Fact sheet

Continuous Counter-Current Multistage Extraction

Technology overview

>>> INTRODUCTION

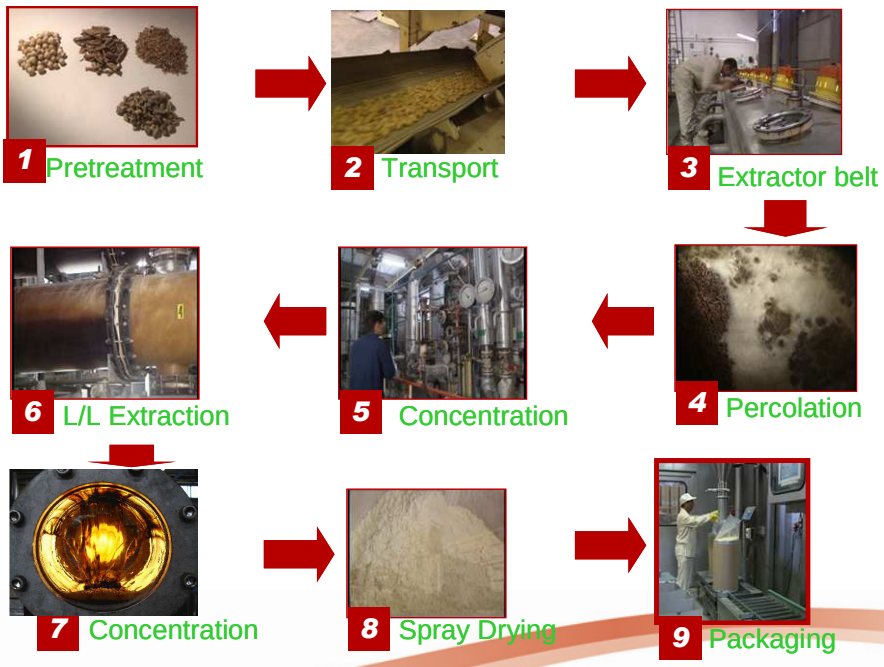
Ajinomoto OmniChem has already a long manufacturing tradition, dating back to the 18th century as producer of black powder. Extraction activities of botanicals were started in Belgium mid of the 1940-ies and were since then continuously expanded and upgraded to meet customer expectations and Food/Pharma requirements.

Since more then 30 years, strong partnerships in contract manufacturing of botanical extracts and natural specialities were built-up with multinational companies active in the nutraceutical, food Ingredients, cosmetical and pharmaceutical sector.

>>> MULTI SOLVENT COUNTER-CURRENT CONTINUOUS EXTRACTION PROCESS

>> Process overview

Besides classical batch extractions, Ajinomoto OmniChem offers state-of-the-art installations for the Continuous Counter-Current Solvent Extraction of botanical materials and fermented products. Prior to the extraction process, the raw material can be pre-treated using different techniques such as milling, pelletisation or other techniques allowing a continuous extraction process and guaranteeing the highest yields. Both continuous solid/liquid (S/L) and liquid/liquid (L/L) extractions are possible with a daily extraction capacity of approximately 20 000 kgs of raw material input. The extraction plant can handle a variety of product dedicated solvents (alcohols, esters, ketones, hydrocarbons etc), which are continuously recovered during the production process. A typical process for the production of polyphenols from plants is described in Figure 1.



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>> Pre-treatment of botanical raw materials

This pre-treatment operation is a crucial step in the extraction process. A typical pre-extraction protocol is described in **Figure 2**.

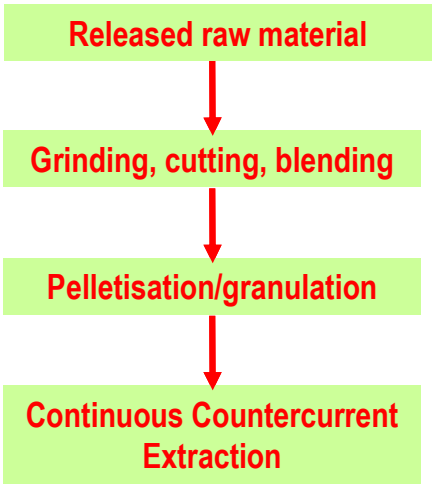

Fig.2: Pre-treatment operation

To optimise extraction kinetics, quite often a **grinding / milling** step is required on the entering Raw Material enabling better mass transfer to avoid diffusion constraints. Depending on the type of Raw Material and targeted granulometry, a chopping or milling (knife or hammer mill) can be applied.

