

ANNEX 3

Table of Separation Technologies

colors according to type of separation

Technology name	Separation Principle	Driving force	Process/Strategy	Function	Continuous/Discontin	Type of Separation
Cryogenic distillation/separation system	Cryogenic separation	Heat	liquefaction by cooling (then distillation) Separation by freezing	Separate gas/liquid from gas stream Separate solids from solids	discont	Gas-Gas
Cyclones and Hydrocyclones	Density Separation - Sedimentation by gravity and centrifugation	Gravity Centrifugal force	Sedimentation/Liquids Separation via gravity and centrifugal force	Separate two liquids/Separate solids/liquid from liquid/air.	Contin/discont	Gas-Liquids
Coalescers	Density Separation enhanced by coalescence and electric field	Gravity, Surface energy, Van der Waal forces Electric field	Separation via coalescence by interception and hydrophobicity/philicity or by electric fields (dehydration and desalting)	Separate two Liquids or Liquid from gas	Contin/discont	Gas-Liquids
Wet and Dry Scrubbers	Depth filtration assisted by chemical reactions and adsorption	Hydraulic pressure Absorption Adsorption (surface energy)	Chemical reaction and or Depth filtration (absorption/adsorption)	Separate (and recover) liquid or solids from gas streams	discont	Gas-Liquids
Mist Eliminators	Surface Filtration Depth Filtration	Coalescence Gravity	Surface filtration than coalescence and depth filtration	Separate liquid from gas streams	discont	Gas-Liquids
Strainers	Surface - Dead-end Filtration	Hydrostatic pressure	Liquid/air Surface filtration via meshed surfaces	Separate solids from air and liquid of different viscosity	Contin/discont but limitation for contin.	Gas-Solids
Panel Filters	Surface - Dead-end Filtration	Gas pressure	Gas Surface filtration	Separate (and recover) solids from air/gas.	discont	Gas-Solids
Pad filters	Depth Filtration	Gas pressure	Gas Depth filtration	Separate (and recover) solids from air/gas.	discont	Gas-Solids
Bag Filters	Surface - Dead-end Filtration Depth Filtration	Gas pressure Hydraulic pressure	Liquid and gas Surface/Depth filtration depending on media. Also some cake formation	Separate (and recover) solids from liquid and air/gas.	discont	Gas-Solids
Pocket filters	Surface - Dead-end Filtration Depth Filtration	Gas pressure	Gas Surface/Depth filtration	Separate solids from air/gas.	discont	Gas-Solids
Candle filters	Surface - Cake Filtration	Hydraulic pressure Gas pressure	Liquid/gas Surface filtration (cake formation and removal)	Separate (and recover) solids from liquid and gas streams	discont	Gas-Solids
Capsule filters	Depth Filtration	Hydraulic pressure	Liquid/air Depth filtration	Separate solids (bacteria) from liquid and gas streams	discont	Gas-Solids
Cartridge Filters thin media	Surface - Dead-end Filtration	Hydraulic pressure Gas pressure	Liquid/air surface filtration	Separate (and recover) solids from liquid and air/gas.	discont	Gas-Solids
Cyclones and Hydrocyclones	Density Separation - Sedimentation by gravity and centrifugation	Gravity Centrifugal force	Sedimentation/Liquids Separation via gravity and centrifugal force	Separate two liquids/Separate solids/liquid from liquid/air.	Contin/discont	Gas-Solids
Wet and Dry Scrubbers	Depth filtration assisted by chemical reactions and adsorption	Hydraulic pressure Absorption Adsorption (surface energy)	Chemical reaction and or Depth filtration (absorption/adsorption)	Separate (and recover) liquid or solids from gas streams	discont	Gas-Solids

