Research Grants for PhD students from the China Scholarship Council

Information Form **(please read the guidelines carefully on the website www-csc.utt.fr)**

Supervisor's name : NELIAS

Given names : Daniel

Status (prof., assistant prof., …) : Professor

Laboratory : LaMCoS, UMR5259 CNRS

Website address : https://lamcos.insa-lyon.fr/

Institution : INSA Lyon

Website address : https://www.insa-lyon.fr/

Scientific competence of the supervisor:

Daniel Nélias is Professor of Mechanical Engineering, with a long experience in the field of contact mechanics and modelling. In the recent years he has launch research on silicon fracture for photovoltaic applications, and has been involved in the modelling of salt rocks, as those used in salt caverns to store energy in the form of compressed gas. He is the co-author of more than 140 papers published in peer-reviewed journals and the mentor of 26 MSc and 65 PhD students. Web of Sciences / Core Collection (15/04/2025): 147 articles, 4396 citations, 3089 citing articles, Times cited/article=29.9, h-index=39.

Two major publications in the field proposed for the PhD :

1. Li Z., Suo J., Fan J., Fourmeau M., Jiang D., Nelias D. (2023) 'Damage evolution of rock salt under multilevel amplitude creep-fatigue loading with acoustic emission monitoring', Int. J. of Rock Mechanics and Mining
2. Suo J., Fan J., Jiang D., Li Z., Fourmeau M., Chen J., Yang Z., Nelias D. (2024) 'Experimental study on fatigue failure properties of mudstone interlayers under discontinuous loading in salt cavern gas storage', Eng. Failure

Website address of the personal page : https://lamcos.insa-

Supervisor's email : daniel.nelias@insa-lyon.fr

Description of the research work proposed for a PhD

Topic # (see list) : V-5. Energie

Title : Research on Stability and Tightness of Surrounding Rocks in Layered Salt Rock Hydrogen Storage Caverns under Thermo-Hydro-Mechanical Coupling

Subject :

France and China possess abundant wind and solar energy resources, and are accelerating their energy structure transition. However, the intermittent, fluctuating, and discontinuous nature of renewable energy makes it difficult to integrate into the power grid stably. Large-scale energy storage technologies have emerged to resolve these challenges. These technologies store excess electricity during low-demand periods and release it during peak demand, balancing grid loads and achieving "peak shaving and valley filling". Current mainstream energy storage technologies include pumped hydro storage (PHES), compressed air energy storage (CAES), and underground hydrogen storage (UHS). UHS, due to hydrogen's high energy density, offers large-scale and long-duration storage potential, meeting the demands.

Natural salt formations are predominantly layered, characterized by thin salt layers, multiple interlayers, high impurity content, and limited total thickness. Compared to salt dome formations commonly used globally, layered salt rock poses more complex challenges for hydrogen storage. Hydrogen's small molecular size and low viscosity enable it to easily permeate through interlayers and high-permeability rock layers, leading to leakage risks. Studying hydrogen permeability characteristics, damage evolution, and seepage mechanisms in layered salt rock formations is crucial for

Keywords :

Salt cavern; Creep behavior; Compressed air energy storage (CAES); Underground hydrogen storage (UHS).

Expected collaborations :

with the University of Chongqing (China) and with Lulea University (Sweden)

Background required from the applicant :

- Strong background on Mechanical Engineering or Civil Enginering
- An interest in numerical simulation and modeling

Existence of a PDF file detailing the proposal ("yes" or "no") : yes

(see guidelines on the website www-csc.utt.fr)