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C1Po1D-05 [28]: Design of dewar supports through topology optimization

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Dewars are used to store and transport cryogens like LNG, LN2, LOX, LHe etc. These comprise two vessels, one placed inside the other and held together either at the "neck"(input/output port) or by support systems, depending on the capacity, the mechanical loads on the vessel and the boil-off characteristic of the stored cryogen. Support system based dewars are more common for real-life and industrial applications. Design of the support system are based on the principles that are used for high temperature pressure vessels. On the other hand, support system to be used for cryogenic fluid storage should also address the heat inleak through the supports along with the imposed mechanical load and thermal contraction-expansion effects. Some safety factors are prescribed in the literature to address these concerns; however, the scientific basis of design strategies available in the open literature so as to give a more scientific basis of design. This would result in reduction in use of excessive dimensions or material thereby reducing the payload and the capital cost. Considerations of mechanical load and thermal heat inleak often lead to diametric conclusions in terms of the diameter/thickness of the support system, leading to pareto-optimal solution. Topology optimization (TO) is often used to design structures like bridges, vehicles, robotic arms etc. by a systematic and sequential removal of the mass of the material being used to fabricate the given structure while meeting the constraints in terms of load bearing capacity of the structure and heat inleak. This methodology may be followed to arrive at an optimized geometry for the support system when the designer is unsure of the initial shape to start working. In this work, TO has been tested with various thermal and mechanical boundary conditions to arrive at optimized support geometry.

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