

Development of innovative smart industrial dishwasher prototype that reduces water and detergent consumption in the washing process according to variable dishwasher capacity and types

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Abstract: Industrial dishwashers, which are widely used in the field of an industrial kitchen, are among the indispensable products. It stands out with its efforts to reduce water and detergent consumption in industrial dishwashers, and the consumers' preference for these products is increasing. Our company produces industrial dishwashers in various models and capacities. Unlike our existing products and our competitors' products, the washing area and the products to be washed are technically detected by the users in R&D studies. An innovative prototype has been designed and developed that contributes to the reduction of detergent consumption. In the industrial kitchen sector, for the first time in our country, variable dish capacity (providing washing specific to various filling capacities) with an innovative smart technology (providing washing only in the filled section with the detection system) that reduces water and detergent consumption in the washing process according to their types (glass/plate, spoon/fork, etc.) is applied to the industrial dishwashers. It has been ensured that the industrial dishwasher prototype is obtained with several new and innovative features compared to the original and existing industrial dishwashers reducing water and detergent consumption. R&D studies have been made by using engineering calculations, simulations, and experiments in cooperation with industry-universities.

Keywords: INDUSTRIAL DISHWASHERS, WASHING AND CLEANING SYSTEMS, WATER AND DETERGENT CONSUMPTION, WASHING PERFORMANCE

1. Introduction

Industrial dishwashers, which are widely used in the industrial kitchen area, are indispensable products. Our company manufactures industrial dishwashers in various models and capacities. Different from our existing industrial dishwashers and imported products, the washing zone and the products to be washed, which are filled by users for various capacities (eg 1/2, 1/4, and 3/4, etc.) It is aimed to obtain an innovative prototype that will contribute to energy saving as well as reducing water and detergent consumption through technological sensing.

For the first time in the industrial kitchen area, activities were carried out to develop the washing process, which provides energy-saving and variable dish capacity (basket filling capacities specific to the dishes to be washed) and types (glass/plate, spoon/fork, etc.) based on R&D systematic studies. In addition, with the original design and prototype manufacturing of an innovative smart industrial dishwasher prototype that reduces water and detergent consumption, a commercialized prototype that has different technological features from our current product has been developed with the cooperation of industry-university.

The most important innovative aspect is to obtain a uniquely designed industrial smart dishwasher prototype, which, unlike our industrial dishwashers, will save energy and reduce water and detergent consumption in the washing process according to variable dish capacities and types.

Mohedano and his team from England investigated the cleaning process of dishes contaminated with egg yolk by simulation modeling and experimentally in domestic automatic dishwashers using a fast camera kit at different washing temperatures (30°C and 55°C). They reported that the modeling created according to different parameters gave results compatible with the test data [1].

Mohedano and his team analyzed the water movement during the washing process in household dishwashers with camera data processing (Positron Emission Particle Tracking - PEPT) and simulation analysis (Computational Fluid Dynamic - CFD) at the different pump and wash arm speeds, with/without detergent, empty state and the full basket. situations etc. analyzed according to the variables. They emphasized that the detergent effect can be neglected in the water flow and the importance of design data

(washing arm, distribution of dishes, etc.) according to different dish areas [2].

Saker and his team, in household dishwashers and washing machines, use of hot water in the washing process, detergent consumption, energy efficiency, etc. have made assessments [3].

Bundgaard and his team made evaluations on energy efficiency in line with the Ecodesign Directive in 2017. They evaluated the developments in energy efficiency [4].

Although there are various researches on household products for energy efficiency, this study will be the first study in the field of industrial dishwashers with data based on R&D systematics [5-10].

It is not possible to make a selection according to the filling capacity and types of dishes to be washed. For this reason, the innovative smart industrial dishwasher prototype, which was obtained through R&D project studies, stands out with its contribution to both saving energy and reducing water and detergent consumption, specific to dish capacity and types.

2. Methodology

In the innovative smart industrial dishwasher prototype, four washing and four rinsing arms are placed above and below the washing basket.

The placement and movement directions of the washing and rinsing arms of the innovative smart industrial dishwasher prototype are given in Figure 1.

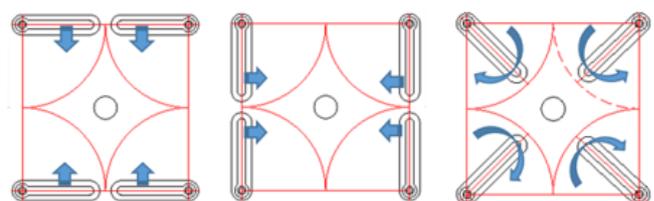


Fig. 1 The placement and movement directions of the washing and rinsing arms of the innovative smart industrial dishwasher prototype (top view).

The schematic representation of the innovative smart industrial dishwasher prototype according to the different filling capacities of the dishes sensor detection system is given in Figure 2.

There is always hot water in the washing chamber under the innovative smart industrial dishwasher prototype washing basket. The temperature-sensitive infrared sensor located in the middle of the upper part of the prototype detects lower temperatures than the empty dish basket area (red area) due to the shadowing of the products (plates, forks, spoons, etc.) in the area filled with dishes on the washing basket. The area filled with the products (plates, forks, spoons, etc.) to be washed on the washing basket is perceived as green by the sensor.