Electrostatic Precipitators	Electrostatic precipitation	Electric field	Separation charging particles via electric field	Separate solids from gasses	discont	Gas-Solids
Acoustic Wave separators (acoustophoresis)	Acoustophoresis	Acoustic pressure	Separation by orthokinetics via acoustic waves	Separate solids or liquid from liquid or gas stream	Contin/discont	Gas-Solids
Solid (cascade) impactors	Surface - Dead-End filtration	Gas pressure	Separation by inertia increased via change of direction	Separate solids from gas stream	discont	Gas-Solids
Adsorption filters (Activated Carbon and others)	Depth Filtration by adsorption (Activated Carbon Filtration)	Hydrostatic pressure Hydraulic pressure Adsorption (surface energy)	Depth filtration via Adsorption (physical/chemical) via Van der Waal forces or chemical bonds	Separate solids from liquid or gasses.	discont	Gas-Solids-molecules
Vapor-Liquid separator	Density Separation - Vapor-Liquid Separation	Vapour/Heat	Separation of gas from liquid via pressure reduction	Separate gas from liquid	Conti/discont	Liquid-Gas
Centrifuges (sedim)	Density Separation - Sedimentation by centrifugation	Centrifugal force	Sedimentation/Liquids Separation via centrifugal force	Separate two liquids/ Separate solids from liquid. Clarification	contin/discont	Liquid-Liquids
Cyclones and Hydrocyclones	Density Separation - Sedimentation by gravity and centrifugation	Gravity Centrifugal force	Sedimentation/Liquids Separation via gravity and centrifugal force	Separate two liquids/ Separate solids/liquid from liquid/air.	Contin/discont	Liquid-Liquids
Coalescers	Density Separation enhanced by coalescence and electric field	Gravity, Surface energy, Van der Waal forces Electric field	Separation via coalescence by interception and hydrophobicity/philicity or by electric fields (dehydration and desalting)	Separate two Liquids or Liquid from gas	Contin/discont	Liquid-Liquids
Distillers	Phase change separation - Distillation	Heat	Evaporation and condensation	Separate liquid from a mixture	contin/discont	Liquid-Liquids
Freeze desalination/cryodesalination apparatus	Phase change separation - Freeze desalination	Heat	Separation of liquids by freezing (freezing points difference)	Separate liquid from liquid	discont	Liquid-Liquids
Extraction (Hydrometallurgy)	Phase change separation - Leaching Partitioning	Redox potential	Extraction via leaching using solvent or/and partitioning	Separate solids from solids	discont	Liquid-Liquids
Flotation/Froth flotation system	Density Separation enhanced by Flotation and use of surfactants	Gravity Surface Energy	Separation by differential density and hydrophobicity via air bubbles	Separate solid/oil from liquid	discont	Liquid-Liquids
Stripping system	Phase change separation - Stripping	Vapour/Heat	Separation via vaporization of liquid via vapour stream	Separate liquids from liquid	contin/discont	Liquid-Liquids
Recrystallization apparatus	Phase change separation - Recrystallization	Heat	Separate by transforming via chemical reaction	Separate liquids from liquid	discont	Liquid-Liquids
Acoustic Wave separators (acoustophoresis)	Acoustophoresis	Acoustic pressure	Separation by orthokinetics via acoustic waves	Separate solids or liquid from liquid or gas stream	Contin/discont	Liquid-Liquids
Dialysis /electrodialysis system	Dialysis Electro Dialysis	Chemical Potential Hydraulic Pressure Electric field	Surface filtration via semi-permeable membrane enhanced by electrical field	Separate molecules from liquid (blood)	contin/discont	Liquid-Molecules
Membrane filtration Systems	Surface - Dead-End Filtration Surface - Cross-Flow Filtration	Hydraulic pressure Chemical Potential Osmotic potential	Liquid cross-flow, dead-end surface filtration via pressure/Reverse/forward Osmosis. Micro, Ultra, Nano filtration, dynamic cross flow filtration	Separate solids/molecules from liquid.	contin/discont	Liquid-Molecules

