

# Introduction to Mass Transfer

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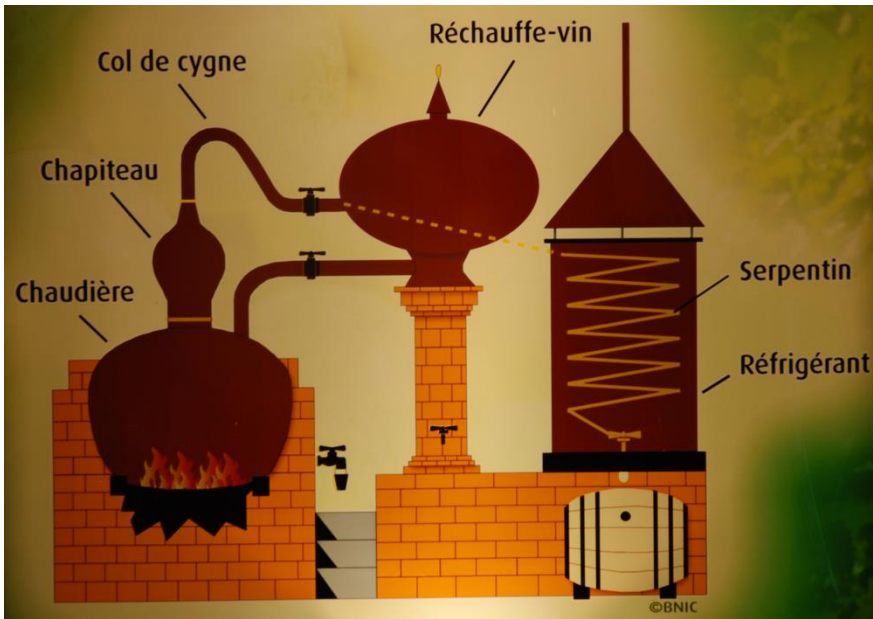
Phase	Operation
<b>Direct contact</b>	
<b>Gas - Gas</b>	-
<b>Gas – liquid</b>	<b>Distillation Condensation Stripping Absorption</b>
<b>Gas – Solid</b>	<b>Sublimation Desorption Adsorption</b>
<b>Liquid – Liquid</b>	<b>Extraction</b>
<b>Liquid – Solid</b>	<b>Melting – Solubilisation Lixiviation Crystallisation – Solidification Adsorption – Chromatography Ion exchange – Desorption</b>
<b>Solid – Solid</b>	-
<b>Indirect contact</b>	
<b>Gas- Gas</b>	<b>Gaseous diffusion</b>
<b>Gas – Liquid</b>	<b>Permeation - Pervaporation</b>
<b>Liquid - Liquid</b>	<b>Dialyse – Electrodialyse Osmosis – Inverse Osmosis Micro, Ultra or Nanofiltration</b>

# Operations with a system Gas – Liquid

System	Process name
Liquid $\rightarrow$ Condensable Vapor	Distillation
Condensable Vapor $\rightarrow$ Liquid	Condensation
Liquid with solute $\rightarrow$ Gas	Stripping or aeration
Gas loaded with a compound $\rightarrow$ liquid	Absorption

