Assessment of dynamical loads due to Fluid-Structure Interaction during a solid rocket motor ignition: Tools development and validation

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ABSTRACT

The ignition of a solid rocket motor constitutes a stiff phenomenon. The pressure and the temperature increase from ambient values, usually 1 *bar* and 300 *K,* to the working ones about 100 *bar* and 3000 *K* in a really short time. Therefore, significant dynamic loads may be induced by the ignition on key elements of the rocket. Side loads on the nozzle[1] or pressure oscillations[2] are examples already taken into account during the industrial design process.

Smaller solid rocket motor with a shape more spherical than a classical Ariane 5 P230 or Vega P80 can be subjected to a more particular kind of dynamic load. The latter is generated by the interaction between the propellant load and the composite material of the main structure when the motor inflates because of the increase in pressure during the ignition sequence. Such behaviour is highly sensitive to the pressure repartition in the combustion chamber and cannot be assessed by simulation without taking into account the fluid-structure interactions.

The following paper presents the development of a coupled software assembly done by Ariane Group between the ONERA CFD-Software CEDRE[3] and the MSC structural solver MARC with the OpenPalm coupler[4]. The validation of the numerical and physical behaviour is achieved through the realization of simple 1D[5] and 2D[6] test cases with a known analytical solution. This simulation tool is subsequently used to solve an industrial configuration coming from the solid propulsion and results are compared with measurements from an actual prototype.

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