An Overview of Vortex Tube on CFD with Straight and Helical Nozzle

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Abstract— Hilsch Ranque Vortex Tube is a very simple device, known for its phenomenal separation temperature effect. With a compressed gas inlet pipe simultaneously produces two different gas streams - one is hotter and the second is colder than the gas inlet. In recent years, various theories have attempted to explain this effect without achieving universal consent. The small size of the Vortex tube has considerable difficulty in predicting the temperature, pressure and flow field inside. This is Computational Fluid Dynamics analysis comes to the aid of scientists. Many researchers have attempted such analysis using turbulence models such as the Standard Model k-e, RNG k-e model and the delivery model k-e, Large Eddy Simulation Technique (LES), etc. This article attempts to provide an overview of recent qualitative research on RHVT using CFD. Care was taken to explore the various parameters related to the physical movement within RHVT, instead of being a monotone. It is expected that the evaluation to help future research in the related field.

Key words: CFD, Vortex Tube, Turbulence Model, Temperature Separation, Helical Nozzle

I. INTRODUCTION

The Ranque–Hilsch effect was first discovered by Ranque in 1933 and was later reintroduced and improved in efficiency by Hilsch in 1947. The Ranque–Hilsch vortex tube is a simple device with no moving parts that is capable of dividing a high pressure flow into two flows of different temperatures. The vortex motion in Ranque–Hilsch vortex tube is created by tangential injection of a compressed gas.

When compressed gas is injected through one or more tangential nozzles into the tube, a strong vortex-like flow field is established, giving rise to a non-uniform temperature field. The gas closer to the axis is colder than the incoming feed gas, and the gas near the periphery of the tube is hotter.

II. LITERATURE SURVEY

This paper presents the detailed literature review on a vortex tube on CFD with Straight and helical nozzle. Finally, this paper concludes with the scope of the present work.

According to Hui Yua et al. [1] a series of CFD simulations were conducted for single fiber DCMD modules with and without baffles using a simplified 2D heat-transfer model in this study. The numerical simulations have been verified by experiments with less than 5% error in predicted outlet temperatures. A comprehensive analysis on the dominant effect in the MD heat-transfer process based on the resistance-in- series model was provided to reveal the impacts of key parameters that could contribute to an enhanced direct contact membrane distillation system. Potential enhancement strategies under different circumstances have been discussed.

P. Wang et al. [2] Have been researched numerical simulation was studied to examine the effect of introducing metal foam into a parabolic trough collector tube heat transfer. The effects of the system (up / down) , geometrical parameter (H) and porosity (u) metal foams resistant to flow , heat transfer and thermal efficiency - Hydraulic are analyzed . the optimum thermal efficiency of the hydraulic due to the greater flow resistance is achieved at H = 0.25 (bottom) , Nu increases from about 5 to 10 times with an increase from 10 to 20 times the PEC f range from 1.4 to 3, 2 . Optimum results are achieved when the thermal H = 0.75 (top), Nu is increased about 10-12 times increase in F and 400-700 times PEC range 1.1 to 1.5.

Jiangfeng Guo et al. [3] A number of spiral tube provided with regularly spaced strips of screw inserts were examined with regard to the principle of field synergistic. The calculation of the SST turbulence model k -omega show better agreement with experiments that the results obtained by the model K - epsilon RNG prediction of a vortex in the lower region of the Reynolds number k -omega Model SST is in good agreement with the quantitative and qualitative experience of Tal results in the entire region of Reynolds numbers discussed in this book. It is found that spiral inserts fringe alternative left to the right and have a much better performance than the screw inserts Twists evenly right heat transfer.

Baiman Chena et al. [4] it presents a series of works on the fluid dynamics and heat exchange rotating current collapse created using a set of ribs in the axial line concentric rings. The test improve heat exchange by passive methods, namely, a swirling flow is supplied.

Xinyi Tang et al. [5] In this work, the experimental study was conducted to investigate the heat transfer characteristics and flow of water in the twisted oval tube movement and turned three-lobed tube ranges RE 8,000 to 21,000, it can be inferred that at the same height , twisted Nusselt number twisted tri -lobed pipe improves 5.4% , and the coefficient of friction twisted corrugated tubes increased by 8.4% compared with the oval tubes twisted. Increasing the CEP implied that clover twisted tube is more suitable to replace the straight pipe heat exchange equip her. Numerical study was conducted at Re = 4000 to 20,000 for the analysis of the influence of geometric parameters of fluid flow and heat transfer inside the tubes twisted and find the optimal value for the overall thermal efficiency different geometric parameters .

