Job Title: CEDoc - UM6P - MAScIR: Phosphogypsum biotreatment : sulfur bio-extraction and CO2 capture.

Requisition ID **12320** - Posted - **Engineering**

Mohammed VI Polytechnic University is an institution dedicated to research and innovation in Africa and aims to position itself among world-renowned universities in its fields

The University is engaged in economic and human development and puts research and innovation at the forefront of African development. A mechanism that enables it to consolidate Morocco's frontline position in these fields, in a unique partnership-based approach and boosting skills training relevant for the future of Africa.

Located in the municipality of Benguerir, in the very heart of the Green City, Mohammed VI Polytechnic University aspires to leave its mark nationally, continentally, and globally.

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Job Description :

1. Introduction UM6P :

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2. Context.

In collaboration with IRD France, the MAScIR Foundation and MIO Marseille have recently launched the "Jeune Équipe Associée à l'IRD (JEAI) EXTREM BIODIV VALOR." One of the main objectives of this collaborative partnership is to establish a proof of concept (POC) for a new bioprocess for treating Moroccan phosphogypsum. This process comprises two main stages (Literature on the topic : Lin et al., 2018; Sánchez-Andrea et al., 2014; Tang et al., 2009; Valenzuela et al., 2020). In step 1, performed in sea water under anoxic conditions and fed upstream by a stream of H2 and CO2, sulfates present in phosphogypsum are reduced to sulfide by sulfate-reducing bacteria (SRB), according to equation 1 (Rittmann & McCarty, 2001).

In stage 2, the sulfides generated in stage 1 are partially oxidized in elementary sulfur (S°) under micro-oxygenation conditions by sulfo-oxidizing bacteria (SOB), according to equation 2 (Rittmann & McCarty, 2001).
(see also Bounaga et al., 2022; Camiloti et al., 2019; Luo et al., 2020; Schwarz et al., 2020; Suárez et al., 2020; Xu et al., 2012; Zhang et al., 2018)

3. Research Objectives.

The proposed research aims to valorize phosphogypsum by selecting two distinct microbial consortia, one rich in sulfate-reducing bacteria (SRB) and the other rich in sulfur-oxidizing bacteria (SOB). These consortia should be sampled in phosphogypsum-rich marine sediments. After cultures in a reactor under anoxic conditions and fed with H2/CO2, the anaerobic microbial consortium, enriched therefore with BSR, will be identified by metagenomic analysis. Likewise, in a reactor performed under micro-oxygenated conditions and fed with an H2S stream, the consortium enriched with SOB bacteria should be analyzed. During these experiments performed in reactors, the parameters such as pH, and H2, CO2, O2 consumptions, and H2S productions are tracked to calculate the yields and rates of (i) sulfate reduction to sulfide (stage 1) and (ii) sulfide oxidation to elemental sulfur.

4. Admission Criteria.

Highly skilled and qualified Master holding candidates, Skills in microbiology and biochemical engineering are mandatory. Soft skills will be appreciated.

5. References

Bounaga, A., Alsanea, A., Lyamlouli, K., Zhou, C., Zeroual, Y., Boulif, R., & Rittmann, B. E. (2022). Microbial transformations by sulfur bacteria can recover value from phosphogypsum : A global problem and a possible solution. *Biotechnology Advances, 57,* 107949.

Camiloti, P. R., Valdés, F., Delforno, T. P., Bartacek, J., Zaiat, M., & Jeison, D. (2019). A membrane aerated biofilm reactor for sulfide control from anaerobically treated wastewater. *Environmental Technology, 40(18),* 2354-2363.

Lin, S., Mackey, H. R., Hao, T., Guo, G., van Loosdrecht, M. C., & Chen, G. (2018). Biological sulfur oxidation in wastewater treatment : A review of emerging opportunities. *Water Research*, *143*, 399-415.

Luo, H., Bai, J., He, J., Liu, G., Lu, Y., Zhang, R., & Zeng, C. (2020). Sulfate reduction and elemental sulfur recovery using photoelectric microbial electrolysis cell. *Science of The Total Environment, 728,* 138685.

Rittmann, B. E., & McCarty, P. L. (2001). *Environmental biotechnology : Principles and applications.* McGraw-Hill Education.

Sánchez-Andrea, I., Sanz, J. L., Bijmans, M. F., & Stams, A. J. (2014). Sulfate reduction at low pH to remediate acid mine drainage. *Journal of hazardous materials*, *269*, 98-109.

Schwarz, A., Suárez, J. I., Aybar, M., Nancucheo, I., Martínez, P., & Rittmann, B. E. (2020). A membrane-biofilm system for sulfate conversion to elemental sulfur in mining-influenced waters. *Science of The Total Environment, 740,* 140088.

Suárez, J. I., Aybar, M., Nancucheo, I., Poch, B., Martínez, P., Rittmann, B. E., & Schwarz, A. (2020). Influence of operating conditions on sulfate reduction from real mining process water by membrane biofilm reactors. *Chemosphere, 244,* 125508.

Tang, K., Baskaran, V., & Nemati, M. (2009). Bacteria of the sulfur cycle : An overview of microbiology, biokinetics and their role in petroleum and mining industries. *Biochemical Engineering Journal, 44(1)*, 73-94.

Valenzuela, E. I., García-Figueroa, A. C., Amábilis-Sosa, L. E., Molina-Freaner, F. E., & Pat-Espadas, A. M. (2020). Stabilization of potentially toxic elements contained in mine waste : A microbiological approach for the environmental management of mine tailings. *Journal of Environmental Management, 270,* 110873.

Xu, X., Chen, C., Wang, A., Fang, N., Yuan, Y., Ren, N., & Lee, D.-J. (2012). Enhanced elementary sulfur recovery in integrated sulfate-reducing, sulfur-producing rector under micro-aerobic conditions. *Bioresource Technology,* 116, 517-521.

Zhang, Y., Zhang, L., Li, L., Chen, G.-H., & Jiang, F. (2018). A novel elemental sulfur reduction and sulfide oxidation integrated process for wastewater treatment and sulfur recycling. *Chemical Engineering Journal, 342,* 438-445.

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