

# The Management and Manufacture of Essential Oil Distillation Equipment using the Direct Steam Distillation Method

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The production of Atsiri oil is a complex process that requires significant planning in order to create products that are both high in quality and quantity. Prior to production, it is important to have an understanding of essential oils. This includes knowledge regarding types of oils and their uses, the manufacturing processes including refining mechanisms and materials used, as well as the targeted time frames for production. Essential oil, also known as etheric oil (aetheric oil), essential oil, volatile oil, and aromatic oil, is a large group of vegetable oils that form viscous liquid at room temperature but easily evaporate to give a typical scent. Essential oils are used as raw materials in various industries, such as perfume, cosmetics, pharmaceuticals, and flavouring agents in the food and beverage industry. These oils usually consist of various mixtures of chemical compounds formed from elements of Carbon (C), Hydrogen (H), and oxygen (O). The most common method of purifying essential oils is through Direct Steam Distillation. This paper observes the implementation of Essential Oil Machine Manufacturing Activities. The analysis methods include: site surveys, production processes, equipment purchases, equipment testing in workshops, equipment delivery, installation and assembly of equipment on site, and field trials. Through this research, it was found that the distillation of essential oils from 2.1 kg, raw material for patchouli leaves, obtained essential oils as much as 62 ml (2.95%).

**Key words:** , *Essentials oil, Distillation.*

## **Introduction**

Indonesia is an agricultural country and holds great potential in the cultivation of plants such as patchouli which can be used as raw materials for essential oils. On initial appearance, patchouli plants appear to have no economic value as they appear to be mere weeds. However, essential oils from these shrubs are the highly sought after worldwide as a raw material for perfumes, cosmetics, and pharmaceuticals.

This oil-processed material has the potential for significant market opportunities for international trade. This opportunity for Indonesia must be further developed as current essential oil production only ranges between the islands of Sumatra and Java. Regions such as Kalimantan, Sulawesi, Maluku Islands, and Papua do not have an industrial centre for refining essential oils.

The business of essential oil production in Indonesia in the form of small and medium scale industries has the potential to increase foreign exchange for Indonesia. According to the Chairperson of the Indonesian Essentials Council (2015), the main essential oils produced by Indonesian are Clove Leaf (Stem Oil), Wangi Citronella oil, Patchouli oil, Cajuput oil, and Turpentine oil. The world essential oil trade is currently valued at an estimated of USD 4,000,000,000. The total export of Indonesian essential oil is USD 120,000,000. In terms of the variety of oils, there are 300 types of essential oils currently in world trade. There are also 40 additional types of essential oils that have the potential to be developed in Indonesia are. The Ministry of Trade's data stated that the export of the Essential Oils, Cosmetics and Fragrances in the January-May 2016 period fell 0.74% to US \$ 266 million compared to the same period in 2016.

Therefore, Indonesia's essential oil diversity must be increased. Based on the projected import value of world essential oils and the export value of Indonesian essential oils by using the regression equation shows that Indonesia's essential oil export value is further away from the import value of world essential oils. This demonstrates that the opportunity for Indonesia's essential oil market in the international market is still wide open and the rate of increase in Indonesia's exports must be increased. Based on the above conditions and through a study conducted by the Directorate General of IKM, the Ministry of Industry in 2011 has established West Sumatra as the centre of national essential oil development.

## **Essential Oils**

Essential oils are a smelling substance primarily made from plants. This oil is also called evaporating oil, etheric oil, essential oil because it evaporates at room temperature. The term

“essential” is used because essential oils represents the smell of the original plant. In a fresh and pure state, essential oils are generally colourless. During long storage, essential oils can be oxidized. To prevent this, essential oils must be stored in dark coloured glass vessels, sealed, and stored in a dry and cool place.