# Gas - Liquid transfer

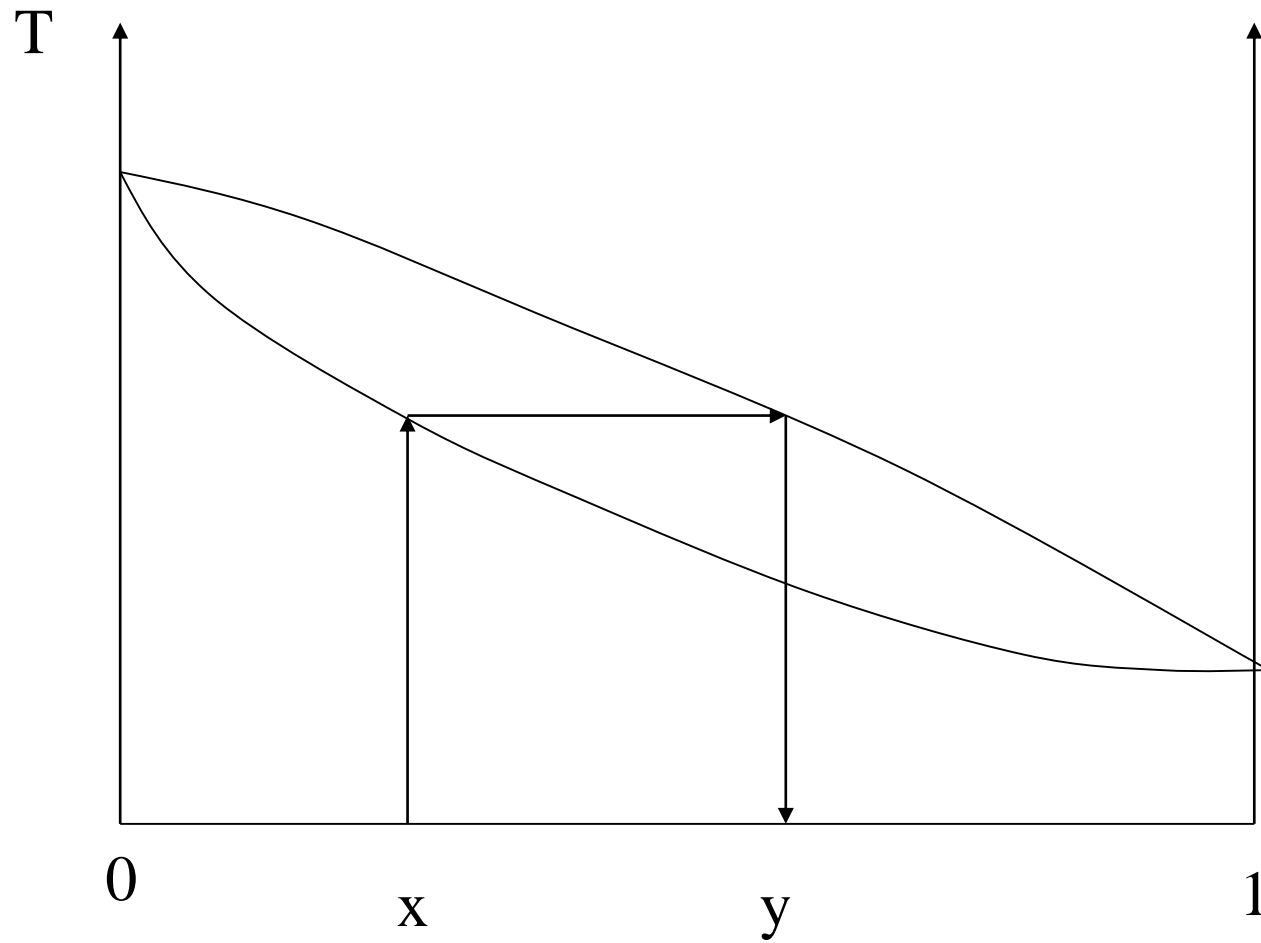
## Distillation

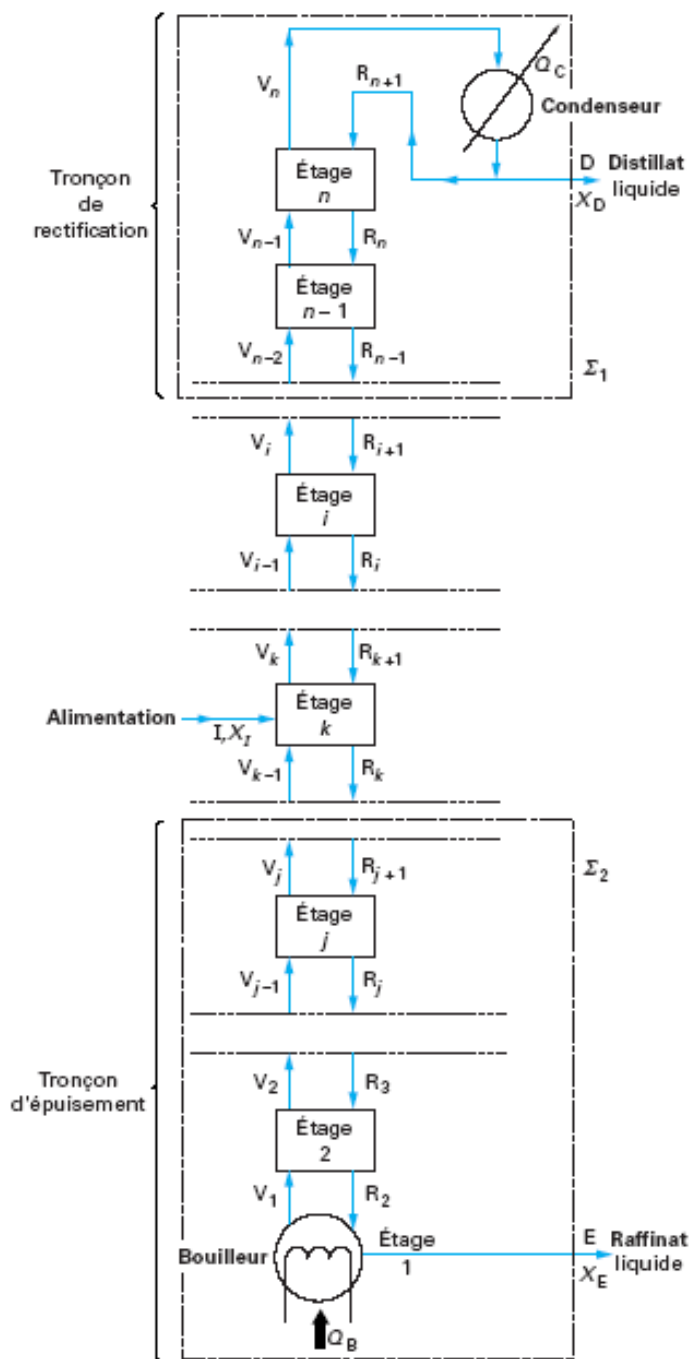


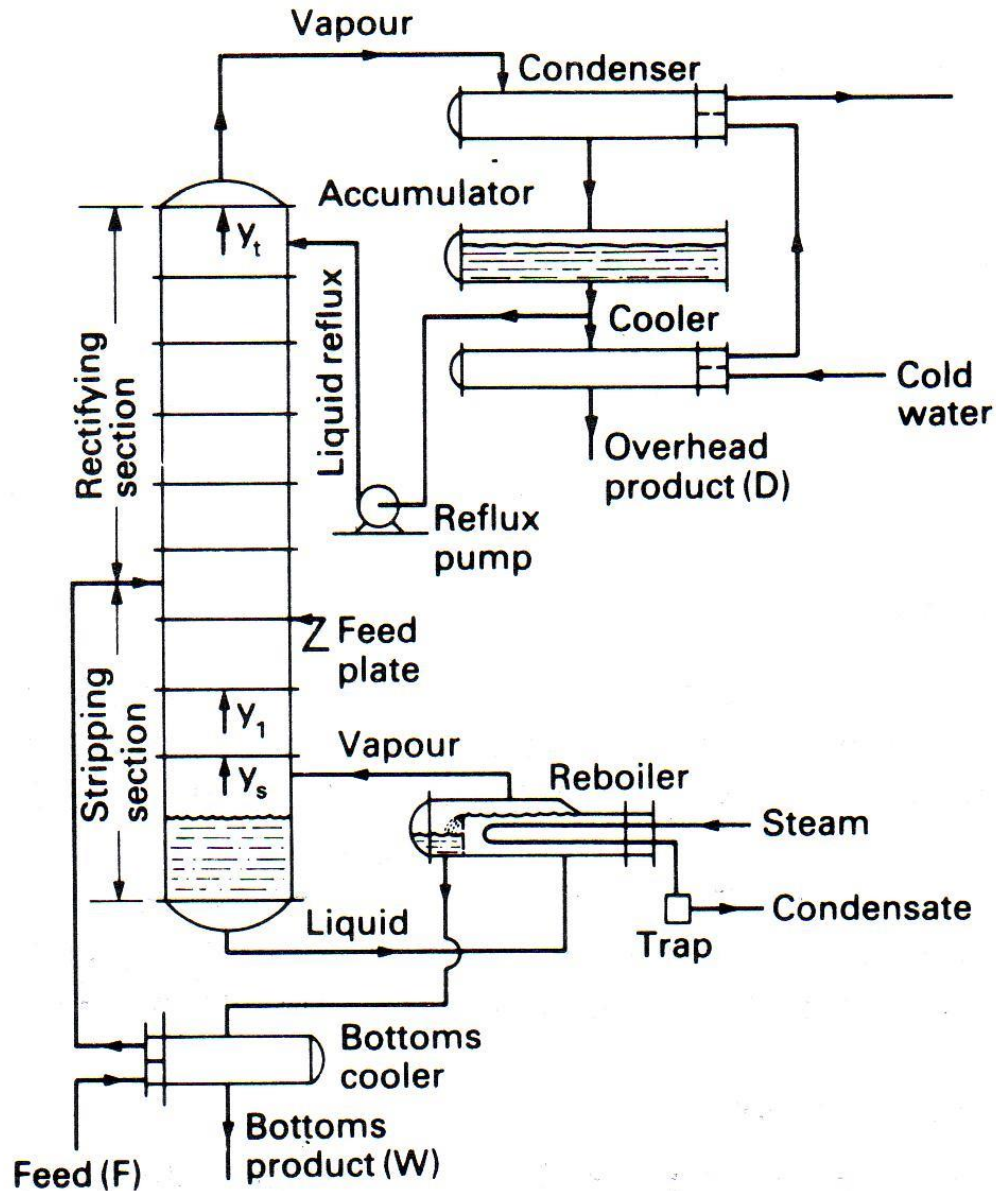
## Distillation du Cognac



## Distillation - Alcool de riz Shanghai









# Approvisionnement en pétrole brut

## Moyen-Orient

Arabie Saoudite, Irak, Iran, Koweït, Emirats Arabes Unis

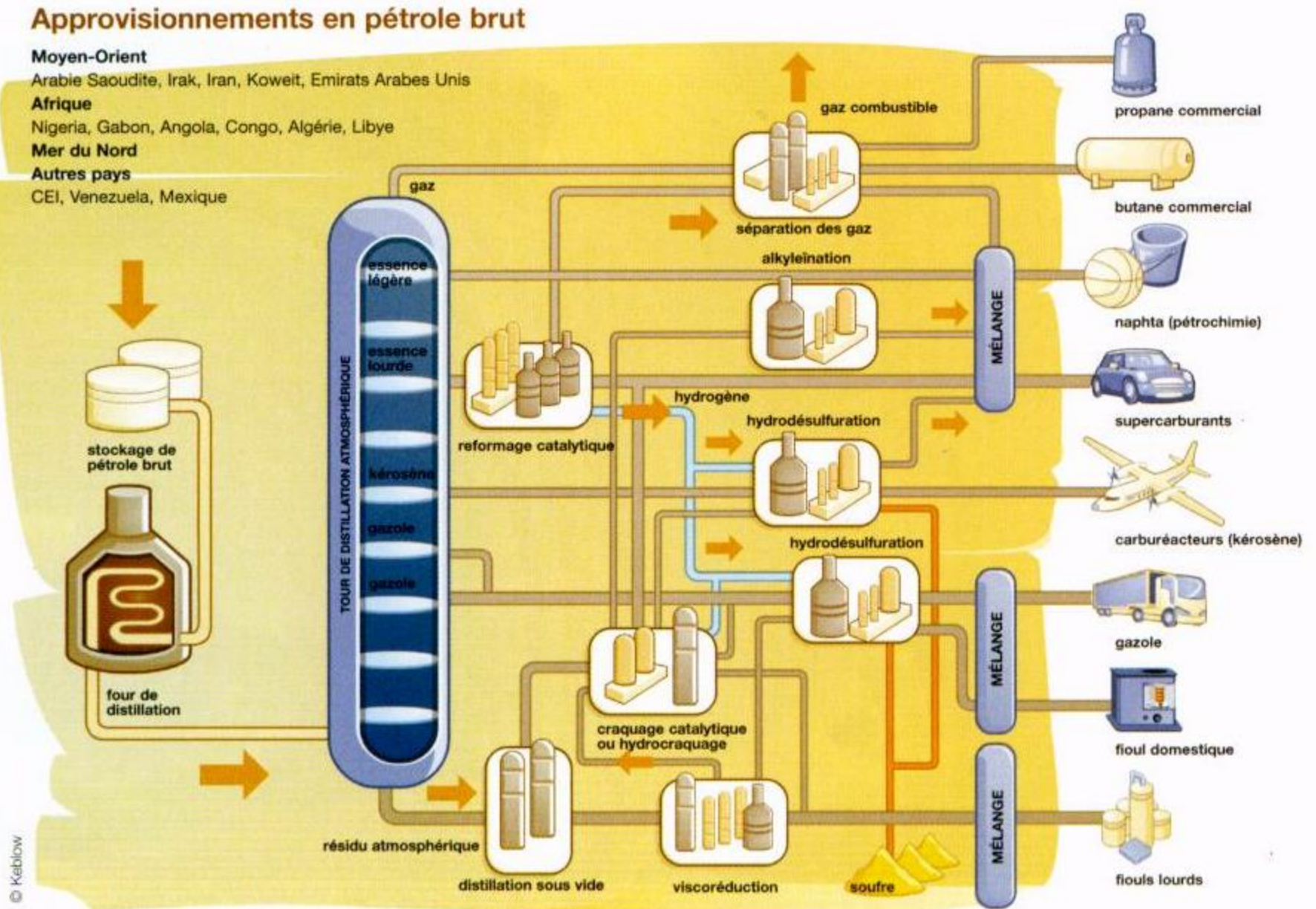
## Afrique

Nigeria, Gabon, Angola, Congo, Algérie, Libye

## Mer du Nord

## Autres pays

CEI, Venezuela, Mexique



Etapes de traitement et transformation du pétrole brut dans une raffinerie





Transport d'une colonne du DHC (Distillate HydroCracker) de la raffinerie de Normandie (Gonfreville, près du Havre)



