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Design of Bio Mimic Impeller

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Abstract

Biomimicry is learning from nature and then emulating nature's forms, processes, and ecosystems to create more sustainable designs. The concept of biomimicry is based on a key idea: nature always operates on the principles of economy and efficiency while generating no waste. Biomimicry is needed in today's world because designers are innately curious, and biomimicry provides the opportunity to learn about life's complex processes and strategies, broadening the design space and bringing new solutions to the table. In this project I am going to combine the biomimicry used in Lily Impeller which is inspired by the shape of calla lily flower and based on the logarithmic curve (known as the Fibonacci spiral) found in nautilus shells, it's function is similar to that of whirlpools but with slight difference and the biomimicry of Humpback Whale which is the Tubercles on its flippers, together designed to develop a new impeller with possibly higher efficiency than the existing impellers in the market. The new impeller has function similar to that of whirlpool but with slight difference, an ideal whirlpool generates centrifugal force outwards from the center of rotation whereas the new impeller generates centrifugal force towards the center of rotation this result is the reduction or elimination of drag and resistance. It has a number of sinusoid-like bumps similar to tubercles, which are arranged periodically along the leading edge. The presence of these bumps modifies the water flow over the surface, creating regions of vortex generation between the bumps. These vortices interact with the flow of water over the bumps and accelerate that flow, helping to maintain a partially attached boundary layer. This hydrodynamic effect can delay stall to higher angles of attack, increases lift, and reduces drag. In this research paper I have done solid modelling using Solid works software.

Keywords: Biomimicry, whirlpools, tubercles, drag, resistance, angles of attack.

1.Introduction

Motivation:

In mixing water storage tanks stagnation occurs when water is poorly mixed or inadequately circulated, often due to the mismatch between tank size and daily demand. Tanks can be ten or more times larger than daily demand in order to meet future projected demand and fire/emergency capacity. This overcapacity is particularly exaggerated in new developments with incomplete residency, and therefore insufficient daily turnover of stored water. Additionally, thermal loading by sunlight and ambient air results in temperature stratification-the vertical separation of water with varying temperatures. This condition prevents natural mixing, as new, colder water slides under the older, warmer water. Stratification only requires 0.1-degree Celsius temperature differential. The older, warmer water at the top loses its disinfectant capacity and can experience bacterial and microbial growth. Chemical treatment, aside from being associated with potential safety issues, has been unsuccessful in preventing stratification and stagnation. The last of developments made in this field to solve this problem was that of lily impeller back in 2006, since then as we are aware that there have been many technological advancements in every field also Conventional fluid dynamics holds that the the leading edge of the impeller should be smooth but research has found that the humpback whale flipper have a number of sinusoid-like rounded bumps, called tubercles, which are arranged periodically along the leading edge this increases angles of attack, increases lift, and reduces drag compared to the post-stall condition of conventional wings. So, I wanted to design and upgrade the current model used in this area. So that we can achieve better results as per current scenario.

Sr. No	Author	Work Done	Remarks
1	Barbero, Silvia; Pallaro, Agnese	Analysis of how the changing relation between man and water in history has been translated in the design of different kinds of tools for water management.	The Systemic Design approach shares the vision of nature as a living organism that provides the best model of efficiency available. In relation to the topic of water the design process is based on the detailed analysis of the behaviour and properties of water with the aim to build tools that are truly sustainable.

2	Fish, Frank E., Paul W. Weber, Mark M. Murray, and Laurens E. Howle	The Tubercles on Humpback Whales' Flippers: Application of Bio-Inspired Technology.	The tubercles on the leading edge act as passive-flow control devices that improve performance and maneuverability of the flipper. Experimental analysis of finite wing models has demonstrated that the presence of tubercles produces a delay in the angle of attack until stall, thereby increasing maximum lift and decreasing drag.
3	Norbert Hoeller, Margo Farnsworth, Shoshanah Jacobs, Filippo Arnaldo Salustri	A Systems View of Bio-inspiration: Bridging the Gaps.	The paper explores three levels of biomimicry bridging, discusses benefits and implications of adopting a systems perspective, and proposes initiatives for further development. Searching for 'sweet spots' leveraging the synergy between our aspirations, our growing knowledge of natural systems, and the market economy will improve the ability of biomimicry to deliver meaningful and impactful solutions.
4	Weichao Shi, Mehmet Atlar, Rosemary Norman	Learning from Humpback Whales for Improving the Energy Capturing Performance of Tidal Turbine Blades.	This paper summarizes a project on the potential of further improving the performance of horizontal axis tidal turbines via the application of leading-edge tubercles to the turbine blades inspired by humpback whales. Within this framework, a wide variety of experimental investigations, supported by numerical studies, have been conducted.
5	Siobhan Watson, Chris Garvin, and Namita Kallianpurkar, Terrapin Bright Green	Biomimicry in New York State.	Biomimicry is both a methodology and a design mindset that helps identify and solve problems in areas such as energy performance, efficient use of water, toxin reduction, and waste elimination. It helps point the way to advancements that are essential to ensuring the long-term competitive success of NYS companies.
6	Kamran Mahmudov	A Computational Fluid Dynamics Approach for Dissolved Oxygen Modelling With Application to Wind-Powered Aeration Systems.	The main contribution of this thesis was the development of a computational model that can predict spatial and temporal distribution of dissolved oxygen concentration in water bodies. The model enables the design and optimize aerations technologies to have higher efficacy.
7	Weichao Shi, Mehmet Atlar, Rosemary Norman, Batuhan Aktas, Serkan Turkmen	Biomimetic improvement for a tidal turbine blade	This paper is to investigate the leading-edge tubercle of humpback whale fins to be apply on a hydrofoil which is based upon a tidal turbine blade by using computational and experimental approaches.