Essential oils are also contained in various organs, such as in glands, hair (in the family Labiatae), inside parenchymal cells (such as the Piperaceae family), and in the schizogen cavities and lysigen (in the family Pinaceae and Rutaceae). Essential oils are used as raw materials in various industries, such as the perfume industry, cosmetics, pharmaceuticals, and as flavouring agents in the food and beverage industry. Essential oils usually consist of various mixtures of chemical compounds formed from elements of Carbon (C), Hydrogen (H), and oxygen (O). In general, the chemical components of essential oils are divided into two groups, namely: 1) Hydrocarbons, which mainly consist of terpenes compounds and 2) Oxygenated hydrocarbons.

#### a. Hydrocarbon

Products which belong to this group are formed from elements of Carbon (C) and Hydrogen (H). Most types of hydrocarbons contained in essential oils consist of monoterpenes (2 isoprene units), sesquiterpenes (3 isoprene units), diterpenes (4 isoprene units) and politerpenes.

#### b. Oxygenated Hydrocarbons

The chemical component of this compound is formed from the elements of Carbon (C), Hydrogen (H) and Oxygen (O). The compounds included in this group are alcoholic compounds, aldehydes, ketones, esters, ethers, and phenols. The carbon bonds contained in the molecule can consist of single bonds, double bonds, and triple bonds. Terpene contains a single bond and double bonds. The terpene compound has less fragrance, is difficult to dissolve when diluted in alcohol and if stored for a long time will form a resin. Oxygenated hydrocarbons are important compounds in essential oils because they generally smell better. The terpene fraction needs to be separated for certain purposes, for example, for the manufacture of perfumes, so that essential oils are free of terpenes.

It is estimated that there are 150-200 essential oil-producing plants species including the Pinaceae, Labiateae, Compositae, Lauraceae, Myrtaceae, and Umbelliferaceae families. Essential oils can be sourced in every part of the plant, namely from leaves, flowers, fruit, seeds, stems or skin and roots or rhizome.

#### Essential Oils from Plant Leaves

Name of oil	Producing Plants	Country of origin
Citronela (Sereh)	Cymbopogo Nardus R	Ceylon
Patchouly (Nilam)	Pogostemon cablin benth	Malaysia
Cajuput (kayu putih)	Melaleuca Leudendron L	Indonesia
Bay	Pimenta Ocris	Dominika
Cassia	Cinnampmum Cassia L.	China
Cedar Leaf	Thuya accidentalis	Vermont
Eucalyptus	Eucalyptus sp.	Australia, Uruguay
Lemon grass	Cymbopogan Citratus	Madagaskar, Guatemala
Cherry laurel	Prunus laurocerasus L.	Prancis

#### Essential Oils from Plant Flowers

Name of oil	Producing Plants	Country of origin
Cananga (kenanga)	Canana odorata Hook	Indonesia
Champaka (cempaka)	Michelia campaca L.	Madagaskar, Filipina
Clove (Cengkeh)	Caryophyllus aromaticus L.	Zanzibar, Madagaskar, Indonesia
Basil	Ocimum basilieum	Madagaskar
Chamoomile	Matricaria chamomile L.	Jerman, Hongaria
Lavandin	Lavandula vera D.C	Perancis
Lavender	Lavandula Officinalis Chaix	Perancis, Rusia
Marjoram	Origanum majorana L.	Perancis, Afrika
Rose (Mawar)	Rose alba L.	Bulgaria, Turki
Rosemary	Rosmarinus Officinalis L.	Tunisia

#### Essential Oils of Plant Seeds

Name of oil	Producing Plants	Country of origin
Caraway	Carum Carvi	Belanda, Rusia
Cardamom	Elettaria Cardamomum	India
Carrot Seed (Wortel)	Daucus Carota L.	Amerika, Eropa
Celery seed (Seledri)	Apium Graveolen L.	Inggris, India
Croton	Croton Triglium L.	India, Ceylon
Cumin	Cuminum Cyminum L.	Maroko, India
Drill	Antherium Graveolans	Eropa Tengah
Caraway	Carum Carvi	Belanda, Rusia
Cardamom	Elettaria Cardamomum	India
Carrot Seed (Wortel)	Daucus Carota L.	Amerika, Eropa

