

§21. A Study for the Practical Trails of Sintering Ceramics by the Microwave Kiln

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In a microwave sintering of ceramics, an improved sintering quality at shorter sintering time, with lower energy consumptions, at lower costs can be expected, as compared to a traditional sintering method. It is also expected that it leads to reduced environmental load by decreasing the CO₂ emission, leading to possible solutions for various problems of ceramics industry and environment.

Various kinds of products in small lots and a quick delivery system are required in the markets. Manufacturers have to tackle the development of the high value-added products and the high quality products.

These problems can be settled with the uniform and the rapid heating by the microwave sintering.

The possibility of the microwave gas hybrid kilns for industrial manufacturing is verified in the practical trials of some ceramics productions. The way to the widespread use of the microwave gas hybrid kilns starts to be led.

Experiment

The practical trials were experimented with six microwave gas hybrid kilns which were set up at the Ceramics Processors Cooperative Association in Toki City. The practical trials are the estimation for durability of the microwave oscillation system, the insulator and cavity, usability of the kilns, trial productions, new product developments, extractions of improvements and measurements of consumption energy in various sintering patterns.

The specifications of the microwave gas hybrid kiln are 10kW of its microwave power, 0.5m³ in an inner volume, permissible temperature 1350 degree Celsius in max. The basic sintering time has been set to 4 hours with the amount of contents that is 250kg in the kiln.

Results

The Prototypes and the test pieces which is identical to products were sintered 987 times during

H21.2 – H23.3. One of the kilns had sintered up to 316 times. Properties of most test pieces that sintered by microwave gas hybrid kilns are equally to the products that was sintered with gas kilns by trial and error.

The Energy consumptions had been reduced from 20% to 27% than gas kilns size of from 4 m³ to 7m³ with the microwave gas hybrid kiln.

The Electric power supply of the microwave oscillation broke down when it had been used for over 8200 hours. The Durability of the microwave oscillation is identical with designed value of 8000 hours. The component replacement is possible. The cracks on the inner surface of the insulators by the thermal shrinkage were monitored over time. The energy consumptions were without a change before and after repaired and replacement of insulators. The thermocouples broke by 100 times or more. The structure and the material of protection tube will be changed. The stirrer of the motor gears broke at Hida and Tokitsu by oil leaks. The bolts of gear boxes were tightened stronger.

The coloration with pigments and the glaze made from the copper are deeper. The Designs with the traditional pigments called “Gosu” made from the cobalt appeared sharpen and brightly more. The amounts of the calcium in glaze and the Gosu have an effect on sharpness and brightness. The color of the Gosu by the gas kiln is not lack of sharpness and brightness under the identical conditions. (Fig.1)

A lifter which makes it easier to set them into the kiln and a rapid cooling system for the quick cycle process were produced experimentally by commands of testers. The kiln was cooled from 14 hours to 5 hours with the rapid cooling system.

Ceramics Processors Cooperative Association use the microwave kilns to a regional activities for children, a festival and a beatification.

Next studies are development of high value-added products and new products utilizing property by microwave. The improvements in the strength and the water absorption of pottery are possible. Durability research and sintering in the diversified test pieces are kept on. Further the energy saving must be improved in sintering pattern, that is because of the savings in the Electricity.



Fig. 1 Bright coloration of Gosu Left; microwave gas hybrid kiln Right ; gas kiln