

## ABSTRACT

The objectives of this project are to ensure safe operation and to provide insights on updating the current API 12F tank design standard by American Petroleum Institute (API). This study is the phase 4 of the project. The API 12F shop-welded storage tanks are commonly used in the oil and gas industry for temporary production liquid storage. The work presented in this thesis focuses on refining the design of the API 12F tanks to optimize the material use and reduce cost, as well as assessing the changes made in the latest 2019 edition.

The failure mode determination, brittle fracture and fatigue evaluations were performed for twelve tank designs presented in the latest 13<sup>th</sup> edition of API 12F. The nominal capacity of these twelve API 12F tank designs ranges from 90 bbl. (14.31 m<sup>3</sup>) to 1000 bbl. (1590 m<sup>3</sup>). In this study, the new cleanout design was studied, a new roof-to-shell connection was proposed, and various component thickness combinations were considered. In addition, a 0.01 in. (0.25 mm) gap was modeled as the shell and the bottom plate cannot fully attach to each other during welding process. These tanks are designed with consideration of experiencing hydrostatic pressure and internal pressure. Therefore, the yielding pressure, rupture failure pressure, and buckling failure pressure were assessed in this study. In addition, the lowest permissible joint efficiency and the capacity of walkway bracket lugs were determined for API 12F tanks.

The brittle fracture evaluation and fatigue evaluation were conducted at the top, bottom, and cleanout junctions at where geometric discontinuities present (i.e., the location of stress hot spot). The brittle fracture evaluation was performed in accordance with API 579, and the fatigue evaluation was performed in accordance with ASME BPVC VIII-2. The stress state at the top and bottom junctions were obtained with the axisymmetric model as they were away from the cleanout junction, while the sub-modelling technique was used to obtain the stress state near cleanout junction.

There were two postulated crack sizes have been considered in the brittle fracture evaluation, which are the surface crack and the through-wall crack. The postulated length of both cracks was 1/8 in. (3.18 mm), while the depth of the surface crack was 1/16 in. (1.59 mm) and the depth of the through-wall crack is the corresponding component thickness. The brittle fracture evaluation was executed assuming the tank operates at a location with the one-day mean temperature of -55 °F (-48.3 °C).

The fatigue evaluation estimates the maximum allowable number of operation cycles of the API 12F tanks. It is helpful to have an idea on tank fatigue life at the locations that typically experience high stresses due to the repeated liquid storage process. Safety factors were applied when performing this fatigue evaluation. Therefore, the conservative estimation of allowable number of operation cycles was obtained in this study.