

DESIGN & DESIGN EVALUATION USING FINITE ELEMENT ANALYSIS (FEA) OF MOUNDED STORAGE TANKS

The storage of highly inflammable, toxic and pressurised gases such as LPG is a challenging task. Storage of such fluids above ground poses lot of threat to safety of personal as well as surroundings when there is a leakage thereby causing explosion. Therefore, underground storage is the most preferred storage method due to safety related issues. Mounded bullet is nothing but a pressure vessel which is intended for the pressurized storage of liquefied petroleum gas (LPG) under ambient temperature. This being buried underground; the chances of explosion are almost nullified. In mounded storage facility, a mound of earth or suitable inert material is provided to cover the bullet, which is kept completely below ground, except for nozzles and manhole covers. Mounded bullets are installed on sand bed foundations which allow the load to be transferred uniformly to the underlying sand. This requires no heavy foundation work and offers an uncomplicated, low cost installation. The preferred type of foundation for a mounded storage vessel is a continuous sand bed, supporting the vessel over its entire length.

Mounded Tanks are a special category of pressure vessels, with some unique design and construction features. These mounded tanks can be several hundred meters in length and several meters in diameter. The tanks have stiffeners in the circumferential direction. For the required quantity of gas to be stored, the length and diameter of the tank is chosen according to the codes. The tank is designed considering various loads such as weight of tank, internal pressure, external pressure, mound weight, uneven displacement of sand bed and hydrostatic pressure.

The design of mounded tanks can be done using ASME Sec VIII Div.1, Sec VIII Div.2, and PD-5500 codes. Typical mounded tank is an assemblage of different components like shell, heads, nozzles and stiffener rings. Cylindrical type of shells are preferred as they have maximum section modulus and minimum induced stress for a given diameter. Curved type of head is preferred over flat head as the curved configuration is stronger, lighter and less expensive. The design calculations are done as per ASME Boiler and Pressure Vessel codes (B&PV). Design validation of tanks is done by finite element analysis (FEA). The behaviour of the mounded tank under operating conditions is simulated using FEA. These tanks are subjected to rusting due to condensing of water droplets occurring from endothermic reaction of LPG. Hence corrosion allowance has to be considered during design. The effect of soil is considered by placing the tank over a distributed stiffness (elastic foundation stiffness-EFS). Analysis is done for two conditions: middle soft and middle hard conditions by appropriate

change in EFS along the length of the vessel. The weight of mound is calculated as per EEMUA 190. The effect of design temperature is also studied. Different load combinations are performed based on requirements of PD-5500 and stresses for each case are observed. Stresses are then compared with the allowable limits in PD-5500, Annexure A. Design is validated if the stress calculated from finite element analysis is within the allowable limits. If prima facie, the design fails to meet the stress levels, and fails, the mounded vessel or tank has to be redesigned and reanalysed to achieve optimisation of the design of mounded tank / vessel.

ProSIM has been designed, validated and optimised the design of mounded bullet tanks for several oil and gas companies. Using their competence in finite element analysis (FEA) and design codes such as ASME B&PV, PD5500, prosim is providing detailed design reports of high quality to customers quickly.

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