Structural simulation of a Horizontal Pressure Vessel for predicting stress under extreme weather conditions

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Abstract: Offshore containers are exposed to the movement caused by wind, ocean currents, and unpredictable weather conditions so a good structural resistance is required for them. A dynamic analysis has been developed using Abaqus/Explicit to study the structural response of a horizontal pressure vessel mounted in Floating Production Storage and Offloading (FPSO) topsides in the Gulf of Mexico (GOM) coast. The model includes fluid behavior of crude oil inside the container for which the linear Us-Up Hugoniot equation of state is used. The viscosity of the oil was varied according to temperature. A single adaptive meshing rule is also used to prevent distortion of fluid elements.

The structural resistance of the horizontal pressure vessel must satisfy the ASTM, ASME and API Standards to prevent catastrophic failure under extreme weather conditions. The vessel is made of a SA516-70 steel, for which mechanical properties are taken into account. The analysis considers thermal effects of fluid and weather conditions by using an appropriate heat transfer coefficient. Wind velocity is expressed in terms of an external pressure load. Stress results have been compared with a stress distribution obtained from a simulation of a pressure vessel located on a fixed platform. This type of simulation is very important since no historical data exist for this FPSO location.

Keywords: Offshore, FPSO (Floating Production, Storage and Offloading), pressure vessel, FEM (Finite Element Model).

1. Introduction

Oil exploration and production companies are exploring further out into the sea and deeper under the ocean floor, at depths greater than 900 m to tap into pockets of oil and natural gas around the world. Since 1975 oil industry started exploring in deepwater to obtain energy resource developing new technology equipment. The FPSO (Floating Production Storage and Offloading System), a floating platform as shown in Figure 1a, receives the fluid from the undersea oil reservoir via flexible risers through a turret mounted swivel, then the fluid is separated to oil, gas, and water by the process equipment, and usually packaged into modules and secured on the deck of the vessel (*production function*). The separated oil is stowed in the vessel's tanks (*storage*