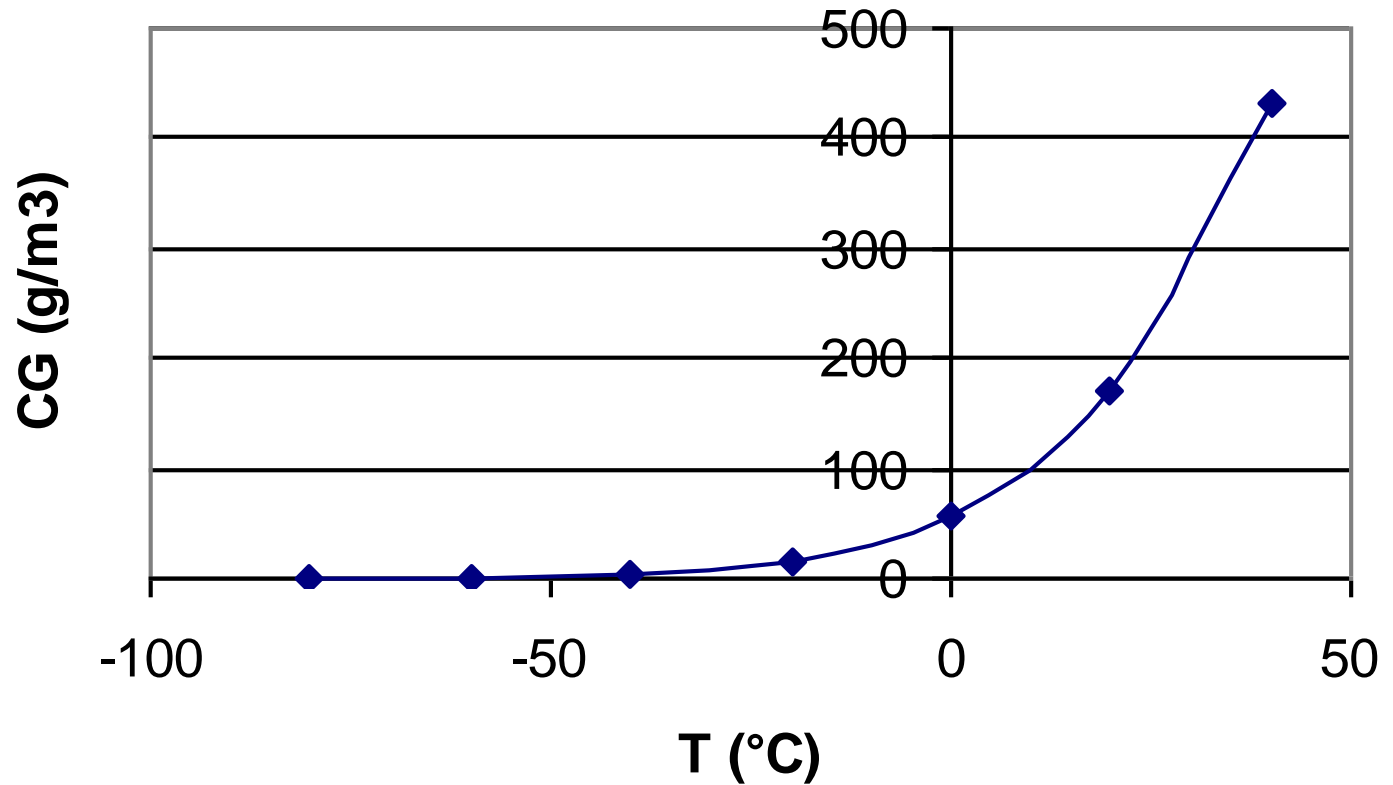


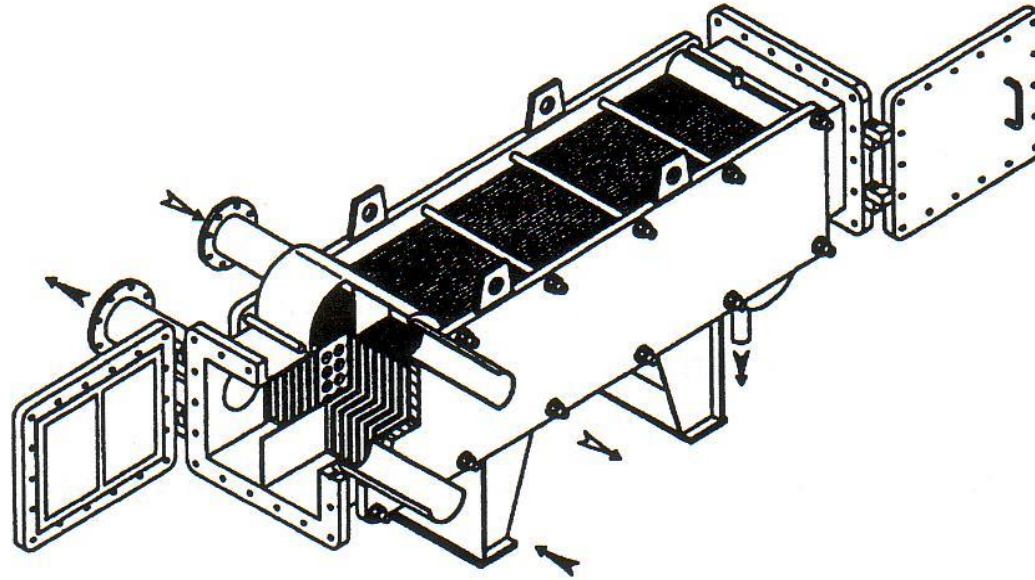
**Complexe de production de bioéthanol à partir de sucre  
Société Tereos, Origny Sainte-Benoîte**

