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ON THE POSSIBLE APPLICATION OF TUBERCLES ON PUMPING IMPELLER TO DECREASE HYDRAULIC RESISTANCE

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This article is devoted to the biomimicry engineering approaches. The main idea of a tubercle technology and its advantage are presented. The conveniences of the usage of pumping impellers with tubercles in the main pipeline transport were formulated. It was also suggested to make profound learning of application of the tubercle technology in rotating devices.

Life has existed on earth for billions of years and during that time life has learnt what works, what is appropriate here, and what lasts here. The idea is that we should be looking at living organisms, at these mentors, at these biological elders that have figured out how to create a sustainable world. Rather than inventing it from scratch we should take our cues from them. These organisms are the consummate engineers, they are consummate chemists and technologists. They have learned how to do it in the context. The core idea behind biomimicry is that the best ideas might not be ours, they might already have been invented.

Biomimicry is a practice that learns from and mimics the strategies found in nature to solve human design challenges. Biomimicry offers an empathetic, interconnected understanding of how life works and ultimately where we fit in. Biomimicry is an innovation inspired by the nature. It is a new discipline in which the people that make our world: chemists, architects, material scientists and product designers, draw engineering ideas from evolution.

Solutions to global challenges are all around us. Here can be shown some biomimicry examples [1].

The first instance is the shopping Eastgate centre located in Harare, Zimbabwe. Rather than using a traditional fuel-based air-conditioning system to regulate temperature within the building, the Eastgate Centre is designed to exploit more passive and energy-efficient mechanisms of climate control. This building saved 10% on costs up-front by not purchasing an air-conditioning system. Architect Mick Pearce worked with the construction company Arup to design the Eastgate Centre. Pearce was inspired by models of internal temperature regulation in termite mounds.

The more streamlined Shinkansen train not only travels more quietly, it now travels 10% faster and uses 15% less electricity. Eiji Nakatsu, an engineer with JR West and a birdwatcher, used his knowledge of the splashless water entry of kingfishers and silent flight of owls to decrease the sound generated by the trains. Kingfishers move quickly from air, a low-resistance (low drag) medium, to water, a high-resistance medium. The kingfisher's beak provides an almost ideal shape for such an impact.

EvoLogic developed and patented their Sweep Spread Carrier technology to manage the challenging conditions presented by ocean waters. They developed underwater sensors that can transmit frequencies similar to those emitted by dolphins. These sensors can be used to detect underwater earthquakes and therefore aid in tsunami warning systems. They can also be used for guiding ships. The device is based on eight years of research on the physics of dolphin communication. According to the website [2], dolphins and whales have adapted to the situation under water very well, communicating over long distances. They chirp and sing across a broad frequency bandwidth. This continuous change of frequencies not only serves to transmit information, but also to compensate for sources of interference such as echoes and noise.

As we can see biomechanics is able to be used in engineering industry and the main pipeline transport is not an exception as a complex of industrial dangerous objects which have to comply with the regulative requirements. The applications of pipelines span domestic, commercial and industrial purposes. Pipelines can be used to carry natural gas to homes, jet fuel to airports, and crude oil to refineries. The efficient transport of oil from production wells to oil refineries would be impossible without the use of an elaborate network of pipelines. This important midstream oil and gas component is also critical to the transfer of finished petroleum products to end-users or dependent industries. The use of expansive networks of pipelines ensures that domestic and industrial users have access to an uninterrupted flow of vital, energy generating gases and liquids. At the same time the industry is quite energy intensive. The main pipeline transport accounted for more than 4% of total world transportation energy consumption [3].

The facilities of pipeline transport can be divided into site and linear objects. The ideas of engineering bionics, in their turn, can be applied to both of them. As to the linear part of an oil transport the ideas of the Austrian inventor Viktor Schauberger [4,5], who was inspired by nature, are extremely important for the designers of modern gas pipelines, oil pipelines, water lines of hydro stations and all other types of pipeline transport. The thing is about using the phenomenon of swirling flow in pipelines, which is still not used as a positive effect. This approach can be used to reduce the dynamic resistance of main pipelines and water lines of hydroelectric power plants. Swirling the flow along the central axis with usage of elementary butterfly inserts or placing a curled spring inside the pipe can significantly reduce the energy costs of moving the contents of any transport pipe. The cost of upgrading the transport pipe with such inserts are minimal. At the moment, a huge part of the energy produced in the world is used precisely for pumping oil and gas products. Reducing these energy costs through trunk transportation, even if only by a few percent, can be of immense importance.

As to the site facilities they are presented by a reservoir park, an oil metering unit with filters, the main pumping and booster pumping stations, a pressure control unit and nodes with safety devices, the units for starting and receiving treatment devices, the technological pipelines with shutoff valves. Among them the most important and responsible part is the main pumps which require a lot of electrical energy in order to transform the rotation energy into the kinetic energy. In this case, the observation of nature can help to solve the engineering problem of improving the operating parameters of a pump.

Humpback whales are the only whales that have bumpy leading edges on their flippers and that can have some important engineering consequences. Scientists ran some fluid dynamic simulations of wings with tubercles and wings without tubercles. It turned out that the tubercles increased the lift and simultaneously reduced the drag. For a specialist who works on wing performance, that is a spectacular achievement to be able to increase the lift and reduce the drag at the same time. Further investigations followed with several researchers involved. Soon it became clear that these bumps give benefits. Tubercles focus the flow between the bumps. That focused flow helps to keep the flow attached to the wing and it also helps to isolate the lift in-between the tubercles on the reason of existence of a high-lift region [6].

Moreover, something that improved the performance in the water could also bring big benefits in the air. WhalePower Corporation is a Canadian company established in Toronto. It creates energy efficient rotating devices for different applications. The WhalePower team developed prototypes and tested them. As a result, there were 20 percent energy savings, improved efficiency, greater stability and greater durability. The tests have shown that blades with tubercles are more energy-efficient and quieter than standard blades [7].They literally revolutionize low speed performance far beyond any conventional blades. Scientific studies have established that the addition of tubercles to the leading edges of airfoils directly addresses the fundamental limitations of conventional aerodynamic performance:

- tubercle airfoils display enhanced stable lift;
- tubercles keep drag low even at high pitch angles;
- tubercles dramatically improve stall angle (pitch) performance;
- tubercle airfoils deliver stable operation over an unmatched range of pitch angles and better still, when they do stall, they stall gradually.

This technology can be used for such equipment as wind turbines, fans, compressors and pumps. We propose to apply this technology to the main oil pumps, which will lead not only to a quieter and more stable operation of the equipment, but also to a decrease in hydraulic resistance and a more rational use of energy. In pumps, tubercles can be made by cutting spades of pumping impeller with notches. It is difficult to talk about the exact numbers of hydraulic resistance at the moment. To do this, it is necessary to conduct research with special software programs and, possibly, in a wind tunnel, which demand many scientific resources.

The tubercle effect is a phenomenon where tubercles or large 'bumps' on the leading edge of an airfoil can improve its aerodynamics. Tubercle technology is both sustainable and unique. The technology is not very widespread in the world yet. However, it is proved that this technology has certain advantages in the operation of various kinds of equipment in different industries compared to blades with straight leading edge. Tubercles are a technology for the future.

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