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Comparing stabilized methods and approaches for the simulation of buoyant flows

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SUMMARY

Two stabilized methods for the simulation of buoyant low speed flows are presented and compared. The formulations are based on the unified approach for compressible and incompressible flows [1], which solves monolithically the continuity, momentum and total energy equations.

The first strategy uses the Boussinesq approximation to account for the temperature driven forces. This method models the thermal terms in the momentum equation through a temperature-dependent nonlinear source term. The SUPG and SGS stabilized methods will be applied to solve this set of equations. It is known that the Boussinesq approximation poses numerical challenges for high Rayleigh numbers, which manifest in slow or lack of convergence.

The second approach introduces variable density thermodynamics of the liquid or gas without any artificial buoyancy terms, thus, without introducing any approximate models into the full Navier-Stokes equations. Furthermore, this formulation holds for flows driven by high temperature differences and it is thermodynamically consistent.

Various benchmarks [2,3] will be used to illustrate the performance and advantages of each approach. Finally, the technology will be applied to study passive energy efficient devices to climatization.

Keywords: Buoyancy, Boussinesq approach, climatization, stabilized methods, SUPG, SGS, VMS adaptivity

AMS Classification: 65L11,65M60

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