According to Junbo Wang et al. [6] Equation potential available in the steady state was obtained, wherein the local energy of the rate of destruction is determined to express the irreversible loss in the process of convective heat transfer. It differs from the method of determining the value of the base surface of the heat exchange method is based fluid is selected taking into account both the heat resistance and flow. The optimal model is a mathematical

process in both regions better reflect the principle of heat exchange fluid.

Pengxiao Li et al. [7] in this study, firstly, the effect of hollow beam and slow the transfer of heat and strength properties cartridge belt hollow tube twisted cross is analyzed. This effect of the number of twisted-sided tape on the heat exchange efficiency and resistance is examined. The results show that the hollow tube with the cross twisted web exhibits good overall performance. An empty value is the width to get the best heat exchange efficiency. The best performance of the overall heat transfer hollow sleepers twisted increased band 03.07 to 12.03% when compared to the twisted strip center cleaned and 4.3 to 28.1% compared to the conventional twisted strands. More fun, the better the heat transfer capacity. Furthermore, the tube-sided four twisted strands have the best overall heat transfer efficiency. Finally, nu empirical formulas for f include a hollow rate range, the compression ratio and the number of wound strips of single-sided.

Zhang-Jing Zheng et al. [8] In this article, a new method of coupling optimization genetic algorithm (GA) and Computational Fluid Dynamics (CFD) , is based on the Windows sockets found to optimize the configuration of the porous liner in the pipe to improve the heat transfer . In the region of the reinforcement in the tube is divided into several layers in the radial direction. The porosity of the porous layer was filled with each design variable, which varies from 0.5 to 1.0. The results show that the improved performance of Thermo hydrauliques tube can be improved by effectively using the optimized porous insert and in particular by an optimized multi-layer porous insert. However, there are many porous insert the corresponding layer to ensure optimal performance reinforced pipe for a given set of parameters.

Samer Ali et al. [9] mixing and heat transfer enhancement , which is important in many engineering applications , and is supported by a number of methods based on monitoring the flow of active or passive . This study focuses on innovative ways to improve the mixing and heat transfer through the manipulation of the dynamic flow of passive laminar flow. The method is based on the use of vortex generators mounted flexible duct wall , which can rotate freely as a result of the forces created by the flow . Oscillations flaps are induced by transient eddies shed advanced upstream flap edges that periodically change external load on flexible structures.

Wayne L. Staats et al. [10] examined the improvement of heat transfer by convection in an air-cooled heat sink using the integrated alternating rotors were tested. Radiator tested experimentally representative subcomponent of unconventional heat exchanger loop heat pipe, a number of flat parallel interdigitated capacitors and integrated centrifugal fans, designed to meet the challenges of managing heat in compact electronic systems. The close integration of the rotor blades of the heat transfer surfaces to decrease the thermal resistance by the pumping energy compared to a conventional heat sink by forced convection.

Xiaoze Du et al. [11] it has been observed that improved heat exchange with the four types of longitudinal vortex generators have hit at the end of the corrugated tube to flat numerically studied experimental verification. These results can benefit from the increased efficiency of heat exchange on the air side of the air cooled condensers direct.

Anil Singh Yadav et al. [12] in this article, digital test is carried out to analyze the two-dimensional incompressible Naviera- Stokes flows through the solar air heating system artificially matte appropriate number Reynolds ranges from 3,800 to 18,000. Twelve different configurations of the equilateral triangle is divided web (P / E = 7.14 to 35.71, and e / D = 0.021 to 0.042) were used as a member of roughness. These equations are solved with numerical method based on the finite volume.

III. CONCLUSION

This document assessment provides an analysis of vortex tubes with CFD simple nozzle and the screw. Higher speed vortex can actually have an effect on the temperature of the cold gas outlet. Screw nozzles are adapted to separate a desired amount of energy, and the difference in the highest temperature of cold gas.

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