# Gas - Liquid transfer

## Condensation

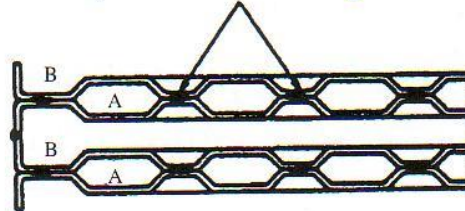
## $P_v = f(T)$ METHANOL



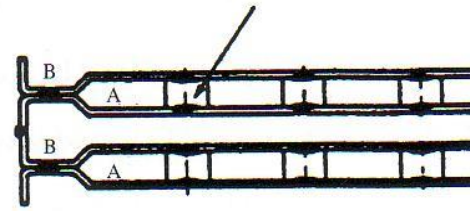


(a) Vue d'ensemble

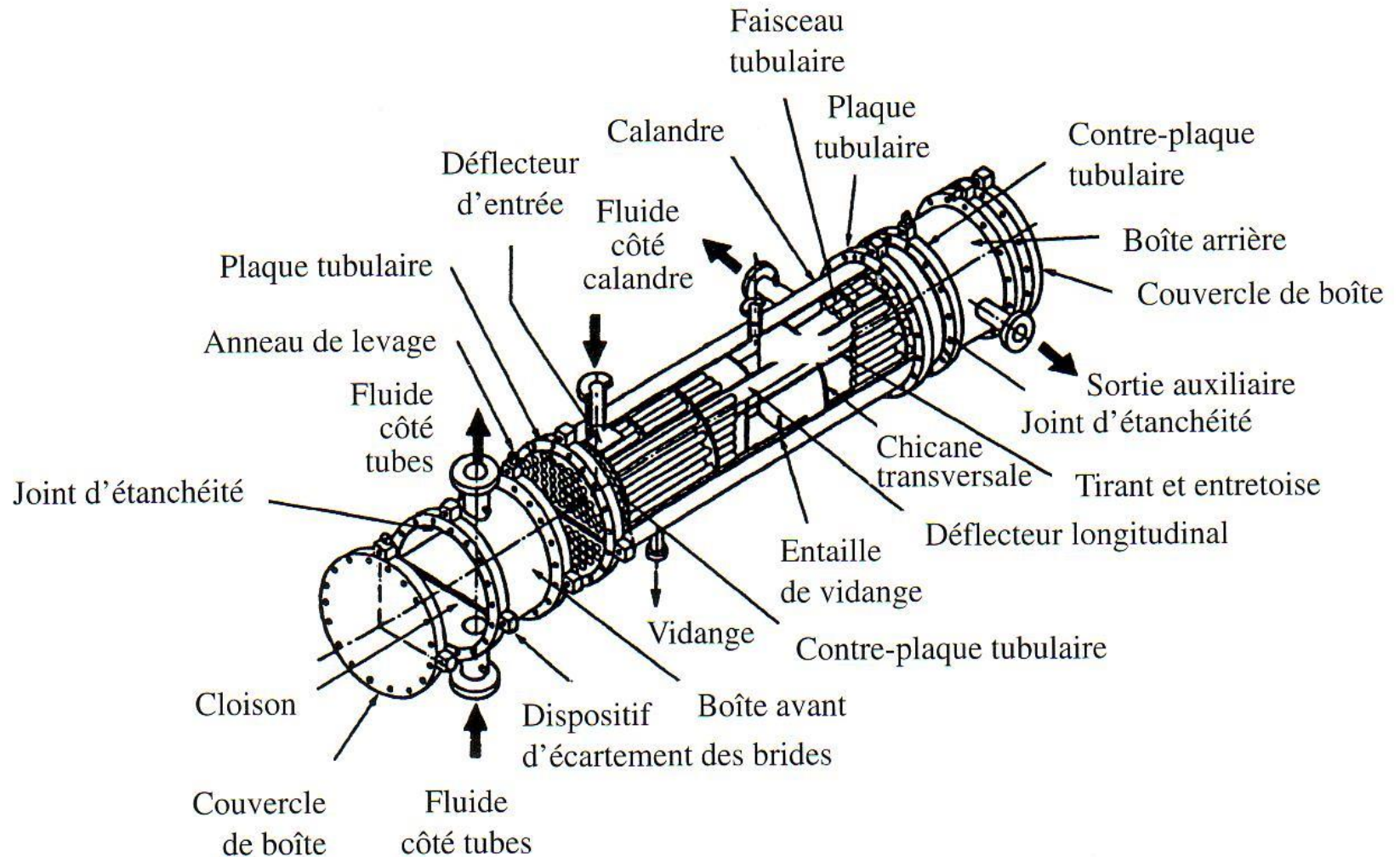
Bossages obtenus  
par emboutissage



Studs servant  
d'entretoise





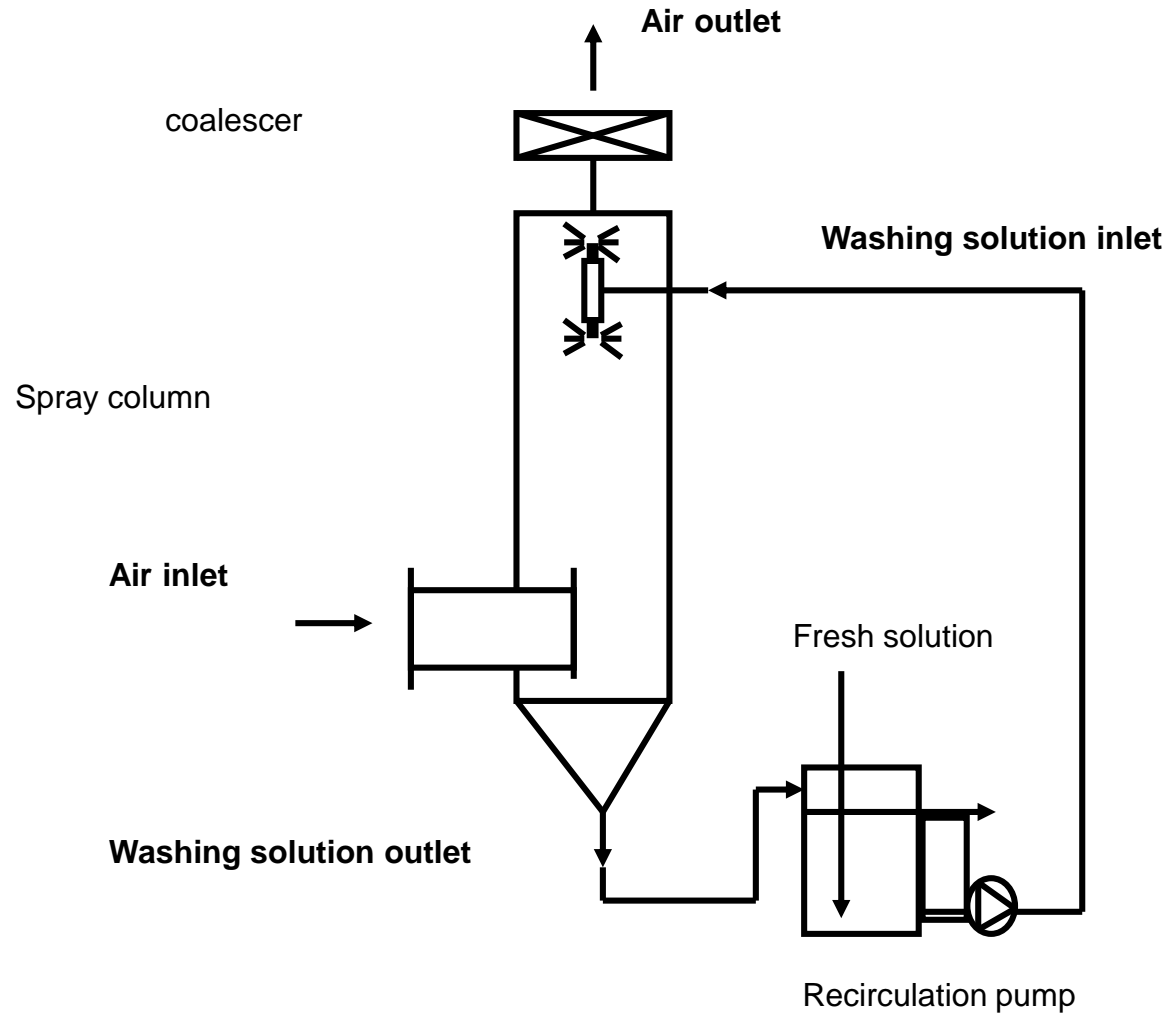


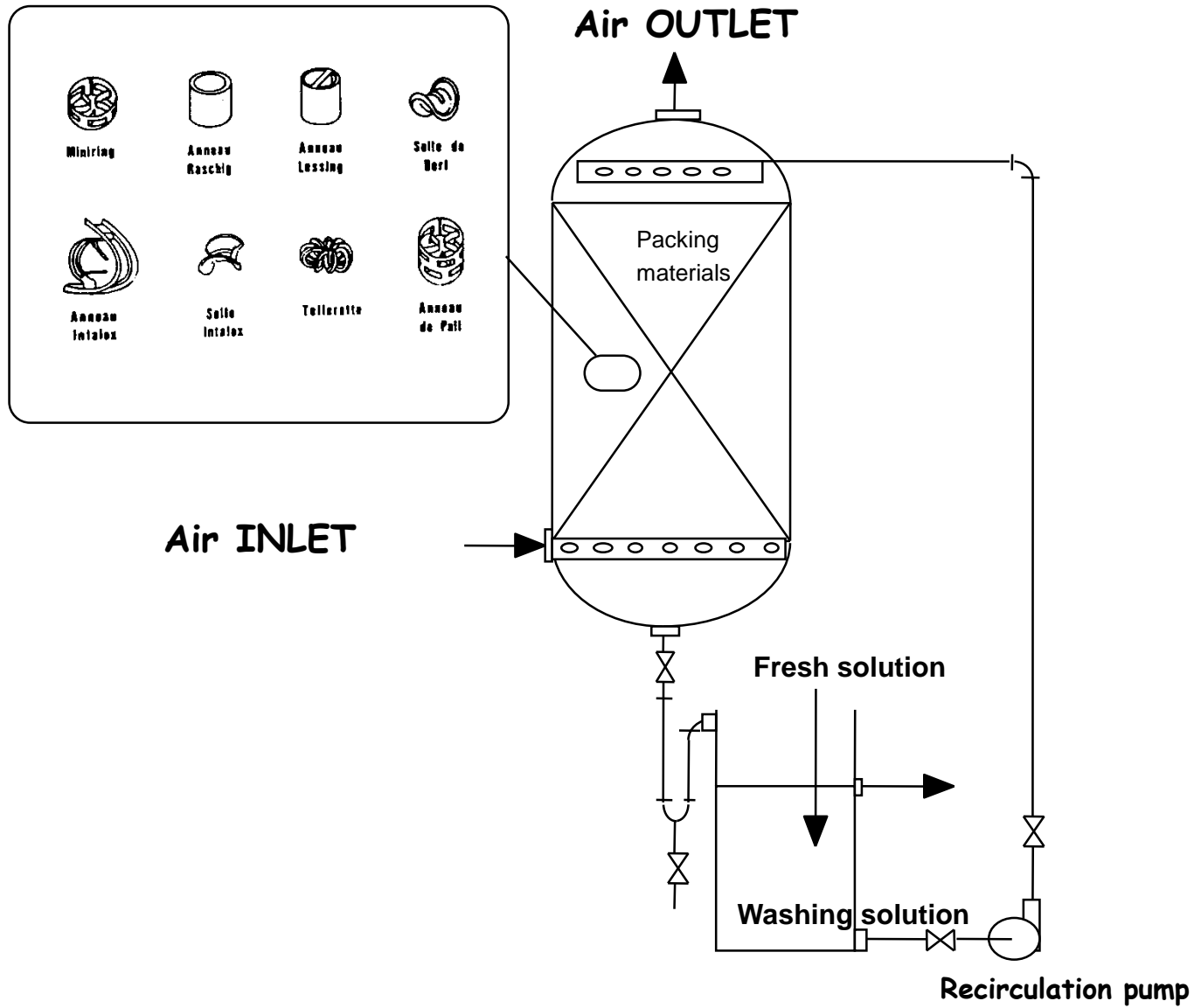
# Gas - Liquid transfer

## Absorption



- Spray column
- Packed column
- Venturi - scrubber







**Miniring**



**Anneau Raschig**



**Anneau Lessing**



**Selle de Berl**



**Anneau Intalox**



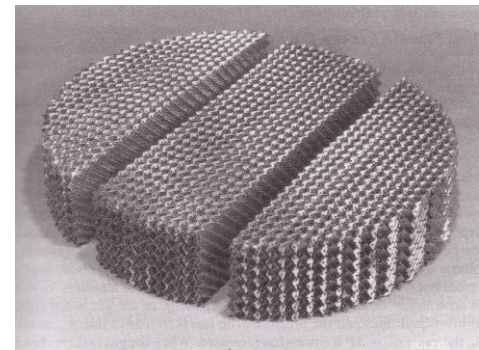
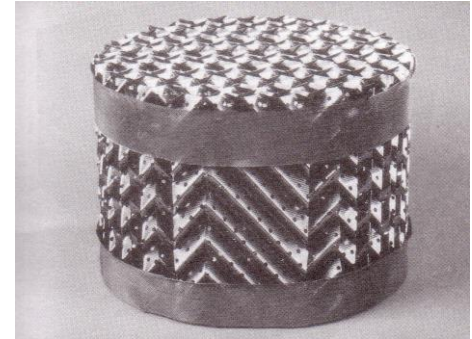
**Selle Intalox**



