OPTIMIZATION OF CELL CULTURE EQUIPMENT DESIGNS USING CAD

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The Łukasiewicz Research Network – Industrial Institute for Automation and Measurements PIAP is a well-known manufacturing organization based in Poland, specializing in the production of mobile robots for applications such as C-IED and reconnaissance. These robots are utilized by various agencies responsible for security, crisis management, and population protection, including the Army, Police, Fire Brigade, and others. With a presence in over 20 countries, the organization is recognized globally for its comprehensive solutions and high-quality products.

Apart from their mobile robots, the Industrial Institute for Automation and Measurements PIAP also collaborates with the Department of Biotechnology and Engineering to explore opportunities in the biotechnological and pharmaceutical industries. These researchs primarily focuses on process automation and identifying optimal parameters for biotechnological equipment through computer modeling. In particular, a novel bioreactor design was developed to cultivate anchorage-dependent cell cultures in a monolayer, which underwent computational simulation to test its hydrodynamics. This research utilized the k-e turbulence model in the CFX module (Ansys), as demonstrated in Figure 1 [1].

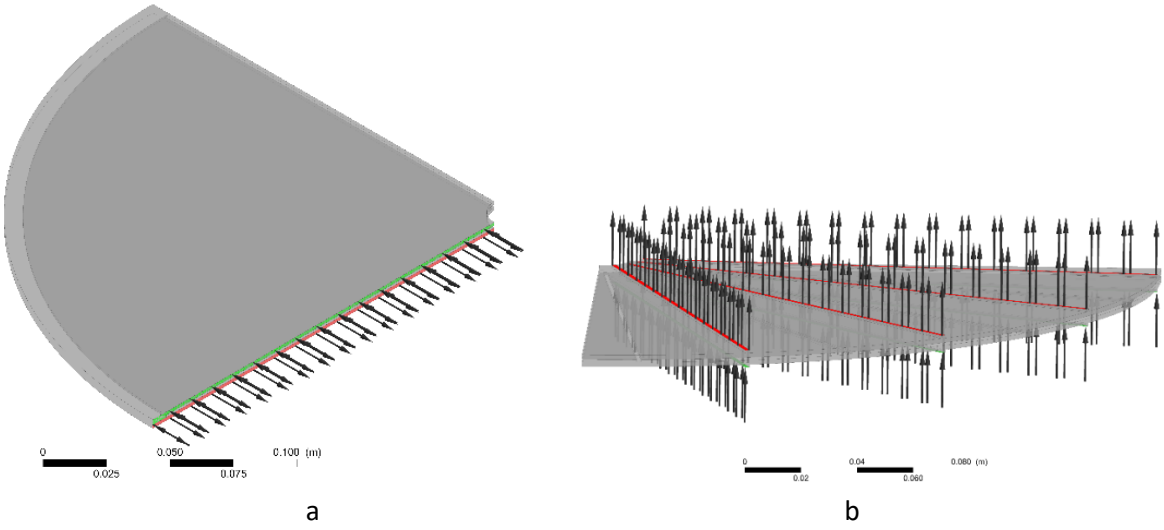


Fig. 1. Scheme of the boundary conditions (gray volume – liquid, green – inlet flow; red – outlet flow): a –developed design; b – Xpansion® (Pall) bioreactor

The research conducted demonstrated that the newly developed bioreactor design can provide optimal hydrodynamic conditions for the cultivation of biological agents. Specifically, the design significantly reduced the value of shear stresses in the area of cell anchoraging and growth compared to the reference bioreactor, Xpansion® (Pall). The stress exerted on the plate walls of the newly designed bioreactor was found to be 46% lower than that of the reference bioreactor (Figure 2). Overall, these findings suggest that the newly developed bioreactor design has the potential to offer superior conditions for the cultivation of anchorage-dependent cell cultures in a monolayer.

