Computer comparative analysis of the material used in the medical drip model

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Abstract

Statement of the problem: The problem that motivates the research and simulations is the idea of replacing traditional aluminum IV holders with polymeric materials. It is possible to reduce the weight of these holders while maintaining their functionality and reducing production costs. In addition, the use of 3D printing technology in the production of the holders is being considered. In the context of this problem, the key issue is to see whether polymer handles will be strong and functional enough to replace traditional aluminum handles. Therefore, it is necessary to conduct simulations to evaluate the behavior of grips made of different materials under operating conditions, taking into account the forces acting on the models and the boundary conditions. The goal is to select an optimal replacement material that meets strength, weight and manufacturing cost requirements while being suitable for use in a medical environment.

The Solidworks research involved modeling and simulating two IV holders with distinct designs: one modified from an IV stand top (Figure 1) and the other designed for hospital bed frames (Figure 2). Boundary conditions, including fixation and forces, were set for simulation using fixed geometries defined based on Figures 3-5. Forces were standardized at 10 N to represent drip weight. Materials - aluminum alloy 3003 and polypropylene - were assigned based on Solidworks data. Simulations aimed to assess fixture behavior under operational conditions, guiding the selection of an optimal substitute material meeting strength, weight, and cost criteria. Polypropylene emerged as a promising alternative, considering its relevance in medical equipment production and potential for reducing grip costs and weight.

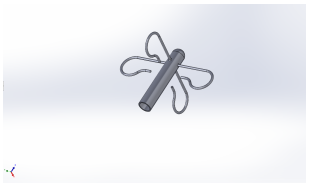

Fig.1. Model of a holder.

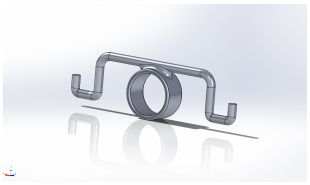

Fig. 2. Model of a holder.

Conclusion & Significance:

In summary, replacing aluminum alloy 3003 with polypropylene led to a weight reduction of nearly 300 percent and potential cost savings in production. The polypropylene models successfully bore the specified loads during simulations without exceeding yield stress. They also demonstrated higher stress tolerance and displacement compared to aluminum models. Moreover, adding more loads on successive grip arms did not escalate stress or displacement.

Recent Publications

1. Bonek M., Śliwa A., Dziwis A., Tilova E. (2023) Use of computer simulation to determine the relationship between chosen properties of the laser-remelted tool steel surface layer, Journal of Achievements of Materials and Manufacturing Engineering, no.121, 93-101
2. Dziwis A., Tański T., Sroka M., Śliwa A., Dziwis R. (2023) Numerical analysis of the strength properties of the movable connection, Archives of Metallurgy and Materials, no.68, 1585-1590
3. Śliwa A., Kwaśny W., Sroka M., Dziwis R. (2017) Computer simulation of the aluminium extrusion process, Metalurgija, nr. 56, 422-424
4. Polis J., Bicz J., Buchaj Z., Szymik R, Zielińska Z., Szojda M., Śliwa A., Sroka M., Dziwis A., Mikołejko W. (2024) Finite elements analysis of hip joint endoprosthesis, Students Scientific Conference, 405-41

Photograph

Biography

Agata Śliwa's work in materials engineering focuses around Computer Methods in Materials Science. As a separate field, computer science of materials is relatively "young", but it is being developed very intensively all over the world. Using advanced computer-aided methods, computer methods in materials science enables a virtual approach to the issues of designing and modeling modern materials that meet the modern requirements of their use. This obviously allows you to shorten the time needed to develop a new material or technology, to produce it, and it does not involve large financial outlays, as is the case in the so-called classical approach. She deals with broadly understood computer simulation based on the finite element method used in various industrial fields.

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