



# Design an Apparatus that is Capable of Extracting Essential Oils

## Essential Oil Distillation Equipment

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In developing countries, there is a need for high-value cash crops that do not degrade the environment. Essential oils, often extracted from the flowers or leaves of tree crops, are an especially good solution to this problem. Lime trees, for example, have three types of essential oils that can be extracted from three different parts of the tree: flowers, leaves, and fruit. A single ounce of most essential oils is worth thousands of dollars.

Extracting essential oils requires a distillation process that traditionally uses large, centralized equipment. Such equipment requires a high initial purchase that is unmanageable for many small farmers and even groups of farmers in most developing countries. Further, some essential oils come from extremely delicate flowers that must be processed soon after harvesting. Thus, for functional and economic reasons, there is a need for small-scale, decentralized steam distilling equipment.

### Project

An essential oil distillation unit has three primary components.

1. A steam generator, which uses a heat source to boil water and generate steam. The steam passes through a chamber that holds the plant material, extracting the oils, creating an oil-steam mixture.
2. A condenser, which the oil-steam mixture travels into to cool and condense into an oil-water mixture.
3. A separator, which separates the essential oils from the water.

The basic task is to design a small, inexpensive, effective distiller.

You will work in teams, which will then be divided into three sub-teams. Each sub-team should address one of the three components, and all should work together to make sure each component interacts appropriately with the others.



A distillation system used in Haiti currently. From left to right are shown the steam generator, condenser, and separator.

#### Design Issues

**Portability:** the unit should be able to be transported in the back of a small pick-up truck.

**Capacity:** the internal chamber should be approximately 0.5 m<sup>3</sup>

**Energy Efficiency:** you should look at the best ways to recycle the heat in the system. One possibility would be to incorporate a solar water heater into the system to preheat the water before it enters the steam generator.



#### Ylang-ylang:

Another potentially profitable source of essential oils

Image Source: <http://www.augustus-oils.ltd.uk/products/ylang.htm>

## Frequently Asked Questions

### *Where will this type of system be used?*

There is strong interest in a distillation system in the country of Haiti. Haiti is an ideal country for this type of system, for a number of reasons. First, it is 98% deforested, causing a variety of problems, including catastrophic flooding resulting in a loss of topsoil that washes into the sea, choking the reefs and marine life. The crops grown for essential oils will reforest the areas in which they are grown. Second, the average annual income is less than US\$400, so there is a dire need to help farmers increase their income.

### *What are essential oils?*

Essential oils are extracted from plant, flower, or fruit materials, and are often used in the perfume industry.

### *What is the weather like during the flowering season?*

Different plants flower at different times, but Haiti's climate is generally hot and humid, and temperatures vary more during the day than from season to season. Highs are around 23-32°C, and 15-27°C at night. The rainy season varies depending on the region, but rain showers are typically short and occur in the evening. During July-October, hurricanes are often an issue.

### *What components are available in Haiti, so that they can build this type of system easily?*

There is a well-equipped workshop in Camp Perrin, which is part of a Belgian development project. However, it is not as easy to obtain components in Haiti as it is in the US, so try to avoid requiring complex, specialized equipment, if possible.

### *Is there a sufficient water supply to use for a cooling system, or is an air condenser necessary?*

Yes, water is readily available from a canal system, and a gravity fed system could be used. If large volumes of pressurized water are required, then a pump would have to be part of the system.

### *What energy sources are available?*

Deforestation is one of the biggest problems in Haiti, so wood or charcoal is probably the least sustainable energy source. Liquid propane gas (LPG), diesel, and gasoline and kerosene are all available. Another option might be a solar-thermal system. There is also interest in exploring the possibility of used motor oil as a fuel source. There is not a good source for hydropower in the region, and photo-voltaic panels are probably too expensive for this application.