Water and Wastewater Treatment Processes for Energy Industry (10626584)

Lecture 1: Introduction
Basic Concepts and Definitions

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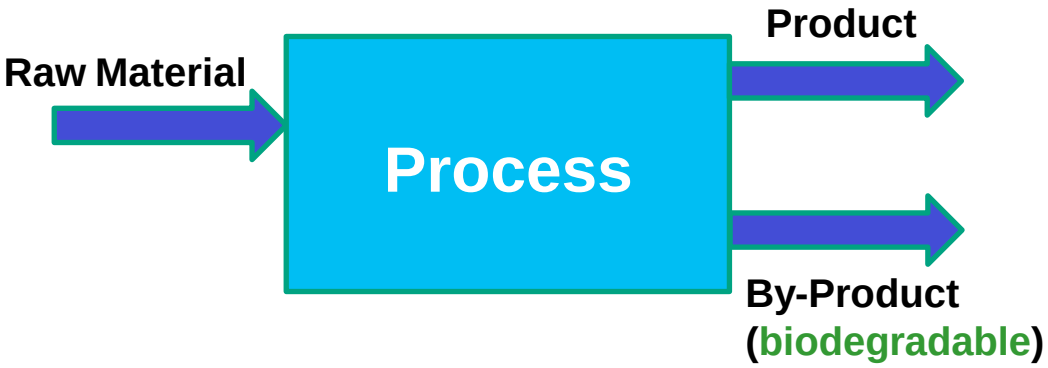
Course slides are adapted from Dr. Nashaat Nassar, University of Calgary

PAST

Production Process



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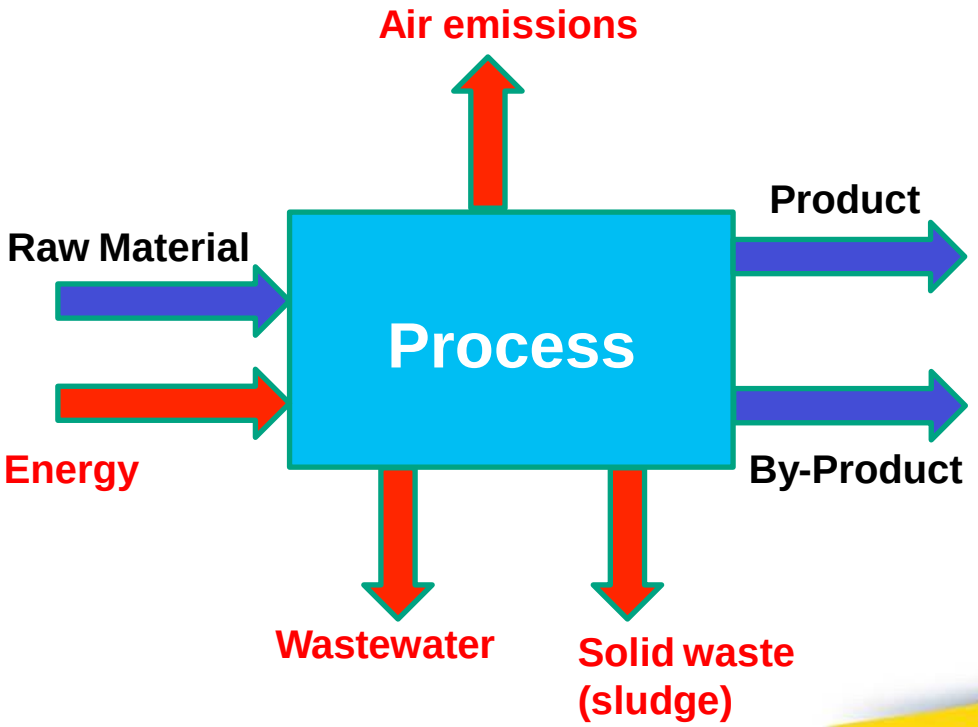
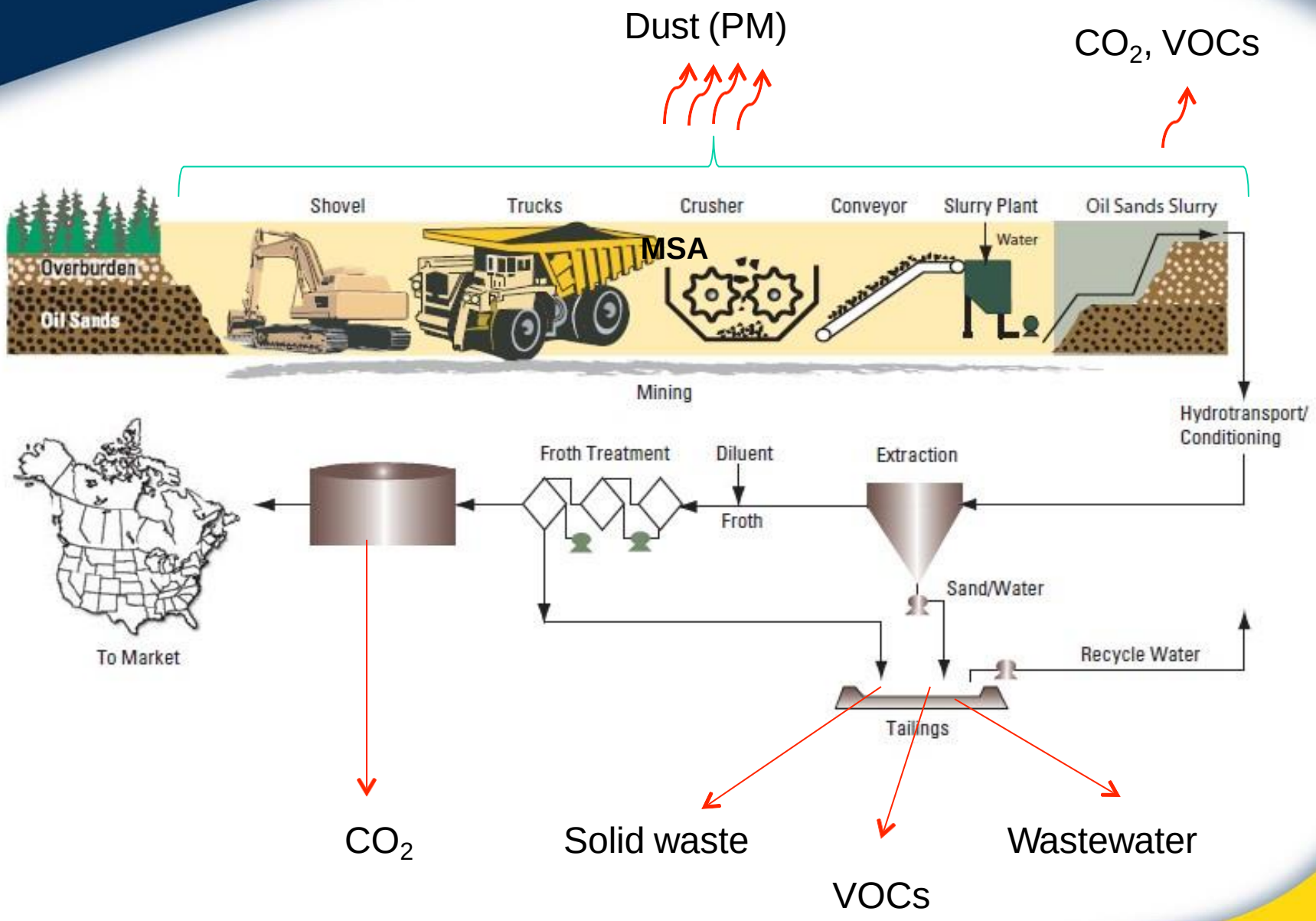


