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TOPOLOGY OPTIMIZATION FOR ADSORBED SYSTEM WITH CONDENSED PCM BODIES

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Abstract: Gas transport and storage are just two vital elements to be considered when analyzing potential solutions involving gas employment. The system efficacy and capacity usually figure out how profitable the gas solution is. A known method for gas storage and transport is the adsorbed natural gas (ANG). It consists in the adhesion of gas at a porous matrix by the adsorption phenomena. Adsorption is an exothermic phenomenon, thus, when gas is adsorbed, heat is generated, heating the system up. One issue regarding ANG engineering is the fact that increasing temperatures cause adsorption capacity to diminish. To solve this issue, processes of controlling the temperature within the vessel can be seen in literature. A temperature control method consists in placing phase change materials (PCM) bodies inside the vessel. In literature, it is confirmed that placing PCM in an adsorption vessel may improve its adsorption and desorption capability by lessening the overall thermal amplitude throughout the cycle. Results vary by altering the total amount and position of PCM bodies at the vessel interior. Employing an effective tool for optimized material distribution, for example, Topology Optimization Method (TOM) is an increasingly attractive answer. Several studies have been conducted about TOM abilities and implementations and it is currently known to be a flexible method for material distribution inside a domain. In this work, it is studied the employment of a topology optimization formulation capable of increasing efficiency of ANG tanks by optimizing PCM distribution at the container inside. The modeled vessel includes a cylindrical vessel with adsorbent substance in its interior that is vulnerable to a pressure growth at the inlet. The FEniCS library is used to manage the differential equations problem and the routine is built in python. Sensitivities calculation are performed by dolfin-adjoint libraries. For TOM, the Project Variable is the distribution of PCM inside the vessel. By tackling the non-linearity caused by phase change periods, an analytic solution to the phase change is linearized and implemented for the numerical process. Helmholtz filter is implemented to remove intermediate values of PCM distribution. This implementation benefits TOM when it avoids the necessity of adaptive mesh solutions, often essential when tackling phase shift problems. By employing TOM, an ANG vessel with PCM is optimized. Optimization results are presented and benefits that the optimization brings are discussed.