

Description of a design method for cryogenic concrete tanks based on a comparison between 2D and 3D numerical models

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Ammonia is used in the industry for the manufacture of fertilizers, explosives and polymers and is stored at -33°C in refrigerated tanks. In most cases, tanks are cylindrical and are composed of a steel liner that contains the ammonia, with the liner itself being protected by an outer reinforced concrete tank.

The function of the concrete tank is to keep the ammonia safe in case of a leak in the liner. If a leak happens, the concrete wall will be suddenly subjected to a thermal shock, with a large temperature gradient between its internal and external faces (20°C to -33°C). These thermal effects lead to cracks in concrete that allow the ammonia to escape. The junctions between walls and the base slab and, walls and the roof are particularly sensitive to this cracking phenomenon.

The aim of this paper is to present a method for the design of concrete ammonia tanks, especially taking into account thermal effects.

Firstly, a 2D finite element model based on a plane frame is developed. The advantage of this approach, compared to 3D modelling, is that it requires little computing power and engineering time. Then, a 3D model is used to validate the 2D approach, and to identify its limitations. Particular attention is paid to the modeling of the weakest parts of the structure. Lastly, the paper will give the results of a parametric study based on the above 2D and 3D finite element modelling, in order to establish general guidelines for the design of ammonia tanks.