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Short Communication

Fluid Steady Behaviour

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Abstract

There are numerous solvers for computational fluid dynamics, and they are widely used in industry. However, some solvers are simplified theoretical systems. Engineering researchers and students sometimes choose these solvers, leading them to rely on results considered accurate and verified rather than on the solvers themselves and their understanding of physical phenomena. While this may make it easier for peer-reviewed papers to be accepted, it also leads to the decline of science and technology. There is something that can be done about it. Therefore, this paper serves as a warning to all researchers, offering hope for the present and future of computational fluid dynamics and providing guidance for basic research.

Introduction

Although science and technology have made remarkable progress in recent years, basic research has been neglected, seemingly to the detriment of physics' progress. Fundamental physics also seems to have been overlooked in applied research. However, most applied research relies on the International System of Units (SI) [1], which is a global standard. Still, there are some doubts. For example, discrete time resolution is 1 second, but milliseconds may be more appropriate in some cases. There seems to be no theoretical basis for the power consumption conversion formula in any of the books. Nevertheless, I get the feeling that the power consumption argument is not that important at the moment. What is important is learning how to solve for a steady-state fluid. Solving the steady-state fluid problem will lead to an understanding of various unsteady physical phenomena. Therefore, this paper only describes a few ideas that will be discussed in the future.

Materials and Methods

Steady-state analysis is based on assumptions such as "people don't move" and "the river has a constant flow." However, in reality, people move, rivers flow, and some of the flow is turbulent. People move, rivers flow, and some of the flow is turbulent (Figure.1). Does Navier-Stokes' numerical solution method [2] describe the phenomenon universally?

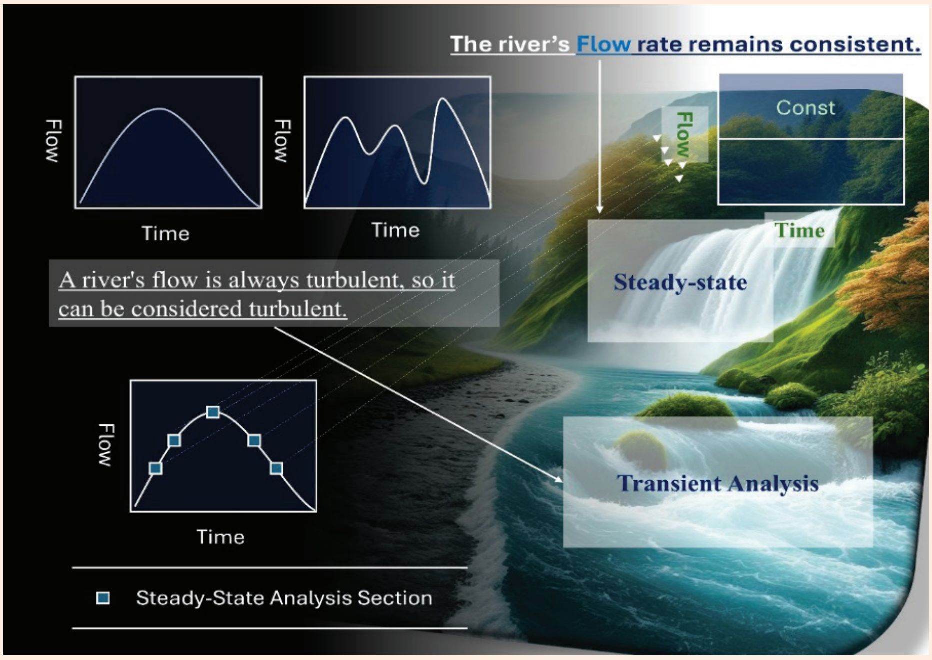

Figure1: Difficulties with steady flow fields and unsteady stationary sections.

The description should be made in terms of simple mathematical formulas rather than partial differential equations [3]. Since unsteady analysis comes after steady-state analysis, the behaviour of the fluid in steady-state analysis must first be considered. Under the assumption of steady-state fluid flow, calculations are sometimes performed from the steady state to perform unsteady analysis. This may seem reasonable, but it is not always the case. If a near-steady state is created in a strict experiment, then it is understandable. However, a steady state cannot easily be created. In architecture, for example, when a house is placed in an environmental test chamber and the surrounding wind flow is like a typhoon, the convective heat transfer coefficient on the outdoor side does not significantly affect the indoor "heat" if the wind strength is above a certain level. Currently, I am strongly attracted to the SI unit system used to describe steady states. With a knowledge of high school mathematics, one can understand it, and it may even capture the results of actual measurements. I believe there is a current trend in the world to conduct complex applied research on steady states that have already been elucidated. In a sense, this is the decline of fluid engineering. Indeed, numerical fluid dynamics is still incomplete. For instance, accurately solving unsteady, complex residential wind flows is difficult. Conversely, a simple analytical model can be validated as "correct and accurate." However, peer review of a simple analytical model assumes that the model is correct, which raises some doubt as to whether the accuracy verification is truly valid. I would like to state that elaborating on the definition of the steady-state assumption will contribute to the development of science and technology in the future. In architecture, for instance, transient analysis of a house sometimes uses the surface temperature of a wall at a certain time as a boundary condition for CFD. However, I am unsure whether this truly captures the transient or steady-state condition. I have struggled many times in the past to reproduce steady-state conditions. In particular, it is extremely difficult to create a steady flow field from an unsteady one. Therefore, I would like to point out that the boundary conditions calculated by unsteady analysis cannot be used directly in steady-state analysis.

Conclusion

This manuscript discusses steady-state and transient problems in numerical fluid dynamics and includes the author's experiences. In other words, it serves as a guide for future research activities. In practice, steady-state analysis is difficult to understand, and it is not easy to simply imagine the flow of a river, for example. To reproduce actual steady-state conditions, it is important to distinguish between non-steady-state and steady-state analyses through rigorous experimentation.

Limitation

It's not wise to think that numerical fluid dynamics is a panacea. This is especially true since the engineering field promotes the use of simple tools. This venerable situation should be reconsidered in terms of how school education is conducted. This paper highlights the fact that steady-state fluids are challenging to understand and cannot be effectively handled with solvers commonly used in engineering fields.

Future Research

In the future, we plan to perform numerical analyses, including taking actual measurements, to determine instances when steady-state analysis results cannot be derived from non-steady-state analysis results. The author's research group will make a concerted effort to publish more peer-reviewed papers with honest content.

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