A new commercial dishwasher design using mineral additives in its drying system

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Abstract: *Commercial dishwashers in different performance classes are used in all industrial kitchens. In contrast to existing commercial dishwashers, there is an increasing demand for products that use drying technology to meet customer wishes and needs. Various household dishwashers having zeolite mineral during drying prevents water droplets and detergent stains (including surfaces of plastic containers) on the surfaces of dishes and rinsing of sensitive products (crystal glass glasses, etc.). By pointing out that they prevent excess steam from spreading when opened, they highlight these products as environmentally friendly and value-adding compared to conventional household products. In this work, we developed a new commercial dishwasher prototype using a mineral in the drying process. Technical simulations and experiments are used during the development of our innovative prototype with a drying system using a mineral that stores moisture and converts it into thermal energy. This is the first prototype in commercial dishwashers with its innovative drying system.*

Keywords*: COMMERCIAL DISHWASHERS, MINERAL ADDITIVE DRYING TECHNOLOGY*

1. Introduction

Commercial dishwashers of different capacities are used in all commercial catering establishments (restaurants, factories, universities, dormitories, etc.). Our company manufactures commercial dishwashers in various models and capacities.

Commercial dishwashers are quite different from household dishwashers according to their working principle and international standards. Commercial dishwashers wash in a very short time compared to household dishwashers. While household dishwashers can wash in 2-3 hours, commercial dishwashers can wash in 60-180 seconds according to the program.

Conveyor-type commercial dishwashers only dry with a snail fan and no minerals are used during the drying process. However, there are mineral additive drying systems in various household dishwashers. Adsorbent minerals can be used as drying minerals.

Adsorbent minerals (zeolite, activated alumina, silica gel, etc.) are widely used as solid desiccants in different fields (chemistry, medical, ventilation, food, etc.) due to their high moisture absorption properties [1-5].

There is no scientific publication on the commercial dishwasher that saves energy and cleaning chemicals with its mineral-added drying system. The limited studies on mineral additive drying applications only in household dishwashers are summarized below.

Italian Santori and his research group evaluated their absorbent properties thermodynamically by using various commercial desiccant minerals (13X zeolite, SAPO-34 zeolite and silica gel, etc.) in a household dishwasher. The specific heat values of the drying minerals (13X zeolite, SAPO-34 zeolite and silica gel, etc.) were investigated with increasing temperature and the specific heat values of all minerals increased linearly with increasing temperature (Fig. 1) [6].

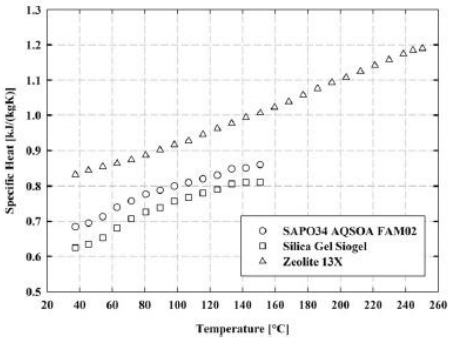

Fig. 1 *Specific heats of the investigated adsorbent materials [6].*

They reported that they contributed to energy saving at various rates by using these dryers in the standard washing process. They stated that electrical energy consumption (0.636 kWh) decreased by 41% in the standard washing process compared to standard type household dishwashers labeled with A energy class [6].

A. Hauer and F. Fischer from Germany evaluated the energy consumption of the household dishwasher they developed compared to standard household dishwashers with the adsorption process using Zeolite (X13 commercial model). They reported that the developed mineral-added (zeolite) household dishwasher saves up to 24% of energy compared to standard household dishwashers [7].

The schematic description of the adsorption and desorption processes is shown in Fig. 2 [7].

