

Autowave™

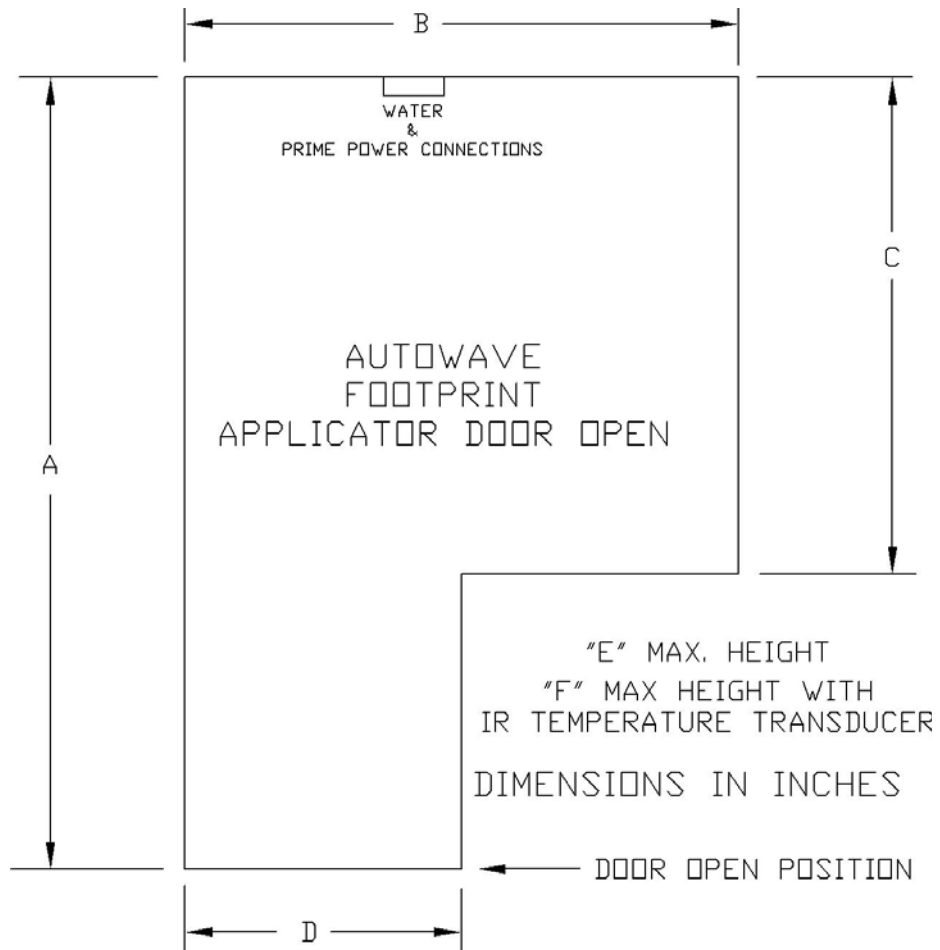
Autowave™
 Microwave Furnace for Laboratory
 and Short Run Production

Features

- Computerized monitor and control via LabVIEW™
- Computerized data-logging (standard)
- Mode-stirring device for more even distribution of microwave fields in the applicator (standard)
- High Temperature capability of over 1800°C with samples in a suitably insulated container
- Working volume more than 2,800 cubic inches
- In-depth knowledge of microwave theory is not required
- Available in 3 or 6 Kilowatt models as characterized below
- Available in 2 applicator sizes as characterized below
- Optional vacuum and gas handling systems for process atmosphere control
- Optional Infrared non-contact temperature measurement with feedback to control temperature
- Optional computerized process-step sequencing



