Essential oil

Uses

Production methods

Importance

- Essential oils have traditionally been used for therapeutic value.
- These oils have the properties of the spice or herb they are derived from.
- These aromatic and volatile oils are extracted from the leaves, stems, flowers of a plant.
- Essential oils are of complex composition and contain aldehydes, alcohols, esters, phenol in varying proportions.
- Since these specialty oils have a very strong aroma and are highly volatile, they are used as a raw material in flavoring and perfumes.
- Since these oils are highly concentrated, they need to be diluted before usage.

Benefits and uses

- The essential oils are traded in high volume and are particularly consumed in the flavor, personal care, industrial and pharmaceutical industries.
- These spice derivatives can have various benefits including anti septic and anti microbial action, for a healing and soothing effect.
- Some of the products in which these essentials are used are :
  - Soaps
  - Cosmetics
  - Perfumery
  - Confectionery
  - Chewing delicacies
  - Aerated drinks
  - Syrups

Essential Oil Production Method

- Steam Distilled
- Solvent Extracted
- Cold Pressed
- Hydro diffused
- Carbon Dioxide Extraction

Spice Oils

- Spice oil is a spice derivative that are extracted generally by steam distillation process.
- The spice oils distilled off from the spices at the initial stage before subject to solvent extraction
- These oils are the volatile components present in spices and provide the aroma and flavor of the spice they are made from.
- India is one of the top most producers of spice oils and contributes to around 70% of the total spice oil production.
- Countries including USA, EU, Japan and other middle eastern countries are major importers of spice oil.
- The exports of Indian spice oils has been rising significantly in the last few years owing to a sharp rise of demand in the fast food sector.

Popular Spice Oils

- Spice oils are traded in large volumes for use in a number of industries.
- Some of the extensively traded oils are as follows:
  - Clove oil
  - Cinnamon oil
  - Pepper oil
  - Ginger oil
  - Cardamom oil
  - Nutmeg and Mace oil
  - Mint oil

Advantages of Spice Oils

- **Standardization :** These oils ensure standardization in various products and hence are popularly used in pharmaceuticals, medicines and chemicals.
- **Consistency :** These oils have a consistent concentration of the spice they are made and hence more reliable.
- **Hygiene :** These oils are manufactured using high technology machinery and processes, hence are quite hygienic.

Use of Spice Oil

- Food processing
- Beverages
- Pharmaceuticals
- Chemicals
- Aromatherapy
- Personal hygiene products: eg toothpastes, mouthwashes and aerosols

Distillation

- The vast majority of true essential oils are produced by distillation.
- There are different processes used, however. In all of them, water is heated to produce steam, which carries the most volatile chemicals of the aromatic material with it.
- The steam is then chilled (in a condenser) and the resulting distillate is collected.
- The Essential Oil will normally float on top of the Hydrosol (the distilled water component) and may be separated off.

Distillation

- Separation process
- Separating components in a mixture
- Some components vapourize more readily than others
- Vapours contain the components of the original mixture, but in proportions which are determined by the relative volatiles of these components
- Vapour is rich in some components, those that are more volatile and so a separation occurs
- In fractional distillation, the vapour is condensed and then reevaporated when a further evaporation occurs.
- Successive distillations may be used for great purity

Applications

- Concentrating
  - essential oils
  - Flavours
  - Alcoholic beverages
- Deodourization of fats and oils

- Equilibrium relationships in distillation are governed by the relative vapour pressures of the mixture components
- By their volatility relative to one another
- Equilibrium curves for two component vapour liquid mixtures can be presented by
  - Boiling temperature /concentration curves
  - Vapour/liquid concentration curves

- Distillation is still the most economical method of extracting essential oil from spices and aromatic plant material.
- The main advantage of distillation is that it can generally be carried out with some very simple equipment, close to the location of plant production.
- Even in relatively remote locations large quantities of material can be processed in a relatively short time.
- Distillation is less labour intensive and has a lower labour skill requirement than solvent extraction.
- Adopting the simplest or cheapest extraction method however, may prove to be false economy because of low yield, poor or highly variable oil quality and low market value.

