



SOLID/LIQUID EXTRACTION SYSTEMS



Unopex E 10

Solid/Liquid Extraction & Evaporation Unit

Solid/Liquid Extraction

History

Solid/liquid extraction of components from natural sources has been practiced since ancient times.

The history of the extraction of natural products dates back to Mesopotamian and Egyptian times, where production of perfumes or pharmaceutically active oils and waxes was a major business.

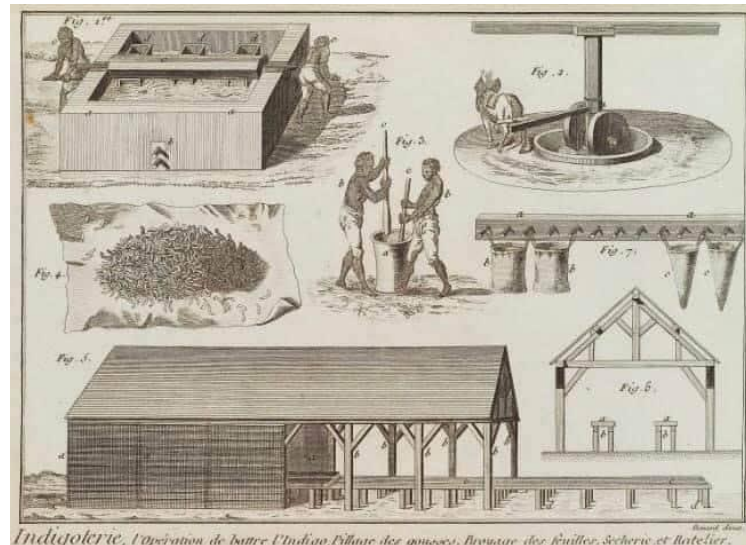


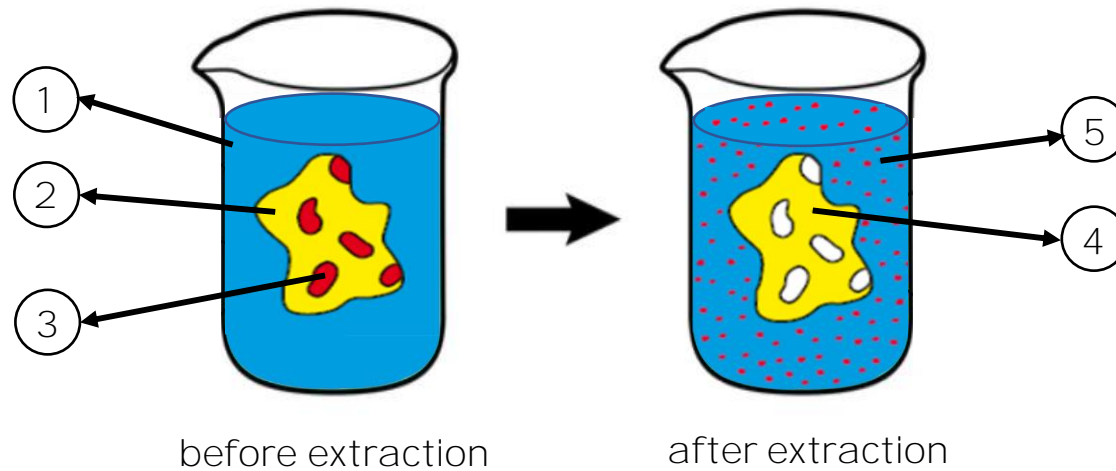
Illustration of an indigo factory in Bengal

Solid/Liquid Extraction

Process Basics

Solid/liquid extraction is a separation process where certain substances are dissolved out from a solid matrix by a liquid solvent forming a solution.