The Continuous Counter-Current Extraction is performed on a Desmet Extractor, that is using a **percolation extraction process**. This implies good percolating properties of the solid material enabling an easy solvent pass. For this reason a **compacting/agglomeration** operation is performed on the milled material. This is done by **pelletisation operation** (**see Figure 3**). Due to the shear forces, cell disruption is obtained resulting in complete extraction. The cylindrical rods formed are sufficiently mechanical stable allowing percolation extraction.

Fig.3: Pelletisation operation

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>> Advantages of continuous extractions compared to batch extraction:

The technology of Continuous Counter-Current Extraction is a proven and well established technique with clear advantages.

- **Large amount of solids** can be handled in compact equipment (large batches)
- More **efficient use** of extraction times
- Autofiltration of miscella during the percolation requiring less downstream filtration capacity
- **Robust & economic processing** resulting in **constant quality**

>> Principle and advantages of Continuous Counter-Current Extraction

The driving force in the extraction process is the **concentration gradient** which is the factor responsible for moving the active component out of the solid. It is important to keep the gradient high, at each point within the extractor. This effect is obtained most economically by the principle of **Counter-Current Multistage Extraction.**

The extractor is divided into **10 distinct extraction stages**. The solvent is introduced at the spent material discharge end (i.e. at the end opposite to the material feeding side of the extractor). It is sprayed on the material, percolates through the bed and the resulting miscella is collected in a sectional hopper underneath the belt, from which it is pumped and sprayed again on the material at the direction opposite to the belt movement. This process of miscella collection, pumping and spraying is repeated until the miscella leaves the hopper at the head-end of the extractor, carrying the highest concentration of active compounds. This principle and a picture of the extractor is visualised in **Figure 4**.

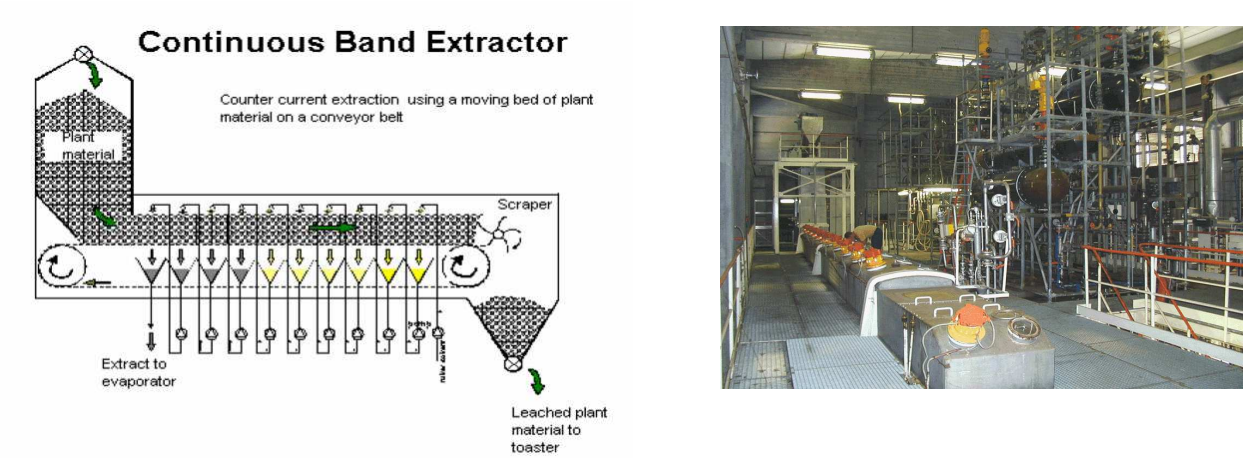

Fig. 4: Principle and plant layout of a Counter-Current Multistage Extractor

>> Solvents recycling

Two streams leave the solvent extraction stage: **an extract** containing the active component (miscella) and solvent-containing **spent material**. The subsequent operations have the objective of removing and recovering the solvent from each of the two streams enabling economic and **environment friendly** processing (**see Figure 5**).