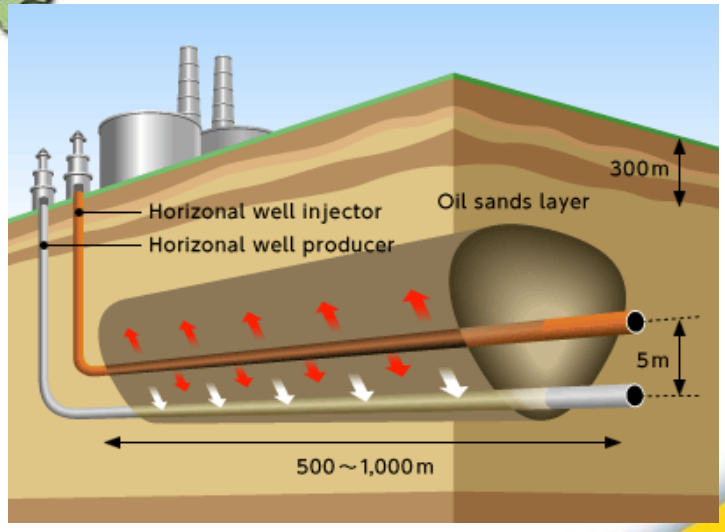
Oil sands Industry:
Surface Mining & Bitumen Extraction



Alberta's Oil Sands

Surface mining
Ex-situ recovery & upgrading

SAGD
In-situ recovery & upgrading



Source: *http://wirelessroadwarrior.blogspot.ca/2008/10/syncrude-and-athabascan-oil-sands.html*

Oil sands Industry:
Surface Mining & Bitumen Extraction

PM, CO_2, VOCs

CO_2, VOCs, NOx, SOx, H_2S

GHG

Oil Sands:
Deposits of sand, sandstone or other sedimentary rocks containing crude bitumen

Extraction

Separation

Wastewater and solid

Bitumen:
A highly viscous mixture, mainly of hydrocarbons heavier than pentanes

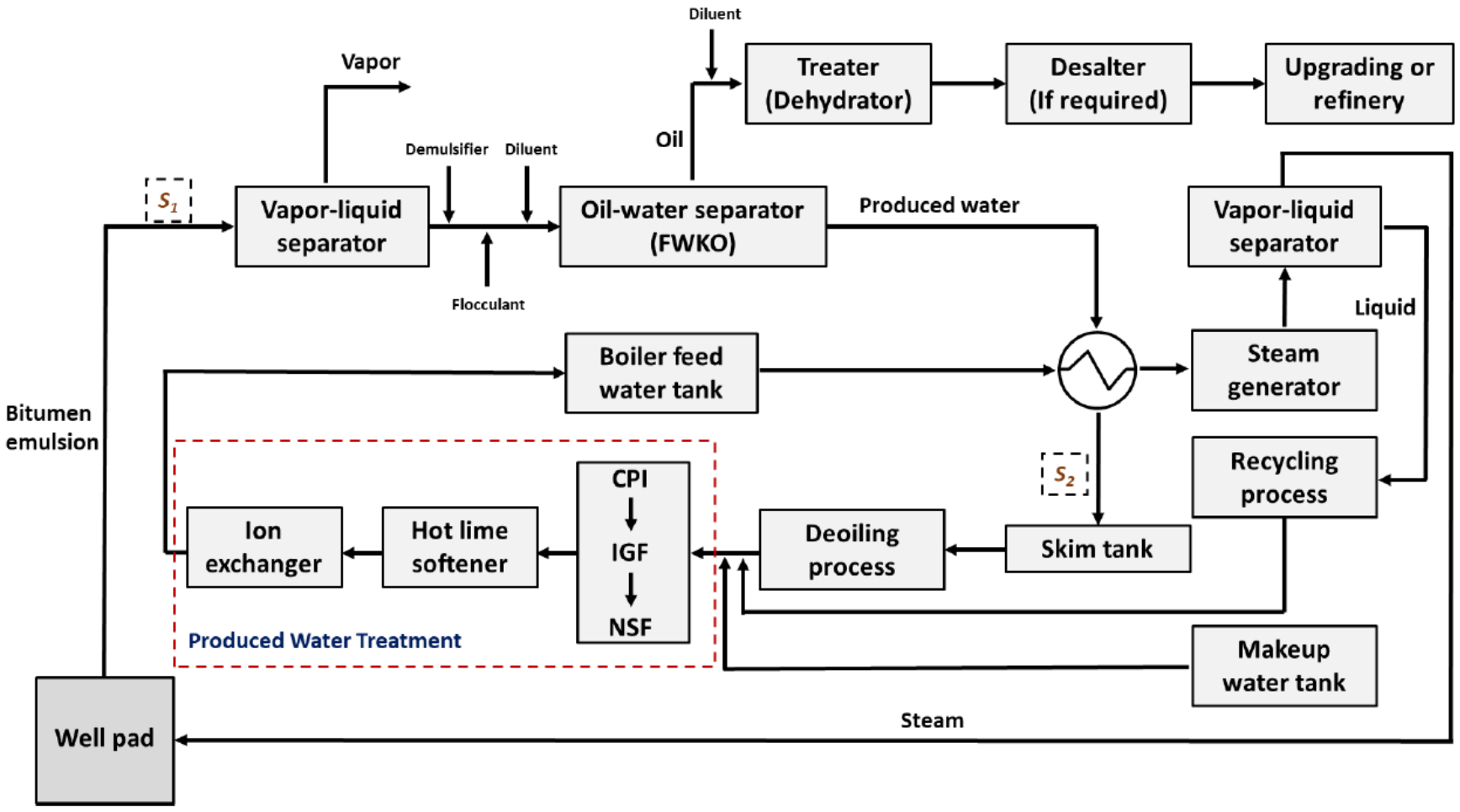
Upgrading

Synthetic Oil:
A mixture of hydrocarbons, similar to light crude oil, that is derived by upgrading crude bitumen or heavy oil

