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Editorial

Experimental and Numerical Modeling of Fluid Flow

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1. Introduction

Fluid dynamics is often related to complex flow conditions and systems, either in the context of fundamental research or in the context of industrial processes. Typically, the study of such flows requires experimental or numerical models which capture their complex, i.e., multiphase and turbulent, nature. Although such models have been the state of the art for a long time in areas such as aerodynamics or weather simulation, the field of the application of experimental and numerical flow models is constantly expanding. The goal of this Special Issue is to present an overview of applied experimental and numerical flow models, with a strong focus on the following topics: (i) new areas of application, (ii) advanced experimental or numerical models, (iii) innovative modeling approaches, and (iv) challenges in modeling techniques.

2. New Applications of Experimental and Numerical Flow Models

T. Zisis, K. Vasilopoulos, and I. Sarris [1] investigate the prevailing conditions in a railway tunnel after a train fire accident by means of CFD simulations. The goal is to analyze the ability of the ventilation system to create the proper conditions for safe passenger evacuation. Three scenarios with different fan activation times and different evacuation processes were examined. They found that the most important action in a tunnel fire is the time at which the ventilation system is activated after the start of a fire.

C. L. Pavlidis, A. V. Palampigik, K. Vasilopoulos, I. C. Lekakis, and I. E. Sarris [2] examine the airflow and pollutant dispersion around an isolated cubical building located in a warm Mediterranean climate with CFD simulations adapted to the local micro-climate conditions. The performance of the numerical model is tested with the help of measured data from the SILSOE cube experiment. In the simulations, the influence of the thermal boundary conditions of the building on the airflow and the pollutant dispersion is evaluated.

M. Zaboli, S. S. Mousavi Ajarostaghi, and M. Saffari Pour [3] analyze different configurations of a parabolic trough solar collector with inner helical axial fins as a swirl generator. After a successful validation of their CFD model, they use CFD simulations in order to resolve the inner flow and temperature fields. They show that the thermal performance of the collector can be significantly improved by using an innovative collector design.

K. Yousef, A. Hegazy, and A. Engeda [4] study complex flow behavior during gas entrainment in water in an inverted vertical U-tube with the addition of side air or water vapor. The results from both experiments and CFD simulations reveal a complex interplay between the water mass flow rate, pressure, and extracted air or vapor flow rates. Furthermore, critical states of the system are identified.

Z. Zhu, Y. Ju, and C. Zhang [5] investigate the obstructive sleep apnea–hypopnea syndrome, a highly prevalent respiratory disorder, in an experimental approach based on a computed tomography scanned extra-thoracic airway model. They use particle image velocimetry to study the air flow in their model. The in vitro measurements of oscillatory respiratory flow velocity show the temporal evolution of the complex flow patterns and

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the potential wall collapse of the extra-thoracic airway model with obstructive sleep apnea–hypopnea syndrome.

D. K. Kim [6] analyzes the performance improvement of refrigerators by different innovative methods. The effects of three methods, modifying the flow channel and the operating conditions and changing the positions of the fan in the mechanical chamber room, are analyzed in a combined experimental and numerical approach. The results show that the efficiency of the refrigerator can be improved by these methods.

T. Bano, F. Hegner, M. Heinrich, and R. Schwarze [7] study the fluid–structure interaction (FSI) involving flexible elastic structures in a water cross stream with an FSI-CFD model. Transient simulations are carried out for flexible flaps of different thicknesses in a laminar glycerin flow with Reynolds numbers ranging from $3 < Re < 12$. The bending line and the maximum tip deflection of the flaps in the simulations agree well with findings from a previous experimental study.

F. Wang, L. Wang, G. Chen, and D. Zhu [8] examine the oil droplet size distribution in an aero-engine bearing chamber with CFD and population balance models. The CFD simulations reveal the correlations between the initial oil droplet size distribution, the oil droplets' coalescence and breakup, air, and oil mass flow, analyzed using the CFD and population balance models.

X. Qu, Q. Guo, Y. Zhang, X. Qi, and L. Liu [9] propose a miniaturized four-sensor electrical probe with a new signal processing method as an innovative multiphase flow measurement technique. Measurements were taken during a gas–liquid two-phase flow experiment in cap-bubble flow regime to test the performance of the proposed signal process scheme. The local flow parameters obtained by the probe measurement are in good agreement with the results from the visual measurement technique in the same flow conditions, proving the correctness of the proposed method.

Finally, Y.-B. Seo, S. S. Paramanantham, J.-Y. Bak, B. Yun, and W.-G. Park [10] use a CFD approach to investigate a boiling model for rod bundle flows related to reactor cooling in nuclear power plants. The comparison of the numerical results with the experimental values of the vapor volume fraction and vapor bubble–water interfacial area concentration show good agreement for different initial conditions.

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References

1. Zisis, T.; Vasilopoulos, K.; Sarris, I. Numerical Simulation of a Fire Accident in a Longitudinally Ventilated Railway Tunnel and Tenability Analysis. *Appl. Sci.* **2022**, *12*, 5667. [CrossRef]
2. Pavlidis, C.L.; Palampigik, A.V.; Vasilopoulos, K.; Lekakis, I.C.; Sarris, I.E. Air Flow Study around Isolated Cubical Building in the City of Athens under Various Climate Conditions. *Appl. Sci.* **2022**, *12*, 3410. [CrossRef]
3. Zaboli, M.; Mousavi Ajarostaghi, S.S.; Saedodin, S.; Saffari Pour, M. Thermal Performance Enhancement Using Absorber Tube with Inner Helical Axial Fins in a Parabolic Trough Solar Collector. *Appl. Sci.* **2021**, *11*, 7423. [CrossRef]
4. Yousef, K.; Hegazy, A.; Engeda, A. Experimental and CFD Investigation into Using Inverted U-Tube for Gas Entrainment. *Appl. Sci.* **2020**, *10*, 9056. [CrossRef]
5. Zhu, Z.; Ju, Y.; Zhang, C. In-Vitro Experimental Modeling of Oscillatory Respiratory Flow in a CT-Scanned OSAHS Tract. *Appl. Sci.* **2020**, *10*, 7979. [CrossRef]
6. Kim, D.K. Experimental and Numerical Study on Performance Enhancement by Modifying the Flow Channel in the Mechanical Chamber Room of a Home Refrigerator. *Appl. Sci.* **2020**, *10*, 6284. [CrossRef]
7. Bano, T.; Hegner, F.; Heinrich, M.; Schwarze, R. Investigation of Fluid-Structure Interaction Induced Bending for Elastic Flaps in a Cross Flow. *Appl. Sci.* **2020**, *10*, 6177. [CrossRef]
8. Wang, F.; Wang, L.; Chen, G.; Zhu, D. Numerical Simulation of the Oil Droplet Size Distribution Considering Coalescence and Breakup in Aero-Engine Bearing Chamber. *Appl. Sci.* **2020**, *10*, 5648. [CrossRef]

9. Qu, X.; Guo, Q.; Zhang, Y.; Qi, X.; Liu, L. A New Vector-Based Signal Processing Method of Four-Sensor Probe for Measuring Local Gas–Liquid Two-Phase Flow Parameters Together with Its Assessment against One Bubbly Flow. *Appl. Sci.* **2020**, *10*, 5463. [CrossRef]
10. Seo, Y.-B.; Paramanantham, S.S.; Bak, J.-Y.; Yun, B.; Park, W.-G. CFD Analysis of Subcooled Flow Boiling in 4 × 4 Rod Bundle. *Appl. Sci.* **2020**, *10*, 4559. [CrossRef]