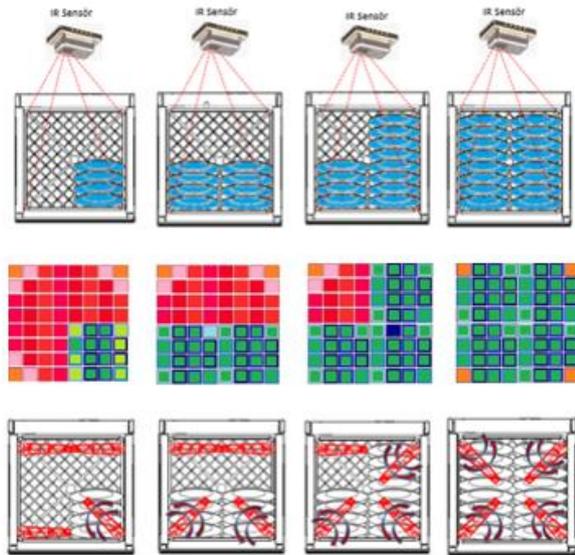


Fig. 2 Schematic representation of the dish detection system of the innovative smart industrial dishwasher prototype (top view).

The visual of the original designed innovative smart industrial dishwasher prototype is given in Figure 3.



Fig. 3 Front view of the innovative smart industrial dishwasher prototype.

The interior view of the innovative smart industrial dishwasher prototype (washing chamber and wash-rinse arms) is given in Figure 4.



Fig. 4 Appearance of the washing chamber and wash-rinse arms of the innovative smart industrial dishwasher prototype.

3. Experimental procedure

Testing and evaluation activities were carried out after the prototype manufacturing and assembly of innovative smart industrial dishwashers that save energy and reduce water and detergent consumption in the washing process according to variable dish capacities and types.

Various examples from the evaluations made with the infrared sensor used in the testing and evaluation phase are given in Figures 5-7. While the green areas on the dish basket show the area filled with the plates to be washed, the red area shows the empty areas on the dish basket.



Fig. 5 Evaluations with the infrared sensor on the innovative smart industrial dishwasher prototype (full capacity).



Fig. 6 Evaluations with the infrared sensor on the innovative smart industrial dishwasher prototype (half-full capacity).

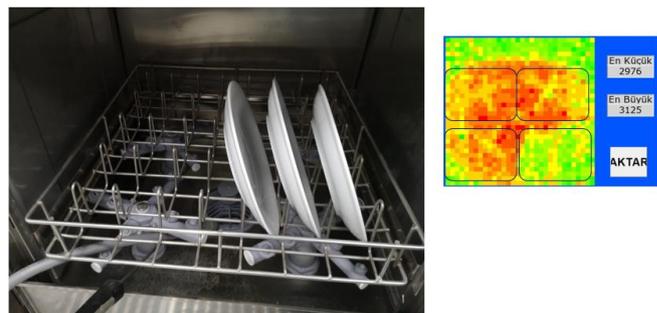


Fig. 7 Evaluations with the infrared sensor on the innovative smart industrial dishwasher prototype (1/4 full capacity).

In the innovative smart industrial dishwasher prototype, the control panel showing the filling ratio (%) according to the basket filling area is given in Figure 8.

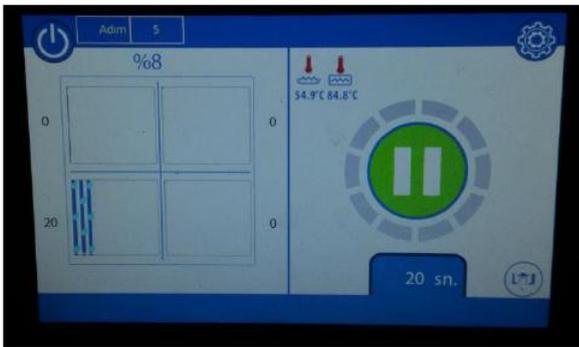


Fig. 8 The control panel of basket filling capacity (8% full - blue part in basket area / lower left part) in innovative smart industrial dishwasher prototype.

At the first stage of the research, our dishwasher spent 1530 g of detergent when it is washing with full capacity. This is reduced to 580 g/hour and 950 g of detergent remained by using the innovative smart industrial dishwasher prototype.

By operating the innovative smart industrial dishwasher prototype at different capacities (1/2, 3/4, 1/4) without reaching full capacity, we have achieved the same amount of reduction both in detergent consumption and energy consumption comparing to the full capacity.

4. Conclusions

The outputs obtained through R&D project studies on the innovative smart industrial dishwasher prototype are given below;

With research-based on R&D systematics, at least 25% energy consumption reduction (4,125 kW/h) has been achieved by using the innovative smart industrial dishwasher prototype compared to our existing industrial dishwasher (OBY 500 model – 5.5 Kw/h).

At least a 25% reduction in water and detergent consumption (35 items of washing in 1 hour) compared to our existing industrial dishwasher (OBY 500 model – water consumption: 98 lt/h and detergent/rinse aid consumption: 0.5 Lt/h) is obtained by using the innovative prototype.

The design-specific innovative industrial dishwasher prototype is provided to wash with variable dish capacity (for example, 1/2, 1/4, and 3/4 at different basket filling rates) and types (glass/plate, fork/spoon, etc.).

For the first time in the industrial kitchen sector, the innovative smart industrial dishwasher prototype, which saves energy and reduces water and detergent consumption in the washing process according to variable dish capacities and types, has been achieved through R&D activities carried out in industry-university cooperation.

Acknowledgment

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