Schematic representation of extraction

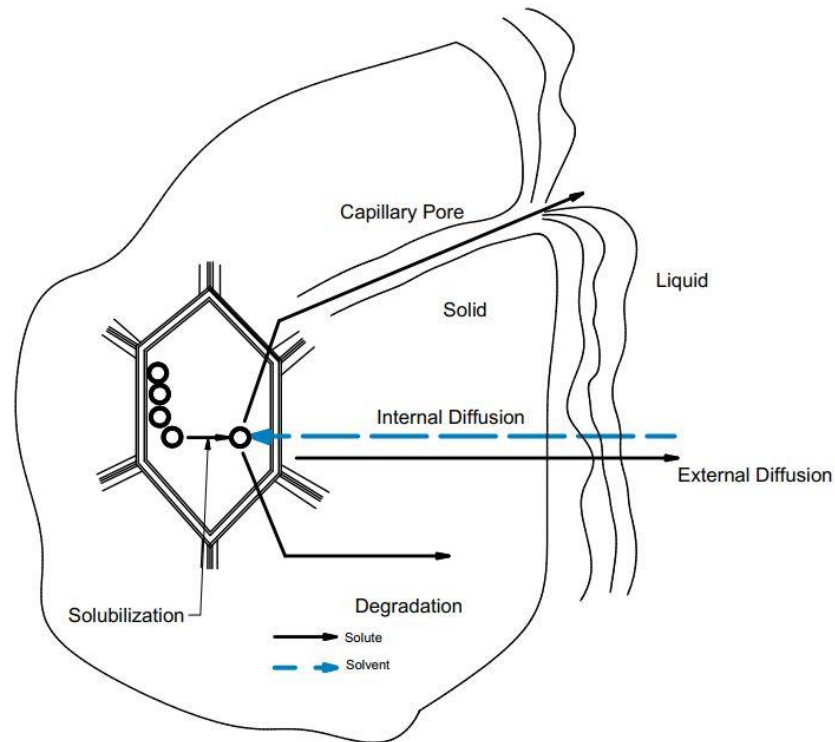


- ① Solvent
- ② Extraction material (solid carrier phase with transition component)
- ③ Transition component
- ④ Depleted solid carrier phase
- ⑤ Solvent with dissolved transition component

Solid/Liquid Extraction

Process Basics

A series of phenomenological steps have to occur during the period of interaction between the solute containing particle and the solvent effecting the separation as represented schematically in the figure below.



1. Entrance of the solvent into the solid matrix
2. Solubilization and/or breakdown of components
3. Transport of the solute to the exterior of the solid matrix
4. Migration of the extracted solute from the external surface of the solid into the bulk solution
5. Movement of the extract with respect to the solid (i.e., extract displacement)
6. Separation and discharge of the extract and solid

Solid/Liquid Extraction

Applications

Raw materials for the extraction of natural products from plants and the final products:

Raw Materials

- flowers, leaves
- herbs
- medicinal plants
- roots, barks
- seeds
- fruits, vegetables



Products

- natural extracts
- active agents
- flavors, aromas
- oleoresins
- colorants
- essential oils



