SEP

Creating Innovation Everyday

Our mission is to generate more sustainable, efficient and high-quality production for global industry.

Our vision is to create innovation that supports a better life. We achieve this by generating more sustainable, efficient and high-quality production for global industry by combining deep know-how and experience to create customized technological and chemical solutions with innovative methods.

Our aim is to have a positive impact

This work has vital impact for our clients and their businesses, but also goes beyond this, effecting the ecosystem of our society and the planet at large. At SEP, we are constantly working to reduce waste, increase quality and improve the efficiency of existing and new production processes in a way that utilizes less energy and resources to the greater benefit of many. Our team takes great pride in their work and invest themselves deeply in each project and client relationship, resulting in genuine partnership and real accountability.

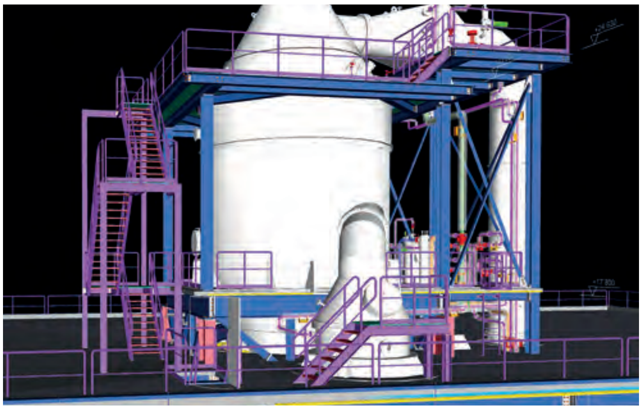
We nurture independent thinking to the benefit of our clients

Due to our size and our goal to provide high quality service, our clients have direct access to our experts and leaders. As we also have a vested interest in the ownership of the company itself, we feel collectively responsible for the success of every project. Integral to SEP's founding vision is the support of independent thinking, allowing us the freedom to make decisions that ultimately benefit the work and the client first and foremost. This is deeply fulfilling for both parties.

Our Company

SEP Salt & Evaporation Plants Ltd. was founded by a team of engineers who are specialists in the field of Evaporation and Crystallisation Technology and are accredited leaders in their fields of expertise.

The company‘s founding members demonstrate their commitment to the success of SEP Salt & Evaporation Plants Ltd. through their shareholding in the company.
The positive response of the market to SEP Salt & Evaporation Plants has been shown by the award of key orders not only for engineering for very large plants but also for the supply of plants based upon new in-house developed technology. SEP is selected because of its ability to develop process concepts that minimize capital and operating costs.
SEP is the natural partner for revamping existing plants to improve product quality, boost capacity or increase economy. The extensive experience of the engineering team which has been gained through the design of a wide range of plants and cemented by the practical knowledge gained through their on site supervision of commissioning builds a sound basis for undertaking such work.



