

MILESTONE



HELPING  
CHEMISTS




# UltraCLAVE

The Next  
Generation  
Microwave  
Digestion  
System



## **UltraCLAVE**

### The Next Generation Microwave Digestion System



Improving upon an established technology is always a challenge. Sometimes, the greatest leaps of advancement can be made by changing the rules. The UltraCLAVE is an entirely different approach to closed vessel microwave sample preparation and is based on high pressure autoclave design. At its heart is a single large reaction chamber. In operation, this sample-containing chamber is pre-pressurized with inert gas and then heated by microwaves. The pressurized chamber serves simultaneously as the microwave cavity and the reaction vessel. The individual sample containers are not pressure vessels. This approach changes the rules of microwave sample preparation removing the limits associated with conventional microwave vessels. Higher temperatures, higher pressures, larger sample masses and greater batch quantities, all becomes possible. Even the toughest sample matrices can be digested by sustained high temperatures and pressures. And chemists can be assured of identical temperature and pressure conditions across any number of discrete samples. It is the truly next generation microwave digestion system.

## The UltraCLAVE *Advantages*



Early researchers investigating the use of microwave to accelerate sample preparation used for their experiments domestic microwave ovens. Today, the same basic concept is used for most laboratory units: a multimode microwave reflective cavity with a robust and safe door.

The major limitation of conventional laboratory systems is due to inherent compromises in the reaction vessel technology: reaction vessels must be constructed of microwave-transparent, chemical resistant inert materials.

Furthermore, the handling of such vessels may be cumbersome and time consuming, particularly for high-throughput carousels.

The UltraCLAVE performs beyond the current limitations of traditional microwave sample preparation. It offers all the advantages familiar to microwave users: speed, quality of results, reproducibility, and no pollution of the laboratory or environment, while overcoming the restrictions of traditional microwave digestion systems.

Chemists can digest large sample masses, large batches of mixed sample types, and difficult sample matrices requiring sustained high temperatures. Cross-contamination does not occur. Extremely high throughput can be achieved.

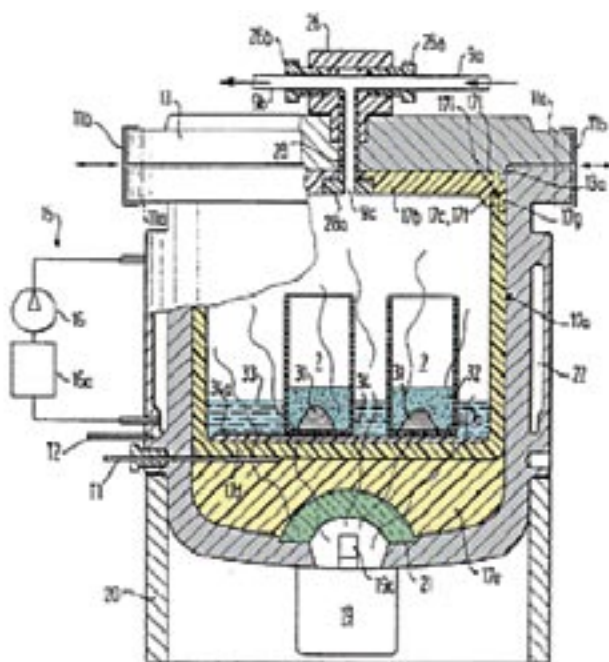
Finally, reduced acid usage, consumables, and need for labor provide long-term cost savings.

- Highest sample amount
- Highest sample throughput
- Highest temperature and pressure
- Same conditions for all samples
- Minimal required labor
- Minimal running cost
- Full automation
- Full documentation