- **The processing starts by extracting the Bitumen from the sand with hot water and agitation.**
- **The sands, some hydrocarbons, and water come out and go to a tailings pond.**

Image courtesy: http://wirelessroadwarrior.blogspot.ca/2008/10/syncrude-and-athabascan-oil-sands.html

Produced Water Treatment



Tailing Ponds Disposal

- Tailings are an aqueous waste product of the bitumen extraction process
- Tailings contain:
  - Unrecovered bitumen
  - Sand, silts and clays
  - Residual solvents and chemicals from bitumen extraction
- Fluid fine tailings are difficult to consolidate
- Alberta's Tailings ponds today are approximately 170 km^2

Image courtesy: http://rethinkalberta.org/facts.php

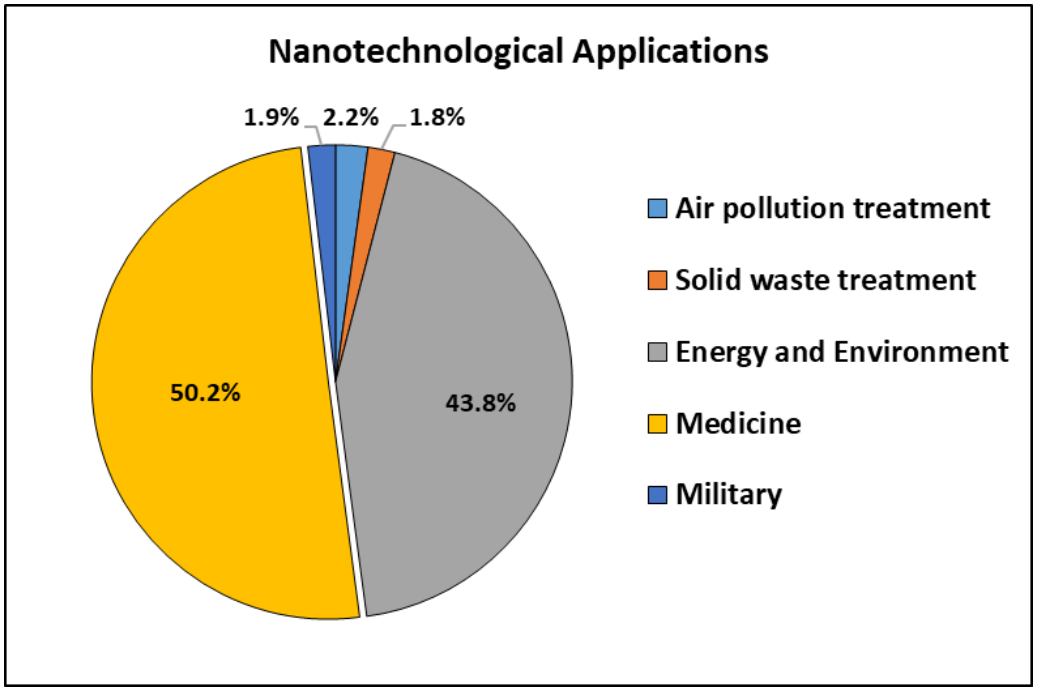
Oil Crisis in 2015

$41.99

$40

A barrel of oil is cheaper than a bucket of chicken!!

- Nanotechnology is a field of applied science, focused on the design, synthesis, characterization and application of materials and devices on the nanoscale.



- Literature references focused on nanotechnology applications in 2016 (extracted by SciFinder®, copyright© 2016 American Chemical Society).

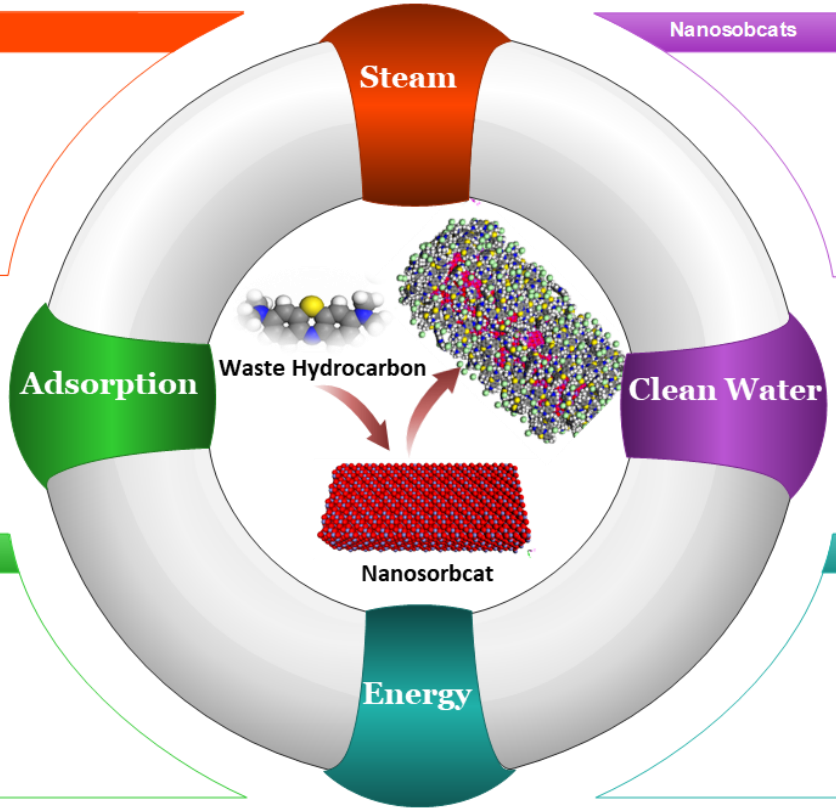
Big Picture

Problem: Industrial Wastewater

- Organic pollutants present in industrial wastewater pose a real environmental and energy conservation challenges worldwide.
- Current treatment technologies focus on water recycling at high capital and operating costs.