MVR Crystallizer in Planning

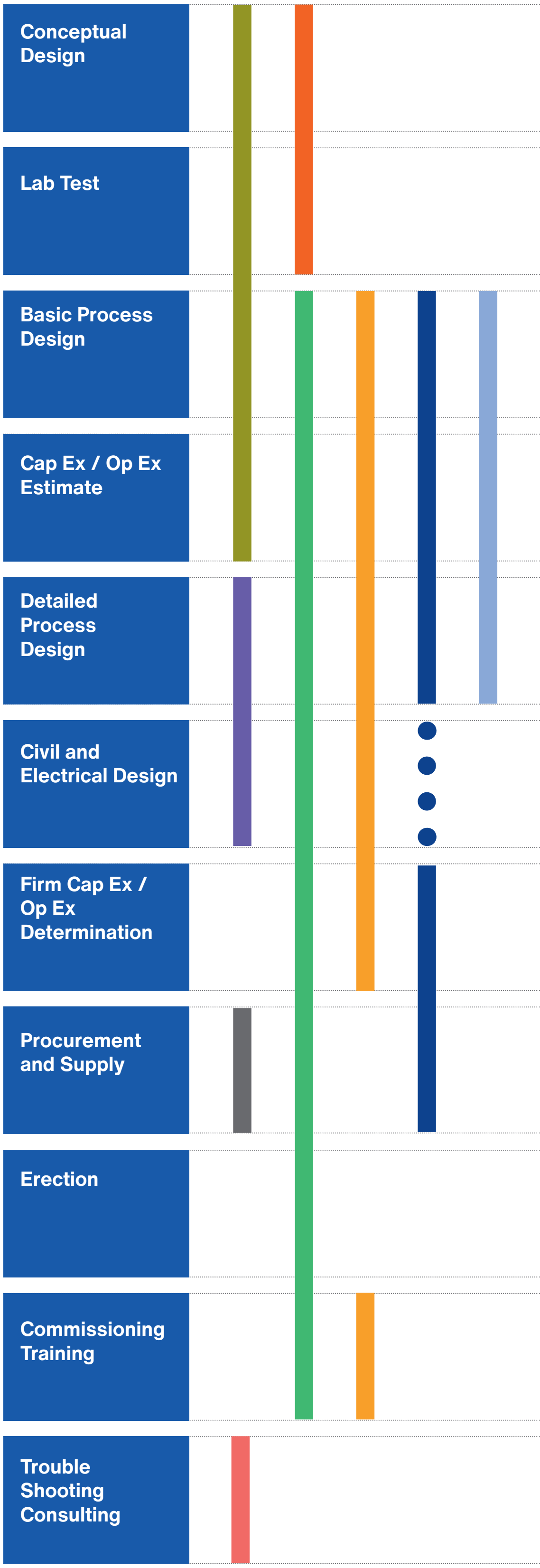
MVR crystallizer under construction

Our Services

Our engineering team has great expertise designing a wide-range of plants in addition to improving production processes for existing facilities. This has been developed over many years by practical knowledge gained through on-site supervision of new plants and revamps.

Our expert understanding of proven and previously tested technologies and processes combined with our creative approach allows us to utilize all our existing knowledge to develop unique and customized applications for each new challenge and seemingly «unsolvable» problems.

Our services can be grouped in customized scope packages depending on our client's needs and project phase.



The blue fields represent the progression of project phases, and the labeled lines above represent scope packages. These are the typical scope packages, but we are able to completely customize the scope engagement based on the individual client's needs.

Engineering Scope

This can be basic and/or detailed engineering, comprising the preliminary documentation for the first phase of a project or even final design work in order to enter into the execution phase of the plant realization.

Engineering and Supply

Classic engineering scope as above including the procurement and supply of the equipment, putting SEPs know-how and long-term experience in the procurement process in order to give stronger process guarantees. Everything out of one hand, from process idea to the delivered equipment.

EPCM

Engineering, Procurement and Construction Management. The full engineering for the plant realization including procurement support for our client's purchasing processes. Well-suited for a combination with start-up services.

Start-Up

Putting the plant into operation, optimizing process and control parameters, confirmation of the plant performance and training of the operating personel.

R&D

From the development of process concepts to the final report generation.

Turn-Key

Project management and execution from basic engineering until final plant acceptance. SEP can be in the role of the general contractor or the designated sub-supplier to a local contractor.

Study

Comparison of different cases or investigation of one process to find the best option under process, environmental and cost aspects. Determination of the technical and/or commercial feasibility of a project to support investment decisions.

Detailed Plant Design

Continuation of a successful study or basic engineering phase in order to evolve the project to the procurement phase.

Spare Parts / Revamp

Supply of commissioning spares, spares for 2-years operation and replacement of key-equipment or parts of it.

Existing Plant Assessment and Improvement

Improvement of non-SEP plants. Analysis of existing process and elaboration of improvement of plant performance, including changes in equipment design and process parameters.

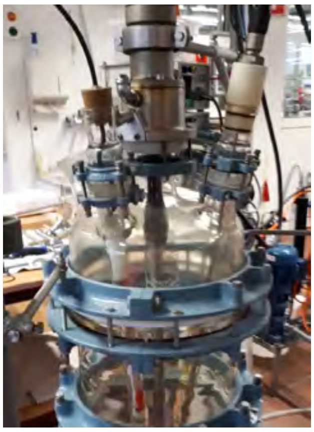
Research & Development at SEP

SEP has its own R&D department. We undertake independent research into industry relevant issues. Clients request us to explore targeted challenges in order to uncover unique and innovative solutions. We also conduct laboratory and bench scale tests on-site.