## The Unique **UltraCLAVE** Technology

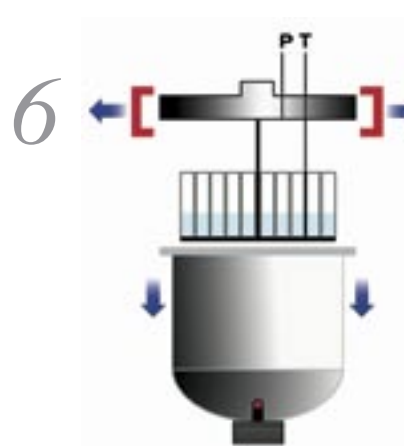
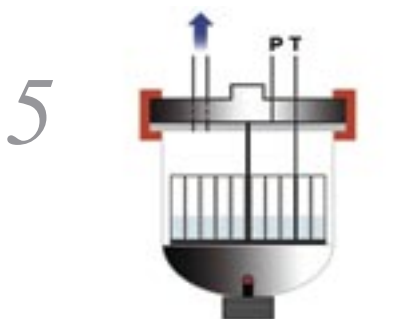
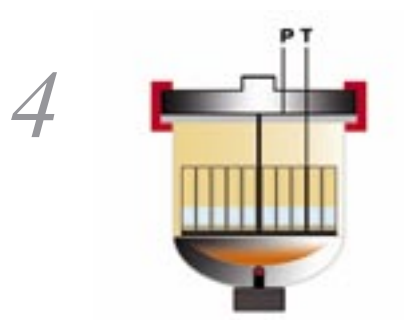
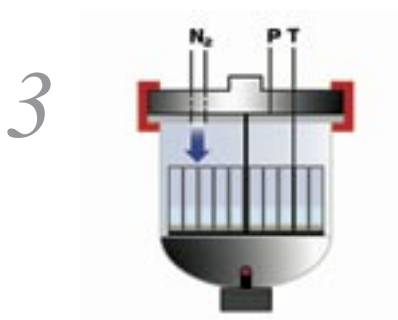
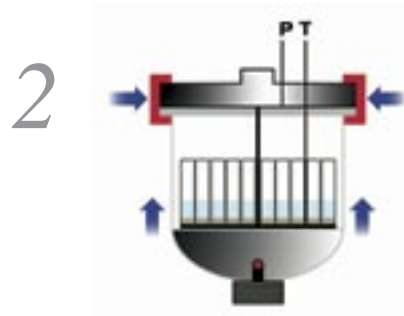
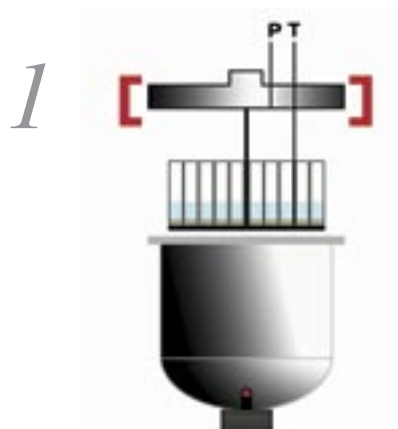
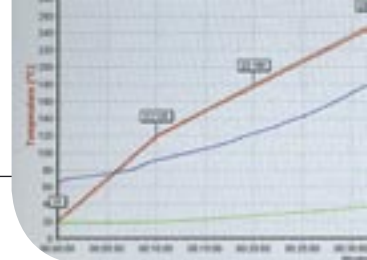


\*Patents: (US 5,382,414-5,725,835) (Germany 4105094-4114525) (Europe EP0728038-W09513133)

The patented\* Milestone UltraCLAVE achieves extraordinary performance capabilities by combining direct microwave heating in a high pressure reactor, which acts simultaneously as microwave cavity and vessel. This high pressure stainless steel reactor has a volume of 4.2 liters. The inner PTFE liner has a volume of 3.5 liters, and it is by far the largest vessel available for microwave sample preparation. Microwave energy is introduced into the reactor through a unique microwave port. This focused-multimode cavity design ensures maximum sample heating efficiency. Heat generated in the reactor is removed by a recirculating cooling system, and the stainless steel vessel remains at approximately room temperature throughout the entire heating cycle.

The UltraCLAVE is designed for simplicity of use. Loading a rack of samples into the chamber is the only manual operation required and can be done in a single motion. After that, methods are initiated with push-button simplicity and automation does the rest of the work, ensuring reproducible performance from run to run. The reaction chamber is sealed, pressurized, heated, cooled, vented, and opened all under computer control. As a result, the system dramatically reduces the need for labor compared to conventional microwave systems.

# Automatic Operation



1. Rack loading
2. Closing
3. Pressurization
4. Microwave heating
5. Cooling and de-pressurization
6. Opening

Once the vessels rack is placed in the UltraCLAVE reactor (1), all subsequent steps are automatically performed and controlled by the EasyCLAVE operating software. The reaction chamber lifts up to dock with the cover (2), creating a pressure seal that is secured in place by steel clamps. Once the chamber is sealed, a high-performance compressor pressurizes the system with inert gas (3). A microwave program, controlling temperature, pressure, and microwave power versus time, is then selected and initiated via the control terminal. During the run, integrated sensors continuously

monitor and display the internal pressure and sample temperature. The UltraCLAVE software dynamically adjusts the applied microwave power in real time to precisely follow the defined temperature profile (4). At the completion of the heating process the reactor and its contents are cooled by an integrated chilling unit, the pressure inside the reactor is released (5), and the remaining process vapors are safely exhausted. Only after ambient pressure is reached, the sealing clamps are released (6). The reactor body is then lowered, and the digested samples can be removed.