Nanosobcats

- Nanoparticles have high, active, and hybrid surface areas, which make them able to work as nano-adsorbents and catalysts (nanosorbcats).
- This recent concept is invented, for the first time, by our research group.



Our Sustainable Solution Approach

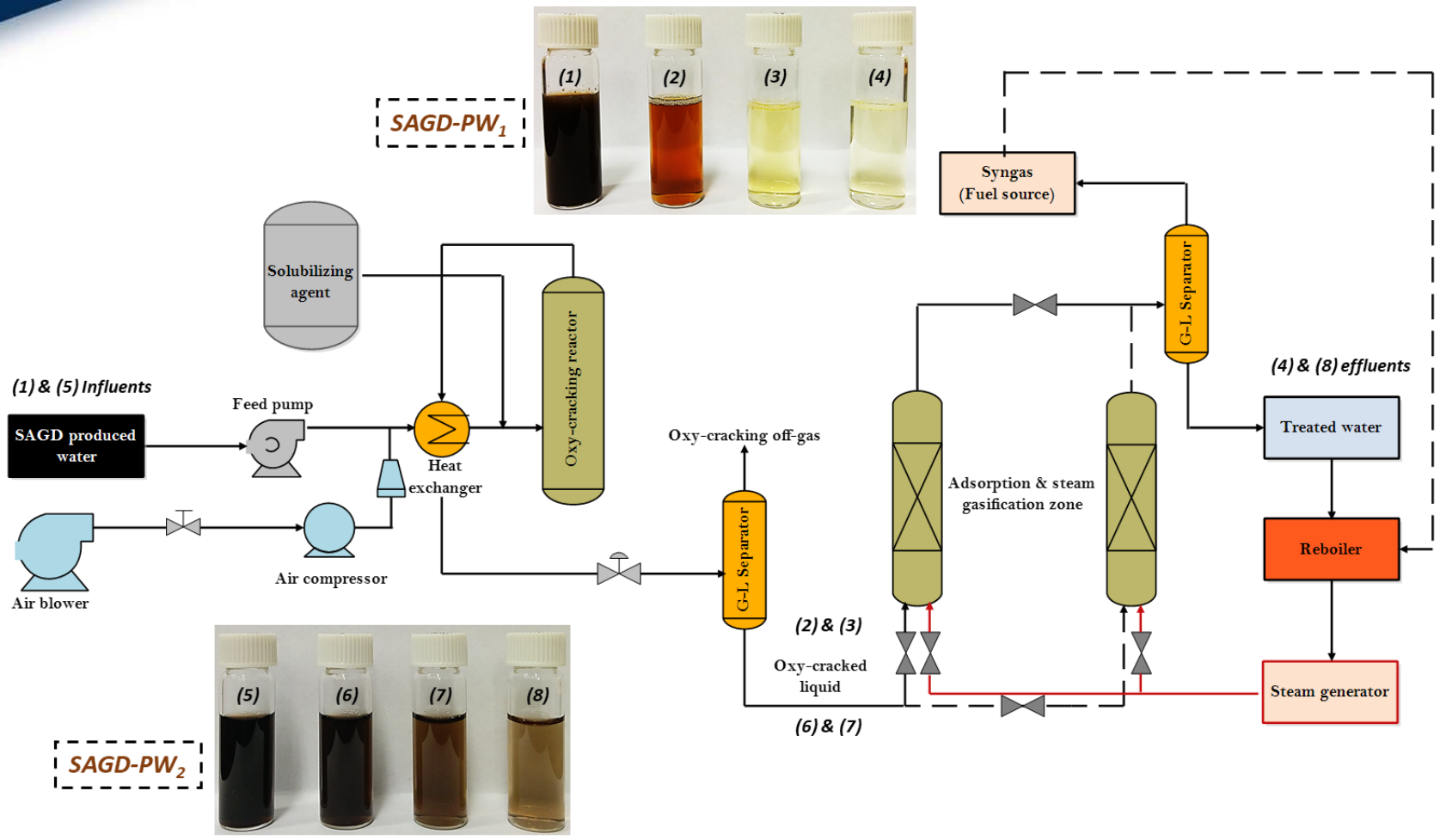
Our futuristic vision is developing hydrocarbon waste utilization process by transforming "energy consuming" to "energy producing" wastewater treatment process by using the right nanosrobcats.

Synthetic and Real Wastewater Effluents

Functionalized silica-based nanosorbcats were successfully prepared and employed in removing different pollutants with different functionalities (cationic, anionic, neutral, and organic acids), in addition to real effluents like SAGD and textile wastewaters.

"If you want to make something dirt-cheap, make it out of dirt. Preferably dirt that's locally sourced." Prof. Donald Sadoway, Materials Chemistry, MIT.