We provide comprehensive R&D reports useful for obtaining applicable processes and in assisting our clients to make vital investment decisions. Our experience is highlighted by discovering new processes and applications for Salts (Drinking Water Recovery, Solution Mining and Waste Handling), Lithium Compounds (exploring the concentration of Lithium containing solutions for recovery of Lithium products like Hydroxide or Carbonate) and Pre-Treatment of Waste Water. SEP‘s R&D department has its own laboratory and pilot equipment for process investigations and is available for clients to rent for on-site tests. This equipment is ideal for DTB simulation and testing salt dissolution for the recrystallisation process, cooling crystallisation as well as investigation of the salt leg efficiency.

Our University Engagement

Working closely with engineering departments at local universities, SEP conducts experimental procedures in the form of lab scale, bench scale and pilot tests. The findings from these experiments support the evolution of our work in Salt, Lithium Compounds and Waste Water treatment.



Our Focus

- To be able to assist our clients more comprehensively in addressing requirements for environmental protection.
- Researching how to more effectively concentrate valuable Lithium compounds from different sources in order to support industry's ever-growing investment in renewable energy.
- Supporting the optimization of existing plants, reducing waste by avoiding the need for a completely new green field construction.

Our Research and Development process outlined below can be the interface to Process Design, which allows SEP and the client to move forward with equipment design, operational cost calculation and capital expenditure estimates.

Research and Development Process

Raw material Analysis	Based on Client's business idea, key chemical and physical parameters of representative samples provided by Clients are determined in SEP or partner labs.
Process Concept Development	A process concept is developed based on Client objectives, raw material analysis, literature, and patent survey as well as SEP's vast experience in this field.
Process Verification	Based on SEP's data base of solubilities and physical properties supplemented by data from literature research basic process concepts and overall mass balances are developed. The process risk is assessed showing where data are secured and where uncertainties exist.
Pilot Plant Operation	Key process steps are tested in a Pilot Plant. SEP designs and supplies pilot plants for onsite-testing and establishes and locally supervises corresponding test programs. Or SEP arranges and supervises test programs in SEP or third-party bench scale or pilot facilities.
Process Optimization	Based on the results of the previous steps, process options are investigated, or processes are optimized as per Client's business idea and techno-economic conditions.
Final Report	Irrespective of the scope of R&D work requested, SEP's report will include the findings of the research, applicable theories, testing methods used, data obtained, interpretation of the results and conclusions regarding applicability of the investigated process concepts for the Client's business idea. This report serves as basis for Scale-up.


Experience
Salt
Chemicals
Fertilizer
Waste Water

Salt

Brine Treatment

Brine purification removes calcium and magnesium from the evaporator feed, improving the on-stream time of the evaporation plant, and the purity of the final product.

Value

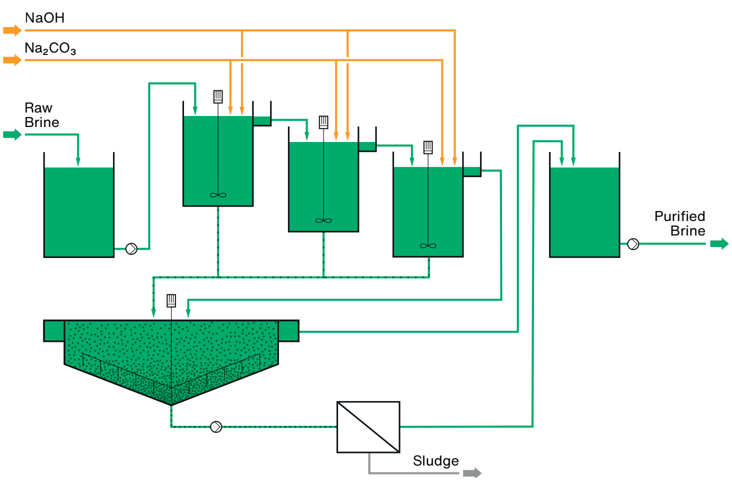
- Improved purity of the salt product
- Extended lifetime of plant equipment
- Reduced energy consumption in the evaporation process
- Fewer cleaning cycles
- Low sodium carbonate consumption
- Optimization of mother liquor recycle
- also applicable for salty industrial waste water
- removal of heavy metals as hydroxides

