ON THE ENERGY STORAGE SITES FOR NATURAL GAS: AN OVERVIEW FOR TURKISH CASE AND REGULATION

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ABSTRACT: It is aimed in this paper to mention about underground storage of natural gas. For this purpose, Tuz Lake underground natural gas storage project and Turkish regulation (UNGSP, 2011) have been overviewed. It is understood from the study that the project (Tuz Lake underground natural gas storage) presents new insights for the natural gas storage. However, investigation about the flow characteristics (rheology) during drilling of salt deposit is offered for better design. The Turkish regulation (UNGSP, 2011) is found to involve with the storage plant in the management viewpoint rather than technical issues. Thus, alternately a new regulation in technical viewpoint dominantly can be useful for the natural gas storage operations.

Key words: energy, natural gas, storage

INTRODUCTION

Energy storage of natural gas becomes one of primary issues of energy politics when the country imports the gas mandatory. Specifically for excessive amount of gas, the requirement of storage becomes more important by considering in the viewpoint of engineering structure, as well as characteristics of soils and rocks under complex and extreme conditions that offer mechanical, hydraulic and geotechnical processes in order for developing analytical tools and methods. In many of energy storage systems, it has been know that cyclic charging and discharging will occur with a known time scale. Energy storage of natural gas could be in different forms particularly in subsurface. Opportunities to store thermal heat energy in salt domes in the form of thermohaline reservoirs is considered an alternative approach (Wuttke et al., 2014), which could be a good candidate for the storage of natural gas. This could also provide sustainable solutions for the energy requirements of country. During the subsurface storage of natural gas, permeability enhancement of rock deposits could be a viable issue via hydraulic fracturing. It could be offered that energy storage for natural gas applications may include the underground spaces in salt caverns or aquifers, or as well as the energy storage in the form of compressed gas in caverns or aquifer (McCartney et al., 2016).

It is reported that there are several applications in engineering practice related to operations in the energy sector that requires new developments. They can be

summarized as pipeline construction, design of foundation systems for offshore wind or tidal energy, mining operations related with oil sands, design of dams for hydro energy storage, and quantification of embodied energy in geotechnical infrastructures, etc. Moreover, in a variety of applications specifically in the geotechnical viewpoint, geosynthetic-reinforced retaining walls, energy piles, tunnels and diaphragm can utilize the ground for heating and cooling of structures, storage of heat, or dissipation of waste heat. Main issues within those applications could be considered to understand the coupled role and the mechanical response of the media (i.e., changes in strength, volume change, changes in stiffness) to predict the flow of fluids, transfer of heat in porous or fractured media, etc. The governing equations for the heat transfer and water flow for water-saturated porous media are well researched in the literature. However, the issues above could also present new insights for civil engineers in terms of technical problems associated with soil-structure interaction (McCartney et al., 2016).

It is aimed in this paper to mention about underground storage of natural gas for energy use. For this purpose, Tuz Lake underground natural gas storage project (Turkey) has been overviewed with present Turkish regulation (UNGSP, 2011).

TUZ LAKE UNDERGROUND NATURAL GAS STORAGE PROJECT AND SOME DISCUSSIONS

A typical description of Tuz Lake underground natural gas storage project has been illustrated in Fig.1. In summary, the salt deposit underground nearly in the depth greater than 700m in Sultanhanı (Aksaray) 40km away from Tuz Lake is attempted to be melted via the clean water supplied from Hirfanlı Dam 120km away. After melting the salt deposit, caverns for natural gas storage are aimed to be constructed. Then, the melted salt is transferred and discharged into Tuz Lake through 40km pipe line. For storage of natural gas, 12 caverns are planned to construct with the volume of nearly 600000m^3 for each. It is reported that Turkey has a consumption of 40 billion m^3 natural gas per year. After completing the 12 caverns within the salt mass for natural gas storage, it is offered that nearly 1 billion m^3 natural gas will be stored per year. This means that Turkey will have 2.1 billion m^3 natural gas storage capacity together with Silivri Plant (having the capacity of 1.1 billion m^3 natural gas). This provides a guarantee for 5% of total natural gas consumption of country (Energy Institution).

It is reported that the natural gas could be alternately stored in hard rock caverns, aquifers, old mine sites, in the consumed reservoirs of oil and gas, as well as salt caverns. But it can be said that for Turkey Tuz Lake site presents new insights in the storage viewpoint for future studies involving engineering structures. However, there may be some querying with relevant discussions about the project (Fig.1) involved with the issues of water supply, drilling operations of salt deposit for caverns and discharge of melted salt into Tuz Lake. The feasibility studies

indicate that Hirfanlı Dam seems relatively sufficient for water supply for melting salt during the storage operations. The supplied water is reported as %1.22 of total volume of Hirfanlı dam reservoir (Botaş, 2017). This can be accepted as a relatively minor effect for the dam use. However, the distance 120km away for water supply could be queried in the economy viewpoint. On the effect of melted water discharged into Tuz Lake 40km away from salt deposit, it is reported that (Botaş, 2013) the melted water will contribute to Tuz Lake that is under the threat of evaporation and aridness. Since the melted water will be discharged inside Tuz Lake (not directly to surface), it is not expected adverse effect on the water surface of lake. As for the operation of drilling of salt deposit for obtaining storage caverns, some technical queering could be useful for optimum drilling. For the structural design within the queering, it could be important to investigate the issues of flow characteristics (rheology) of salt+water mass, drilling velocity, pumping velocity, pumping pressure, flow rate, etc. One more important issue during the storage of natural gas could be considered as the environment protection. For this issue, it is reported (Botaş, 2013) that effect of environmental problems (wastewater, solid waste, noise pollution, ecological impact, use of blasting materials, seepage of boring sludge into groundwater, disposal of boring sludge, etc.) will be in minor level that provides the project of Tuz Lake natural gas storage being friendly environment.

