additional disadvantage of these devices is their limited volume capacity.

These disadvantages can be addressed by the development of a viable method to efficiently trap hydrogen gas molecules in a confined space. This issue can be addressed by employing highly porous materials as storage media, and porous metal–organic frameworks (Shengqian & Hong-Cai, 2010), single-walled carbon nanotubes (Dillon et al., 1997) or in natural zeolite

The result of the solution project VUKONZE, part 1.6 is Automatic large capacity device for energy gases storage VAZEP, protected under the utility model application number (Úrad priemyselného vlastníctva Slovenskej republiky, 2012).

THE PRINCIPLE AND DESCRIPTION

The present invention relates to automatic device, which was designed for safety long-term storage of energy gases and also for their controlled and safe dose for next applications, which are produced, transformed or consumed in manufacturing or power engineering.

The principle device consists in the thermally insulated tank filled with material with large surface area and high affinity for energy gases, for instance zeolite.

This tank is connecting through thermal key to

1. The cooling reservoir - during filling of gas
2. The heating reservoir - during discharge.

The input of tank is connected to the power supply of liquefied gas unit and its output can be connected to a gas appliance energy unit.

The prototype of VAZEP - VUKONZE device was constructed of stainless steel tank with double shields chamber KM modified natural zeolite with a total surface area of 620 000 m^2.

The effective internal volume of 9.45 l (radius of 0.1 mA at 0.3 m) was filled with material M with a high surface area, in our case the gap between walls of the double chamber filled exchange gas thigh pure helium as thermal key TK. The outer shield of the thermally insulated chambers KM was in direct contact with the cold reservoir R. The temperature of reservoir R must be minimum 10 K lower than the boiling point of liquefied energy gas. In our case it was fulfilled, because cold reservoir created the liquid helium bath with temperature 4.2 K and liquefied energy gas we used gas hydrogen.

This stationary state takes during filling and storage of energy gas. The requirement of taking gas from chamber to gas energy unit S. the controller RE provide the break of thermal contact with cold reservoir R and turn the heater O in the chamber. In our case, the break of the thermal key provides withdrawal of helium from area between the shells chamber. The cycles of the filling and discharging of the chamber can be repeated optionally.

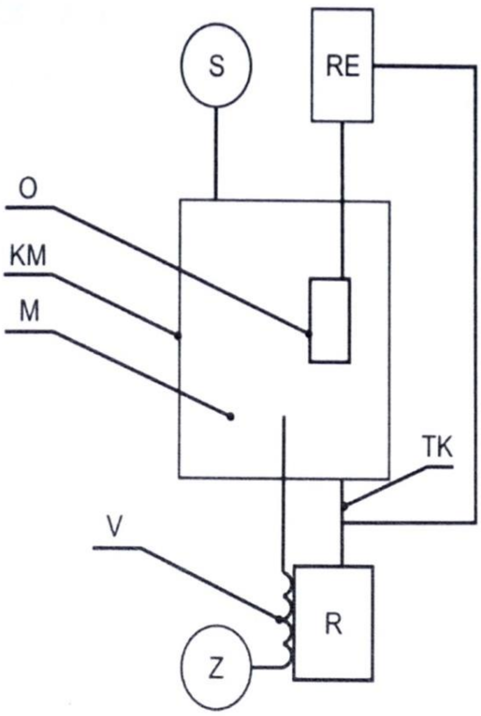

Fig. 1 Operational scheme of device: KM - double shields chamber; M - material with a high surface area, (modified natural zeolite); R - cold reservoir, in our case liquid helium bath; TK - thermal key; O - heater; RE - controller; S - gas energy unit; Z - source of energy gas; V condensing value

The ratio between the usable volume VAZEP and volume of stored gas stored is 600 times at atmospheric pressure, in this time.

CONCLUSION

The automatic large capacity device for energy gases storage VAZEP can be used everywhere for safety long-term storage of energy gases and also for their controlled and safe dose for next applications.