General Process

- Reactive precipitation of calcium carbonate and magnesium hydroxide
- Reactants are sodium hydroxide and sodium carbonate
- Can be conducted as a batch or continuous process
- Optimum design for sedimentation, thickening and filtration

Flow Diagram

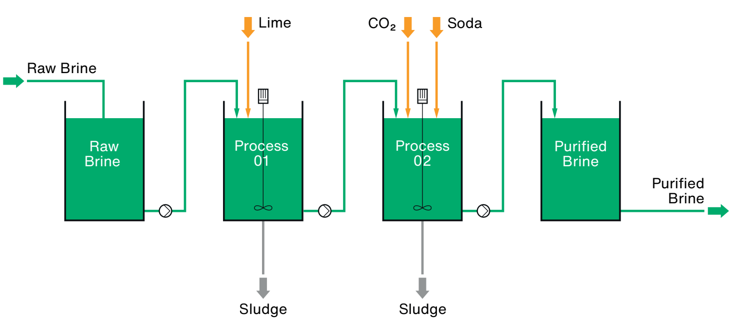
$MgSO_4$	$+ 2\,NaOH$	$\rightarrow Mg(OH)_2\downarrow$	$+ Na_2SO_4$
$CaCl_2$	$+ Na_2CO_3$	$\rightarrow CaCO_3\downarrow$	$+ 2\,NaCl$



Schweizerhalle Process

- Chemicals used: calcium oxide or hydroxide, carbon dioxide, sodium carbonate
- Sodium hydroxide is no longer needed
- Carbon dioxide replaces the more expensive sodium carbonate
- Conducted as a batch process

$MgSO_4$	$+ Ca(OH)_2$	$\rightarrow Mg(OH)_2\downarrow$	$+ CaSO_4$
$CaCl_2$	$+ Na_2CO_3$	$\rightarrow CaCO_3\downarrow$	$+ 2\,NaCl$
$2NaOH$	$+ CO_2 + CaSO_4$	$\rightarrow CaCO_3\downarrow$	$+ Na_2SO_4 + H_2O$



Salt

Vacuum Salt

Crystalline sodium chloride, commonly known as vacuum salt, is produced by evaporative crystallisation. The energy source for the evaporation can be thermal or electrical energy resulting in various plant configurations, Specifically Mechanical Vapour Recompression (MVR), Multiple Effect Evaporation (MEE) and Thermal Vapour Recompression (TVR). All three plant configurations can generate high quality product and condensate.

Mechanical Vapour Recompression (MVR)

MVR technology enables salt producers to benefit from lower operating costs where the relative price of electricity is more attractive than that of steam.

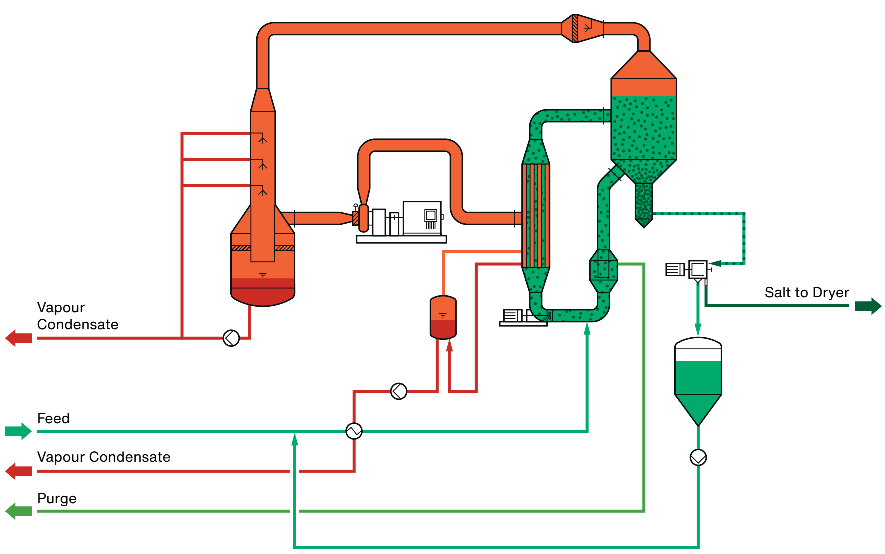
Value

- Low carbon footprint
- Small boiler investment
- Reduced building costs due to compact plant design
- Low cooling water consumption
- Easy Operation
- Higher Quality Condensate

Process

- Brine preheating
- Evaporation / Crystallisation
- Vapour scrubbing
- Vapour recompression
- Centrifugation
- Drying

Flow Diagram



Impeller for Turbo Compressor

Turbo Compressor

Multiple Effect Evaporation (MEE)

MEE technology provides a low-cost and flexible operating solution if the use of steam for evaporation is acceptable.