Solid/Liquid Extraction

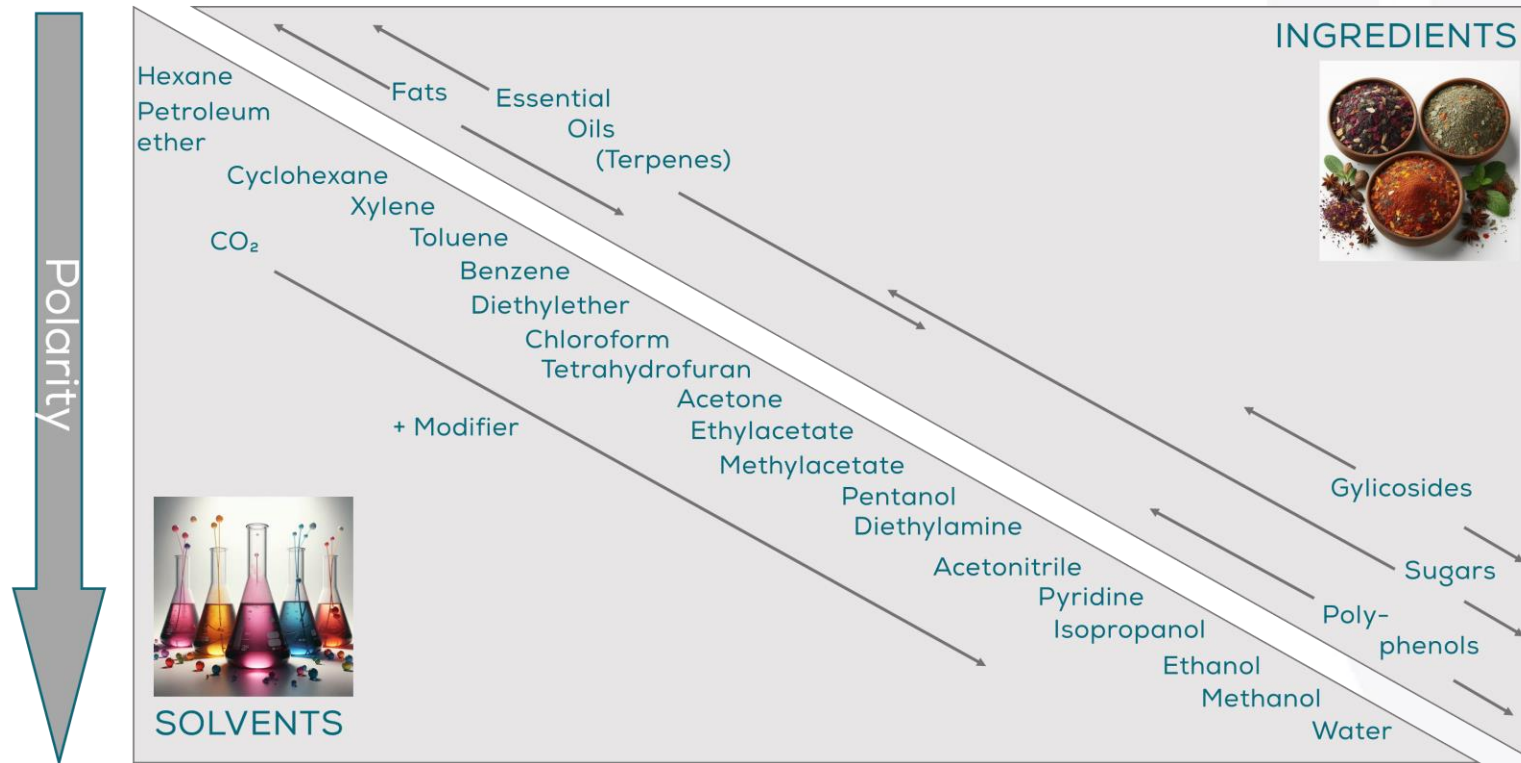
Process Design and Optimization

The most important parameters that significantly affect the extraction efficiency and are determinants for the process design and success, are the following:

- ✓ The preparation of solid material by size reduction (crushing, grinding); the solid size must be suitable (surface area per unit volume) to make the solute more accessible to the solvent and to favor the extraction, but not so fine as to cause packing of solids and impeding free flow of the solvent.
- ✓ The selection of solvent for extraction based on a number of characteristics (capacity, selectivity, chemical inertness, thermophysical properties, flammability, toxicity, cost and availability).
- ✓ The selection of operating temperature; the temperature must be high to give higher solubility of solute in solvents, but not so high as to cause solvent losses, extraction of undesirable constituents, or damage of sensitive components.
- ✓ The equipment depending on the mode of operations (batch or continuous), the solids handled (fixed bed: percolation, full immersion, intermittent drainage, or dispersed/moving contact), or the performing arrangement (one stage or multistage). The technical and economical feasibility of an extraction process is determined knowing the equipment size, operating conditions, solvent flow rates, and extraction yields.

Solid/Liquid Extraction

Process Design and Optimization



ingredient vs. solvent polarity figure for solvent selection

Unopex E 10 Extraction and Evaporation Miniplant Technology

The multifunctional Unopex E 10 Miniplant is designed and manufactured to extract small batches of solid raw materials.

The miniplant is used in food, pharmaceutical, cosmetics, chemical industries as well as in academia and educational institutions.

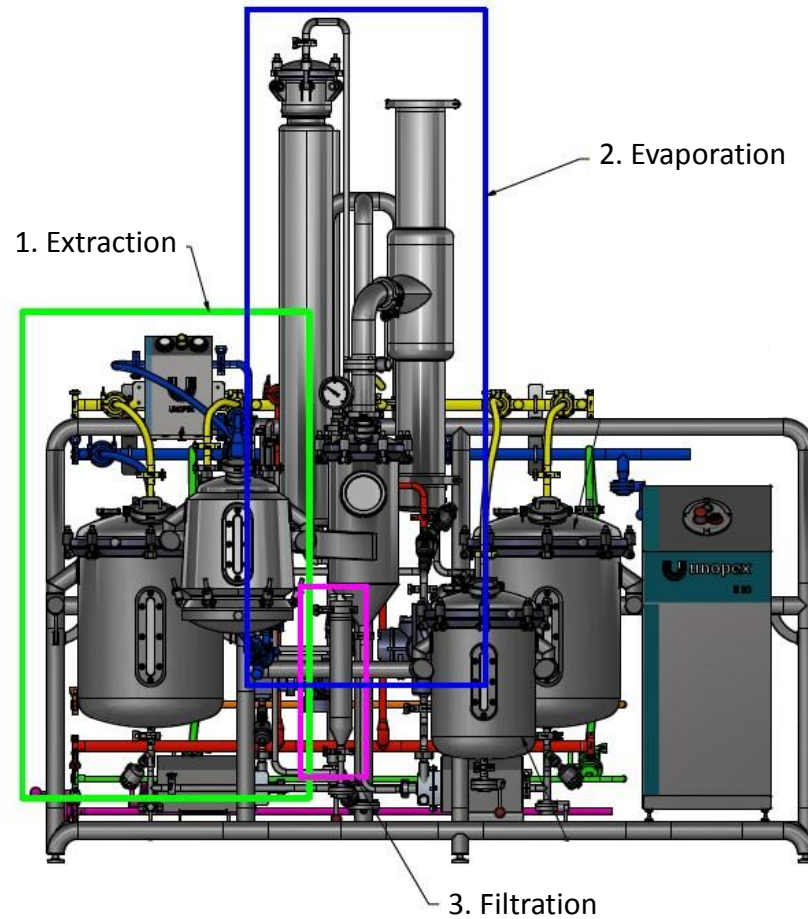
The miniplant is suitable for obtaining a wide range of valuable products such as colourings, flavours, essences, active ingredients, etc. and working in different operating modes.