### Essential Oils from Fruit or Plant Fruit Skins

Name of oil	Producing Plants	Country of origin
Juniper	Juniperus communis	Hongaria, California
Lemon (Sitrun)	Citrus medica L.	California
Pepper (Lada)	Piper nigrum L.	Ceylon, Cina, Madagaskar
Pimenta	Pimenta officinalis Lindley	Jamaika, Inggris
Vanilla (vanili)	Vanilla Planifolia	-
Coriander (ketumbar)	Corandrum Sativum L.	Eropa Tengah
Anise (Adas)	Pimpinella anisum L.	Rusia, Eropa
Grape fruit	Citrus decumana L.	Florida, Texas
Fennel	Foeniculum Vulgare Mill	Eropa Tengah, Rusia
Juniper	Juniperus communis	Hongaria, California

### Refining Process

The purification process and the refining method is based on several considerations such as the type of plant raw material, oil characteristics, oil diffusion process with hot water, oil decomposition due to heat effects, production efficiency, and reasons for economic value and production effectiveness.

#### • *Refining with water (water distillation)*

The method of distillation is to enter the raw material, whether it has been dissolved, dried or wet material into the distiller kettle that has been filled with water and heated. Steam coming out of the kettle is supplied by a pipe connected to the condenser. The steam, which is a mixture of water vapor and oil, will condense into liquid and be stored in a container. The oil and water liquid are then separated by an oil separator for oil only. This method is commonly used to distil aromatherapy oils such as rose and jasmine. It must be noted that the kettle is made from anti-rust materials such as stainless steel, copper or aluminium-coated iron.



water distillation

- ***Refining with water and steam (Water and Steam Distillation)***

Distillation with water and steam is commonly known as a steaming system. This method is similar to a boiled system, except that raw materials and water do not come into direct contact because they are limited by a filter over water. This method is the most widely practiced in the industrial world because it requires a significant amount of water so in order to shorten the production process time.

This steaming method is usually equipped with a cohobation system. The condensate water that comes out of the separator re-enters automatically into the kettle to minimize water loss. However, production costs must also be considered in from a commercial perspective. The cohobation steaming system is more beneficial because it is free from the hydrolysis process of the essential oil components and the process of oil diffusion with hot water. In addition, the decomposition of oil due to heat will be better than the direct steam distillation method. This distillation method using a steaming system can produce steam and heat which is stable due to constant vapor pressure.



water and steam distillation

- ***Direct Steam Distillation***

In this system, the raw material is not in direct contact with water or fire. Only high-pressure steam is used to refine oil. The working principle of this method is to make high pressure steam in the boiler. The steam will then flow through the pipe and enter the kettle containing the raw material. Steam coming out of the kettle is connected to the condenser. Condensate liquid containing a mixture of oil and water is separated by a separator that matches the specific gravity of the oil. Refining with this method is commonly used for raw materials that require high pressure on the process of removing oil from plant cells, such as agarwood, sandalwood, etc.

### **Implementation of activities**

Essential Oil Machine Manufacturing Work Plans are as follows:

- a. Location survey
- b. Production Process
- c. Purchasing equipment
- d. Test the equipment in workshop
- e. Equipment delivery
- f. Test in field

### Implementation Schedule

No.	Detail Job	Sum	Weekly Progress																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Preparation and order of Material and Machine Completeness	1 Paket	■	■																		
2	Distillation of Essential Oils Volume 2,500 Liters	1 unit		■	■	■	■	■	■	■												
3	Boiler Making	1 Unit				■	■	■	■	■												
4	Making Water Circulation Pool	1 Unit																			■	
5	Manufacture of Essential Oil Refining Tools Volume of 50	1 Unit								■	■	■	■	■	■							
6	Trial equipment in the Workshop	1 Paket																			■	
7	Machine / Equipment Deliver	1 Paket																			■	■
8	Trial and Commissioning	1 Paket																				■
9	Handover of Works	1 Paket																				■

The process of carrying out the manufacture of essential oil purification equipment is to use Direct Steam Distillation.