**Tellerette**



**Anneau de Pall**



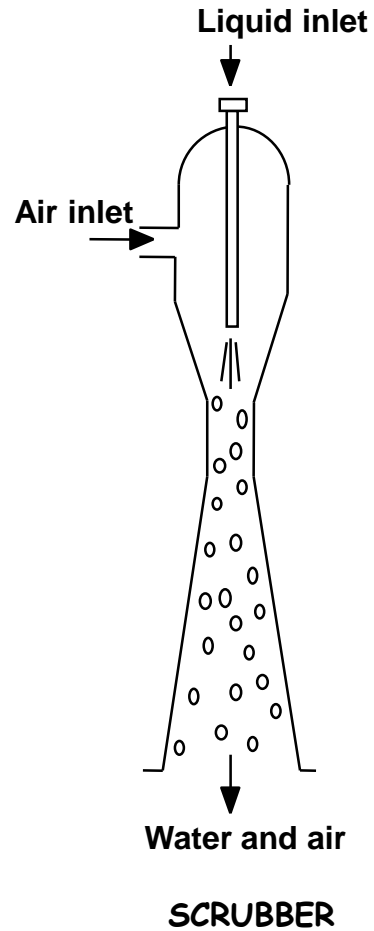
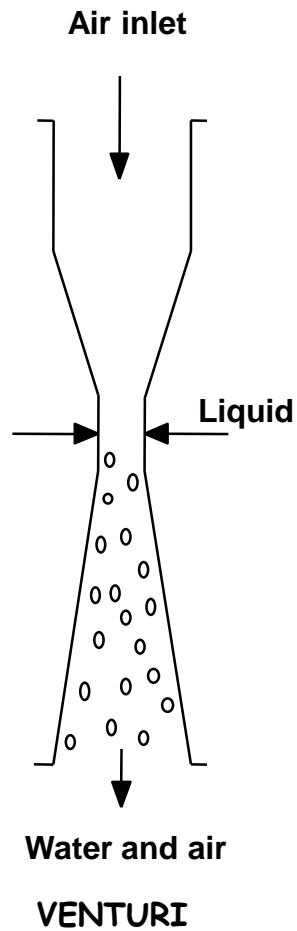
# CO<sub>2</sub> Absorption - Desorption





# $\text{NH}_3$ Absorption





Crédit Photo Mion Ventoltermica

# Operations with a system Gas – Solid

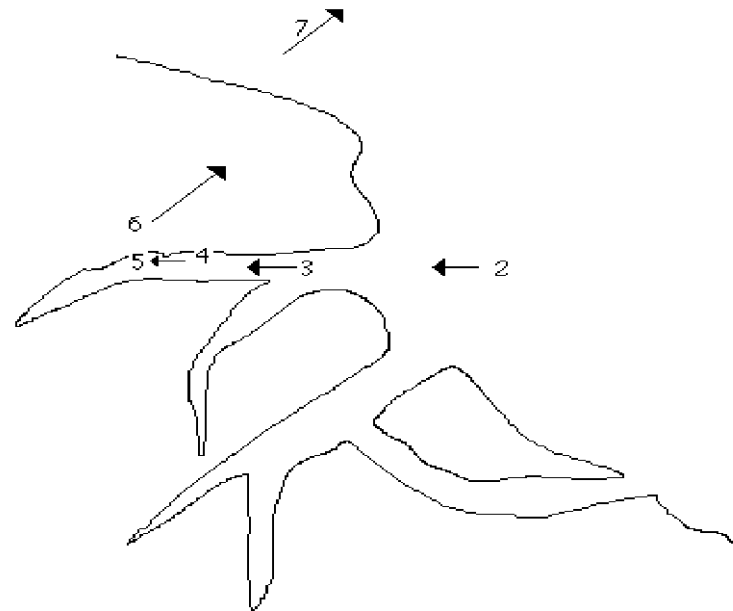
System	Process name
<b>Solid <math>\rightarrow</math> Gas</b>	<b>Sublimation</b>
<b>Gas or Vapor <math>\rightarrow</math> Solid</b>	<b>Adsorption</b>
<b>Solid phase with solute <math>\rightarrow</math> Gas</b>	<b>Desorption</b>
<b>Gas phase with solute <math>\rightarrow</math> Solid</b>	<b>Adsorption</b>

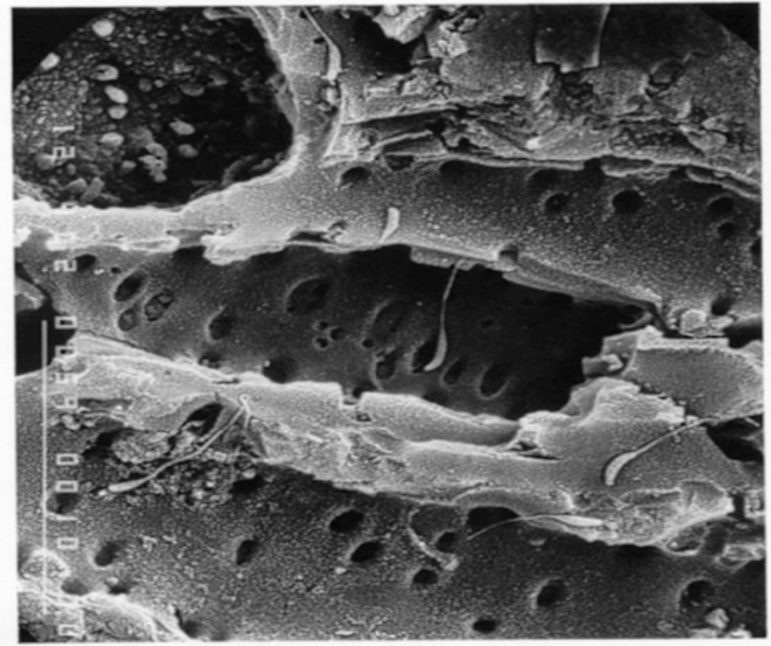
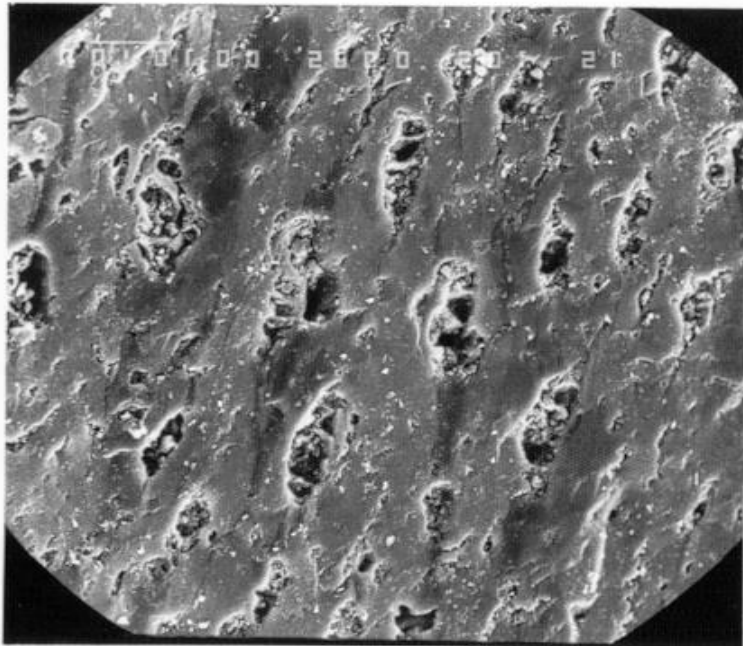