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The miscella solvent recovery is done by using multiple thin layer evaporators. Spent Meal desolventizing is performed by desolventizing - toasting using direct and indirect steam.

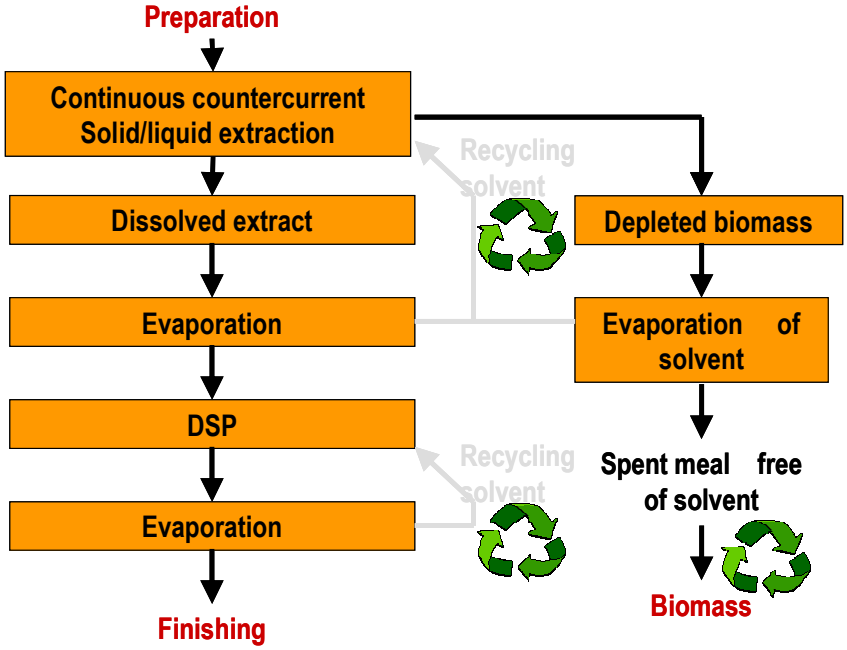

Fig. 5: Solvent recovery scheme

After combining both condensate streams, solvent composition is modified and controlled prior to recycle this back to the extractor. This is done by means of solvent distillation and/or decantation depending on the solvent(s) applied.

>>> DOWNSTREAM PURIFICATION TECHNOLOGIES

Different downstream purification technologies (such as crystallisation, liquid/liquid extraction batch wise or continuous, ion exchange chromatography, preparative chromatography (**see Figure 6**), membrane filtration etc) are available for **further purification of the obtained extract**. In function of the properties of the end product, it can be delivered under different forms, i.e. as a standardised spray dried powder, as a crystalline powder, as an oil or as a solution/suspension in water or solvent.

Specific steps for the **removal of contaminants** such as pesticides and Poly Aromatic Hydrocarbons can be implemented in the standard production processes.

Fig. 6: Industrial Preparative HPLC unit

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>>> QUALITY MANAGEMENT

All manufacturing operations within Ajinomoto OmniChem NaturalSpecialities are complying with international regulations for **Good Manufacturing Practice** (Food GMP - 21CFR Part110) and are in line with the **HACCP guidelines** (compliance with Codex Alimentarius). The company has a manufacturing authorization granted by the Belgian authority FASFC (Federal Agency for the Safety of the Food Chain) and is ISO 14001 certified. Upon specific request, Kosher and Halal certification are provided.

>>> CONCLUSION

Continuous Counter-Current Multistage Extraction is a well established technique for extraction of botanicals or fermentation broths offering clear benefits compared to standard batch extraction. For more than 30 years, Ajinomoto OmniChem Natural Specialities has acquired vast know-how in using successfully this technology for contract manufacturing projects.

Information provided in this paper is based on the present state of our knowledge. Some of the applications and process(es) mentioned in this document can be protected by international patent law. Ajinomoto OmniChem cannot be held responsible for patent law infringements and the customer should contact the patent holder if so required. Due to the many different parameters involved we are not able to submit a general recommendation. It only shows without liability on our part the uses to which our products can be put. Therefore initial trials are absolutely necessary. Ajinomoto OmniChem cannot be held responsible for the consequences of the application of the above mentioned products and processes

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