Microwave System for Silicon Carbide Blocks Drying

This presentation has been prepared as a proposal of Kerone Microwave Dryer Concept for Grindwell Norton Ltd.

Introduction :

Silicon carbide for process equipment applications is manufactured by the sintering process. A process for sintering silicon carbide 1S provided which includes the step of providing a silicon carbide powder of silicon carbide granules; subjecting the purified silicon carbide powder to a gel-casting process; removing the gel-cast part from the mold; drying the gel-cast part; obtaining a dried cast ceramic part (a green body) which is capable of green machining into a final desired shape; firing the green body in an oven at temperatures ranging from about 100° C. to about 1900° C. to remove or burn out any polymer remaining in the ceramic; and sintering the green body at temperatures ranging from about 1600° C. to less than about 2200° C.

This demanding process confers its ultimate corrosion resistance, its extreme hardness.
These blocks are dried from 3.6% moisture content to 0.1% moisture content before sintering/firing process. If blocks are pre-dried using Microwave Drying System, the long drying cycles which is at present requires 3-4days drying time in Conventional Oven can be reduced unto 6-8hrs Max. drying cycle.

Microwave processing is one alternative approach and the aim of this project is to develop microwave Heating System for Drying of Silicon Carbide blocks to reduce processing complexity (and cost) and cut processing times.

Silicon Carbide - A Microwave Susceptor

In the material manufacturing sector, energy efficiency, sustainability and economic viability have become increasing important to the industry and society. Recently, microwave heating has been found to offer faster, simpler and more cost-effective processes for material manufacture.

With the result that it is now widely used for the preparation of novel functional materials One such material is **Silicon carbide (SiC),** an important ceramic material that is in high demand. Using current processes, the production of SiC is a costly undertaking, requiring large amounts of energy and high temperatures in addition to a lengthy drying time. Researchers have shown that microwave heating techniques may be adopted to allow SiC (itself an inorganic material with a strong microwave absorption rate) to be manufactured quickly and energy efficiently.

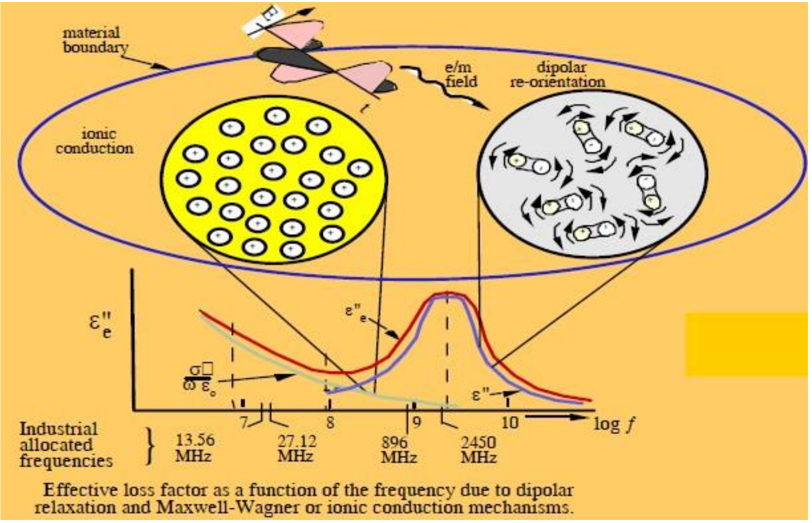
The interaction of microwave energy with different material depends on the type of material exposed to the radiation. The interaction of microwave energy with the material can be categorized based on the interaction of molecule and electromagnetic energy. They can be stated under the group of opaque, transparent, absorbing and magnetic material. For insulating purpose microwave transparent is well suited as it absorbs the negligible amount of microwave energy

Stating the different advantageous such as selective heating and rapid heating, shorter processing time, environmentally friendly process the microwave energy is widely accepted in different manufacturing operation like cladding, joining, casting and sintering process. The molecular vibration generated by the microwave energy absorption produces the heat in the material.