Distillers	Phase change separation - Distillation	Heat	Evaporation and condensation	Separate liquid from a mixture	contin/discont	Liquid-Molecules
Electrophoresis apparatus	Electrokinetic Separation - Electrophoresis	Electric field	Separation by size via electrical charges	Separate molecules from liquid	Contin/discont	Liquid-Molecules
Electro-osmosis system	Electrokinetic separation - Electro-osmosis	Electric field	Separation by size via electrical charges	Separate molecules from liquid	discont	Liquid-Molecules
Gel filtration system	Gel filtration	hydraulic pressure diffusion	Separation by size via gel membrane	Separate (classify) molecules from liquid	discont	Liquid-Molecules
Polymer melt filters	Surface - Dead-end Filtration	Hydraulic pressure	High viscosity Surface filtration	Separate solids from polymer melt	discont/continuous	Liquid-Solids
Strainers	Surface - Dead-end Filtration	Hydrostatic pressure	Liquid/air Surface filtration via meshed surfaces	Separate solids from air and liquid of different viscosity	Contin/discont but limitation for contin.	Liquid-Solids
Screens	Surface - Dead-end Filtration	Hydrostatic pressure	Liquid/air Surface filtration via meshed surfaces	Separate solids from liquid of different viscosity or separating mixtures of solids	Contin/discont	Liquid-Solids
Nutsche Filters	Surface - Cake Filtration	Gas pressure (vacuum)	Liquid Surface filtration via suction (cake formation and removal)	Separate (and recover) solids from liquids	discont	Liquid-Solids
Tipping Pan and Table Filters	Surface - Cake Filtration	Gas pressure (vacuum)	Liquid Surface filtration via vacuum or air flow (cake formation and removal)	Separate (and recover) solids from liquids	contin/discont depending on solution	Liquid-Solids
Rotary Drum Filters	Surface - Cake Filtration (assisted by body feed filtration)	Gas pressure (vacuum)	Liquid Surface filtration via vacuum or pressurized (cake formation and removal)	Separate (and recover) solids from liquids. Also moderate clarification and slow settling liquid solid.	continuous	Liquid-Solids
Rotary Disc Filters	Surface - Cake Filtration (assisted by body feed filtration)	Gas pressure (vacuum)	Liquid Surface filtration via vacuum (cake formation and removal)	Separate (and recover) solids from liquids	continuous	Liquid-Solids
Horizontal Belt Filters	Surface - Cake Filtration	Gas pressure (vacuum)	Liquid Surface filtration via vacuum, gravity, pressed belt on cake (cake formation and removal)	Separate (and recover) solids from liquids (with high solids concentration).	Continuous	Liquid-Solids
Centrifugal Filters	Surface - Cake Filtration	Centrifugal force	Liquid Surface filtration via centrifugal forces (cake formation and removal)	Separate (and recover) solids from liquids	discont. Some almost continuous	Liquid-Solids
Bag Filters	Surface - Dead-end Filtration Depth Filtration	Gas pressure Hydraulic pressure	Liquid and gas Surface/Depth filtration depending on media. Also some cake formation	Separate (and recover) solids from liquid and air/gas.	discont	Liquid-Solids
Candle filters	Surface - Cake Filtration	Hydraulic pressure Gas pressure	Liquid/gas Surface filtration (cake formation and removal)	Separate (and recover) solids from liquid and gas streams	discont	Liquid-Solids
Capsule filters	Depth Filtration	Hydraulic pressure	Liquid/air Depth filtration	Separate solids (bacteria) from liquid and gas streams	discont	Liquid-Solids
Cartridge Filters thin media	Surface - Dead-end Filtration	Hydraulic pressure Gas pressure	Liquid/air surface filtration	Separate (and recover) solids from liquid and air/gas.	discont	Liquid-Solids

Cartridge filters Thick media	Depth Filtration	Hydraulic pressure	Liquid Depth filtration	Separate (and recover) solids from liquids	discont	Liquid-Solids
Yarn-Wound cartridge	Depth Filtration	Hydraulic pressure	Liquid Depth filtration	Separate solids from liquids	discont	Liquid-Solids
Constructed cartridges	Depth Filtration	Hydraulic pressure	Liquid Depth filtration	Separate solids from liquids	discont	Liquid-Solids
Lenticular discs filters	Depth Filtration	Hydraulic pressure	Liquid Depth filtration	Separate solids from liquids	discont	Liquid-Solids
Stacked discs filters	Depth Filtration	Hydraulic pressure	Liquid Depth filtration	Separate solids from liquids	discont	Liquid-Solids
Leaf and Plate Filters	Surface - Cake Filtration	Hydraulic pressure	Liquid Surface filtration (cake formation and removal)	Separate (and recover) solids from liquid. Also clarification	discont	Liquid-Solids
Filter Presses	Surface - Cake Filtration	Mechanical pressure	Liquid Surface filtration via pressure (cake formation and removal)	Separate (and recover) solids from liquids	Contin/discont	Liquid-Solids
Variable Volume Filters	Surface - Cake Filtration	Mechanical pressure	Liquid Surface filtration via pressure (cake formation and removal)	Separate (and recover) solids from liquid.	discont	Liquid-Solids
Screw Presses	Surface - Cake Filtration	Mechanical pressure	Liquid Surface filtration (cake formation and removal)	Separate (and recover) solids from liquids	discont	Liquid-Solids
Magnetic Filters	Magnetic Separation	Magnetic field	Liquid Surface filtration assisted by magnetic field (cake formation and removal)	Separate ferrous particles from liquid.	discont	Liquid-Solids
Electrically Aided Filters	Electrically aided Surface - Dead-End Filtration	Electric field	Liquid/Air Surface filtration via electric field	Separate (and recover) solids from liquid and air stream.	discont	Liquid-Solids
Deep-Bed Filters	Depth Filtration	Hydrostatic pressure	Liquid Depth/Surface / Cake filtration	Separate solids from liquid. Clarification	discont	Liquid-Solids
Sedimenting Separators	Density Separation - Sedimentation by gravity	Gravity (same/opposite direction)	Sedimentation via gravity or air bubble (coagulation and floatation)	Separate solids from liquid. Clarification	discont	Liquid-Solids
Centrifuges (sedim)	Density Separation - Sedimentation by centrifugation	Centrifugal force	Sedimentation/Liquids Separation via centrifugal force	Separate two liquids/ Separate solids from liquid. Clarification	contin/discont	Liquid-Solids
Cyclones and Hydrocyclones	Density Separation - Sedimentation by gravity and centrifugation	Gravity Centrifugal force	Sedimentation/Liquids Separation via gravity and centrifugal force	Separate two liquids/Separate solids/liquid from liquid/air.	Contin/discont	Liquid-Solids
Gravity concentrator	Gravity Separation	Gravity	Separation via gravity provoked by floatation, vibrations, centrifugal force, pressure,	Separate (and recover) solids from liquid and solids mxtures	Conti/discont	Liquid-Solids
Diaelectric separator	Diaelectric Separation	Electric field	Separation via difference in diaelectric constant via electric field	Separate (and recover) solids from liquids	discont	Liquid-Solids
Flotation/Froth flotation system	Density Separation enhanced by Flotation and use of surfactants	Gravity Surface Energy	Separation by differential density and hydrophobicity via air bubbles	Separate solid/oil from liquid	discont	Liquid-Solids