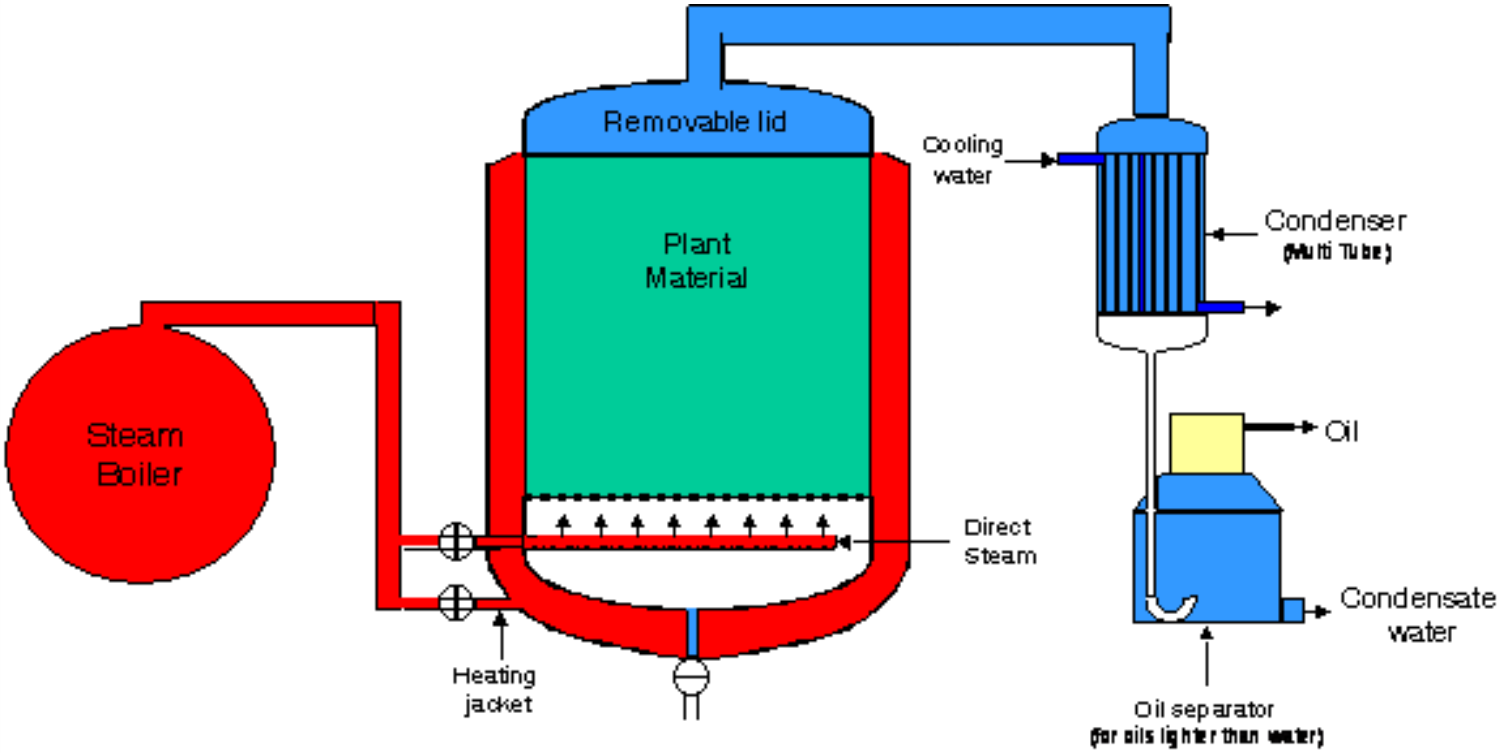
Extraction of essential oils

- Expression
- Hydro- or water-distillation.
- Water and steam distillation
- Steam distillation
- Solvent extraction

Steam distillation

- True Steam distillation uses an outside source of steam which pipes the steam into the distillation unit, sometimes at high pressure.
- The steam passes through the aromatic material, and exits into the condenser

- Steam distillation is the process of distilling plant material with the steam generated outside the still in a stand-alone boiler