Unopex E 10 includes a single percolator and combines all of the important extraction processes like percolation, maceration, steam distillation as well as filtration and concentration of the extract.

Unopex offers the highest quality and efficient solutions.



Unopex E 10 Plant Description



Combined unit for recovery of natural extracts from different plant raw material and the concentration of liquid extracts and recovery of solvents.

1. Extraction
2. Filtration
3. Evaporation

Unopex E 10

Key Features

- ✓ Good contact of plant material and extraction medium
- ✓ Integrated falling film evaporator for extract concentration under vacuum
- ✓ Simple filling and emptying
- ✓ Quick extraction and high extract quality
- ✓ Clear extract with integrated filtration
- ✓ Very quick residue discharge
- ✓ Easy cleaning and inspection
- ✓ ATEX / non-ATEX version
- ✓ Graphical visualization and saving of process parameters
- ✓ Cost and space saving plant
- ✓ Optional IQ/OQ documentation & GMP compliance

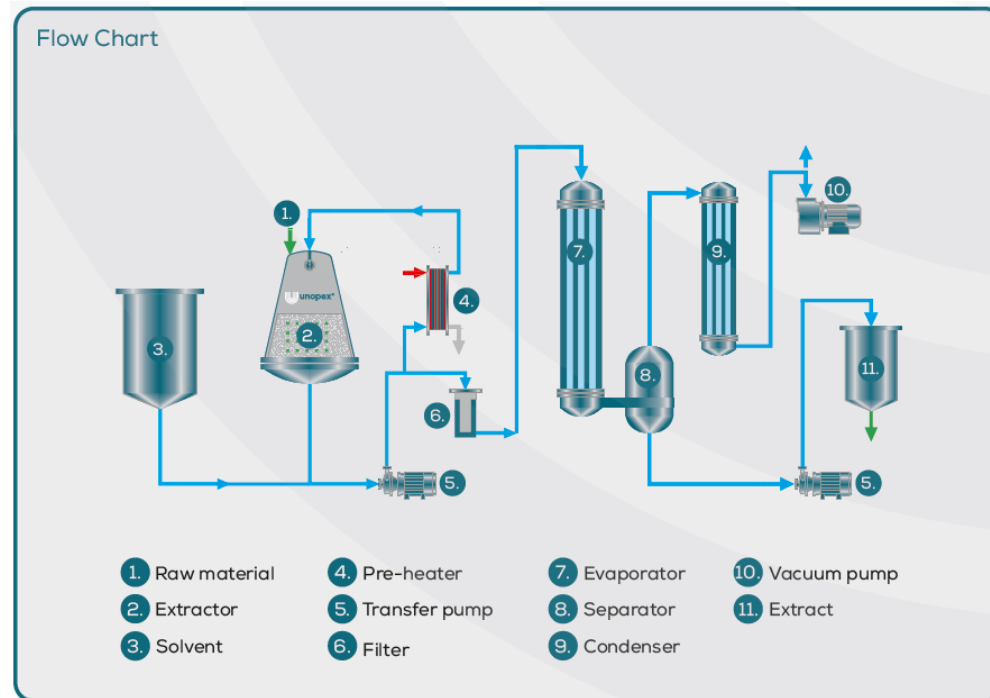
Unopex E 10

Technical Specifications

model	Unopex E 10
percolator volume	10/20 liters
solvent tank volume	50 L
temperature limit	120 °C
pressure limit	-1/+6 bar
evaporation	falling film evaporator
preheating	shell & tube heat exchanger
steam distillation	for essential oils
filtration	stainless steel filter (10-500 µm)
solvent	water and organic solvents
material	AISI316, 316L, 316Ti, 304
gaskets	PTFE, EPDM
process steam	3 barg
connection voltage	3 x 400V, 50 Hz
protection	ATEX / non-ATEX design
dimensions (W x D x H)	2400 x 1400 x 2750 mm
control box	stainless steel, HMI touch screen, PLC control, data logging to record the process parameters

Unopex E 10

Description of Operation: Flow Chart



The raw material is filled into the extractor and extracted with organic solvents and/or water. The solvent can be pre-heated and continuously re-heated during percolation.

