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Letter to the Editor

Reply to a letter of A. Povitsky regarding benchmark problem of 3D flow in a cubic cavity driven by a diagonally moving lid

Dear Editor,

In his letter A. Povitsky correctly argues that he was the first who proposed to consider a 3D flow in a lid-driven cubic cavity with the lid moving along cavity diagonal. At the time of publication of our paper [1], we were not aware about papers of A. Povitsky [2–4], and deeply regret for not citing them. We wish to stress here that the idea about change of the classic formulation, as well as all the results published in [1], were obtained independently from the previous works of A. Povitsky [2–4]. Certainly, we shall include references to these papers in all our future publications on this topic.

In his letter A. Povitsky addresses the modified configuration of the lid-flow he proposed in the three papers [2–4], among which two are published as a NASA report and an AIAA conference proceedings paper, and the third one entitled "3D flow in cavity at yaw", as a regular journal paper. All three papers describe mostly the same results. We wish to draw your attention to the above title, since any electronic search that uses "lid driven" and "cavity" as keywords would never find the article. We think that this is what occurred when we studied previously published results. NASA reports and AIAA conference proceedings are not included in main scientific databases, such as SCI, SCOPUS or INSPEC. Also, the Reviewers of our paper [1], as well as the Reviewers of Yu. Feldman's Ph.D. thesis, apparently were not aware about earlier works of A. Povitsky.

Note also that A. Povitsky never announced the problem as a new benchmark, seemingly because his results were too far from the benchmark quality. They were obtained with commercial multipurpose software Fluent, and are themselves subject to extensive verification with experimental or numerical benchmark quality results. In particular, the convection terms of the flow were discretized by the second order upwind scheme, known for its numerical viscosity, which can significantly affect results if the numerical model is characterized by a large grid Reynolds numbers. Nevertheless, in none of his works [2–4], did A. Povitsky perform an estimation of the numerical diffusion or grid dependence of his results. Our numerical experience shows that use of up to 101 grid points in each direction is insufficient for obtaining benchmark quality results, especially for lower order schemes. A. Povitsky did not report numerical values of the flow characteristics which could have been used for comparison with future numerical and/or experimental studies.

In contrast, all the above points were carefully addressed in our work. Namely, the results reported were obtained with an in-house solver carefully verified against well-established benchmark solutions [5]; second order conservative finite volume schemes were used for the spatial discretization of all terms of Navier–Stokes equations; the solution obtained on 152^3 and 200^3 grids was then extrapolated to its zero-grid-size limit by the Richardson extrapolation, following an acceptable technique for providing benchmark quality results [6]. In our paper, we also report explicit numerical values of pressure and velocity components along the cavity centerlines, allowing for the comparison with oncoming works in the field. Based on the above arguments, we think that our claim for establishing a new benchmark case is not entirely wrong.

We also think that the term "Povitsky cavity flow" mentioned in Ref. [7] is an exaggeration. Both 2D lid driven flow in a square cavity and 3D lid driven flow in a cube do not carry anybody's name, possibly because the configurations are too obvious. In our opinion, there is no reason to assign a name to quite an obvious extension of these benchmarks that only changes direction of the driving lid motion.

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