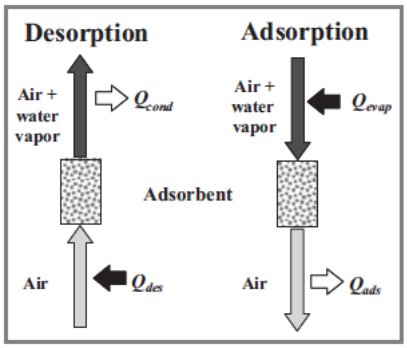

Fig. 2 *Open sorption system (heat and mass fluxes) [7].*

The schematic view of the household dishwasher with an adsorption drying system and the temperatures measured using zeolite are shown above. They reported that energy consumption was reduced by up to 24% by reducing the energy consumption values from 1.05 kWh to 0.8 kWh compared to the standard product in household dishwashers with zeolite mineral additive drying system. In addition, they reported that an environmentally friendly product was obtained by contributing to the reduction of CO2 emission rates with the mineral additive drying system [7].

The effects of Zeolite 13X, Silica Gel 125, SWS-1L and SBA-15 E120 on the drying process in household dishwashers were investigated by M. Erdogan from Aachen University in Germany and her research group [8].

D. Lefebvre from Canada and his research group investigated thermal energy storage processes in heating applications for energy storage technologies. The adsorption process is an exothermic reaction [9].

There are different studies using various minerals in the drying process. Within the scope of this study, the drying performance was evaluated for the first time in the field of the first commercial dishwasher by using adsorbent minerals for the drying process.

2. Methodology

The commercial dishwasher prototype, which provides innovative mineral additive drying, was developed based on our company's most widely used under-counter model in the industrial field.

A mineral additive drying system has been placed on the back of the commercial dishwasher prototype, specific to the design. With the air suction channel on the upper part of the washing chamber, the suction of the steam is provided towards the mineral container. The absorbed steam is sent to the mineral container with the help of the fan. With the exothermic reaction in the mineral container, mineral moisture is absorbed and the hot air formed is sent to the dishes from the bottom with the fan. Thus, effective drying of the dishes in the washing chamber is ensured.

The innovative commercial dishwasher prototype captures the steam coming from the upper part of the washing chamber and converts it into heat energy. The heated air is sent from the lower part to the dishes waiting in the washing chamber, and the drying process is carried out.

Drawing of innovative commercial dishwasher prototype with mineral additive drying system is given in Fig. 3.

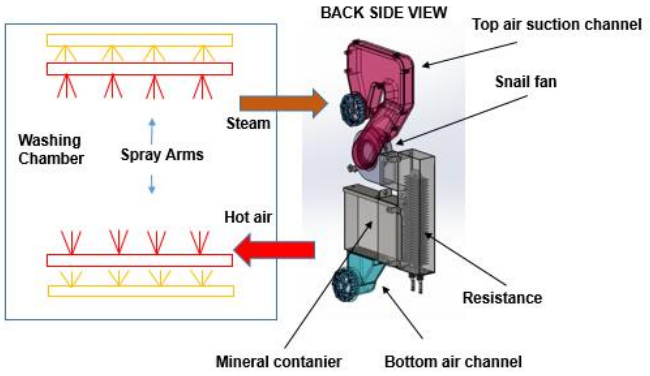

Fig. 3 *Drawing of innovative commercial dishwasher prototype with mineral additive drying system.*

The drawing of the commercial dishwasher prototype (backside) providing drying with mineral additives is given in Fig. 4

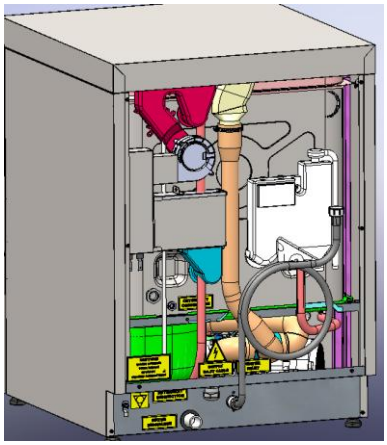

Fig. 4 *Schematic representation of the commercial dishwasher prototype (back side).*

A view of the innovative commercial dishwasher prototype (from the front side) is given in Fig. 5.

Fig. 5 *View of the innovative commercial dishwasher prototype from front side.*

The appearance of the commercial dishwasher prototype (interior and backside) is given in Fig. 6.

