Paper ID: 68726
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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SEAMLESS AND MULTI-DIMENSIONAL DOMES FOR LARGE LIQUID CRYOGENIC TANK

Abstract

Aubert&Duval studies multi-dimensionals structural parts for space exploration for launchers or space crafts.

Aubert&Duval aims to provide domes for large spacecrafts tanks (greater than 1m) used at room temperature or in the Liquid cryogenic field, at low or high pressure.

Currently, aluminum tanks are welded with formed plates. To manufacture seamless domes or to minimize them, the solution of providing a very large half-tank appears to be one of the levers for improvement. In order to reduce the assembly and the non-destructive tests (for instance ultra-sonic test), we develop a new process allowing to form half-tanks of the hemispherical type or Cassini. They are obtained by close die forging under a 65kT press. In this example, only one weld is needed to assemble an entire tank.

Maximum dimensions are diameter: 3800mm, height: 1700mm.

This process makes it possible to:

- reduce costs,
- meet industrial production capacity,
- adapt to each design incl. flanges, junctions, stiffeners ...
- obtain high and homogeneous mechanical characteristics.

The aluminum grades worked are 2219 and 2050.

Methodology

The feedback from A&D, aided by digital forming simulation software, makes it possible to study the various optimization solutions, identify the most efficient tooling to produce a conforming part. The use of a large hot forming press allows an optimization of the displacement of the metal and an orientation of the ideal fibering according to the mechanical stresses.

The starting formats (billet or plate) are chosen according to the metallurgical constraints. The industrial route is defined by stages of open die forging and closed die forging under hydraulic press for hot deformation. A heat treatment gives the requested mechanical characteristics.

Tools can be adapted for different tank designs, reducing the non-recurring cost. The design is intended to reduce the diameter and height and adjust the shape of the die-print. The implementation is carried out by a support tool and shells which are placed in it. Evolutions are then possible apart from the maximum dimensions of the support tool.

Results and conclusion

Equipment forming capacity and half tank's production feasibility of such diameters have been confirmed through simulation studies.

Aubert&Duval study solutions to reduce the input weight used and to supply parts close to final dimensions minimizing machining operations.

Aubert&Duval confirms its desire to support future markets for space exploration.