## Wide Choice of *Digestion Vessels*

The UltraCLAVE reactor offers a larger volume than other commercial single microwave reaction vessel. While it is not likely to be a common use of the instrument, it is possible to process a single, very large sample in a TFM liner fitted to the entire reaction chamber.

The individual sample containers can be much simpler in design than in conventional microwave vessel assemblies. As a result, a higher batch count of discrete samples can be accommodated and each individual sample can be of a larger mass than

is possible in a conventional sealed vessel. Another benefit is the vastly reduced need for consumable vessel components. In normal operation, the combination of pre-pressure nitrogen and partial pressure of process vapors ensures that boiling never occurs in individual sample containers.

Loose-fitting covers on each container prevent loss of sample or cross-contamination between adjacent samples. Several standard racks for the system are designed to hold 6 to 77 individual sample containers made of glass, quartz, or TFM.



Single TFM vessel  
Volume 3,5 liters



6 TFM or quartz  
vessels  
Volume 120 ml



40 TFM or quartz  
vessels  
Volume 20 ml



## *Highest Digestion Quality*

The improvement in laboratory efficiency provided by processing samples at higher temperatures and pressures is easy to understand. At a higher temperature, decomposition takes less time. However, in many laboratories, this will not be the most significant advantage of using the UltraCLAVE. Traditional closed-vessel microwave proceeds by monitoring and controlling conditions in a single reference vessel. The assumption is made that these parameters can be duplicated in all other vessels that are processed simultaneously along with the reference vessel. In order for this to be true, the sample type, sample mass, the volume of acid, and the performance of all the other vessels must be identical to that in the reference vessel. In the UltraCLAVE no single vessel is selected as the reference. Instead, uniform temperature conditions are achieved by positioning all the individual sample

vessels in a pool of microwave absorbing fluid, a microwave "load." It is the effective temperature of this load that is monitored and controlled throughout the heating process.

By eliminating the traditional control strategy, chemists are no longer constrained to process batches of identical samples using identical sample chemistries. To the extent that all the samples in a batch will be satisfactorily processed under the same temperature conditions, many dissimilar samples and chemistries can be combined in a single run in the UltraCLAVE.

Even certified reference materials can be processed along with unknown sample for method validation. This transformation of a sequential process into a parallel one may prove to be the greatest source of increased efficiency in many laboratories.

# Application

## Materials testing

When testing materials for RoHS Directive compliance, the UltraCLAVE can accommodate the entire range of sample types subject to the regulation. Its ability to digest mixed batches allows a variety of components to be processed at the same time.

## Clinical

The UltraCLAVE provides the simultaneous digestion of multiple sample types (blood, urine, feces, hair), reduces acid usage even further, and processes more samples in less time, reducing the daily operating costs.

## Remediation

Soils, sand, cement, organics, and a host of other materials all come into the laboratory at once to be prepared for analysis. The UltraCLAVE can handle these samples simultaneously, in batches of up to 77 mixed samples, and with minimal dilution.

## Environmental

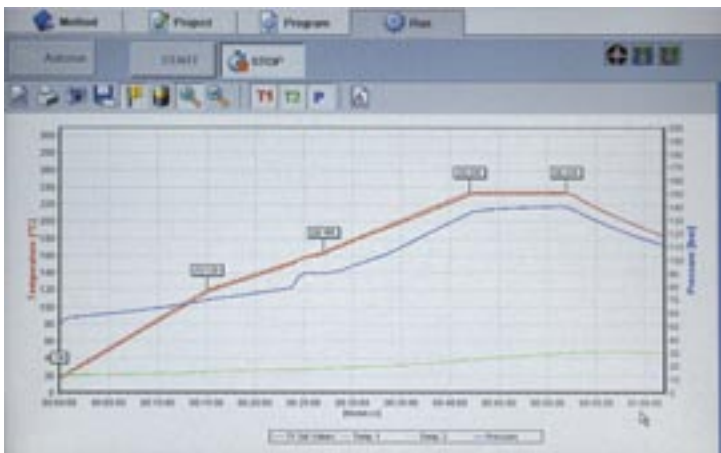
In a busy environmental laboratory, sample preparation is always the bottleneck that determines how much analytical work can be done. The UltraCLAVE can handle large batches of samples in a variety of types (soils, vegetation, drinking water, wipes, and swipes) with faster turnaround, with no loss of volatiles and no vapor pollution of the laboratory or environment.