Fig. 6 *View of the innovative commercial dishwasher prototype from different sides (interior and back side).*

3. Experimental procedure

After the design verification phase of the innovative prototype was completed, prototype manufacturing and assembly were carried out. After this stage, testing and evaluation were carried out. Drying performance with different minerals (zeolite and activated alumina) on the drying system of the innovative commercial dishwasher prototype was evaluated.

The photos of the minerals (zeolite and activated alumina) used in the drying process in the innovative commercial dishwasher prototype are given in Fig. 7.

Fig. 7 *Minerals (zeolite and activated alumina) used in the drying process in the innovative commercial dishwasher prototype.*

The images of the various parts that make up the drying system of the commercial dishwasher prototype, which saves energy and cleaning chemicals with its innovative drying system, are given in Fig. 8.

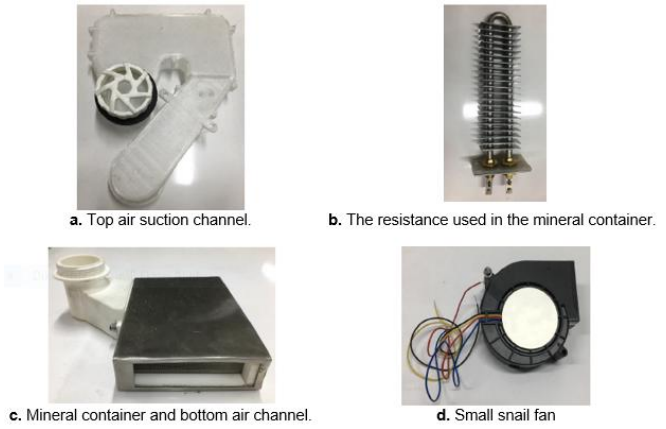

Fig. 8 *The images of the various parts that make up the drying system of the commercial dishwasher prototype.*

Temperature values were measured by using zeolite in the drying process (from the upper suction point and the lower blowing point) in the innovative commercial dishwasher prototype (Fig. 9).

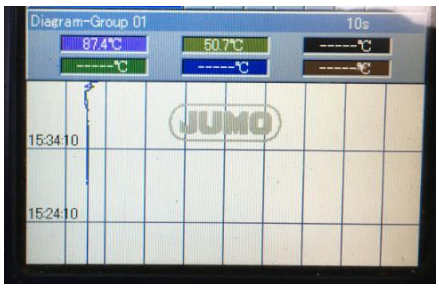

Fig. 9 *Temperature values measured by using zeolite in the drying process (from the upper suction point and the lower blowing point) in the innovative commercial dishwasher prototype.*

4. Conclusions

Following the R&D studies on the innovative drying system commercial dishwasher prototype, the following outputs were achieved;

With studies based on R&D systematics in the industrial kitchen sector, 100% adsorbent minerals (zeolite, activated alumina) are used in the drying system compared to our standard commercial dishwasher (OBY 500 model – no drying system) in the innovative drying system commercial dishwasher.

In the innovative prototype, the temperature of the air drawn into the drying system by the fan after the washing process is 50.7°C at the upper entrance, while the hot air is blown into the washing chamber from the lower part as 87.4°C with the zeolite drying system, contributing to drying. In the use of activated alumina, the blowing temperature remained only around 60°C. After the tests for drying performance, it was determined that zeolite adsorbent provides more drying compared to activated alumina.

In the sector of commercial dishwashers, for the first time in our country, 20,51% energy consumption (4.372 kW/h) has been reduced in the innovative drying system commercial dishwasher compared to our standard commercial dishwasher (OBY 500 model – 5.5 kW/h).

With the original design and prototype manufacturing, an innovative drying system commercial dishwasher using minerals (zeolite and activated alumina) was obtained for the first time in our country compared to existing commercial dishwashers. In addition, it has been achieved to obtain an innovative product with high added value in the industrial kitchen area by providing features that contribute to energy savings.

Acknowledgement

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