### *The Distilled Kettle*

The distilled kettle is the place for the material to be distilled. In the distilled kettle, the ingredients are directly related to hot water vapor. Distilled kettle is generally a cylindrical shape made of steel or stainless-steel plates. The flute kettle is equipped with a lid that can be opened and closed tightly. The size of the distilled kettle varies according to need. A good-sized kettle usually has a diameter ratio with a height of 2:3. The bottom of the kettle is equipped with a buffer filter material. This material will be distilled so that there is a cavity for the even distribution of hot water vapor.

### Distilled Kettle Technical Specifications

Volume	1 unit
Type	DirectSteam Distillation
Volume of row space	2.500 Liter
Boiler material	Plate Stainless Steel SS 304,t 4 mm
Kettle Height	200cm
height of row space	190cm
height of steam space	10cm
Diameter Kette	130cm
Strainer (2 pieces)	Material Stainless Steel perforated plate SS 304 t 2 mm, hole 10 mm with 2 pcs plat strip cross SS 304, 40X4 MM
Pressure protection	Safety valve
Pressure	Presure gauge

Temperature gauge in the kettle	Thermometer
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### ***Condenser***

A condenser is a device in the form of a tub or cylindrical tube. Inside it is a straight or spiral shaped pipe which functions to condense the hot water vapor into liquid.

Condensation occurs when hot water vapor passes through a spiral pipe soaked in cold water. As the vapor passes through the spiral pipe, hot water vapor transfers heat energy through a spiral pipe to the cooling water. Finally, leaving the spiral pipe, the hot water vapor turns into a relatively cold liquid and is usually called distillate.

#### Condenser Technical Specifications

Volume	1 unit
Type	Tubular
Material	Plate stainless Steel SS 304 t 2 mm and 1,5 mm
Length dan volume condenser	Adjusted to the boiler volume

### ***Separator***

A separator is a device to accommodate distillates coming out of the condenser and separate them into oil fractions and water fractions. The principle of separation is to use the difference in density between water and oil. Oil that has a lighter weight than water will move towards the top of the separator. Oil that has a heavier weight than the water will move towards the bottom of the separator. Water that has been separated with oil is released continuously, while oil can be temporarily stored or removed continuously.

#### Separator Technical Specifications

Volume	1 unit
Type	The double container tub is open
Material	Plate stainless Steel SS 304 t 1,5 mm
Dimension (LxWxH)	60cm x 30cm x 65cm

### ***Boiler***

The boiler is a closed vessel in that contains water to be heated. The heat energy from the boiler's steam output is then used for various purposes, including for steam turbines, space heaters, steam engines, and so on. In the energy conversion process, the boiler has a function to convert chemical energy stored in the fuel into heat energy which is transferred to the working fluid. Pressurized vessels in boilers generally use steel materials specified in the

ASME standard (The ASME Code Boilers). These standards are especially applicable for boiler use in large industries.

#### Boiler Technical Specifications

Volume	1 unit
Steam Volume	1000 liter
Pressure	1 s/d 5 atm
Speed of steam	1 s/d 5 liter/menit
Fuel	Solar/Listrik
Pressure regulation	Pressure Regulator valve (PRV)
Steam pressure gauge	Pressure gauge
Temperature gauge of steam coming out	Thermometer
Steam, elbow, etc. pipes from boiler to kettle	SS 304 2 inchi or Adjusted

#### Evaluation and Results

The evaluation and results are carried out by the evaluation team prior to the commissioning process, which includes the evaluation of the target time, the process of making machines, and testing the results of the refining process (product).



Boiler



Kettle and Condenser



Separator



Test on field

Based on the results of the field inspection (commissioning). It was found that, all equipment and materials used for the distillation process are in accordance with the standards set [5]. In addition, the refining machine has functioned well and produced essential oil from the raw material of 2.1 kg of patchouli leaves, obtained 62 ml of essential oil (2.95 %) [6].



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