Proposed Nanoparticle Technology



GHG Emissions

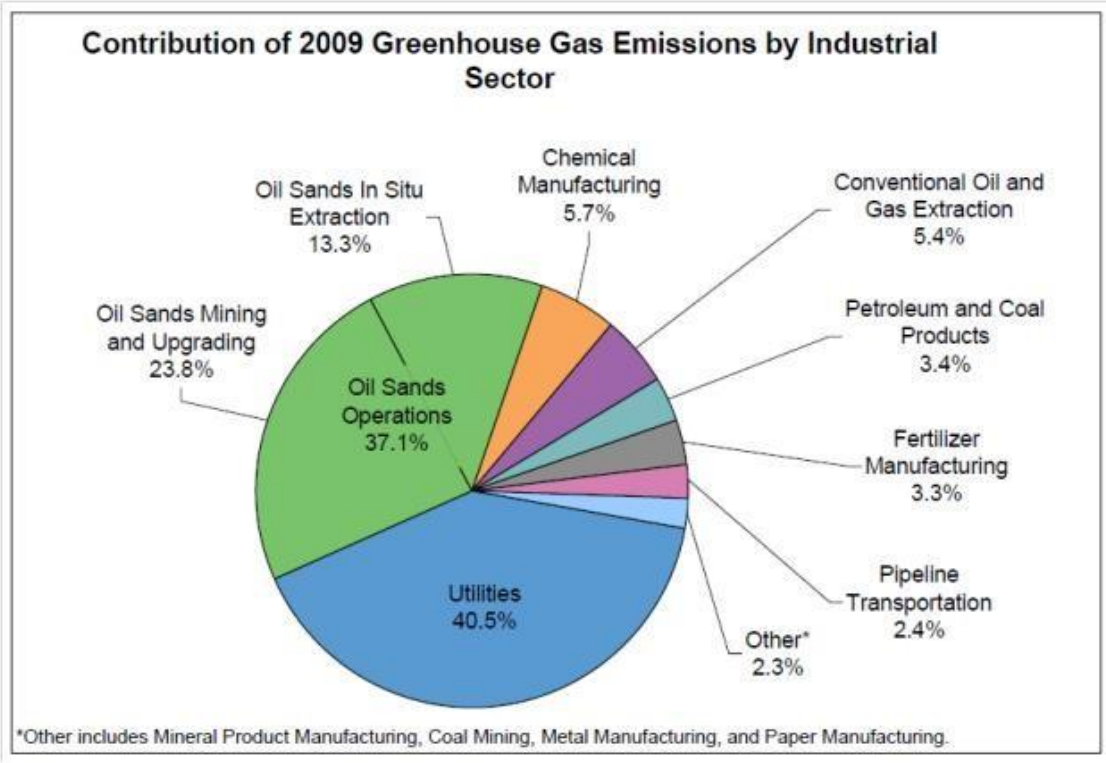
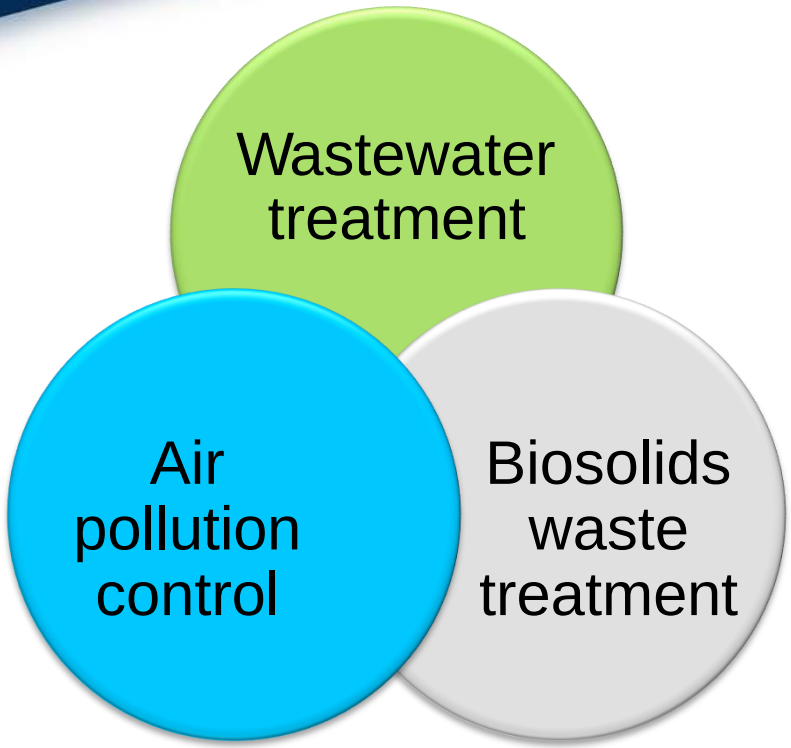


Image courtesy: http://www.energy.alberta.ca/oilsands/791.asp

Image courtesy: http://www.climatechangeconnection.org/emissions/World_emissions.htm