Figure 1

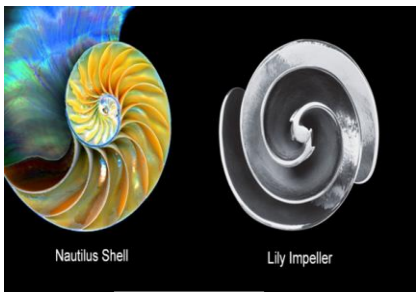

Figure 2

Figure 3

Figure 4

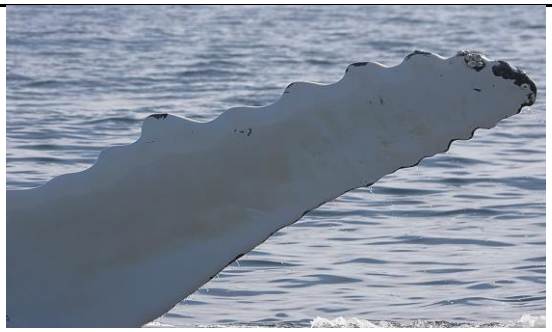

Figure 5

2.Literature Review

The review has been carried out for the project work by referring to the previous work done in this filed and future development.

3.Methodology

Literature review: Different research papers, journals, thesis and articles are reviewed to get better understanding of the topic.
Solid modelling: Modeling is done on Solid works software. Comparative Study.

4.Result and Discussion

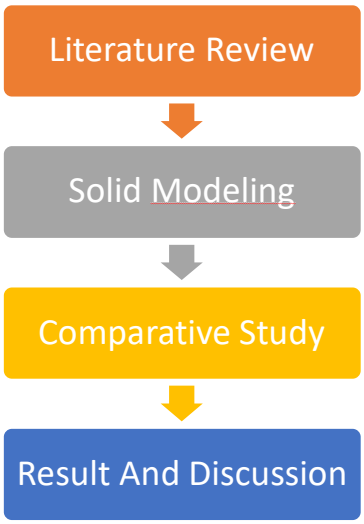

Figure 6

5.Software Model

Solid works software is used for modeling.

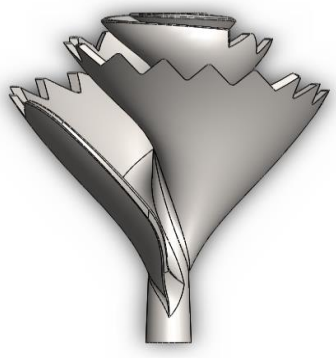

Figure 7

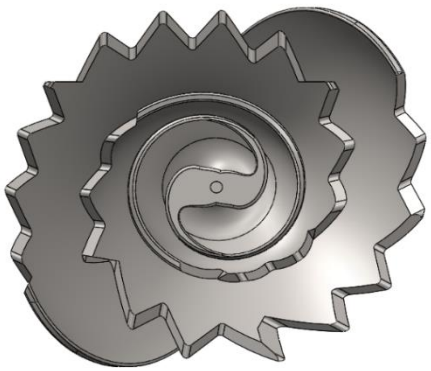

Figure 8

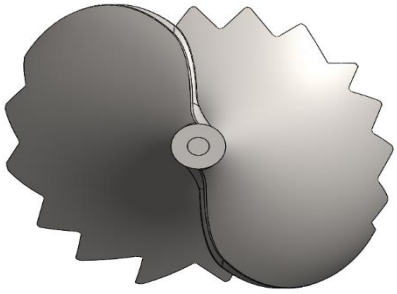

Figure 9

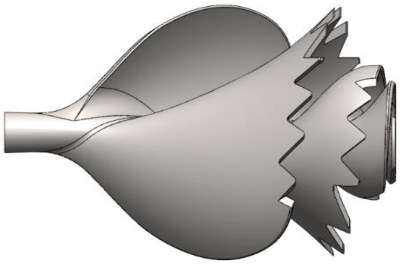

Figure 10

In this project the new impeller design was achieved by studying various resources available online such as research papers, journals, thesis and articles. All these resources helped me in the better understanding of different types of impellers used in mixing water storage tank, the concept of biomimicry and how biomimicry helps us to design existing technology in much efficient way.

6.Conclusion

This project has helped in achieving new design of a impeller by combing biomimicry used in Lily Impeller which is inspired by the shape of calla lily flower and based on the logarithmic curve (known as the Fibonacci spiral) found in nautilus shells, it's function is similar to that of whirlpools but with slight difference and the biomimicry of Humpback Whale which is the Tubercles on its flippers, together designed to develop a new impeller with possibly higher efficiency than the existing impellers in the market. The new impeller has function similar to that of whirlpool but with slight difference, an ideal whirlpool generates centrifugal force outwards from the center of rotation whereas the new impeller generates centrifugal force towards the center of rotation this result is the reduction or elimination of drag and resistance. It has a number of sinusoid-like bumps similar to tubercles, which are arranged periodically along the leading edge. The presence of these bumps modifies the water flow over the surface, creating regions of vortex generation between the bumps. These vortices interact with the flow of water over the bumps and accelerate that flow, helping to maintain a partially attached boundary layer. This hydrodynamic effect can delay stall to higher angles of attack, increases lift, and reduces drag. The expected results from this project are:

1)Increase in efficiency of impeller.
2)Reduction in drag.
3)Improve performance of impeller.

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