DESIGN AND TEST OF THE NITROGEN TORUS SYSTEM ASPIRATING GASEOUS H2 FROM ENGINE ON ARIANE 6

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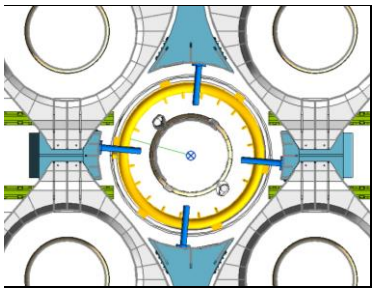
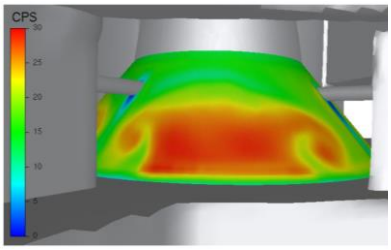
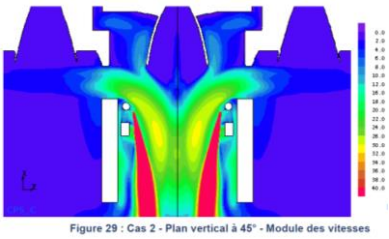
Abstract:
The purpose of the subject is to verify the correlation between the calculated results and test results.
The purpose of the torus nitrogen system on the Ariane 6 launch table is to suck up the residual hydrogen from the Vulcain engine chill-down and to drive the flames resulting from the combustion of hydrogen gas to the jet guide.
This system is powered by a nitrogen storage of 40m^3 to 250 bar. The detailed studies made it possible to determine by calculation and the various CFD simulations from the digital model, the best configuration in order to guarantee a suction speed greater than 8m/s for more than 78s in the cone between the Vulcain nozzle and the beginning of the guide jet over table. The suction speed must not exceed 20 m/s around the propane burners in order to avoid flame suction. The variable parameters taken into account were the storage volume, the diameter of the calibrated orifices, the nozzle profile, the number and position of the nozzles in the jet guide, the angle of the nozzles. The calculations showed that the chosen configuration allowed to achieve the desired performance with margin. The Ariane 6 jet guide being shorter than on Ariane 5, it was necessary to optimize the configuration. Thus it was retained the use of 18 nozzles with convergent profile 30 ° -divergent 18 ° evenly distributed except on 2 sections of 40 ° at the turbopump outputs, brought as close as possible to the jet guide with an angle of 10 ° in order to guarantee a flow of nitrogen at the nozzle output parallel to the jet guide. The studies also took into account the thermo-mechanical aspects of cold nitrogen expansion and the heat flux and pressures generated by the vulcain flame and ESR in nominal configuration and 600 s vulcain hot firing tests.



Configuration torus nitrogen and its environment seen from above



Suction velocity gradient (m/s) in the cone between vulcain nozzle and jet guide



Speed Profile

At the end of the manufacturing and assembly phase on the launch table, a series of full-scale tests was carried out with 18 anemometer speed measurements, 2 pitot tube measurements for nozzle output speeds distributed in the environment of the Vulcan engine and pressure measurement.

Structure for measurement before testing

System behaviour during testing

The test results were as expected.