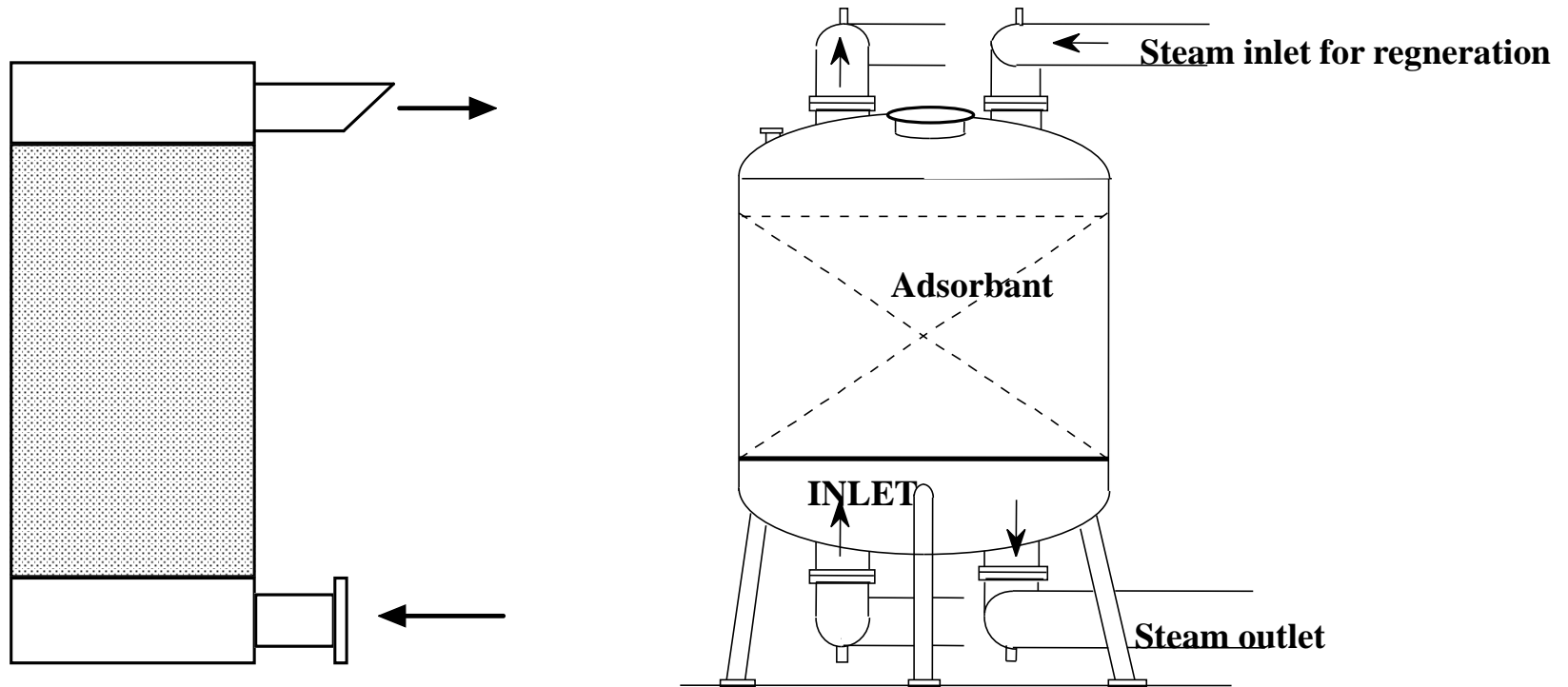
# Gas - Solid transfer

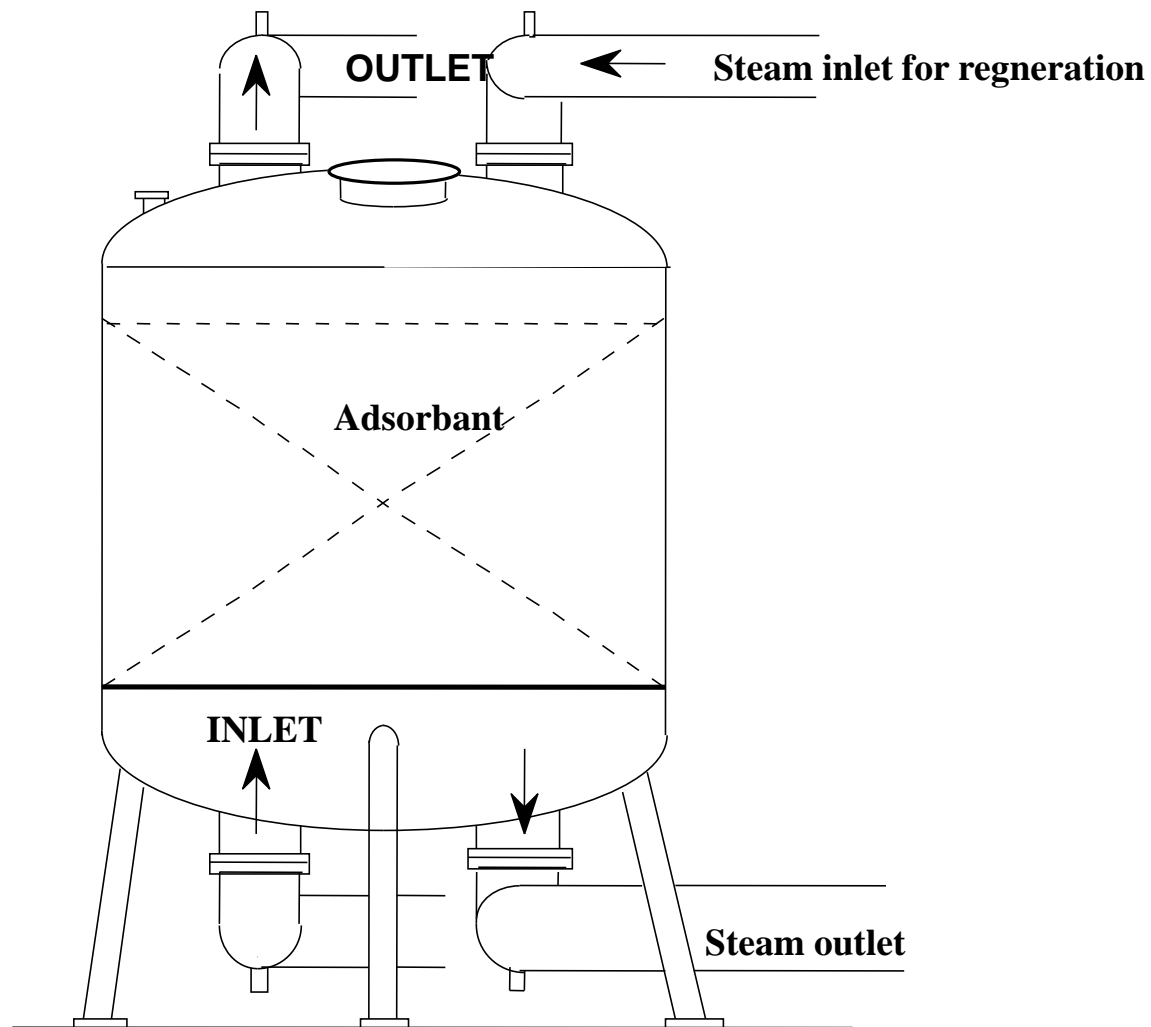
# Liquid - Solid transfer

# Adsorption - Desorption

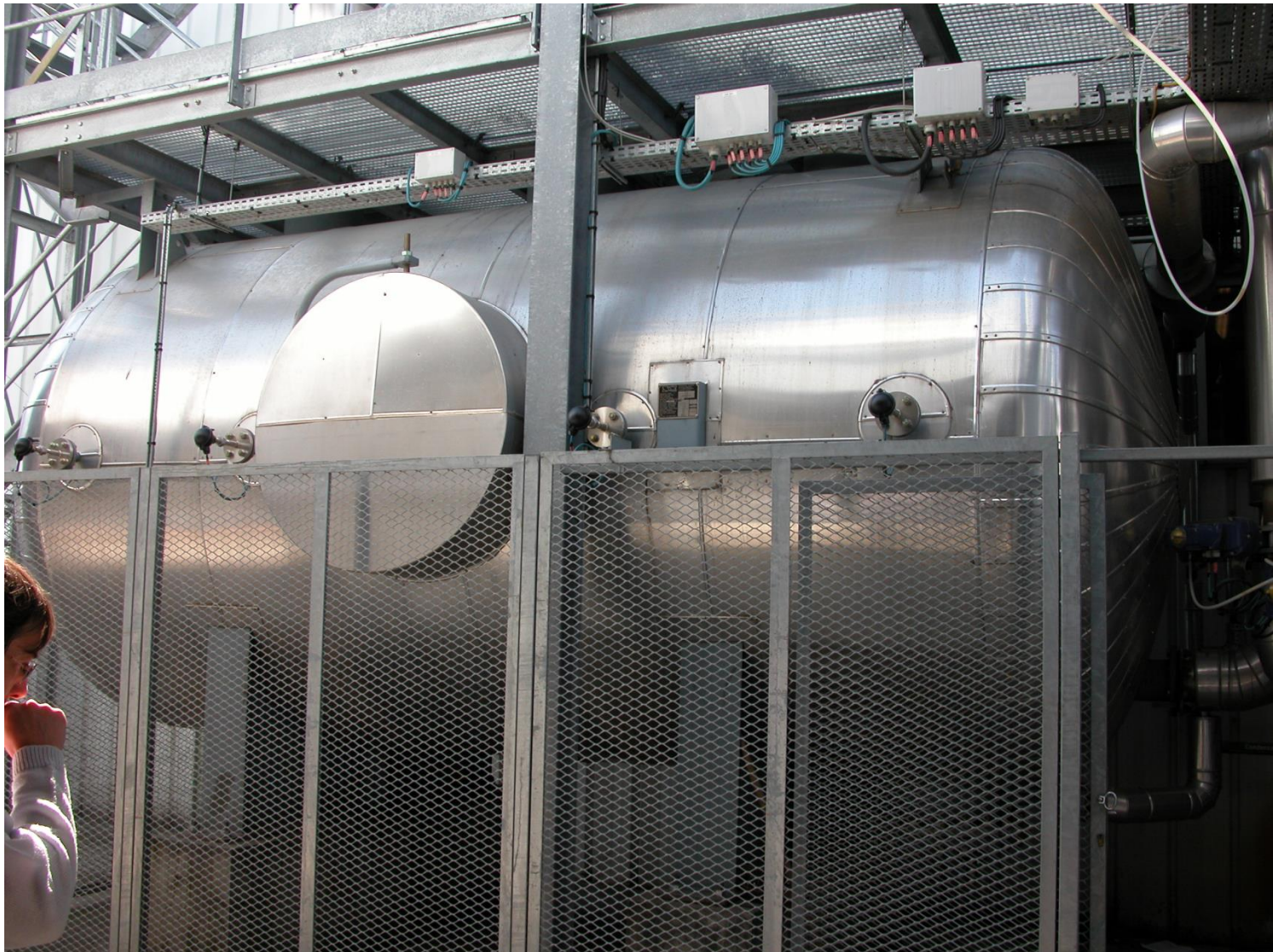


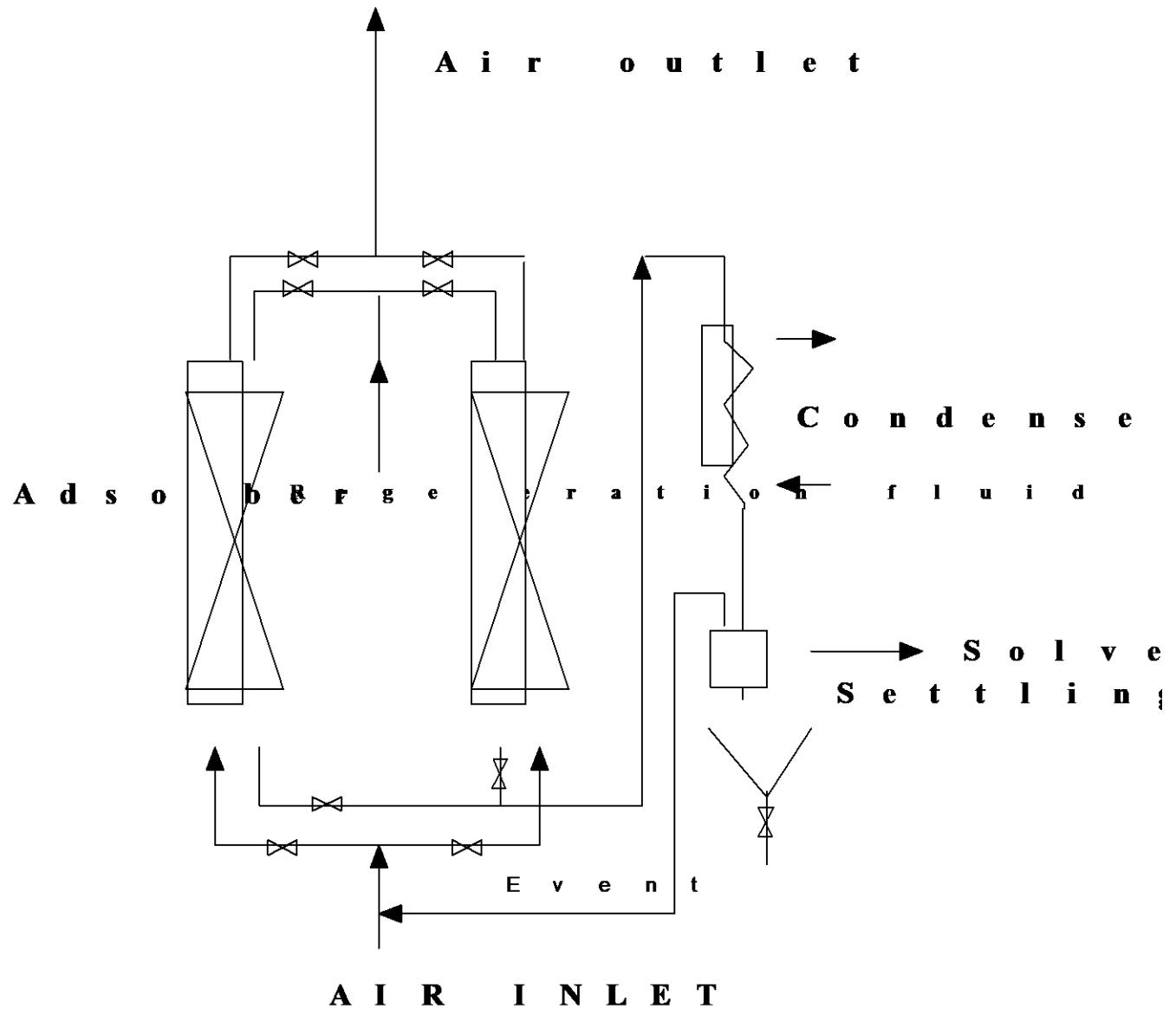


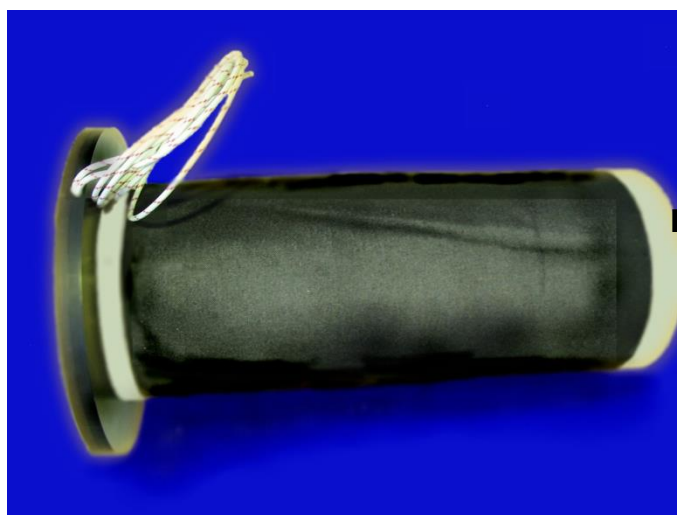




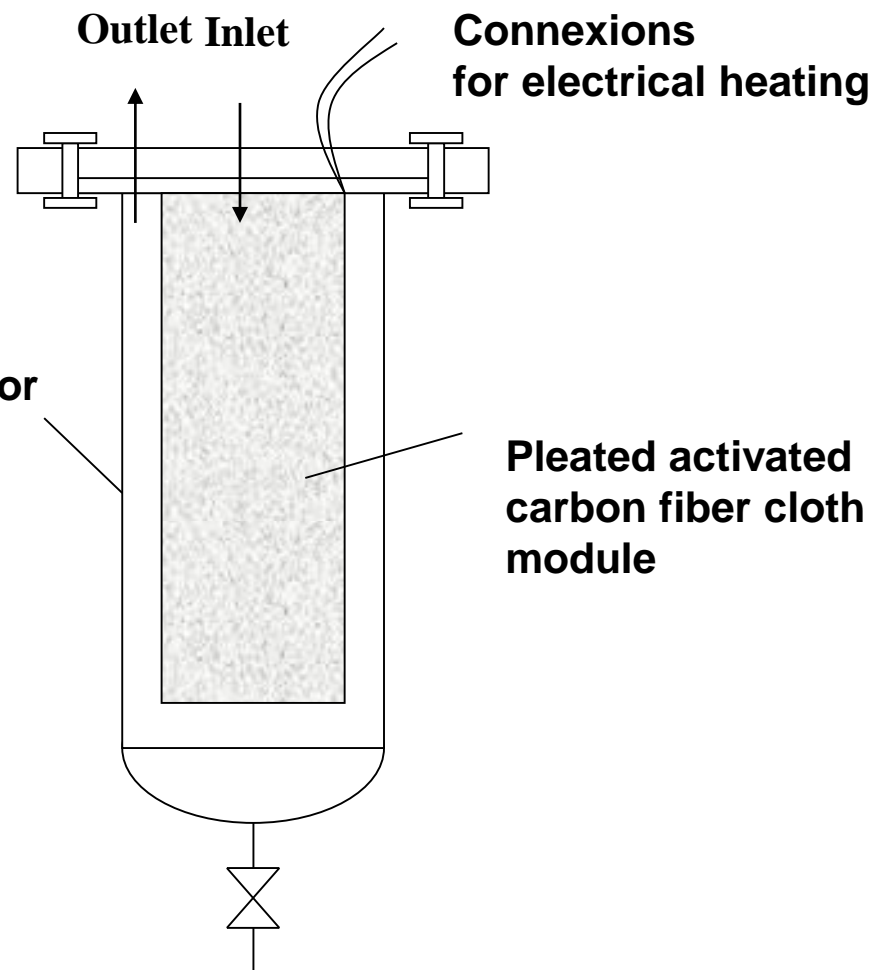








reactor