The microwave absorbing material comes under the materials which absorb the electromagnetic energy and convert it into heat and is commonly termed as susceptor material & silicon carbide is one of them. Another important beneficial factor was water, used as a binder in the block making process, it minimized the intergrain void space between particles and possibly acted as a polar liquid microwave susceptor.

The dielectric properties are dependent on the mobility of the dipoles within the structure, and therefore the dielectric properties depend on a series of parameters and the ability of the material to absorb energy varies during processing. For example, at room temperature, silicon carbide (SiC) has a loss factor of 1.71 at 2.45 GHz. The loss factor at 695 °C at the same frequency is 27.99.

Principle of Microwave heating



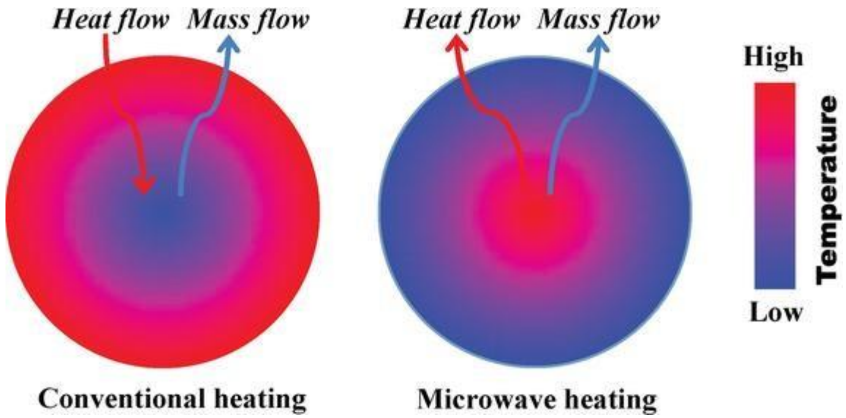
Effective loss factor as a function of the frequency, the dipolar re-orientation and conductive loss mechanisms

MW frequency regime, there are primarily two physical mechanisms through which energy can be transferred to a non-metallic material. At the lower microwave frequencies conductive currents flowing within the material due to the movement of ionic constituents, such as salts for example, can transfer energy from the microwave field to the material. This loss mechanism is characterized by an equivalent dielectric conductivity term σ, giving effectively a loss parameter of $\sigma/\omega\varepsilon^{o}$.

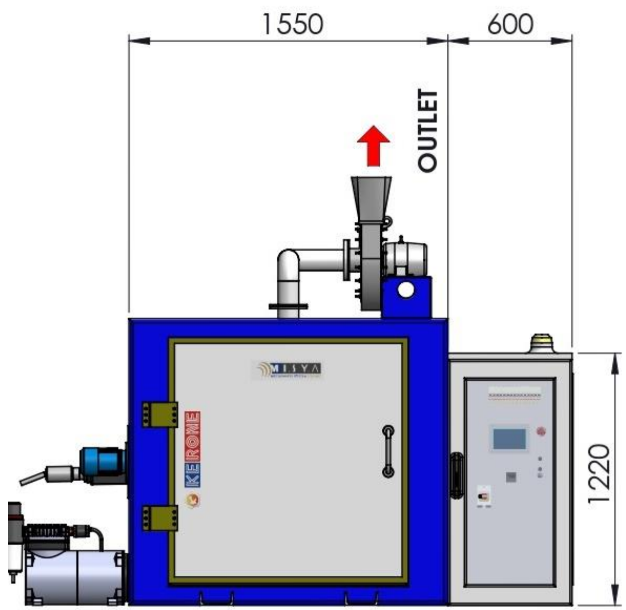
Microwave heating spectrum, around 3000 MHz, the energy absorption is primarily due to the existence of permanent dipole molecules which tend to re-orientate under the influence of a microwave electric field.

This re-orientation loss mechanism originates from the inability of the polarization to follow extremely rapid reversals of the electric field.