Value

- Simple and robust operation
- High operational flexibility
- Longer life-span of equipment due to lower process temperatures

Process

- Brine preheating
- Serial reuse of process vapour
- 1-6 evaporative crystallisers
- Final vapour condensation
- Centrifugation
- Drying

Multiple Effect Evaporators for Pharma Salt

Multiple Effect Evaporators for Sodium Chloride Production

Thermal Vapour Recompression (TVR)

TVR technology is a variant of MEE which increases the energy efficiency of the steam at the expense of a higher operational cost for the boiler.

Value

- Simple and robust operation
- Improved energy efficiency
- Higher return on investment
- Improves the performance of a MEE plant

Process

- Brine preheating
- Combination of boiler steam and process vapour as the energy source
- 1-6 evaporative crystallisers
- Final vapour condensation
- Centrifugation
- Drying

Pure dry Salt Storage Pile

Droplet Separator in Vapour Duct

Salt

Sodium Chloride Purification by Recrystallisation

The purification of rock or solar salt through recrystallisation is an energy efficient way to produce high quality vacuum salt.

Related Technologies

- **Thermal Vapour Recompression (TVR)**
- **Mechanical Vapour Recompression (MVR)**
- **Multiple Effect Evaporation (MEE)**
- **Flash Evaporation / Crystallisation**

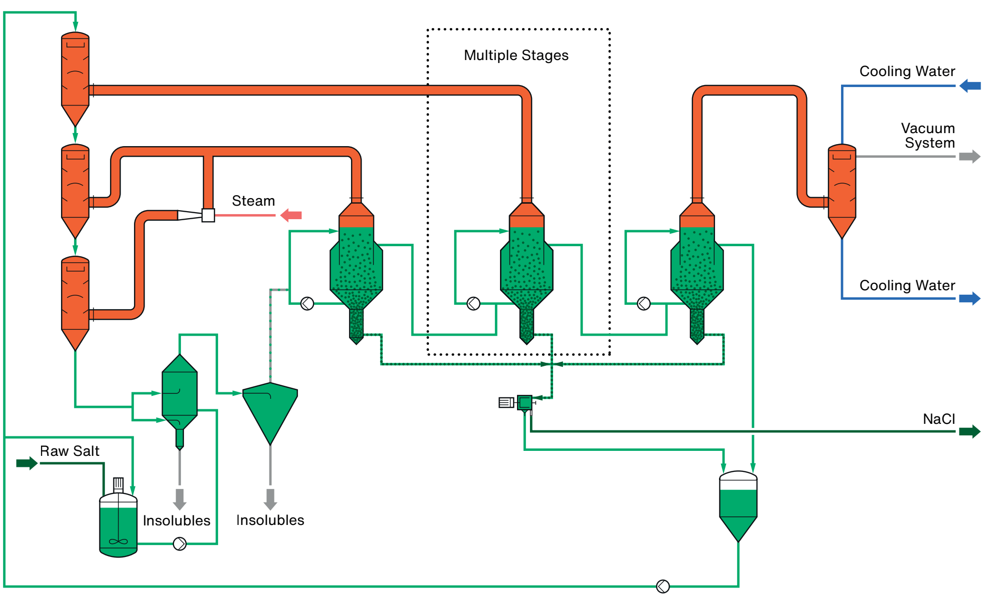
Value

- High product purity at low capital cost (no brine purification is required)
- High degree of fluctuations in raw salt composition is acceptable with minimum impact on product quality
- High energy efficiency and lower operating cost
- Longer operating cycle due to design that reduces scale formation

Process

- MEE or MVR can be employed
- Proprietary design allows for more robust solid-liquid separation
- Non-scaling heat transfer characteristics

Flow Diagram




Pusher-Type Centrifuge


Elbow-Type Circulation Pump

Depleted Brine Concentration

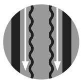
Depleted brine is a by-product of chlor-alkali plants that needs to be concentrated. Specifically sodium sulphate can be recovered as a valuable product.