## Polymers

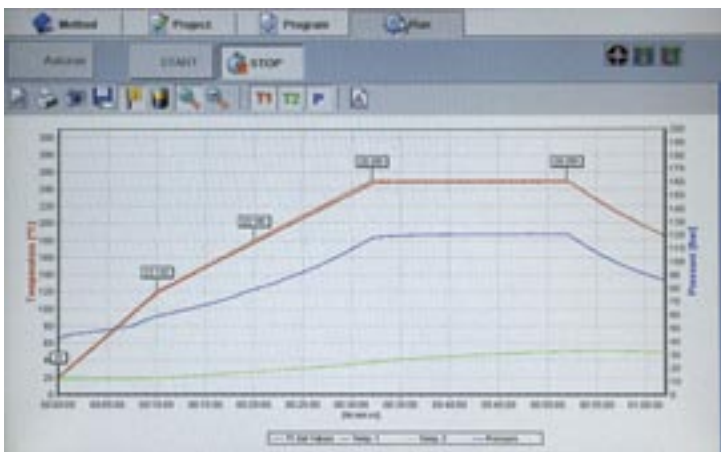
A fundamental part of polymer QA/QC is the need to digest or extract large sample masses. The UltraCLAVE can digest 25 to 30 g, distributed among multiple vessels.

## Food and Feed

Organic samples can be easily prepared with the UltraCLAVE, at temperatures substantially higher than those obtainable with traditional microwave systems, thus assuring complete digestions.



Simultaneous digestion of 40 different organic samples (vegetables, food and feedstuff etc.). Typical sample size 0,5 grams each.



Simultaneous digestion of 40 different polymers (polyethylene, polypropylene, PET, etc.). Typical sample size 0,5 grams each.





# UltraCLAVE Technical Specifications

## UltraCLAVE Labstation

### Hardware

- High pressure stainless steel reactor with 3,5 liters TFM liner

### Cover lift mechanism

- Auto-lift and clamps controlled by electronic position sensors

### Microwave power

- Fully programmable from 0 to 1000 Watt at 2450 MHz frequency

### Microwave coupling

- Directly to pressure reactor

### Vessel cooling

- Closed-loop cooling system

### Operating software

- Via external Windows™-based computer through dedicated EasyCLAVE software

### Maximum temperature

- 260°C for extended time

### Maximum pressure

- 200 bar

### Vessel safety and test certifications

- Hydrostatically tested at 315 bar for German TUV certification

### Dimensions

- 64 x 100 x 164 (h) cm
- Weight Approximately 400 kg
- Power 230V/50Hz; 2,4 kW



### Control terminal

#### Control terminal PCE with:

- 15" large high resolution color screen
- 'Touch-control' display
- Windows™ XP operating system
- Keyboard and mouse
- Interfaces for microwave unit, USB port, balance (serial), Ethernet RJ45
- Dimensions 35 x 27,5 x 7,5 (h) cm
- Weight of approximately 4,5 kg

Specifications are subject to change without notice.



MILESTONE srl  
Via Fatebenefratelli, 1/5  
24010 Sorisole (BG) - Italy  
Tel: +39 035 573857 - Fax: +39 035 575498  
E-mail: analytical@milestonesrl.com  
www.milestonesrl.com

UNI EN ISO 9001: 2000 CERTIFIED

MLS GmbH  
Auenweg 37 - D-88299 Leutkirch im Allgau - Germany  
Tel: +49 (0)7561 9818-0 - Fax: +49 (0)7561 9818-12  
E-mail: mws@mls-mikrowellen.de  
www.mls-mikrowellen.de

MILESTONE INC.  
25 Controls Drive - Shelton, CT 06484 - USA  
Tel: (203) 925-4240 - Toll-free: (866) 995-5100  
Fax: (203) 925-4241  
E-mail: mwave@milestonesci.com  
www.milestonesci.com

MILESTONE GENERAL K.K.  
KSP, 3-2-1, Sakado - Takatsu-Ku, Kawasaki 213-0012 - Japan  
Tel: +81 (0)44 850 3811 - Fax: +81 (0)44 819 3036  
E-mail: info@milestone-general.com  
www.milestone-general.com