Energy Efficient Ceramic Sanitaryware Production Planning with a Hybrid Simulation Optimization Method

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Abstract

The ceramic sanitaryware production process consists of casting, drying, glazing, and firing operations. The operation that uses the most energy is the firing process. This study handles a case sanitaryware production factory and proposes a production planning method for energy-efficient manufacturing. In the case factory, the firing process takes place on wagons that carry the products through a tunnel-gas oven. Increasing the wagon surface area utilization decreases the energy consumption per unit product. The wagons continuously move with a predetermined speed and pick up their loads from the end of the glazing lines. The glazing lines have limited-sized end buffers, and products are manually carried in case of a buffer overflow. A wagon can load a product only if the product is ready in the glazing line end buffer while the wagon is passing in front of that line in real-time. Efficient wagon loading requires having the right products at the end buffers at the right time. This study develops a hybrid simulation optimization model to determine the production plan that minimizes the number of wagons used and the buffer overflows. The proposed method consists of two parts. The first part uses a linear programming model to assign the product demands to appropriate glazing lines such that the glazing lines' workload is balanced in terms of total production time and total product surface in lines. Then the model orders the products in each line according to their types and assigns them to drying process vehicles. The second part of the model uses a hybrid simulation - genetic algorithm heuristic to obtain the best product/wagon assignments with the given glazing production plan. The production plan is further improved with a heuristic drying vehicle replacement rule. The model gradually improves the production plan within a closed-loop cycle between the wagon-product assignment heuristic and the drying vehicle replacement heuristic. Results show that the model can effectively reduce the number of wagons used and buffer overflow for a given demand.

Keywords
Hybrid Simulation, Energy Efficient Ceramic Manufacturing, Ceramic Production Planning.

Biographies

Emre Doğru received his BSc in Industrial Engineering from TOBB University of Economics and Technology, Ankara in 2019. He is currently student of master degree in industrial engineering from TOBB University of Economics and Technology.

Nilgun Fescioglu-Unver is an Associate Professor in the Industrial Engineering Department of TOBB University of Economics and Technology, Ankara, Turkey. She received the Ph.D. degree from Northeastern University, USA in Industrial Engineering in 2008. She holds an MS in Information Systems from Northeastern University, an MBA degree, and MS and BS degrees in Mechanical Engineering from Middle East Technical University, Turkey. Her research is mainly concentrated on developing mechanisms for real time self-adaptive and self-controlling production/service systems. Her current studies are in energy and transportation areas.