Diagrammatic representation of steam distillation unit

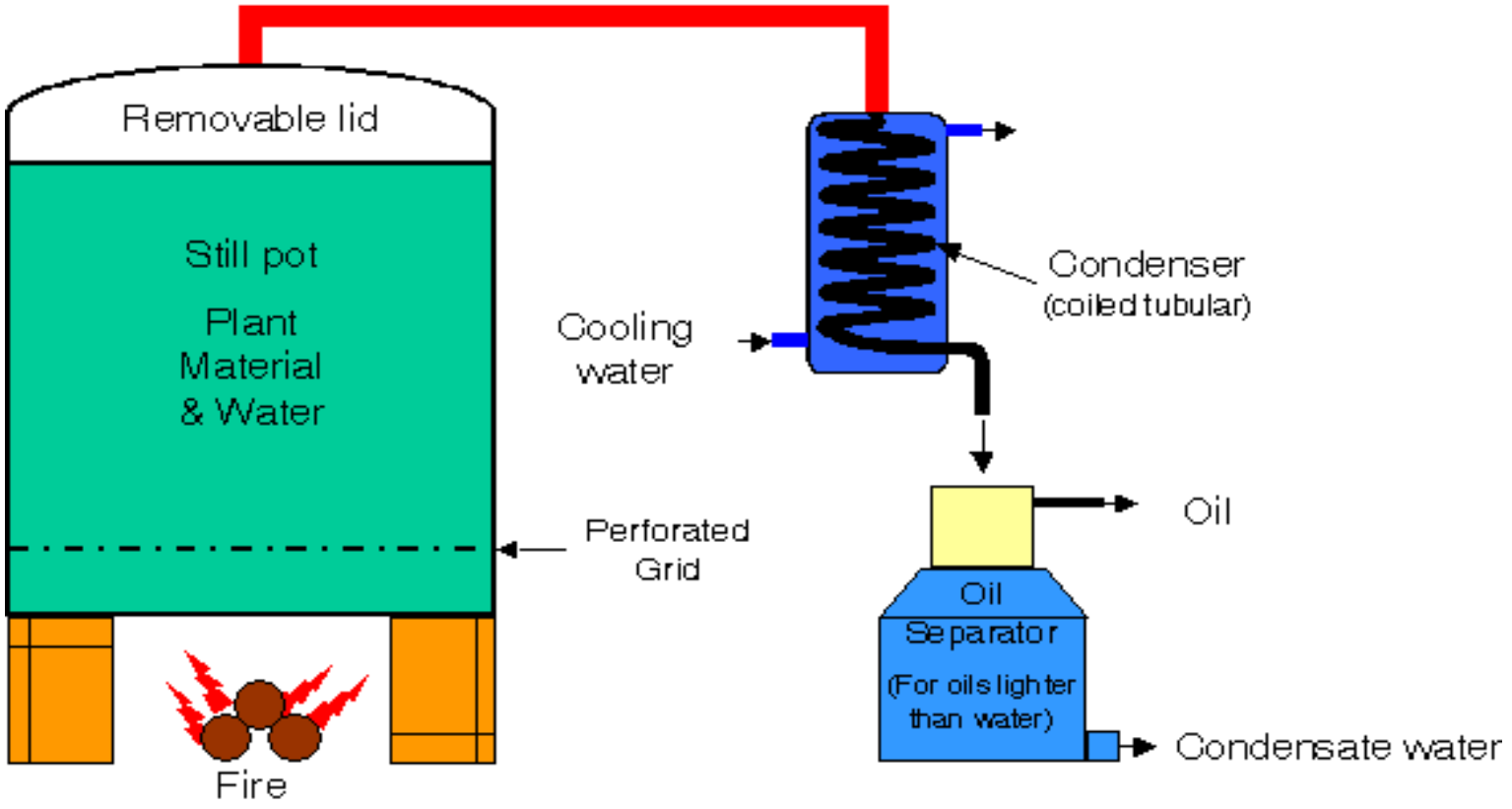
Advantages and Disadvantages

- The amount of steam and the quality of the steam can be controlled.
- Lower risk of thermal degradation as temperature generally not above 100 °C.
- Most widely used process for the extraction of essential oils on a large scale.
- Throughout the flavour and fragrance supply industry it is the standard method of extraction.
- There is a much higher capital requirement and with low-priced oils the pay back period can be over 10 years.
- Requires higher level of technical skill and fabrication and repairs and maintenance require a higher level of skill.
- Many variations of the process exist, e.g. batch, hydrodiffusion, maceration distillation, mobile stills and continuous distillation process.

