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Microwave Technology

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Q: How does microwave technology work to extract my samples?

A: Microwave technology works with the dipole moment of polar solvents. Polar solutions readily absorb microwave energy, which in turn generates heat as a result of the reorientation of the molecules at high frequency. In addition, microwave systems will incorporate a stainless steel cavity to reflect the supplied microwave energy. This reflected microwave energy will then be absorbed by the load within the cavity. The load/sample will be contained in a microwave transparent material to maximize localized superheating, thus reducing the time needed to reach the desired temperature. Pressurized vessels allow the temperature to be raised above their ambient boiling point which significantly reduces digestion/extraction time.

Q: What makes microwave extraction superior to other extraction methods?

A: Extraction of the analytes of interest from the sample matrix is the least evolved (many people still use the Soxhlet method invented in 1879) and most error-prone step in the analytical procedure. **Microwave extraction is faster than other methods and produces more accurate & precise results.**

Q: Why is microwave extraction faster than other methods?

A: Microwave-assisted extraction uses closed vessels to heat the extraction solvent to 2–3 times its atmospheric boiling point. The elevated temperature of the solvent increases the solubility of the analyte of interest and lowers the viscosity of the solvent, allowing it to better penetrate the matrix. This leads to dramatically reduced extraction times.

Q: Why does microwave extraction produce more accurate and precise results?

A: The reflux action that occurs during microwave heating brings the sample in contact with fresh solvent during the extraction process. The homogeneity of the microwave field and the precision of the temperature control are also key factors in efficiency of microwave extraction. If the microwave field is not homogeneous, then the samples will heat at different rates and the extraction temperature will not be uniform, leading to poor precision.

Q: What can microwave extraction be used for?

A: The best applications for microwave extraction are those which currently use Soxhlet, Sonication and ASE. The following environmental contaminants can be extracted using microwave extraction:

- PAH's
- PCB's
- Diesel Range Organics
- Semi Volatiles
- Organophosphorus pesticides
- Chlorinated pesticides
- Phenols
- Dioxins and Furans



Q: How does microwave extraction speed up the extraction process?

A: The use of Microwave Extraction using US EPA 3546 significantly increase sample throughput. The historical and standard method is Soxhlet extraction which is time and solvent consuming. Microwave extraction significantly reduces both the solvent usage and the overall time. This time savings comes from the elevated temperatures reached using closed vessels as well as overall throughput compared to the Thermo ASE or Soxhlet methods (24 batch style vs 24 sequentially). In addition, the use of closed vessels allows the extraction of volatile compounds that would have been lost in an open system.

For instance, an analytical batch of 24 samples can be processed in a microwave extraction system in 40 minutes. During the filtration process of the first set of samples, a second set of samples can be loaded and extracted. It is not unusual for a high throughput labs to process one hundred or more samples in a day using a single microwave. The standard disposable glass vials for the Ethos X – FastEX-24 vessel offers additional time savings and it eliminates the potential risk of memory effect.

Q: How does microwave help my activity?

A: Environmental laboratories performing extraction for environmentally significant pollutants including semi volatiles, pesticides, PCBs, herbicides, petroleum hydrocarbons would significantly benefit from microwave extraction. If you are using Soxhlet, Sonication or Accelerated Solvent Extraction (ASE) for environmental samples, the Ethos X – FastEX-24 will allow you a superior TAT, high productivity with a low maintenance cost and initial investment.

Q: Is there an official method for microwave extraction?

A: Yes, US EPA 3546 is the official standard method for the microwave assisted extraction. This method is used for extracting water insoluble or slightly water soluble organic compounds from soils, clays, sediments, sludges and solid wastes. This method was developed and validated on commercially-available solvent extraction systems. The procedure uses microwave energy to produce elevated temperature and pressure conditions in a closed vessel containing the sample and organic solvent(s). The analyte recoveries are equivalent to those from Soxhlet extraction (Method 3540) but with improved precision and with less solvent usage and significantly less time than the Soxhlet procedure.

Q: What are the analytical methods in use?

A: The extraction process is regulated by US EPA 3546 while each contaminant has its own specific method for the analysis. The table below lists the main official methods available.