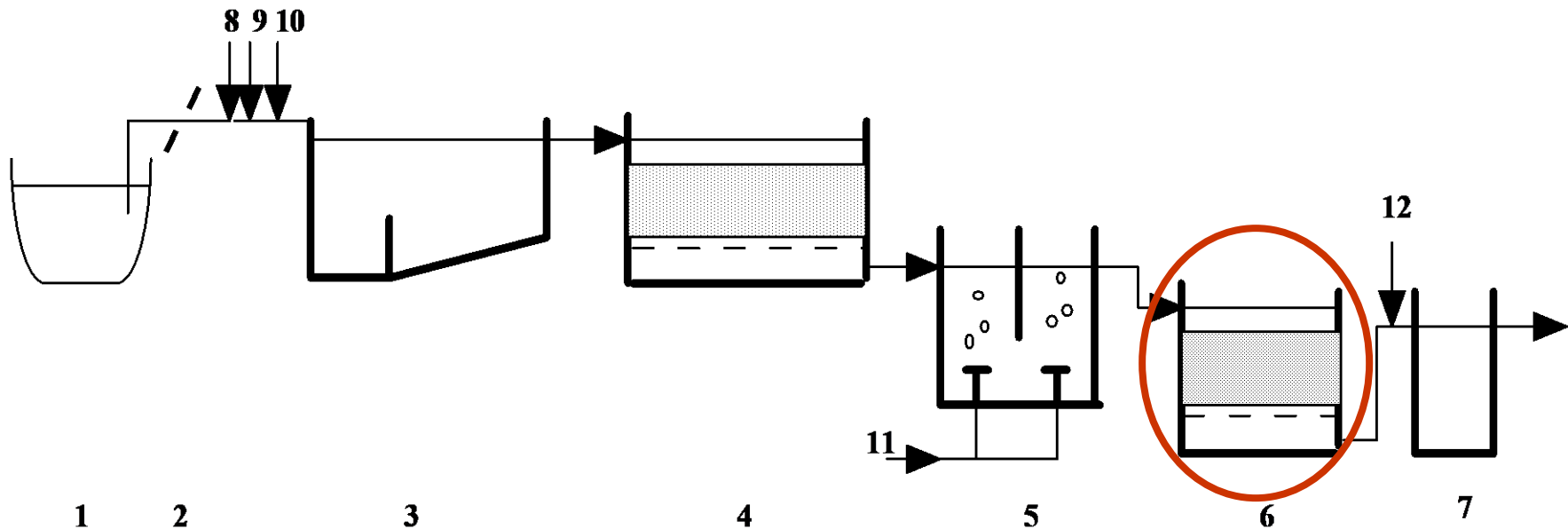




# Operations with a system Liquid – Solid

System	Process name
<b>Solid → Liquid</b>	<b>Fusion – Solubilisation</b>
<b>Condensable Vapor → Liquid</b>	<b>Crystallization - Solidification</b>
<b>Solid phase with solute → Liquid</b>	<b>Lixiviation</b>
<b>Liquid phase with solute → Solid</b>	<b>Adsorption</b>