Hydrodistillation

- The botanicals are fully submerged in water, producing a "soup", the steam of which contains the aromatic plant molecules.
- Most ancient method of distillation and the most versatile.
- It's the method most often used in primitive countries.
- The risk, of course, is that the still can run dry, or be overheated, burning the aromatics and resulting in an EO with a burnt smell.
- Hydrodistillation seems to work best for powders (ie, spice powders) and very tough materials like roots, wood, or nuts.

- Water distillation is the simplest of the three distillation methods.
- The plant material is mixed directly with water in a still pot.
- A perforated grid may be inserted above the base of the still pot to prevent the plant material settling on the bottom and coming in direct contact with the heated base of the still and charring
- Water distillation is probably the simplest and cheapest method of extracting essential oils, but the quality of the oil has the greatest potential to be modified due to the effects of direct heating and the water contact



Diagramatic representation of water distillation unit where the plant material is suspended in the water.

Water & steam distillation

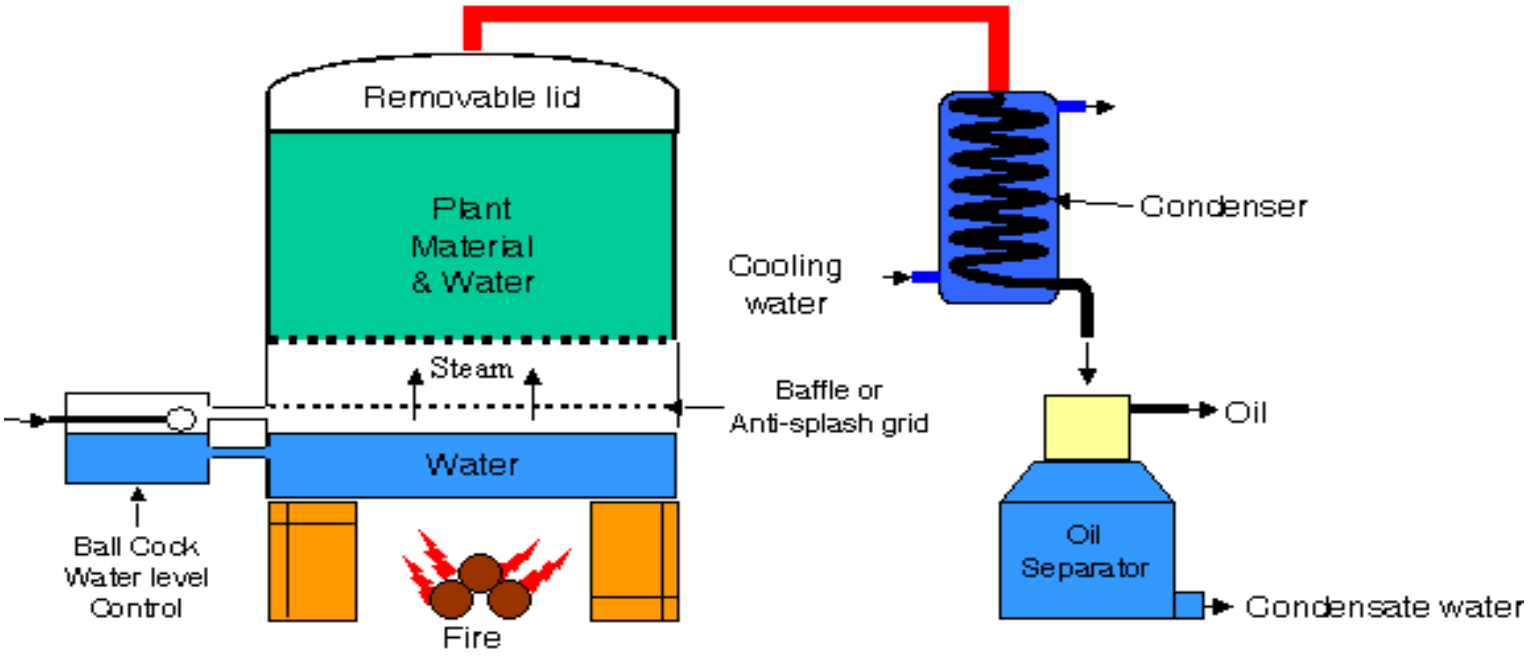
- A water and steam distillation arrangement can be compared to a kitchen steamer basket, with the botanicals supported in a "basket" over boiling water, thus exposing the plant material only to the rising steam vapors