EPA 3546	Reference analytical method
PCBs	EPA 8082
PAHs	EPA 8270, 8100
Semivolatile organics	EPA 8270
Phenols	EPA 8151
Chlorinated pesticides	EPA 8081
Organophosphorus pesticides	EPA 8141
Organophosphorus pesticides	EPA 8141
Chlorinated herbicides	EPA 8141

Q: What are the main advantages of the Ethos X – FastEX-24 rotor over the other microwave technologies available?

A: It greatly reduces time, reagents and accommodates larger sample size. FastEX-24 can process up to 30g of sample in each vessel. The higher sample amount combined with the use of 100ml disposable glass

Ethos X Frequently Asked Questions

Extraction of contaminants from environmental samples



vials, makes the Ethos X with a FastEX-24 rotor unique and unmatched in terms of throughput and ease of use.

The contact-less temperature control of all vessels and the unique Weflon material eliminates the concern of overheating and provides control of the extraction parameters in all the vessels. Moreover, the innovative design allows a faster cooling time that makes the overall process quicker.

Q: What are the advantages vs other extraction systems?

A: It greatly reduces time and solvent usage and accommodates larger sample size compared to the traditional Soxhlet and Sonication extraction.

Ethos X offers a batch extraction approach over the Accelerated Solvent Extraction. In addition, Ethos X can process more than 120 samples per day, 3 times higher than accelerated solvent extraction (maximum 40 sample per day).

Q: What are the benefits of the disposable glass vials?

A: The use of disposable glass vials reduces the overall cost of the extraction process and eliminates the potential risk of memory effect. The result, an easier, faster and reliable extraction.

Q: What type of samples can I run? What is the maximum % moisture content the sample can contain?

A: The rotor is designed to work with contaminated samples such as soils, clays, sediments, sludges and solid wastes. The pre-treatment is effective up to 30% moisture content in soil samples. The higher the amount of water, the lower will be the ability of the solvent to penetrate the sample and extract the target compounds. A higher moisture content would require more drying agent, limiting the amount of sample that can be used for the extraction.

Q: What kind of pre-treatment do I perform before placing the samples into the vessels?

A: Some laboratories prefer to mix the sample with anhydrous sodium sulphate until a free-flowing powder appearance is achieved. The sample is then transferred to the vessel and the solvent is added.

Q: What is the maximum amount of sample I can run in the FastEX-24 vessels?

A: The max amount of sample that can be added in the glass vessel is 30g. A large sample size will provide the ability to analyze lower concentration limits of quantitation.

Q: What are the post-extraction treatments typically performed before analyzing the sample on the GC-MS?

A: Filtration and evaporation of the sample is required after the extraction. The method for filtration will be referenced in the analytical method. Generally, for pesticides and PCBs, hexane is added to the extract for a complete solvent exchange and for semi volatiles and Diesel Organic Range, typically use dichloromethane as the solvent exchange.

Q: Is it easy to handle the rotor and open and close the vessels?

A: Thanks to the automatic capping station the handling is much easier compared to other technologies. In addition, the capping station affords the user the ability to uniformly close the vessels resulting in reproducible results between samples.

Q: How does the Ethos X control the extraction process?

A: The Ethos X works with a PID advanced control. This system automatically controls the power according to the extraction temperature.



Q: What is the Ethos X hardware construction?

A: Milestone has almost 30 years of experience in the production of microwave hardware. The Ethos X is German engineered to be safe and durable.

- Chassis and door are completely made of 18/8 stainless steel coated with Teflon to protect against corrosion from acid and solvents.
- Self-resealing pressure responsive door ensures maximum safety in case of overpressure release.
- An automatic door locking system keeps the door closed until the set temperature is reached. Users can modify the set temperature according to the lab needs.
- Built-in exhaust system located above the microwave cavity and separated from the electronics to prevent corrosion.
- Dual magnetron system with rotating diffuser provides homogeneous microwave distribution in the cavity.
- Exclusive magnetron protection from reflected microwave power
- Continuous and PID-controlled microwave emission at all power levels

Q: Can I use the Ethos X for closed vessel digestion for metal analysis?

A: Yes, Ethos X is a flexible microwave platform. Just by changing the rotor, the Ethos X can be used for acidic digestion. Ethos X can accommodate all the rotors designed by Milestone for digestion, such as the SK-15 and Maxi-44.