# Scale-Up on OilExTech's EssenEx™ -100

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## What are essential oils?

Essential oils are located in flowers, leaves, and stems of various botanicals.

- *Examples:* mint, lavender, citrus peel, juniper berries
- *Uses:* lotions, aromatherapy, cleaners, candles


## EssenEx™ 100 (Original Unit)

The EssenEx™-100 is a steam distillation unit used to extract essential oil from botanical materials in approximately 6 minutes with the use of an at home microwave.

- 2 L glass jar
- Holds up to 500 g of orange peel
- Designed for 200 mL ice core
- Typical oil extraction of 1-2 g

## Project Objective

To scale-up original EssenEx™-100 design for processing increased amounts of botanical material in order to get more essential oil.


***Fig.1**: Size comparison of the EssenEx™-100, Scale-Up #1, and Scale-Up #2. All units contain 400 g of chopped orange peel.*

## How the Unit Works

1. The microwaves travel into the unit, heating up the ice, turning it into steam.
2. The steam travels through the pores of the material, carrying essential oil vapors out of the botanical.
3. The steam then condenses into the beaker containing both water and essential oil, this is called the hydrosol.
4. The oil is less dense than the condensed ice core which creates two separate liquid layers in the beaker.

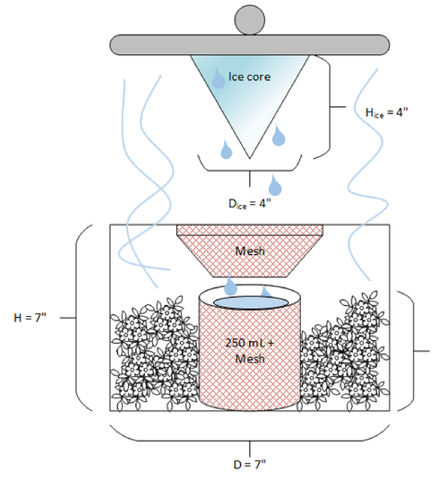


***Fig.2:** Original design of OilExTech's steam extraction unit, the EssenEx™-100.*

## Preliminary Trials

- The amount of oil collected is dependent on the amount of ice core present.
- When is the ice core gone?

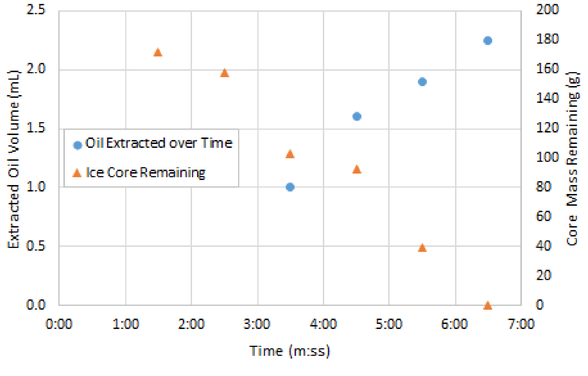


***Fig.3**: Time trials using 100 g of lavender to determine the optimum time at which the amount of oil extracted is maximized.*

## Preliminary Results

The oil mass extracted decreases as the scale-up volume increases because:

- Less energy is being used to produce steam for distillation in larger units. The increase in mass of scale-up systems absorbs more energy which removes some available energy for steam distillation.
- The extracted water/oil vapor mixture must travel an increased distance in larger units, making transfer more difficult.

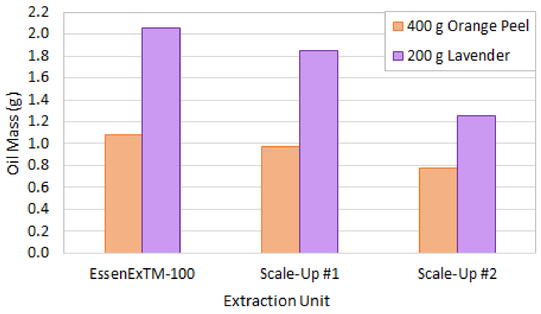


***Fig.4**: Trials showing the amount of oil extracted in each unit size. Unit size is inversely proportional to oil extracted. All trials were run for the same amount of time in the microwave.*

## Results for Final Design

The microwave duration was increased for increasing masses of orange peel. The higher the mass in the unit, the longer the microwave duration. Optimal microwave time was investigated for ideal oil yield and can be seen in Figure 5.

The larger ice core produces more steam in the system and allows more oil to be extracted.

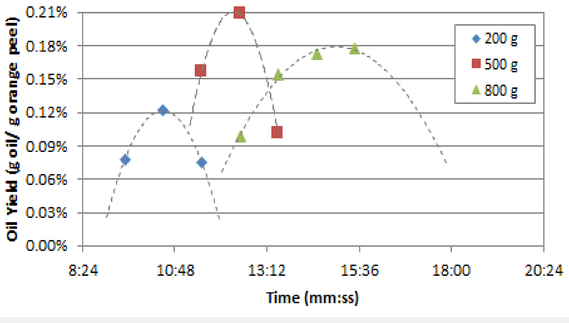


***Fig.5:** The data points represent the average oil yield for the mass of botanical used. The three points represent low, ideal, and high oil yield, respectively. The low region is the time where the ice core is still remaining after the cool down period. The ideal time results in the largest oil yield. The high region is the time where the ice core is depleted during the microwave trial, and oil in the hydrosol re-evaporates. The dotted curves represent the expected trends for each of the masses. All trials were run in final design (Scale-Up #2).*

## Concerns

- Oil yields are inconsistent based on various orange batches
- Mesh and lid compatibility
- Varying level of water in the mug alters energy consumption
- Ice core cracking and falling into the hydrosol during the microwave run

## Conclusions

- Each unit has a different microwave time requirement per unit botanical mass due to an increase in total mass in the microwave
- Final design chosen was Scale-Up #2:

### Specifications

- 6 L glass jar
- Holds up to 400-900 g of orange peel
- Designed for 200 or 250 mL ice core
- Uses larger beaker mesh (1.75 in taller and 0.5 in wider than original design)
- Typical oil extraction of 3-5 g (botanical dependent)

- Final experimental runs in Scale-Up #2:
  - Orange Peel: 800 g yields 2 g of oil
  - Lavender: 600 g yields 5 g of oil

## Recommendations

- Optimize jar parameters (ice core size, jar insulation, microwave time range, cool down time) and experiment with other botanicals
- Investigation on the volume of water in the mug and the relationship to energy consumption

## Acknowledgments

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