- This is the best method for distilling leafy materials, but doesn't work well for woods, roots, seeds, etc.

- In steam-and-water distillation the basic still design is very similar to that of water distillation.
- The plant material is packed into the still pot sitting on a grill or perforated plate above the boiling water.
- The capacity of the still pot volume is reduced but it may be possible to achieve a high packing density because the plant material is not suspended in the water.

Advantages

- Higher oil yield.
- Oil component less susceptible to change due to wetness and thermal conductivity of the still from the heat source.
- The effect of refluxing is minimised.
- Oil quality more reproducible.
- Faster process so more energy efficient



Diagrammatic representation of a steam and water distillation unit with a baffle to prevent direct water contact with the plant material on the perforated grid

Carbon Dioxide Extraction

- This method is also being popularly used for oil extraction from different spice
- Carbon Dioxide in liquid form is used as a inert and safe liquid solvent for extracting aromatic molecules
- The process is more advantageous, as there is no residue left at the end of the process. The liquid Co2 simply reverts back to the gaseous state
- When CO2 is subjected to high pressure, the gas turns into liquid. This liquid CO2 can be used as a very inert, safe, "liquid solvent." which will extract the aromatic molecules in a process similar to that used to extract absolutes
- The advantage, of course, is that no solvent residue remains, since at normal pressure and temperature, the CO2 simply reverts to a gas and evaporates.

Solvent extraction

- Many herbs and spices cannot be extracted from distillation method, so solvent extraction is the safest method for extracting high quality oil.
- Spices or herbs to be extracted are washed with a solvent, which dissolves all extractable matter from the plant.
- These include pigments, volatile molecules and non-aromatic waxes.
- The herbs and spices are then subjected to low pressure distillation and the volatile oil is then separately collected.

Designing a distillation system

- Site
  - Availability of adequate water
  - Energy source: electricity, boiler fuel
  - Easy transport access
  - Skilled and unskilled labour
  - Close proximity to plant material
  - Access to fabricators and machine shop for repairs
  - Environmental zoning, plant waste and waste water discharge

Distillation charge

- Size of the still
- Plant species and oil content
- Daily volume and condition of plant material and frequency of supply
- Distance of the plant material production to still and how it will be transported
- Required pretreatment (chopping, crushing, powdering, maceration)
- Time taken to charge and discharge the still
- Storage capacity of plant material prior to distilling incase of poor weather
- Disposal of waste plant material after distillation

Still

- Design determined by distillation method; seek professional advice
- Ideally constructed of stainless steel
- Size determined by capacity of boiler
- Distillation time affected by height of the charge, flow rate and pressure of steam
- Easy to charge and discharge

Boiler

- Should produce enough steam to adequately remove the oil from the plant material
- Low pressure (saturated steam) or pressurised (dry steam)
- Best to measure output of home made or commercial boiler (condensing steam for set time) to determine capacity
- Seek professional advice on design and access for repairs and maintenance

Condenser

- The role of the condenser is to change the oil and water vapour back to a liquid
- Two main types: coiled tube or multitube
- Multitube difficult to make, needs running water, but has good heat transfer, efficient water use and no pressure build up
- Coiled tube easy to make, just needs a tank of water and sparse use of running water, but has poor heat transfer, risk of high pressure build up during distillation and poor use of water