VAZEP can replace also natural pressure gas storage facilities and even large-underground, but we hope that the main replace pressure hydrogen storage tanks, which are used as reservoir of the ecological fuel. Nowadays, as geotourism rapidly evolves (e. g. Dowling, 2009; Dowling & Newsome, 2010; Rybár et al., 2010) and extensive number of publications has been published in this field (e. g. Compľová, 2010; Hronček & Weis, 2010; López-García et al., 2011; Timčák, 2011), the use of alternative energy sources for geotourism purposes may find its place within geotourism development and research as presented in this paper.

Practical use can be applied to the highly protected areas where it is possible to apply energy, which pollute the environment. VAZEP is especially suitable for areas where are not conventional energy sources, and which can not be applied alternative energy sources fully. Such highly protected areas include:

- high mountain areas,
- the areas above the Arctic Circle,
- densely wooded areas – rainforests.

VAZEP is possible solution to set up and operate research stations (base) in high protected areas. Specific location for the application of VAZEP is Antarctica, where the implementation of this system provides many benefits including:

- Large scale reductions in the emission of greenhouse gases,

- reduced risks of oil spills and damage to the environment,
- increased efficiency of station operations due to the ability to automate more processes.

The use of hydrogen as an energy source has also been demonstrated in Australian Antarctic Division (Renewable Energy, 2013).

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REFERENCES

Compľová M. (2010) The identification of geoproducts in the village of Jakubany as a basis for geotourism development. Acta Geoturistica, vol. 1, nr. 1., pp. 51-56.

Dillon A.C. et al. (1997) Storage of hydrogen in single-walled carbon nanotubes, In: Nature, Vol. 386 No. 6623, 1997, p. 377-379

Dowling R.K. (2009) The growth of global geotourism, pp. 24 – 30. In Neto de Carvalho, C., Rodrigues, J. (eds.): New ChalleNges with geotourism, Proceedings of the VIII European Geoparks Conference, 4. – 6. september 2009, Portugal, 287 p.

Dowling R.K. and **Newsome D. (eds.)** (2010) Global Geotourism Perspectives. Goodfellow Publischers Limited, Oxford, England, 266 p.

Hronček P. and **Weis K.** (2010) Possibilities of using historical mining maps in geo-tourism. Acta Geotutistica, vol. 1, nr. 2, pp. 56-65.

Khurana T.K., Prasad B.V.S.S.S., Ramamurthy K. and **Murthy S.S.** (2006) Thermal stratification in ribbed liquid hydrogen storage tanks, In: International Journal of Hydrogen Energy, 31 (2006), pp. 2299–2309

Klepáč, J. (2009) Podzemné zásobníky zemného plynu - nástroj zvyšovania bezpečnosti dodávok, Slovgas 03/2009, Bratislava, pp. 7-10, ISSN 1335-3853

López-García J.A., Oyarzun R., Andrés S.L. and **Manteca Martínez J.I.** (2011) Scientific, Educational, and Environmental Considerations Regarding Mine Sites and Geoheritage: A Perspective from SE Spain. Geoheritage, vol. 3, issue 4, pp. 267-275. DOI: 10.1007/s12371-011-0040-2

Shengqian M. and **Hong-Cai Z**. (2010) Gas storage in porous mettertal–organic frameworks for clean energy applications In: Chemical Communications Issue 1, p. 44-53, DOI**:** 10.1039/B916295J

Renewable Energy (2013) Australian Antarctic Division. Available at: http://www.antarctica.gov.au/living-and-working/station-life-and-activities/renewable-energy (24. October 2013)

Rybár P., Baláž B. and **Štrba Ľ.** (2010) Geoturizmus – identifikácia objektov geoturizmu. Fakulta BERG, TU Košice, 101 p. (In Slovak)

Timčák G.M. (2011) Iceland as a geotourism learning destination. Acta Geoturistica, vol. 2, nr. 2, pp. 40-48.

Úrad priemyselného vlastníctva Slovenskej republiky (2012) Veľkokapacitné automatizované zariadenie na uskladňovanie energetických plynov a spôsob ich bezpečného uskladnenia. Majiteľ a pôvodca úžitkového vzoru: TU Košice, Ing. Štefan MOLOKÁČ, PhD; prof. Ing. Pavol RYBÁR, PhD., Číslo dokumentu: 6417, číslo prihlášky: 59-2012. Slovenská republika.