After the extraction cycle the liquid extract is filtered from suspended solids and pumped to the integrated evaporator for concentration.

The residual liquid is sucked off from the wet cake by applying vacuum and the final cake is discharged easily from the extractor by opening the bottom cover.

Unopex E 10

Description of Operation: Extraction

The unit includes a percolator of 10/20 liters.

Raw material is manually filled into the extractor through the hole on top. The materials are extracted at a certain temperature with solvent and water for the desired time.

The solvent can be continuously re-heated during percolation. Free choice of solvent flow direction in the extractor, inflow from the bottom or from top, flow direction also changeable according to the pressure.



Unopex E 10

Description of Operation: Extraction

After the extraction cycle the miscella/extract is sucked from the extractor.

In case of steam distillation, the distillate is condensed and can be collected separately for subsequent phase separation. The residual moisture can be sucked off from the wet cake by applying vacuum.

If organic solvents have been used, these can be stripped from the solid matter by steam – both to avoid the release of significant volumes of solvent into the room and to allow recovery and reuse of the solvent.

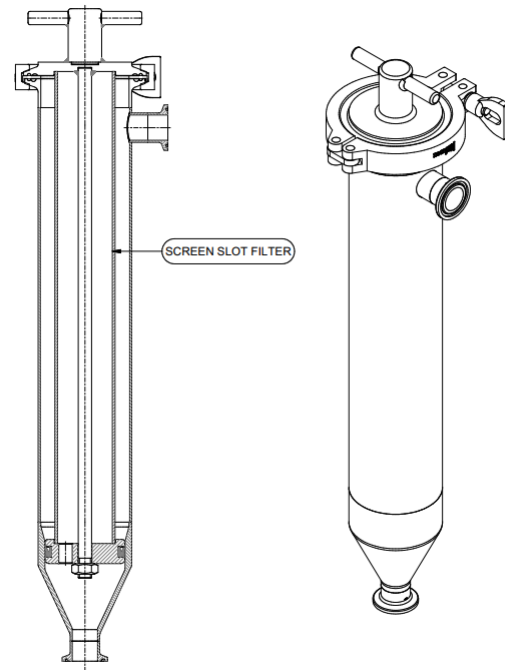
Finally, the wet cake is discharged from the extractor by opening the bottom cover and the solid residue falls into containers.



Unopex E 10

Description of Operation: Filtration

After the extraction cycle the miscella/extract is sucked from the extractor and pumped through a screen slot filter to separate any suspended solids.



- wedgewire microscreens filter for filtration of extract
- filter mesh 25-500 μm

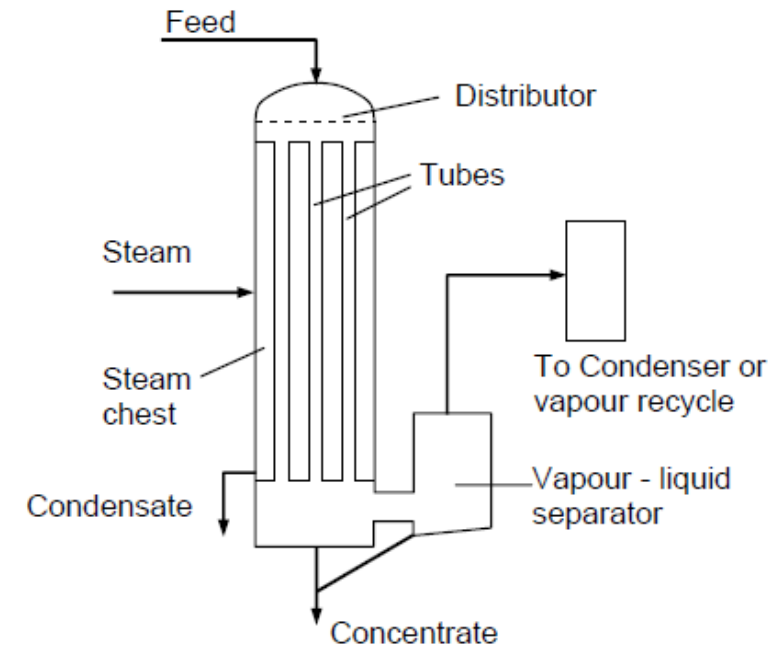
Unopex E 10

Description of Operation: Evaporation

Solvent evaporation for extract concentration take place in a single-effect falling film evaporator.