Related Tools


Mechanical Vapour Recompression (MVR)


Multiple Effect Evaporation (MEE)


Forced Circulation Evaporator / Crystalliser (FC)


Falling Film Evaporator (FFE)

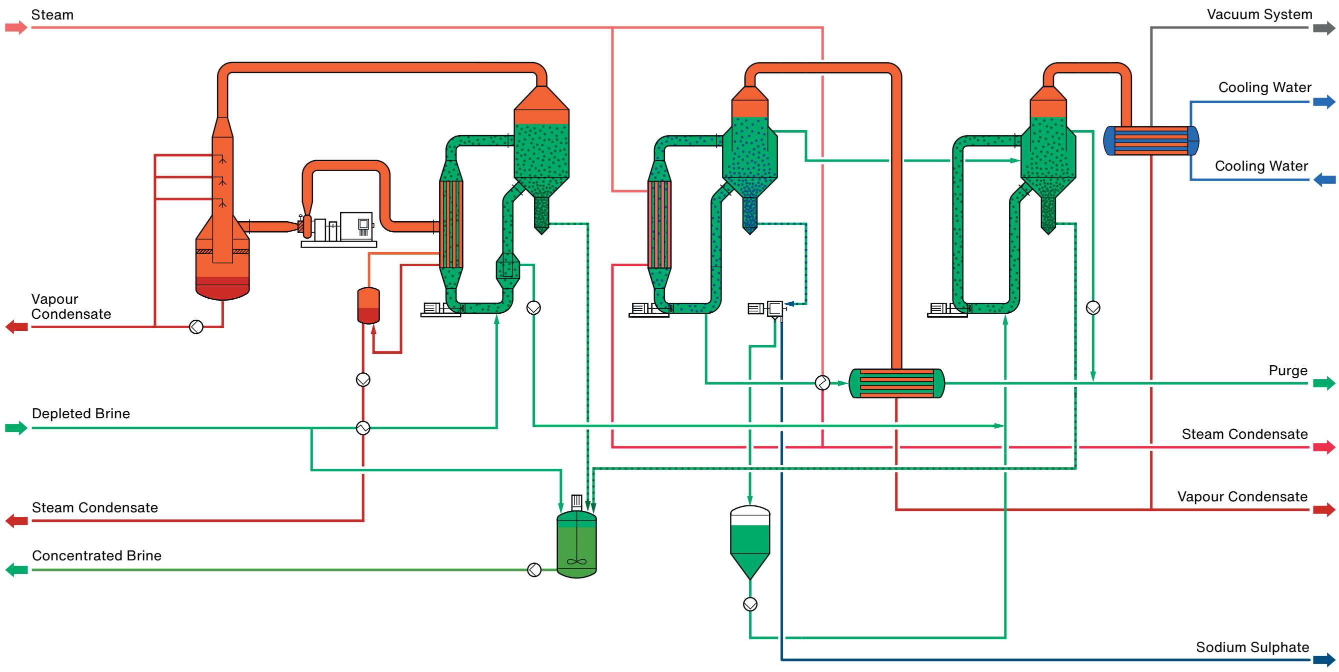
Value

- Reduced equipment size through innovative plant design
- Minimal sodium chloride losses
- High purity sodium sulphate product
- Potential to selectively recover sodium iodide
- Exact control of return brine concentration
- High plant availability

Process

- Feedstock of depleted brine from chlor-alkali plants – all concentrations
- Multiple Effect Evaporation and Mechanical Vapour Recompression are used to concentrate the brine
- Falling Film and Forced Circulation technology can be used in combination
- Sodium sulphate can be removed by crystallisation, filtration and centrifugation
- Concentrated brine returned to the chlor-alkali plant

Flow Diagram



Chemicals

Calcium Chloride from Limestone

Calcium chloride is a product of neutralization of hydrochloric acid with limestone and serves as a basic component for the chemical, food, and construction industries. This chemical is typically produced in the form of flakes or granules.

