## Abstract

Inseparable element of renewable energy sources is large – scale energy stoarge. It is a necessary part, because of low stability of energy output from renewables, caused by variable atmospheric conditions. It is especially significant in wind and solar power plants. One of the solutions is Power – 2 – Gas technology. It allows to produce hydrogen from excess energy in peak production periods, then utilize it as energy carrier in peak demand periods, when renewables are not able to cover energy demand from current production. Hydrogen can be used to prodce synthetic gas (syngas). Carbon source (usually $CO_2$) and additional energy for synthesis process is necessary. Hydrogen can also be utilized as pure gas, both in fuel cells and conventional combustion process, including blending hydrogen with methane in gas pipelines. The main challenge is hydrogen storage, because of high diffusivity and mobility of hydrogen through different barriers, and reactivity with microorganisms.

Limited possibilities of hydrogen storage, which is now only operated in salt caverns, is inducing to seek alternative methods of storage of hydrogen as a energy carrier. Promising technology is LRC (Lined Rock Caverns) storage. This technology is already in use for natural gas storage in a few locations. Isolation liner there is made of stainless steel, which increasing construction costs. This material is also susceptible for hydrogen embrittlement phenomena. Only a few limited metals and alloys are resistant for this phenomena. Material with satisfying isolation properties for hydrogen, available and economic, could cause a possibility to adapt LRC storage technology for hydrogen.

Thesis of this dissertation was to prove, that there is a possibility to point commonly available and economical materials, which could be applied as sealing liners for hydrogen storage. Scientific goal of this work was to investigate and understand the phenomena of hydrogen diffusion through different synthetic materials and natural rocks. Among utilitarian goals were building setup for investigation of gas permeability of materials in different range (from diffusion to gas flow), and selecting promising materials for hydrogen sealing liner.

Experimental study on designed permeability setup (basing on Carrier Gas method) of different polymers (epoxy resin, polyester resin, polyurethane), shows permeability of $10^{-11}$ $cm^3STP*cm*cm^{-2}*s^{-1}*cmHg^{-1}$ ($10^{-1}$ Barrer). Similar permeability was achieved on salt rock after creep process, caused by gas pressure and confining pressure (holding core sample in sleeve). Hydrogen permeability of stainless steel was also calculated, which gives the lower values than polymers ($10^{-17}$ $cm^3STP*cm*cm^{-2}*s^{-1}*cmHg^{-1}$). Cement – based multi grain materials have a gas permeability of $10^{-4}$ – $10^{-5}$ $cm^3STP*cm*cm^{-2}*s^{-1}*cmHg^{-1}$, and ivnestigated rocks, like mudstone and salt rock (before creep process) lower, which was $10^{-7}$ $cm^3STP*cm*cm^{-2}*s^{-1}*cmHg^{-1}$. Simulations of hydrogen permeability of polymers with different fillers were also conducted, using Maxwell model. Estimation of hydrogen loss through different materials from reservoir of known size and parameters was also done.

All the scientific and utilitarian goals were achieved, and thesis of this dissertation was proved.