

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

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In microwave sintering of ceramics, an improved sintering quality at shorter sintering time, with lower energy consumption, at lower cost can be expected, as compared to traditional sintering methods. 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 quick delivery system are required in the markets. Manufacturers have to tackle the development of high value-added products and high quality products.

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

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

Experiment

Practical trials were experimented with five microwave gas hybrid kilns were set up at 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 production, new

product development, extraction of improvement and consumption energy.

Results

Products and prototypes were sintered 212 times. Properties of most test pieces sintered by microwave gas hybrid kilns are equally to products by gas kilns by trail and error. The phenomenon that coloration liven color brightly and concentrated in the graze with copper, cobalt and pigments is observed.

The cracks on the inner surface of the insulators by thermal shrinkage are monitored over time. The mount of gas burner was reinforced for changing of the position by thermal distortion. The big objects burst by the vapor explosion for shortage in drying. Drying before sintering is important. Electric power supply of microwave oscillation was broken down more than 8200 hours.

Testers command kiln car or fork lift for the workability, forcer cooling for the quick cycle process and reduction meter for the management.

The weights of sintering except Hida Cooperative Association are about 300kg, Hida's weight is about 500kg at Hida. Sintering time is the same. The time at Oroshi is longer for drying. That is longer for heavy weight of the test pieces at Hida. Energy consumptions are the same depend on the weight of sintering test pieces.

Next studies are sintering of diversified test pieces, development of high value-added products and new products utilizing property by microwave, increase productivity, the estimation of an additional durability.

Table 1 Results of sintering by microwave gas hybrid kilns at Ceramics Processors Cooperative Association

Association	Oroshi	Dachi	Izumi	Hida	Tsumagi	Total
Number of sintering	121	41	34	25	21	242
Total number of hours of sintering hr	784.3	214.5	177.6	156.3	114.8	—
Mean sintering time hr	6.5	5.2	5.2	6.3	5.5	—
total number of hours of microwave oscillation hr	—	167.5	145.3	143.8	98.0	—
mean oscillation time of microwave hr	—	4.1	4.3	5.8	4.7	—
mean electric consumption kWh	72.2	70.8	77.5	115.6	87.5	—
mean gas consumption m ³	12.3	12.2	12.6	16.2	11.9	—