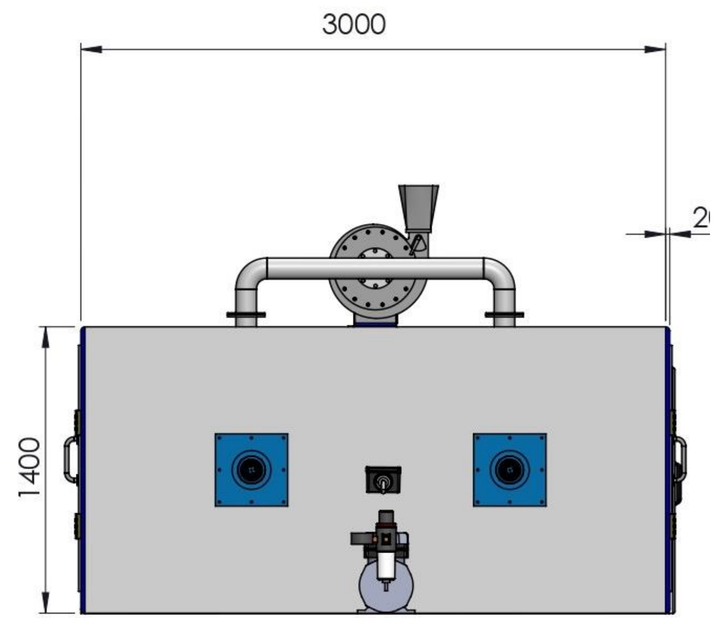
At such high frequencies therefore the resulting polarization phasor lags the applied electric field. This ensures that the resulting current density has a component in phase with the field, and therefore power is dissipated in the dielectric material.



Introduction to Batching Systems



ELEVATION



SIDE VIEW

A batching system is batch operating production process, in this production occurs in sequential steps in discrete batches.

KERONE is having expertise in providing both batching and continuous microwave processing unit, batching system process the input in discrete batched one set of equipments at a time.
Following are the basic steps of the batching process:
A batch raw material(s) is fed, Processing take place (for specified time period), and Outputs are removed.

Trials Conducted at Kerone Research Center

List of work	Status	Remarks
Trial-01, conducted on samples size-7.5x7.5x7.5cm Weight- 1.14kg	Done	Desired results achieved in max 50mins of cycle time.
Trial-02, conducted on samples size 65x24x7.5cm Weight- 22.7kg	Done	Desired results achieved in max 3hrs of cycle time.
Trial-03, conducted on samples size 65x40x7.5cm Weight- 40.7kg	Done	Desired results achieved in max 5hrs of cycle time without cracking or product deformation. Samples send to **Grindwell Norton Ltd, Gujrat** for testing.
Test Results	Done	**Grindwell Norton Ltd, Gujrat** confirmed that treated samples achieved the suitable drying results and succeed in process feasibility test.
Scale up discussion	Done	After successful trial-01/02/03, Kerone will submit quotation for the pilot system 1 Ton/batch.

Product & Process Information Received

1. Min/Max sizes (w x h) and respective weight (kgs/m) of the product.
   Min – 7.5x7.5x7.5cm (3kg) to Max – 65x40x7.5cm (42kg)