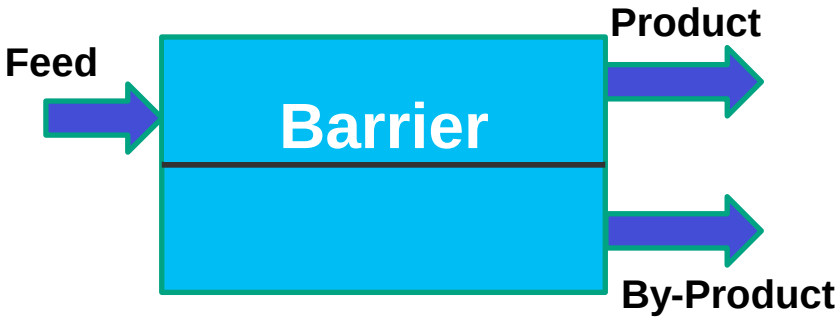
Treatment Processes

Separation Processes

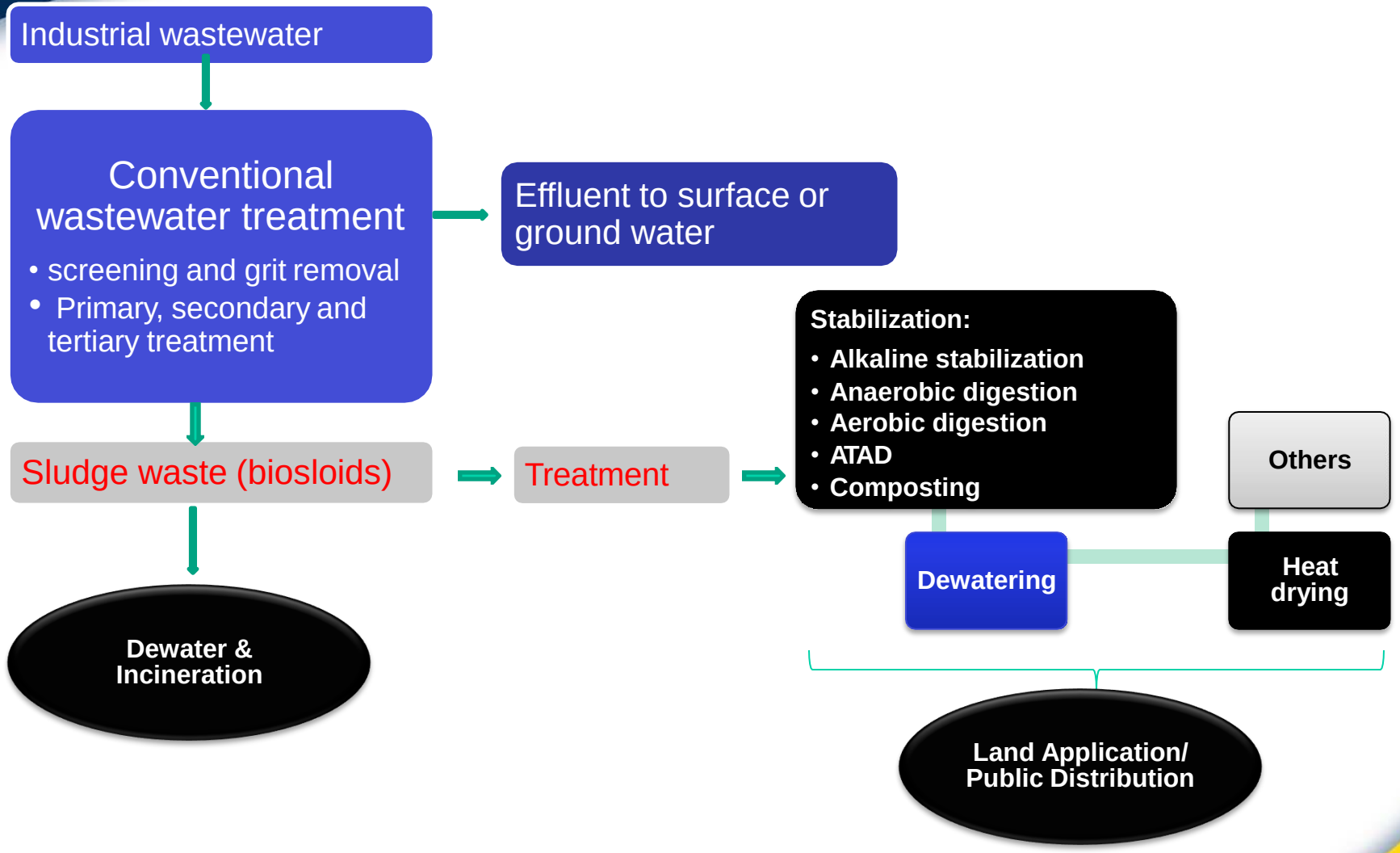
Mass transfer

Thermodynamics

Separation Processes



Wastewater and biosolids treatment: From A to Z



Sedimentation

Image courtesy: http://www.epco.com.au/EQUIPMENT/CLARIFIERS/CLARIFIERS.HTM

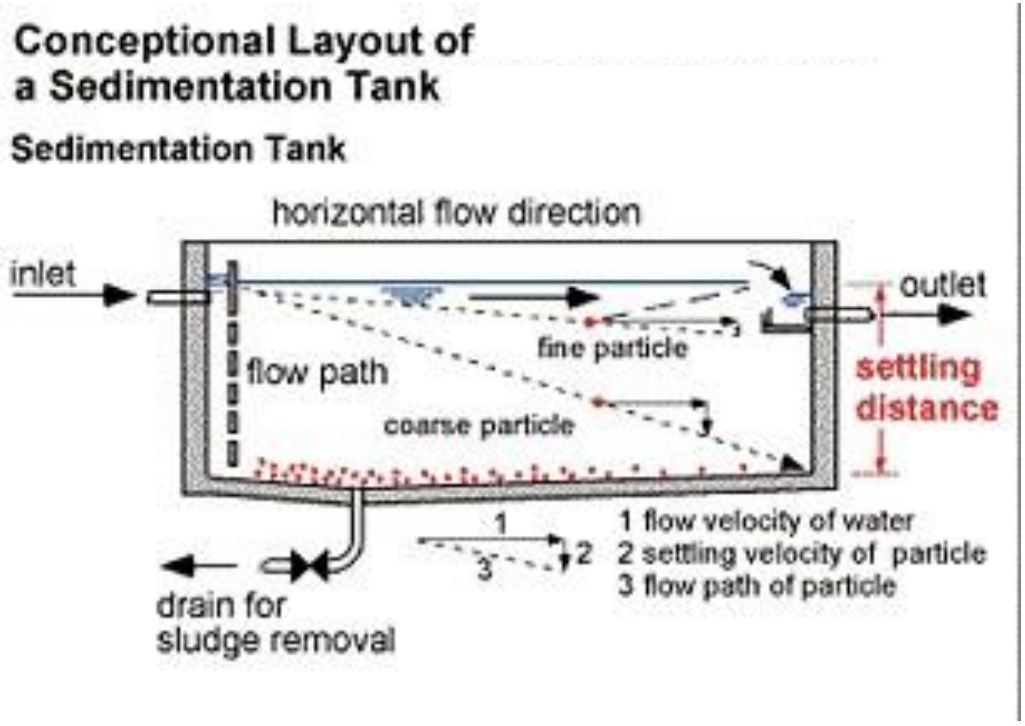
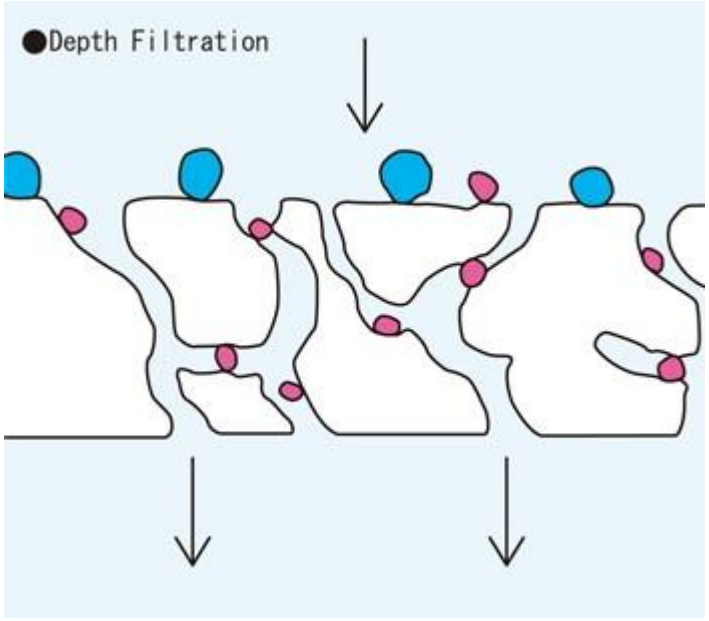


Image courtesy: http://www.eawag.ch/forschung/sandec/gruppen/ws/projects/roughing_filter/index