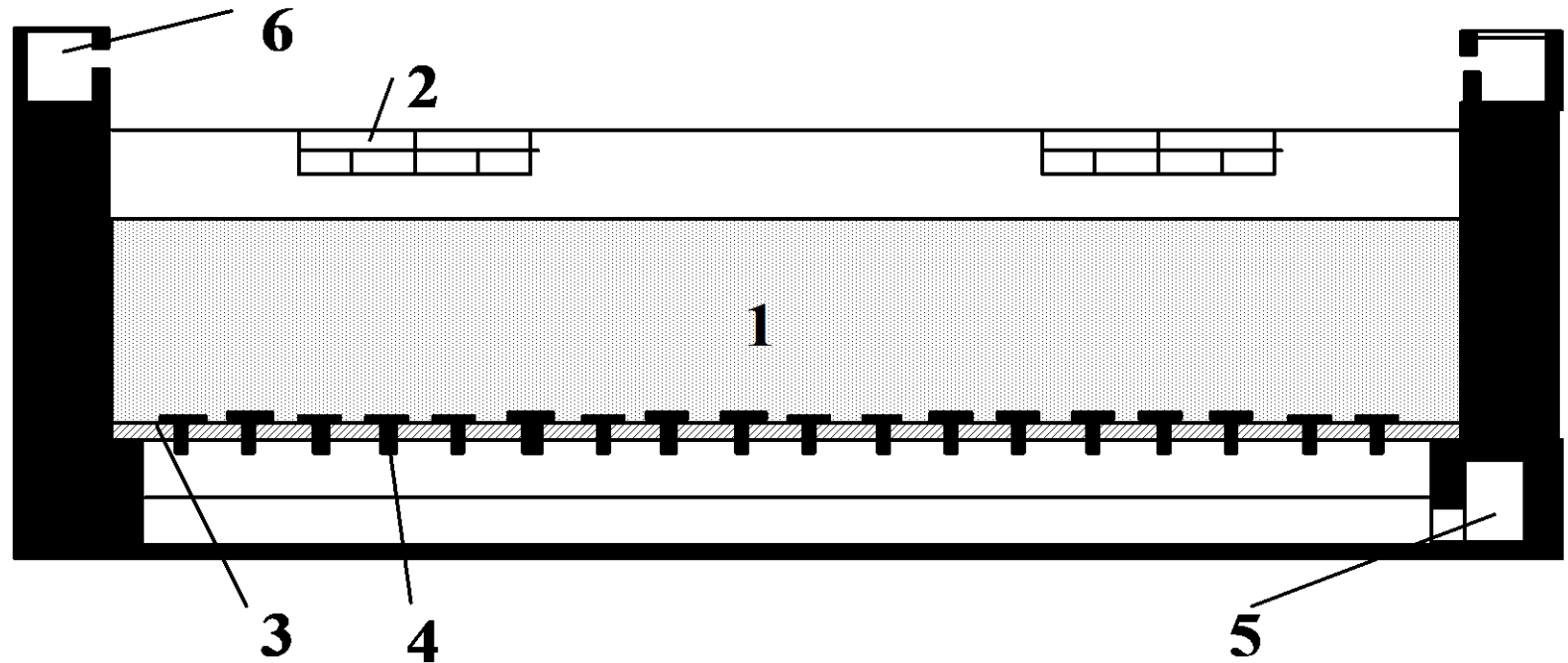
# Typical sequences in drinking water treatment



1 : raw water    2 : pretreatment    3 : coagulation and clarification    4 : sand filtration

5 : ozonization    6 : activated carbon filtration    7 : drinking water reservoir

8 : coagulant    9 : adjuvant    10 : activated carbon powder injection



**1 : activated carbon grains 2 : water inlet**

**3 : concrete floor 4 : nozzles**

**5 : filtered water outlet and backwashing air-water inlet**

**6 : sludge and washing water outlet**

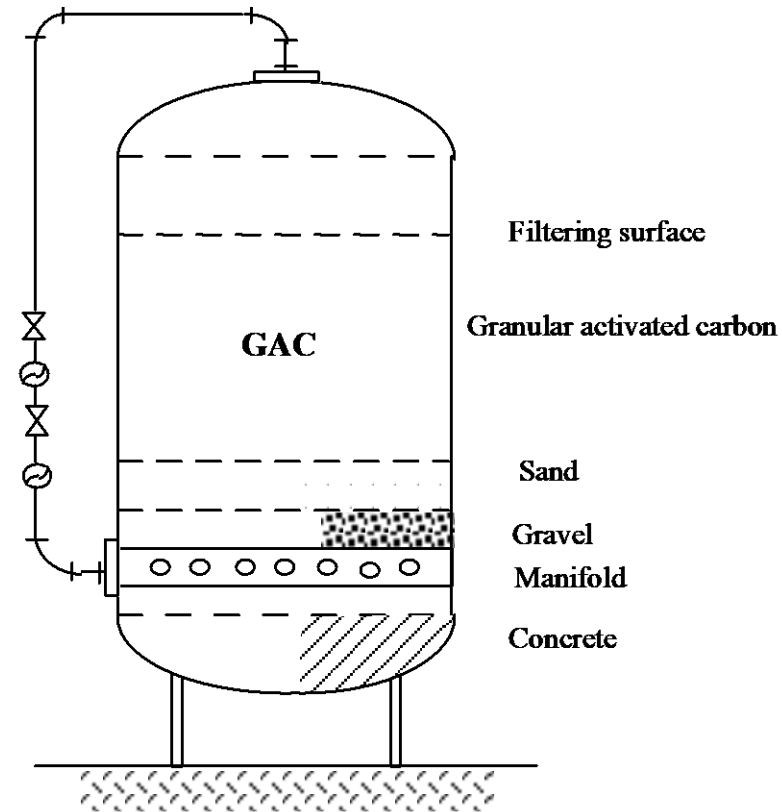


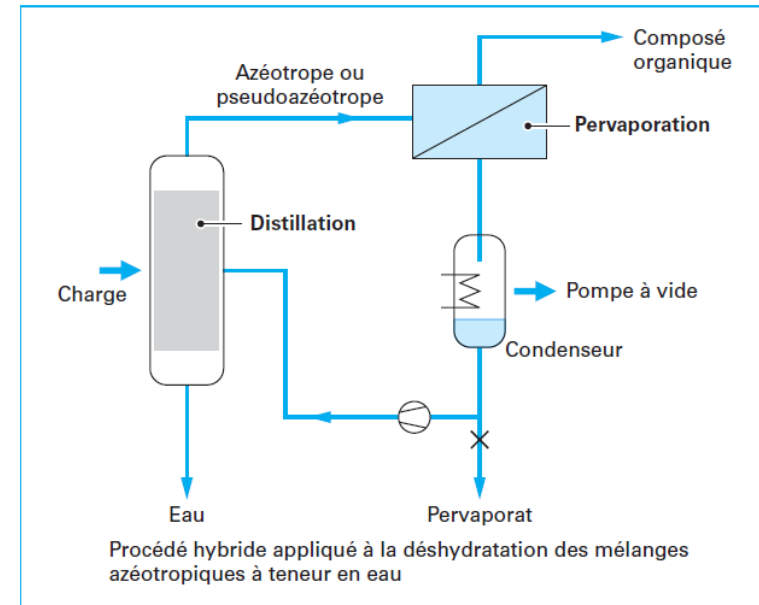
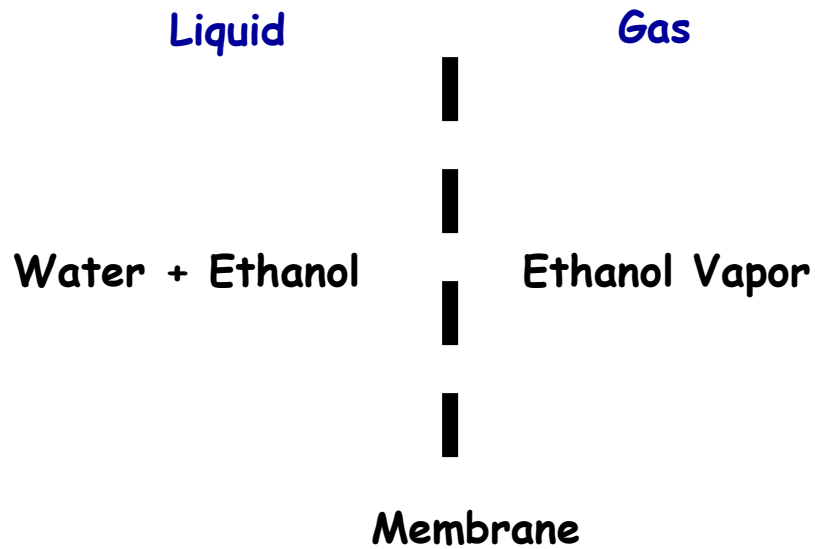


# Leachate treatment by garnular activated carbon filters



**Influent**  
**By-pass valve**  
**Effluent**





Techniques de l'ingénieur