Requirements	3 KW microwave power model	6 KW microwave power model
Power Input Voltage	208/Y120 volt 50-60 Hz	208/Y120 volt 50-60 Hz
Power Input Current	20 amps at full microwave power 30 amp main circuit breaker	45 amps at full microwave power 70 amp main circuit breaker
Cooling Water Temperature (source)	5°C minimum 30°C maximum	5°C minimum 30°C maximum
Cooling Water Pressure Drop (differential from inlet to outlet)	15 PSI minimum 20-30 PSI recommended 50 PSI maximum	35 PSI minimum 37-45 PSI recommended 50 PSI maximum
Cooling Water maximum applied pressure	50 PSI	50 PSI
Cooling Water Flow (at recommended pressure differential)	1.5 GPM	5 GPM
Cooling Water Heat Load (at full microwave power)	6 KW maximum	12.5 KW maximum
Ambient Air Temperature (operating)	5°C minimum 35°C maximum	5°C minimum 35°C maximum
Ambient Air Conditioning Load (at full microwave power)	1.5 KW maximum	3.5 KW maximum
Microwave Characteristics		
Microwave Frequency	2.45±0.02 GHz	2.45±0.02 GHz
Forward Microwave Power	3.0 KW minimum	6.0 KW minimum
Applicator Chamber Microwave Power (waveguide tuned for minimum reflected power)	2.5 KW minimum	5.0 KW minimum



Feature	Small Applicator	Large Applicator
Dimension A (inch)	86	96
Dimension B (inch)	60	68
Dimension C (inch)	54	63
Dimension D (inch)	30	38
Dimension E (inch)	63	72
Dimension F (inch)	68	81
Doorway opening required for installation (inch) (Table/Desk removed)	31.5	40
System weight (pound) (without optional features added and without the shipping container and packing materials)		
Working volume for object(s) being processed (cubic inch) (includes any trays, boxes, fixtures, etc.)	2,800+	5,600+
Working footprint size for object(s) being processed (inch) (includes any trays, boxes, fixtures, etc.)	(12 X 20)	(15 X 25)

Standard Features

Mode Stirring Device

The standard mode stirring device is controlled via a switch that is located on the panel at the desk.

Materials used in the applicator chamber

The applicator door and work-table inside the applicator chamber are constructed of Aluminum alloy. The applicator side-wall and chamber end that is opposite the main chamber door is constructed of a non-magnetic stainless steel alloy.

Water cooling

The side-wall of the applicator chamber and the work-table inside the chamber are forced-water cooled. In addition, the magnetron and waveguide isolator are also force-water cooled. Other system components may also be water cooled.

Computer control

National Instruments Corporation's LabView™ software was used to develop the control software that is used in all variations of the Autowave™ product line. An executable version of the control software as well as the source code that was used to develop the software is included with each Autowave™ system. A license for the full development LabView software package may be purchased directly from National Instruments Corporation. A laptop/notebook computer equivalent to the Dell Inspiron 1501 is standard. For interface and control of system components, the computer is USB connected to a National Instruments Corporation multi-function DAQ module. The computer's operating system is Windows®.

Applicator atmosphere

The standard system is configured for processing in ambient air at ambient pressure. A pressure relief valve on the applicator chamber will equalize pressure with the ambient atmosphere when/if the pressure internal to the chamber exceeds the ambient atmospheric pressure.

Main door seals

There are two seals on the main applicator chamber door. A Viton® o-ring seal provides a hermetic seal between the door and the chamber. An RF seal is achieved by using a Parker Monel mesh-strip with elastomer core in an o-ring-like groove on the door. Both of these seals are field replaceable.

Waveguide tuning

A hand-operated 3-stub waveguide tuner is standard. The applicator chamber and working-load contained therein presents a mismatch for the transfer of microwave energy from the waveguide into the chamber. When it is used properly, the 3-stub tuner adjusts the match-conditions so that the maximum energy can be transferred into the working load.

Waveguide isolator

A microwave waveguide isolator is used to keep any reflected energy from returning to magnetron. The magnetron may be damaged by excessive reflected energy and the isolator protects the magnetron. The isolator is water cooled and it is capable of absorbing reflected microwave energy up to the rated power level of the Autowave™ system.