Liquid enters at the top of the evaporator, where specially designed distributors evenly distribute the feed into each of the tubes.

The falling-film evaporator has the advantage of gravity pulling the film downward. The liquid film starts to boil due to the external steam heating of the tubes and is partially evaporated as a result.



Schematic diagram for a falling film evaporator

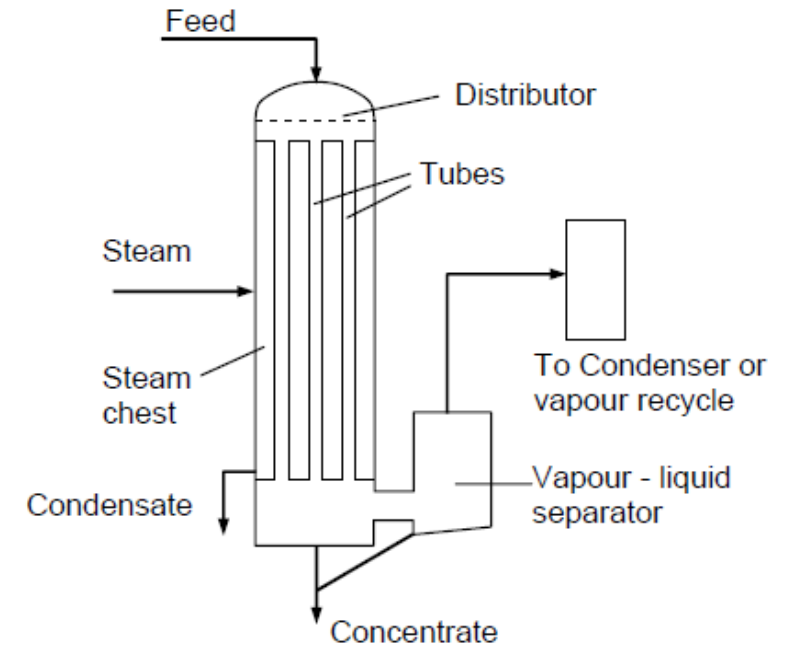
Unopex E 10

Description of Operation: Evaporation

Liquid and vapour is separated in the lower part of the calandria and in the downstream centrifugal droplet separator.

The vapor separated in the separator is condensed in the tube and shell heat exchanger type condenser, collected and can be recirculated to the extraction process.

The concentrate is either removed towards the next production step or recirculated for stronger concentration.



Schematic diagram for a falling film evaporator

Unopex E 10

Description of Operation: Evaporation

These processes occur under adjustable vacuum conditions to lower the boiling point and reduce the heat effect on the final product.

To simplify operating the plant with a precise target concentration, a density measurement is installed in the concentrate pipe.

The combination of the ability to function at low temperature differences and short residence times makes the falling-film evaporator suitable for use with temperature-sensitive products.

The primary advantages of falling-film evaporators are:

- Relatively low cost
- Large heating surface in one body
- Low product hold-up
- Small floor space requirements
- Good heat-transfer coefficients at reasonable temperature differences

Unopex E 10

Process Control

The stainless steel control box is mounted directly on the unit.