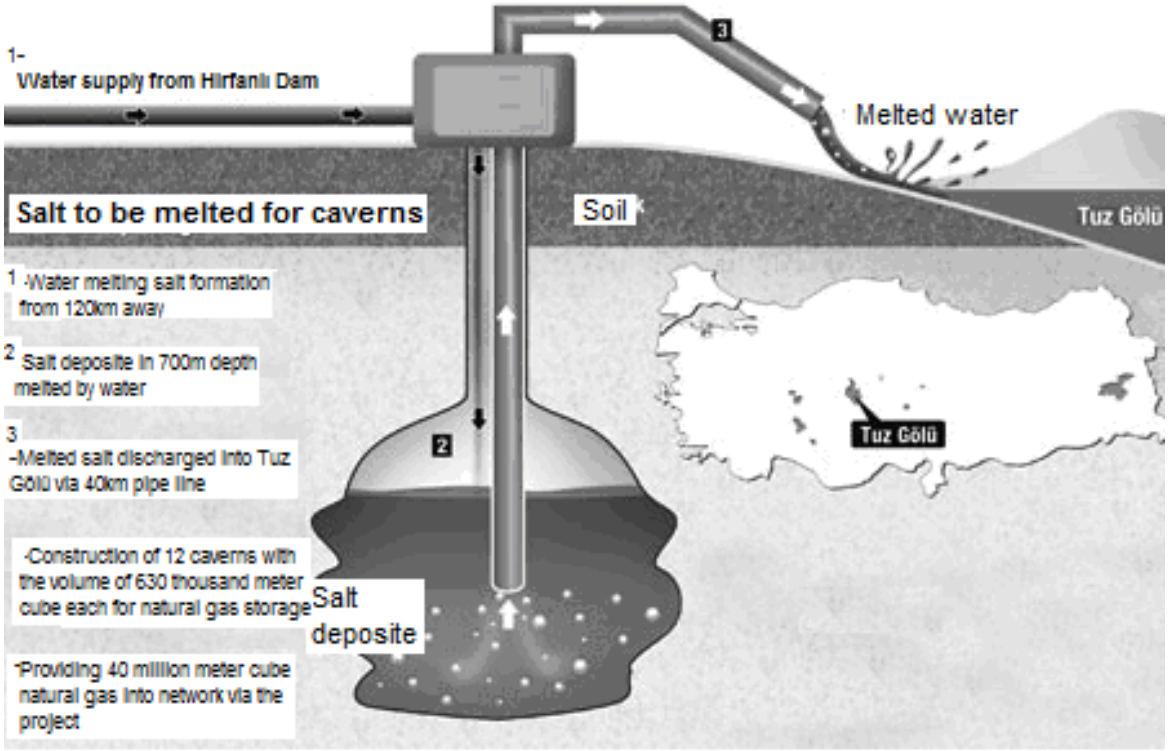

Figure 1. A Typical Description of Tuz Lake Underground Natural Gas Storage Project (Energy **Institution, 2017)**

A TURKISH REGULATION FOR UNDERGROUND NATURAL GAS STORAGE PLANT

A Turkish regulation (UNGSP, 2011) was published by Republic of Turkey Energy Market Regulatory (T.C. Enerji Piyasası Düzenleme Kurumu) for the fundamentals of underground natural gas storage plant. Highlights of some fundamental points could be summarized as follows:

-The company of Natural Gas Storage Plant serves in accordance with related codes and regulations (Pr or Provision 5.2).
-In the cases of security risk for natural gas storage plant or network and restoration or maintenance of plant, there could be power cut or reduction by the company (Pr.9.1).
-The company of storage plant is responsible for operating natural gas system in safe and efficiency (Pr.11.1).
-The company should conduct the maintenance and restoration works without power cut or reduction in storage servings. However, in mandatory cases of power cut or reduction due to the maintenance and restoration, the power cut and reduction should be equally reflected to the clients (Pr.14.1).

As understood from the regulation UNGSP (2011) highlighted above, the provisions of the regulation is mostly related with management operations of storage plant. It can be said that there are missing considerations or indirect points in the regulation (UNGSP, 2011) in the technical viewpoints when considered Tuz Lake natural gas storage project Thus, UNGSP (2011) should be discussed with an extension, or alternately a new regulation should be prepared by more technical provisions in the viewpoint of engineering structure. In view of this, it is recommended some provisions for the natural gas storage operations including water supply for melting, drilling of salt deposit for storage cavern and discharge of melted water into environment.

CONCLUSION

From the study in this paper, it can be concluded that drilling operations of salt deposit (Tuz Lake underground natural gas storage project) needs rheological investigations for optimum design. In addition, the present Turkish regulation (UNGSP, 2011) is found a lack of technical issues of storage that could be offered for future regulations.

RECOMMENDATIONS

Flow characteristics of salt deposit during drilling operation (Tuz Lake underground natural gas storage project) could be investigated for better design. The present Turkish regulation (UNGSP, 2011) could be improved with more

technical issues, or a new regulation including technical issues could be prepared for underground natural gas storage.

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