Related Technologies

- **Thermal Vapour Recompression (TVR)**
- **Multiple Effect Evaporation (MEE)**
- **Rising Film Evaporator**
- **Forced Circulation Evaporator / Crystalliser (FC)**

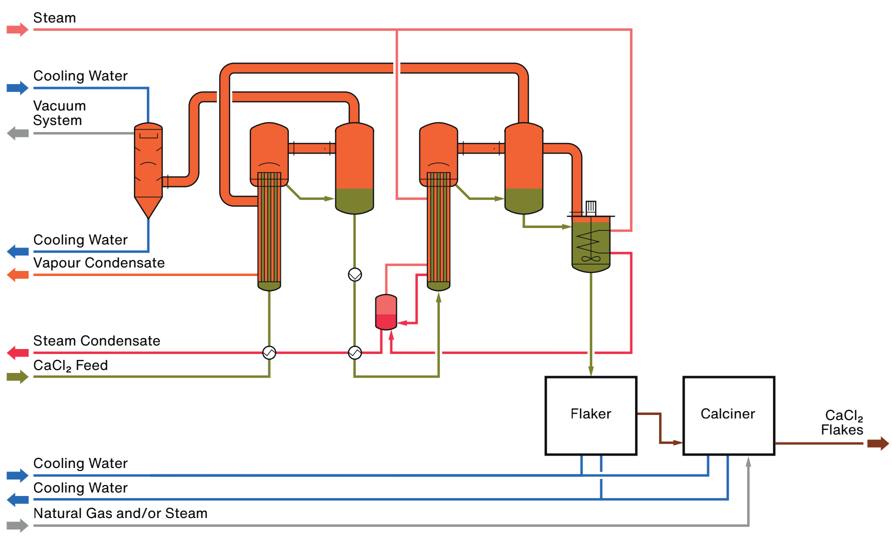
Value

- High temperature differences and proven material of construction ensure optimal equipment design
- Multiple Effect Evaporator achieves high energy efficiency
- A variety of feedstocks can be accommodated using Rising Film or Forced Circulation Evaporator
- Feedstocks include: All concentrations of aqueous calcium chloride
- Salt brines from the soda industry (soda ash); and by reaction of hydrochloric acid and limestone
- Sources of hydrochloric acid can be byproduct of chlorination of organics: $Cl_2 + R\text{-}H \rightarrow R\text{-}Cl + HCl$
- reduction of chlorine gas by hydrogen as bypro-ducts of chlorine alkali electrolysis: $Cl_2 + H_2 \rightarrow 2\ HCl$

Process

- Concentration in field-proven evaporator equipment
- Calcium chloride flakes 78–80% (via flakers and calciners)
- Calcium chloride granules 78–80% or 95–98% (via fluid bed granulators)

Flow Diagram



Aluminate Liquor

Weak aluminate liquor (spent liquor) from the Bayer process is concentrated (green liquor) and returned to the digester to recycle caustic.

Related Tools

Flash Evaporation / Crystallisation

Multiple Effect Evaporation (MEE)

Falling Film Evaporator (FFE)

Forced Circulation Evaporator / Crystalliser (FC)

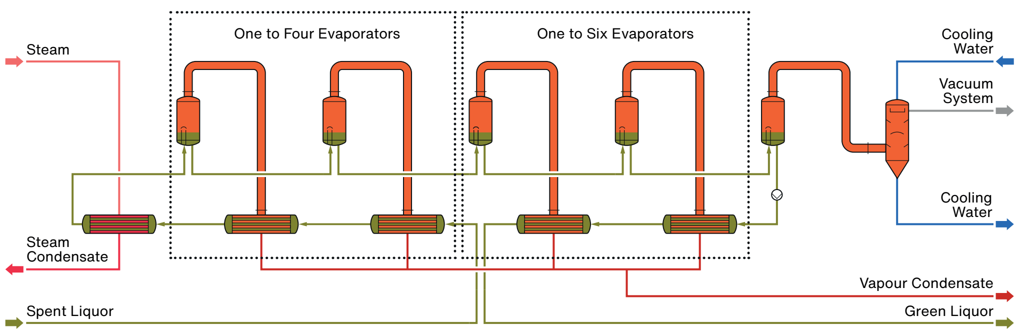
Value

- High steam economy
- High on-stream factor
- Flexible configuration maintains production while allowing for the washing out of any one effect
- Operational flexibility allows for a range of production rates
- High grade condensate

