Industrial Microwaves for Heating and Drying

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6. Heating of Sheet Material

Ciba Spezialitätenchemie Grenzach GmbH

Innovations in Microwave Process Technology

www.pueschner.com
Company Profile

PÜSCHNER was founded in 1970 in North Germany
- 20 people working at PÜSCHNER Headquarters
- 5.5 mio USD turnover and 1MW installed Microwave Power in 2005

Memberships
ZVEI - AMPERE - ISPE - IEC - DIN / VDE Working Group 'Dielectric Heating' K362

www.pueschner.com
**Principle & Benefits**

Volume Heating within the Penetration Depth

**Benefits:**
- Speed
- Quality
- **Uniformity**
- Control
- Size

Conventional Heating

Microwave Heating

alternating electric field
space charge polarisation
orientation polarisation
Penetration Depth of Microwaves

Two industrial Microwave Frequencies:
- 2450MHz (12cm wavelength) 1-10kW
- 915MHz (34cm wavelength) 30-100kW

Penetration depth depending on frequency, temperature and on dielectric losses of the product.
Automatic Production Line in the Mine Industry

Batch Dryer

Full Automatic Drying of Filter Cake coming from a Filter Press (4 shift operation) using a Multi-Batch System

<table>
<thead>
<tr>
<th>Criteria</th>
<th>conv</th>
<th>mw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>6hrs</td>
<td>20min</td>
</tr>
<tr>
<td>Space</td>
<td>10m²</td>
<td>3m²</td>
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</tbody>
</table>

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Automatic Production Line for Producing Chimney Blocks

30kW/2450MHz Microwave Batch Dryer using a Bosch TS2plus Transfer System

<table>
<thead>
<tr>
<th>Criteria</th>
<th>conv</th>
<th>mw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>1-2hrs</td>
<td>5-10min</td>
</tr>
<tr>
<td>Space</td>
<td>30m²</td>
<td>12m²</td>
</tr>
</tbody>
</table>

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Automatic Production Line
for the medical Industry

- 6kW/2450MHz Chamber Oven for Drying Dialysers
  3-5min Drying Cycle, from 100g to 10g with a
  Standard Deviation of ± 1.5g

<table>
<thead>
<tr>
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<th>conv air</th>
<th>mw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>1-2hrs</td>
<td>5-10min</td>
</tr>
<tr>
<td>Space</td>
<td>5m2</td>
<td>1m2</td>
</tr>
</tbody>
</table>

www.pueschner.com
## Continuous Microwave Dryer

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**Criteria** | **conv air / gas** | **mw**
--- | --- | ---
**Duration** | 35min | 5min
**Space** | 35m² | 8m²

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*www.pueschner.com*
Continuous Microwave Dryer

- Drying of chemical raw material with poor dielectric losses from 6% down to 300ppm residual moisture within 2min residence time using 2x30kW/915MHz microwave power.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>conv air</th>
<th>mw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>40min</td>
<td>2min</td>
</tr>
<tr>
<td>Space</td>
<td>35m²</td>
<td>6m²</td>
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</tbody>
</table>
Constant Dosing important for constant drying results. Therefore gravimetric dosing strongly recommended for high-end drying processes.
Moisture Measurement

Moisture-measurement based measuring dielectric losses using a spectrum analyzer with a resonator

Dielectric measurement
Differences in dielectric Applications

Application Categories

**Inorganic Inert Chemicals**
like Drying of Si-Powder

- Ability to absorb microwave energy:
  - H2O: high, medium, low
  - Product: Not critical

**Organic Chemicals**
Biotec and Food
Like Drying pharmaceutical raw materials

- H2O: high, medium, low
- Product: becomes critical at MC < 5-10%

**Active Chemicals**
Like Drying of Graphite and SiC-Powders

- H2O: high, medium, low
- Product: Very critical
Microwave Vacuum Drying

Continuous Vacuum Drying of Dialysers using two 8kW/240MHz Batch Systems

Batch Vacuum Dryer

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Microwave Vacuum Drying

Combination of an air/vacuum/microwave 2.4qm dryer for pharmaceutical products under explosive protection

Batch Vacuum Dryer
Microwave Vacuum Drying

• 4-12kW/2450MHz Vacuum Dryer for 100-200kg/h Throughput Rate
Continuous Flow Heater
for liquids under high pressure

Continuous thermal pressure Hydrolyse for Recovering/Splitting biological organic Products in the Range of 300bar/300°C

Figure 1. Scheme of the microwave thermochemical conversion process
Continuous heating of sheet material in the printing industry with 1m/s.

Heating from 20°C to 120°C in 100ms using 4x2kW/2450 MHz with 80W/cm², efficiency >50%

Conti Heater of Webs / Sheet Material

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Huge Potential for Microwave Drying Applications but all concepts need to be specially designed and proven for each single application.

Thank you for Your Attention.