Depth Filtration



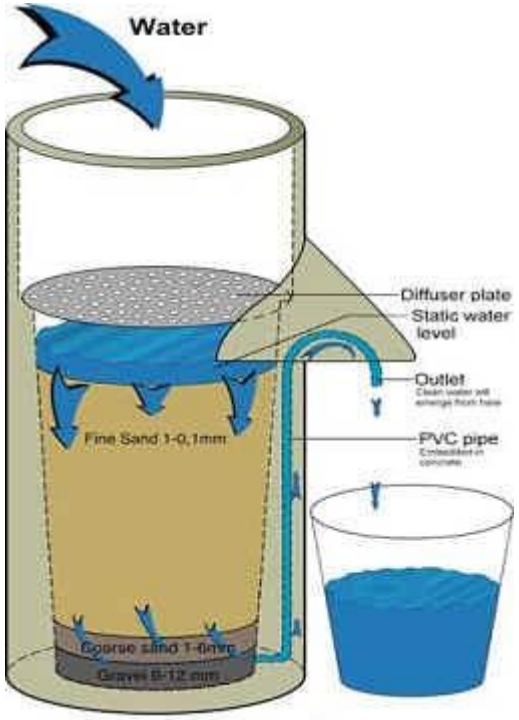
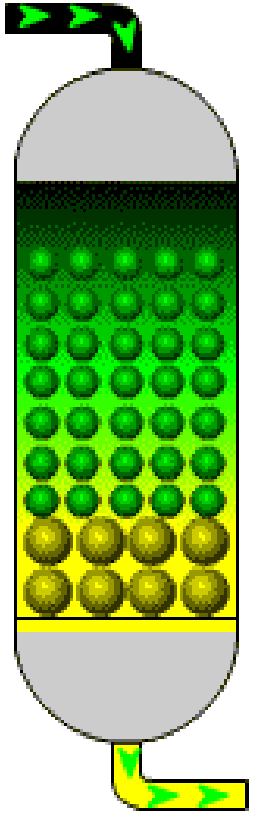
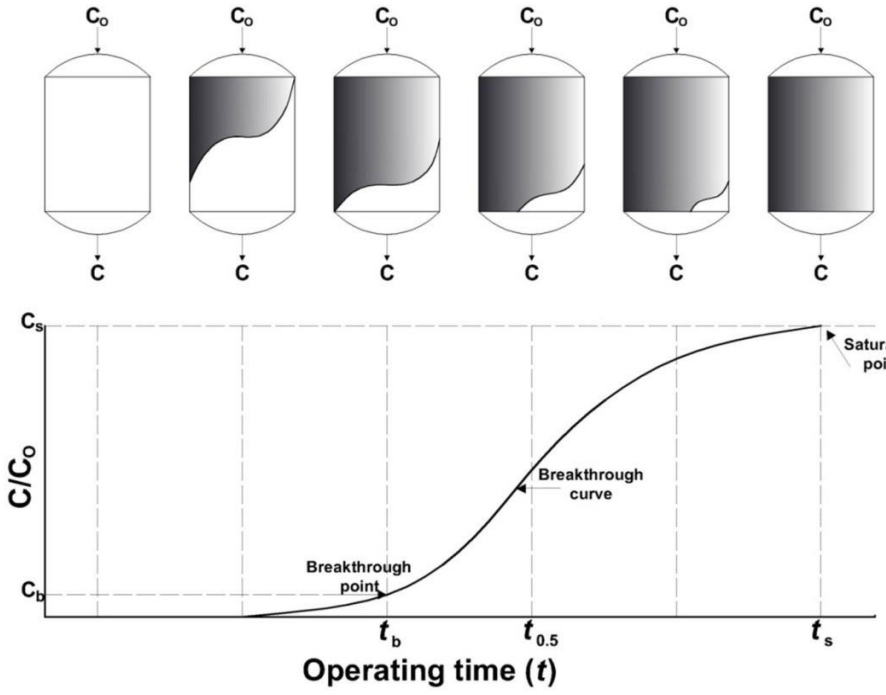


