Influence of frequency of exchanges in quasi-dynamic methods for transient conjugate heat transfer problems.

G. Gimenez [1,2], D. Baillis [1], Y. Smith [2], M. Errera [3]

[1]Université de Lyon, CNRS, LaMCoS, INSA Lyon, UMR 5259, F-69621 Villeurbanne Cedex, France

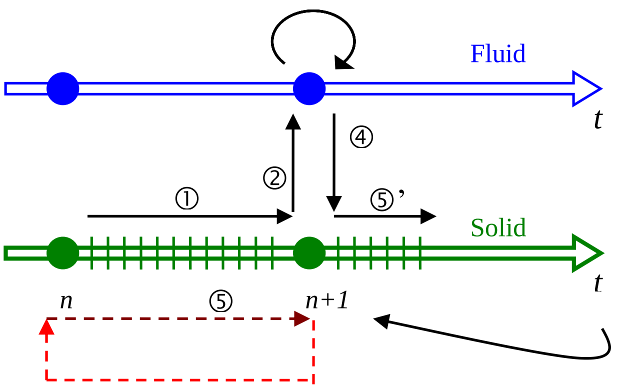
[2] Turbomeca (Safran Group), BP17, 64 511 Bordes Cedex, France

[3] Onera, The French Aerospace Lab, 29 Avenue de la Division Leclerc, 92 322 Châtillon Cedex, France

ABSTRACT

In many industrial modern systems (combustors, turbine blades, heat exchangers, etc.), the high gas temperatures and high temperature gradients can result in significant thermal stresses in the solid structures which can lead to serious damage. As a result, a detailed knowledge of heat transfer characteristics is of prime importance in the design process to preserve the integrity of the components under extreme thermal conditions and therefore, an accurate representation of the temperature loading in the solid is essential. Conjugate heat transfer (CHT) is used to describe thermal interactions between fluid and solid, and then improve accuracy of temperature predictions.

This study deals with development of a coupling strategy at fluid solid interface for transient heat transfer problems. The numerical techniques presented in this paper are based upon a partitioned approach between a finite-volume fluid code and a finite-element solid code interacting with each other at a common interface. A quasi-dynamic method is used to bridge the significant disparity in time scales between the two media. In this approach, the transient conduction modeling in the solid is coupled with a sequence of steady states in the fluid. The quasi-dynamic algorithm was described recently in detail in a previous paper [1].



①: Transient calculation in the solid.
②: Exchange from the solid to the fluid.
③: Steady fluid computation.
④: Exchange from the fluid to the solid.

Convergence Test - Comparison between solid & fluid states at the interface:

⑤ No: Go back to *n* (step①). One more iteration between *n* and *n*+1 until convergence.

⑤' Yes: new transient procedure in the solid from *n+1*

Figure 1: quasi-dynamic coupling algorithm

Influence of frequency of exchanges between the codes is analyzed in this paper, in terms of stability, precision and CPU time. Various frequencies of exchanges are tested on a test-case of flat plate with transient boundary conditions.

REFERENCES

[1] Errera, M.-P., & Baqué, B., "A quasi-dynamic procedure for coupled thermal simulations," *Int. J. Numer. Fluids*, *72*, pp. 1183-1206, (2013).