Oil Separator

- Design of separator depends on density of the oil (if <1, oils are lighter than water and float; if >1, oils heavier than water and sink). Only a few wood and root oils are heavier than water
- Large enough capacity to allow the oil particles to form droplets and readily separate from the water (recommended at least a 4 minute retention time in the separator before out flow)
- Controlling temperature can be used to improve separation
- Seek professional advice on design as poor separation affects all the effort of distillation to extract oil

Storage

- System to filter separated oil
- Storage in suitable containers that exclude light
- Method to remove dissolved water (filtered bed of anhydrous sodium sulfate or chilling)
- Removal of residual still notes and dissolved oxygen (bubbling stream of nitrogen or allow oil to breathe and topping drum to over flowing to remove all air)

Steam Distillation

- One of the most popular method for extracting oil from spices.
- The process involves heating the water to produce steam, which is a carrier of volatile chemicals present in the spice.
- An outside source of steam is used, which is introduced into the distillation unit at a high pressure.
- The steam is finally condensed and the resulting essential oil is collected separately.

Hydrodistillation

- This is one of the oldest methods of extraction used.
- The spice is fully immersed in hot water. The result is a soup, which carries aromatic molecules of the plant.
- The method is not much in use these days, because of the risk of over heating the plant and subsequent loss of the oil.
- The method is best suitable for spice in dry and powdered form of roots and barks.

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The liquid CO_2 simply reverts back to the gaseous state.

And now for the most modern technologies, Carbon Dioxide and Supercritical Carbon Dioxide extraction.

Both methods involve the use of carbon dioxide as the 'solvent' which carries the essential oil away from the raw plant material.

The lower pressure CO_2 extraction involves chilling carbon dioxide to between 35 and 55 degrees F, and pumping it through the plant material at about 1000 psi.

The carbon dioxide in this condition is condensed to a liquid.

Supercritical CO2 extraction (SCO2) involves carbon dioxide heated to 87° F and pumped through the plant material at around 8,000 psi – under these conditions, the carbon dioxide is likened to a 'dense fog' or vapor.

With release of the pressure in either process, the carbon dioxide escapes in its gaseous form, leaving the essential oil behind.

These carbon dioxide methods have a couple of advantages: Like steam distillation, there are no solvent residues left behind, and the resultant product is quite pure.

Like solvent extraction, there is no heat applied to the plant material or essential oil to alter it in any way.

The oil produced is very accurate with respect to the original state of the plant.

The CO_2 methods also are the most efficient, producing the most oil per amount of plant (one of the reasons for the high cost of essential oils is the low yield of oil from most plants – one ton of Rose petals produces less than 1 pound of oil, for example).

The efficiency of CO2 extraction is particularly important when rare or endangered plant species are involved, such as Indian Sandalwood oil – less of the precious plant is needed to produce an equivalent amount of oil.

Cold Pressing

- Finally, there is the 'cold pressing' of citrus oils from the peels of fruit, as is done with Bergamot oil, Orange oil , Lemon oil , and the like.
- This method involves the simple pressing of the rind at about 120°F to extract the oil.
- Little, if any, alteration from the oil's original state occurs – these citrus oils retain their bright, fresh, uplifting aromas like that of smelling a wonderfully ripe fruit.

Spice Oleoresins

- Spice oleoresins are essentially the concentrated liquid form obtained from spices.
- This spice derivative has the same character and property of the spice it is obtained from.
- Oleoresins are popularly used for food flavoring in the food processing industry..

Manufacturing Process

- Spice oleoresins are derived through non-aqueous volatile solvent extraction of powdered and dried spices.
- These spices are mixed with a suitable solvent and subsequently removed at the end of the process through evaporation.
- Spice oil, being volatile in nature, is distilled from the grounded spice and thereafter the wet spice, is dried and extracted with a solvent to produce oleoresins.
- The extraction method will also vary depending on the properties of the spice being extracted.

Use of Spice Oleoresin

- Spice oleoresins find wide application in a number of industries for its strong flavor and aroma.
  - Meat Canning
  - Beverages
  - Pharmaceutical
  - Perfumery
  - Confectionery
  - Tobacco
  - Sauces