Image courtesy: http://www.reuk.co.uk/Sand-Filters-for-Greywater.htm

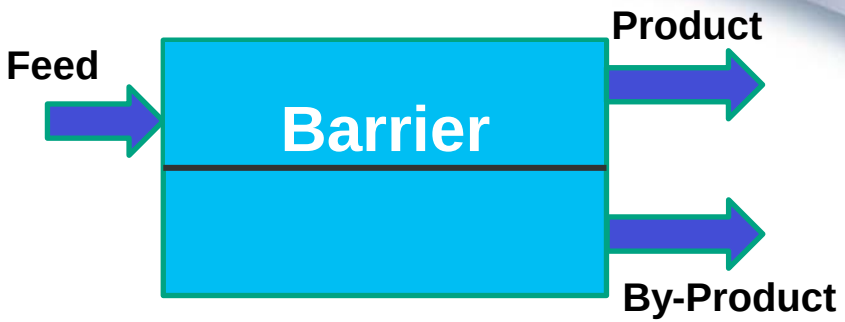
Adsorption

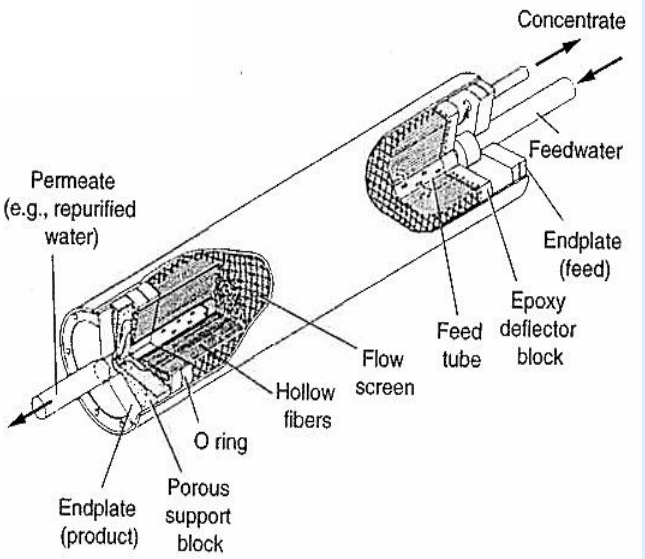


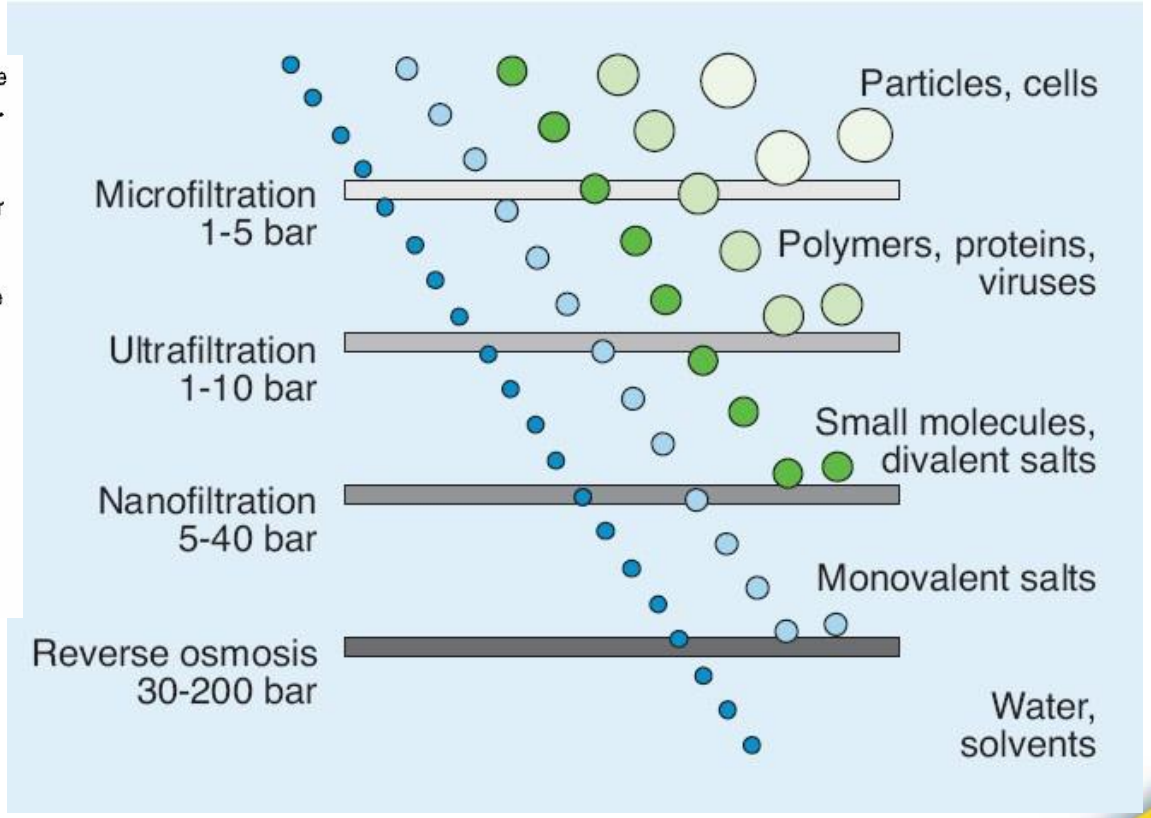


Source: Nassar, N. N., 2012, Ch3 In: *Application of Adsorbents for Water Pollution Control.* pp 81-118

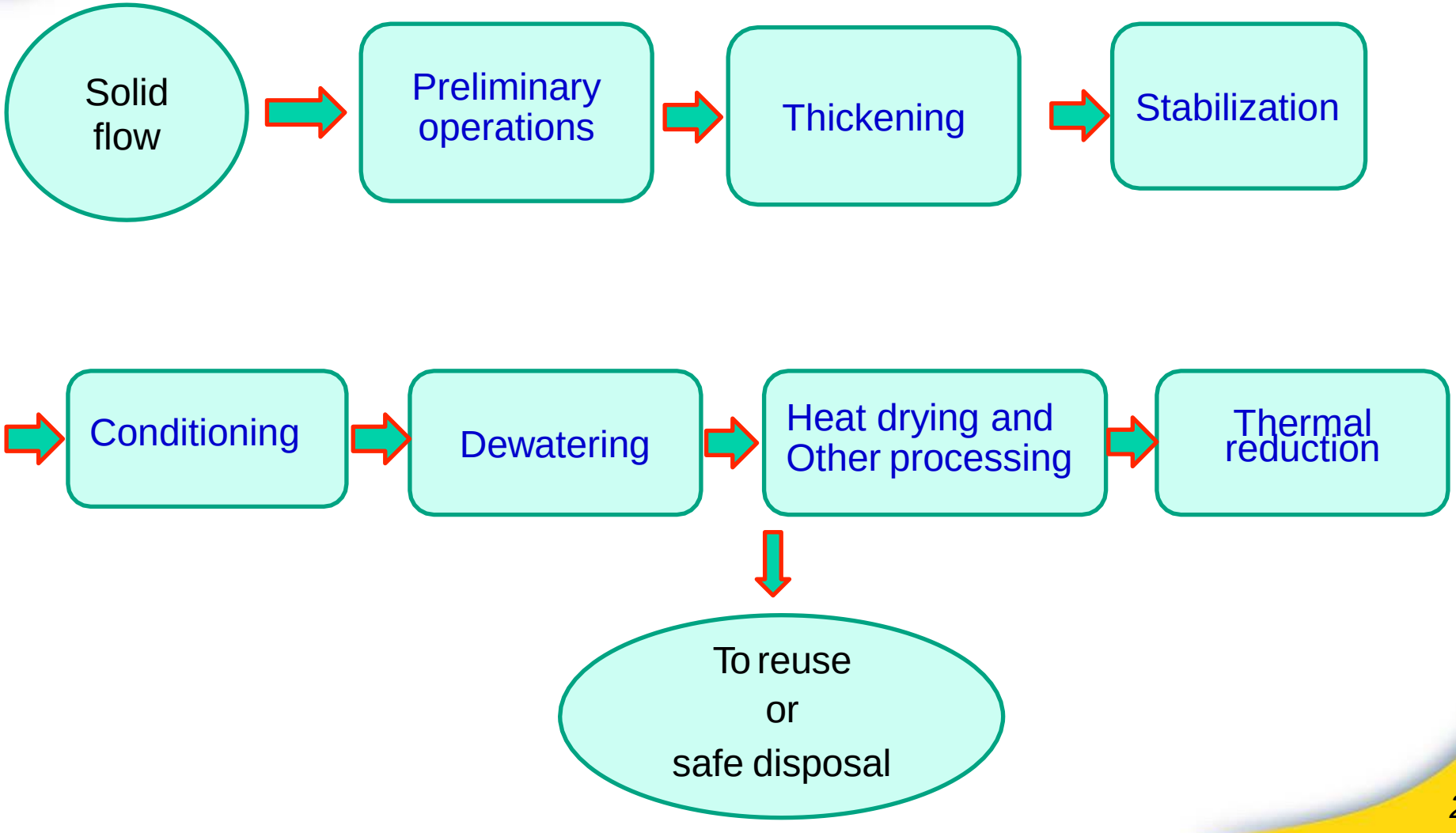
Membrane Filtration







Biosolids treatment: A to Z



Air Pollution Control

Common air pollutants (NAAQS): PM & Gases

Control of Stationary Sources: Gaseous pollutants

- **Incinerators**
  - Thermal
  - Catalytic
  - Flares
  - Boiler
- **Adsorber**
- **Absorber**

Control of Stationary Sources: PM

- **Venturi**
- **Fabric filter (baghouse)**
- **Settling champer**
- **Momentum separator**
- **Cyclone**
- **Electrostatic precipitator**

Your way to be an environmentalist!

Go Green!!