Field flow fractioning apparatus	Density Separation - Fractioning enhanced by field flow	Hydraulic pressure Gravity Centrifugal force Heat Electric field Magnetic field	Separation via perpendicular force fields	Separate solids from liquid	Contin/discont	Liquid-Solids
Flocculation system	Density Separation - Sedimentation enhanced by Flocculation	Hydrostatic pressure Gravity	Separation via flocculation of colloids suspension	Separate solids from liquid	discont	Liquid-Solids
Acoustic Wave separators (acoustophoresis)	Acoustophoresis	Acoustic pressure	Separation by orthokinetics via acoustic waves	Separate solids or liquid from liquid or gas stream	Contin/discont	Liquid-Solids
Adsorption filters (Activated Carbon and others)	Depth Filtration by adsorption (Activated Carbon Filtration)	Hydrostatic pressure Hydraulic pressure Adsorption (surface energy)	Depth filtration via Adsorption (physical/chemical) via Van der Waal forces or chemical bonds	Separate solids from liquid or gasses.	discont	Liquid-Solids-Molecules
Optical tweezers	Optical sorting	Optical force	Separation via light beams	Separate solids, molecules from liquid	Contin	Liquid-Solids-Molecules
Evaporators and dryers	Phase change separation - Evaporation dehydration	Heat	Evaporation	Separate liquid from solids	Continuous	Solids-Liquids
Acoustic Wave separators (acoustophoresis)	Acoustophoresis	Acoustic pressure	Separation by orthokinetics via acoustic waves	Separate solids or liquid from liquid or gas stream	Contin/discont	Solids-Liquids
Screens	Surface - Dead-end Filtration	Hydrostatic pressure	Liquid/air Surface filtration via meshed surfaces	Separate solids from liquid of different viscosity or separating mixtures of solids	Contin/discont	Solids-Solids
Cyclones and Hydrocyclones	Density Separation - Sedimentation by gravity and centrifugation	Gravity Centrifugal force	Sedimentation/Liquids Separation via gravity and centrifugal force	Separate two liquids/Separate solids/liquid from liquid/air.	Contin/discont	Solids-Solids
Gravity concentrator	Gravity Separation	Gravity	Separation via gravity provoked by floatation, vibrations, centrifugal force, pressure,	Separate (and recover) solids from liquid and solids mixtures	Conti/discont	Solids-Solids
Sublimation apparatus	Phase change separation - Sublimation	Heat	Separation via sublimation	Separate (and recover) solids from solids mixture	discont	Solids-Solids
Cryogenic distillation/ separation system	Cryogenic separation	Heat	liquefaction by cooling (then distillation) Separation by freezing	Separate gas/liquid from gas stream Separate solids from solids	discont	Solids-Solids
Extraction/Transformation - Pyrometallurgy processes	Phase change separation - Roasting Smelting Calcining Refining	Heat	Separation by physical/chemical transformation via heat	Separate solids from solids	discont	Solids-Solids
Extraction (Hydrometallurgy)	Phase change separation - Leaching Partitioning	Redox potential	Extraction via leaching using solvent or/and partitioning	Separate solids from solids	discont	Solids-Solids
Elutriation system (air classifier)	Density Separation - Sedimentation - Elutriation	Gas Pressure Gravity (opposite direction)	Separation by different terminal sedimentation velocities via fluid stream opposite to sedimentation direction (gravity)	Separate solids from solids	discont	Solids-Solids
Winnowing	Density Separation - Sedimentation - Elutriation	Gas Pressure Gravity (opposite direction)	Separation by different terminal sedimentation velocities via pulsing opposite to sedimentation direction (gravity)	Separate solids from solids	discont	Solids-Solids

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