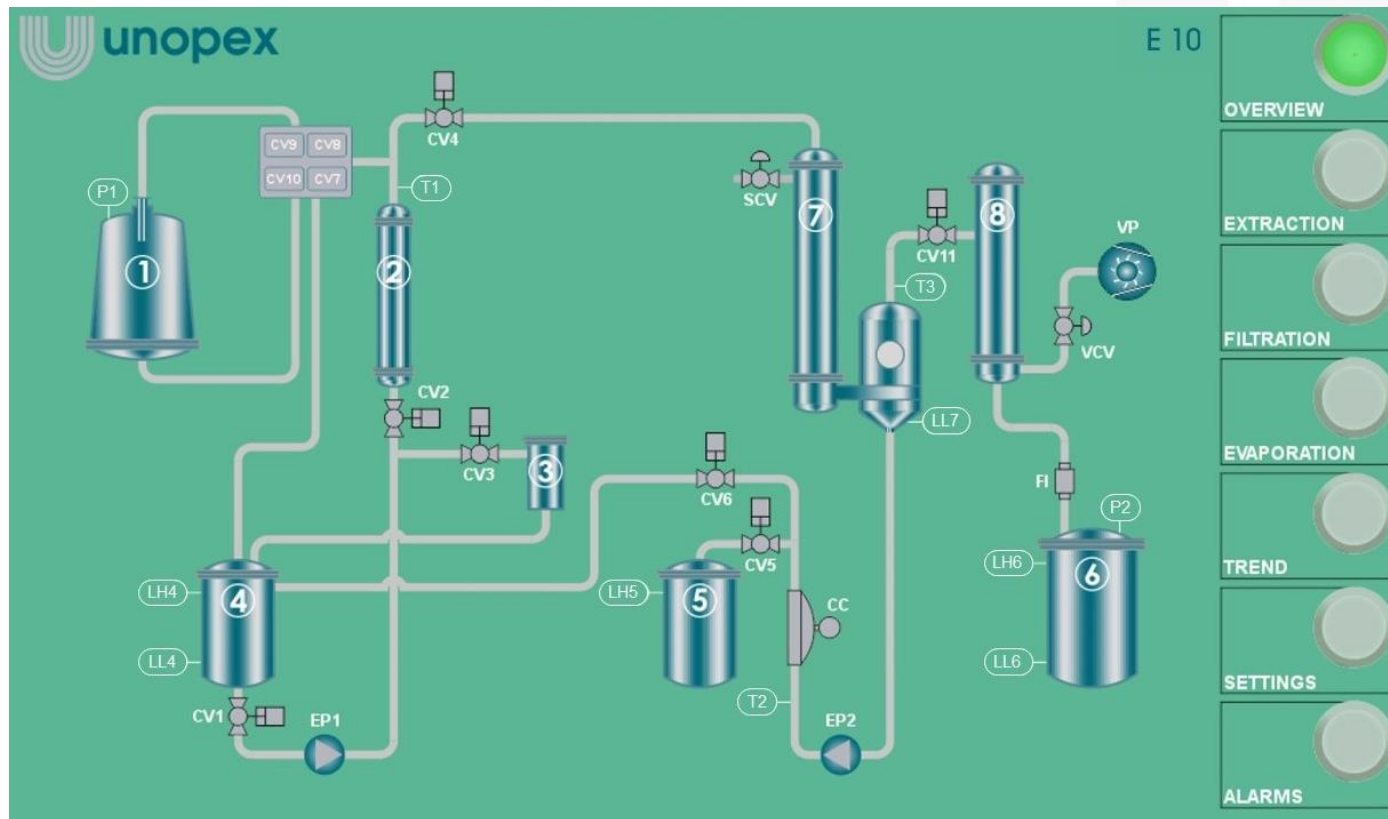
Automatic control system based on PLC control is used.

All commands for operating the extraction, filtration and evaporation processes are entered on separate screens via the user-friendly large touchscreen. Overview visualization and animated diagrams are available for easy control and monitoring.

The parameters of all process steps can be continuously saved during operation for documentation and retracing.

Unopex E 10

Touchscreen Display: Overview



Unopex E 10

Touchscreen Display: Extraction

The screenshot displays the Unopex E 10 control interface. On the left, a table shows the following parameters:

		SET	ACTUAL
Pump Rate	EP1 (%)	50	0
Extraction Time	t (min)	50	0
Flow Direction	FD	↑	↑
Extraction Temperature	T1 (°C)		25
Extraction Pressure	P1 (mbar)		0

Below the table are 'START' and 'STOP' buttons. The 'STOP' button is highlighted in red. The central diagram shows a process flow involving a pump (P1), a tank (1), a column (2) with temperature sensor (T1) and control valve (CV2), and a bottom tank (4) with level sensors (LH4, LL4) and control valve (CV1). A pump (EP1) is also shown at the bottom. On the right, a vertical menu contains buttons for OVERVIEW, EXTRACTION (which is highlighted in green), FILTRATION, EVAPORATION, TREND, SETTINGS, and ALARMS.