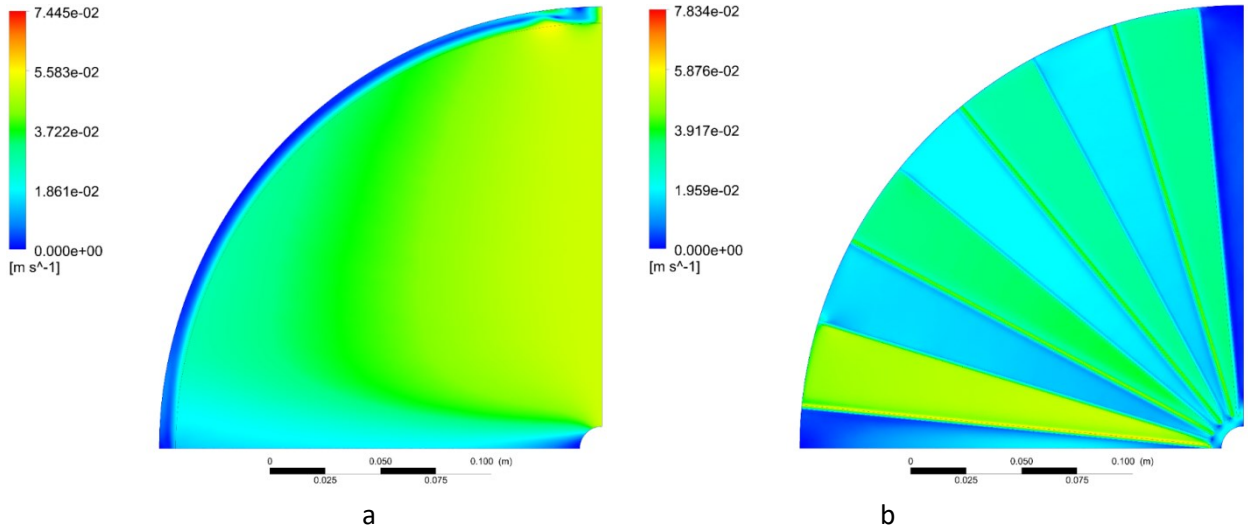


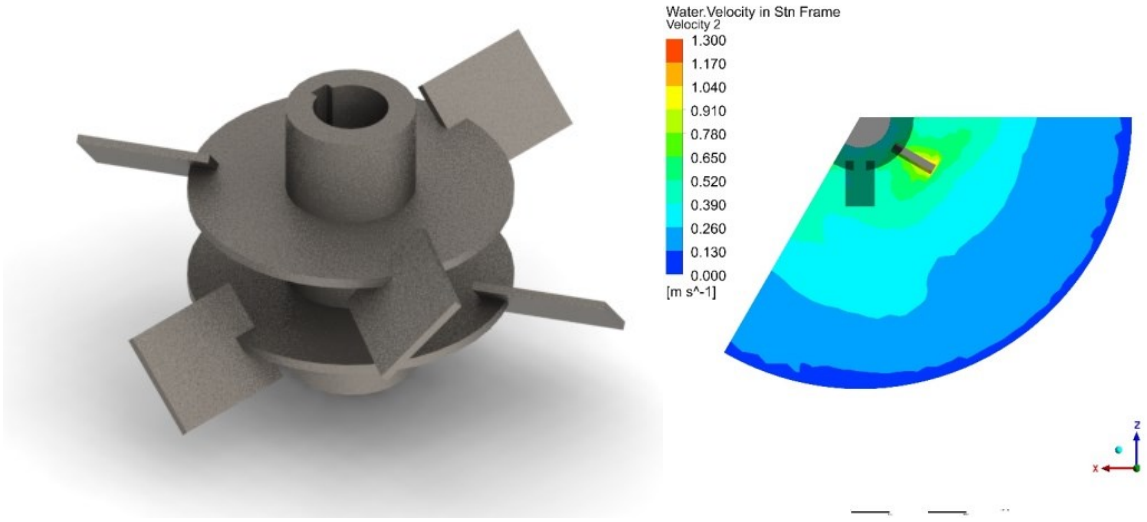
Fig. 2. Fluid velocity on the plate: a – developed bioreactor; b – Xpansion® (Pall) bioreactor

Collaboration with Department of Biotechnology and Engineering has embarked on an important research endeavor to optimize the construction of stirrers used in bioreactors for cell cultivation processes. A recently published article focused on the computer simulation of the hydrodynamics of a bioreactor with various types of open-type turbine mixers, including the standard open-type turbine mixer and a new design featuring a two-disc open-type turbine mixer with differently oriented blades at an angle of 45º and 135º. ANSYS software was used to simulate the hydrodynamics of each mixer design.

The new design of the open-type two-disk turbine mixer with differently oriented blades demonstrated a reduced probability of vortex formation during mixing, thus addressing a long-standing issue in bioreactor operation. Specifically, the proposed turbine design was found to produce minimal vortex formation, as illustrated in Figure 2 [2]. These findings highlight the potential of the newly designed mixer to enhance the efficiency and efficacy of bioreactors in cell cultivation processes.

The Łukasiewicz Research Network - Industrial Institute for Automation and Measurements PIAP has a robust focus on the automation and robotisation of production lines and factories. With our vast experience in developing and implementing new technologies, automation systems, production equipment, and special-purpose control and measurement instrumentation, we provide comprehensive and innovative solutions to various industries.

Our expertise in commissioning and upgrading current lines has made us a valuable partner for companies seeking to optimize their manufacturing processes. Our robotic workstations, both standard and research and development, are designed using professional engineering tools. Our areas of focus include robotised welding stations, palletising and pick & place stations, control and measurement stations, as well as robotised machine operation stations.



a b

Fig. 3 Proposed turbine stirrer: a – 3-D model; b – distribution of water velocity

In the pharmaceutical industry, our work is particularly crucial in ensuring aseptic conditions, reducing potential sources of contamination, and ensuring the output of products of the required quality.

In addition to our technical capabilities, we offer training, technological audits, and servicing to provide end-to-end solutions to our clients.

Future plans of collaboration between the Department of Biotechnology and Engineering and The Łukasiewicz Research Network – Industrial Institute for Automation and Measurements PIAP involve the implementation of proposed and validated through computer simulations designs in PIAP laboratories and preparing joint proposals to Calls held by the European Commission

References:

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2. Korobiichuk, I., Shybetskyi, V., Kostyk, S., Kalinina, M., Tsytsiura, A. (2022). Ways to Reduce the Creation of Vortex During Homogenization of Liquid Products. In: Szewczyk, R., Zieliński, C., Kaliczyńska, M. (eds) Automation 2022: New Solutions and Technologies for Automation, Robotics and Measurement Techniques. AUTOMATION 2022. Advances in Intelligent Systems and Computing, vol 1427. Springer, Cham. https://doi.org/10.1007/978-3-031-03502-9_33