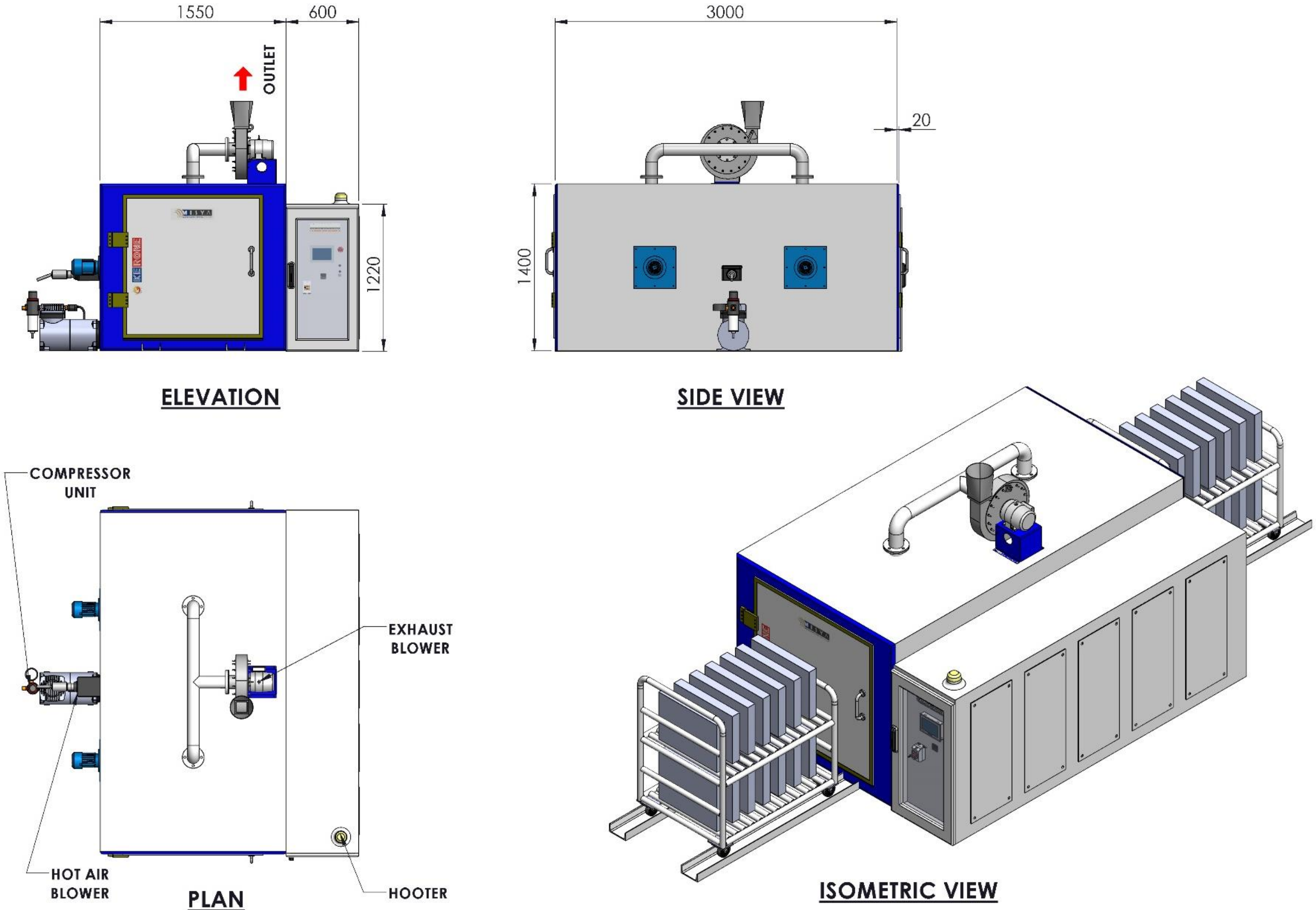
2. Throughput (kgs/batch).
   1000 kg/batch

3. Maximum temperature allowed for the drying
   300-400C

4. Initial Moisture Content
   2.8%

5. Final Moisture Content
   0.1%

KERONE Microwave Drying Oven Concept



Accreditations

Member of AIMCAL	Member of IHEA	Strategic Partners of Emitech Italy	IRQAO Certified For Quality
Recognized and Rated by CRISIL	CRISIL Verified	Member of A.M.P.E.R.E. (Europe)	ASCB(E) Certification for Best practice

ISO 9001:2008 | ISO 9001:2015 | OHSAS 18001 | EMS 14001

Locate-Us

UNIT I

B/10,Marudhar Industrial Estate, Goddev Fatak road, Bhayander(E), Mumbai-401105

Phone : +91-22-28150612/13/14

UNIT II

Plot No. B-47, Addl. MIDC Anandnagar, Ambernath (East),
Dist. Thane- 421506

Phone : +91-251-2620542/43/44/45/46

EMAIL

info@kerone.com | sales@kerone.com | unit2@kerone.com

WEBSITE

www.kerone.com | www.kerone.net | www.keroneindia.com