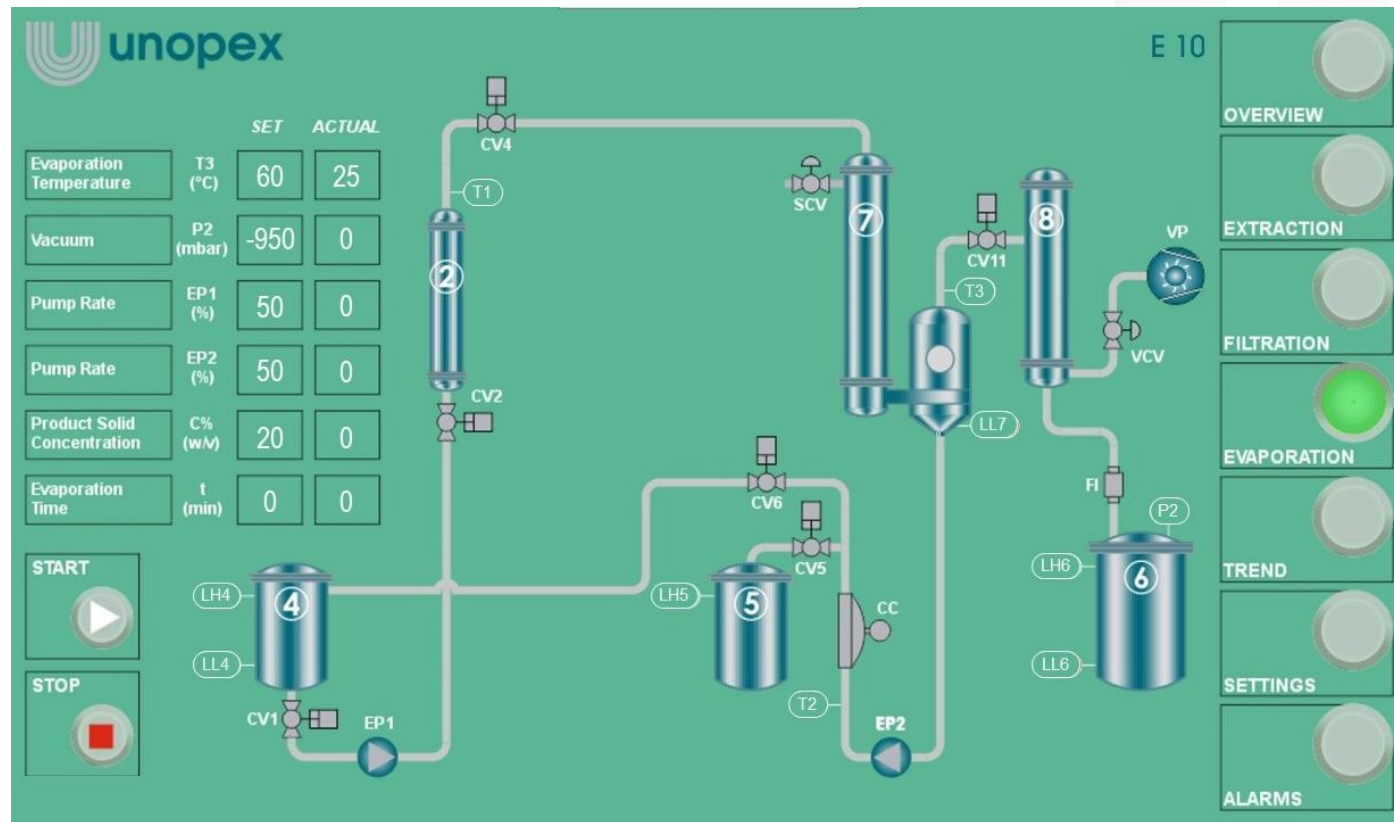
Unopex E 10

Touchscreen Display: Filtration

		SET	ACTUAL
Pump Rate	EP1 (%)	50	0
Filtration Time	t (min)	15	0

Unopex E 10

Touchscreen Display: Evaporation



Cutting Mill

Raw materials require a size reduction to minimize the particle size before extraction. Cutting mills are well-known for the grinding of soft, medium-hard, tough, elastic and fibrous materials.

After size reduction, particles are transported from the grinder to the cyclone with the help of a fan, separated from the air and classified through a vibrating screen. A cartridge filter cleans the exhaust air, thus minimizing product loss and protects the user and the environment.



CIP (Clean-In-Place)



The plant can be cleaned with water and adequate chemicals by a CIP unit. Furthermore, the plant can be sterilized with steam after CIP cleaning.

Unopex E 50 Extraction and Evaporation Unit

Unopex E 50



Unopex E 50 (Twin)



Unopex E 100 Extraction and Evaporation Unit





Unopex is an engineering and manufacturing company located in Turkiye, specialized in producing of process equipments and devices for the pharmaceutical, food, nutraceuticals, cosmetics, chemicals and materials industries as well as educational institutions.

We are thrilled to contribute to researchers and producers all over the world to easily realize their projects that protect nature and serve humanity with our expertise, experience, motivation, talent, product and services.

Thank You

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