Options

Vacuum & gas handling (manual)

In the Autowave™ system, the purpose of the optional vacuum and gas handling sub-system is to provide for a faster introduction of the working gas to the applicator chamber. A rotary vane mechanical pump and 3-valves are provided for that purpose. The pump is capable of reducing the pressure within the chamber to less than 0.3 millibars. A hand-operated valve controls the connection of the pump to the chamber. A different hand-operated valve controls the connection of the regulated working gas to the chamber. A third hand-operated valve is used for venting the chamber to the ambient atmosphere. When this vacuum and gas handling option is specified, a chamber pressure gauge is provided as a part of the option-package.

CPI has experience only with air and dry nitrogen gasses used for the working atmosphere. It is possible that alternate gasses may also be used. Regardless of the type of working gas, the chamber pressure should be

greater than 1,000 millibars when microwave power is being injected into the chamber. Care should be taken to assure that the gas in the applicator chamber does not become ionized. Ionizing the gas and continuing to keep the gas ionized will result in braking of the quartz barrier window at the applicator chamber microwave launching location. Care should also be exercised to assure that the gas used will have no possibility of combining with other materials that may be present that would be capable of igniting or forming an explosive mixture of materials.

Vacuum & gas handling (automatic)

The three valves described in the manual option are automated. This option also includes interlocks to assure that microwave power is applied to the applicator chamber only when the chamber pressure exceeds 1,000 millibars. The computer controlled valves will exhaust the chamber then backfill with the desired gas. The number of exhaust/backfill cycles is user-selected. At the conclusion

of the process run, the chamber is vented to the ambient atmospheric pressure for ease in breaking the hermetic seal on the main chamber door.

Aluminum applicator chamber

The standard applicator chamber side-wall and chamber end that is opposite the main chamber door is constructed of a non-magnetic stainless steel alloy. Selecting this option will change the chamber side-wall and end that is opposite the main chamber door to an Aluminum alloy. The applicator door and work-table inside the applicator chamber are already constructed of Aluminum alloy.

Infrared (IR) non-contact temperature transducer

The standard Autowave™ system allows the user to input a microwave power level setpoint to control the forward microwave power being generated by the magnetron. Due to many variables within a processing run or from one processing run to another, the temperature of the object being processed might vary significantly. This option adds an IR temperature transducer plus the software that is used to automatically control the temperature of the object being processed. There are 2 automatic processing modes that can be selected by the user when this option has been included into the Autowave™ system. They are as follows.

- User enters a setpoint for the desired temperature. Microwave power is then controlled automatically to achieve and then maintain the setpoint temperature.
- User enters multiple steps for either power or temperature setpoints. Microwave power is controlled to achieve the setpoint value in the duration that is specified for each step of the process.

Automatic waveguide tuning

As noted above in the standard waveguide tuning description, there is generally a significant reflection of microwave energy because of the dynamic microwave match condition that happens as the working load changes temperature. In addition, the load itself and positioning of the load within the applicator chamber may change from one process run to the next. A fully automatic 3-stub tuner will counteract load and other variations that cause a reflection of microwave energy. This assures that the most microwave power that is available from the magnetron will be delivered to the working load. Consistency in performance from run-to-run with similar working loads is more easily achieved when this option is selected.

When it is time to scale-up your process



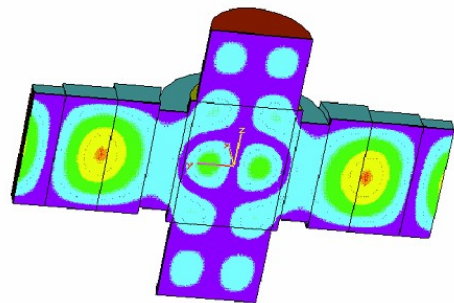
60 KW, 2.45 GHz, NEMA 4X enclosure



120 KW, 2.45 GHz, NEMA 12 enclosure



10 KW, 28 GHz, Laboratory enclosure



Type = E-Field (peak)
 Monitor = E915 (11)
 Component = Abs
 Plane at x = 0
 Frequency = 915
 Phase = 10 degrees

0 260 V/m

Applicator Design tools