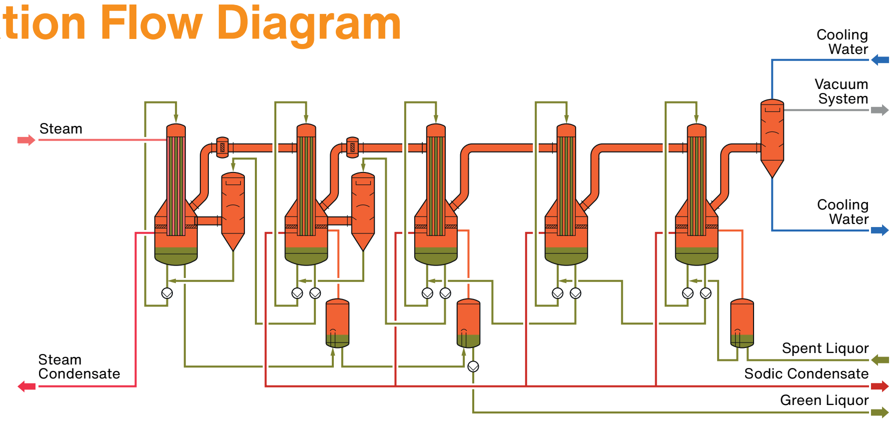
Process

- Evaporation capacity up to 300 t/h per train
- Various evaporative systems can be supplied: Multi-Stage Flash, Multi-Stage Falling Film, or Forced Circulation (for crystallising liquors).
- Crystallisation of carbonate and vanadate
- Separation of suspended particles

Flash Evaporation Flow Diagram



Falling Film Evaporation Flow Diagram



Chemicals

Sodium Sulphate

Sodium sulphate is a common by-product of many chemical operations and can be recovered by evaporative crystallisation from aqueous solutions.

Related Tools

Mechanical Vapour Recompression (MVR)

Multiple Effect Evaporation (MEE)

Recrystallisation

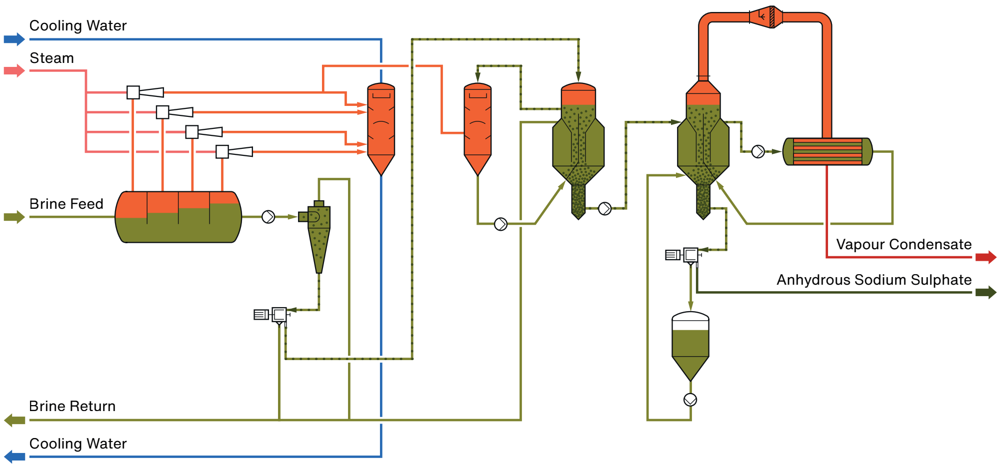
Value

- Broad range of feed compositions can be processed
- Product purity greater than 99.8%
- Narrow crystal size distribution with minimal fines
- High efficiency due to lower power, cooling water and steam requirements by internal heat recovery
- High plant availability

Process

- Mechanical Vapour Recompression or Multiple Effect Evaporation depending on utility cost
- Cooling crystallisation of Glauber‘s salt
- Direct conversion of Glauber‘s salt to anhydrous in a melter
- Utilization of Glauber‘s salt route to minimize energy consumption

Flow Diagram



Pusher-Type Centrifuges

Tubes of a Heating Chamber

Magnesium Sulphate

Magnesium sulphate is a common by-product of salt or potash production from natural brines or mining operations and can be recovered by evaporative cooling crystallisation from aqueous solutions.

Related Tools

Mechanical Vapour Recompression (MVR)

Multiple Effect Evaporation (MEE)

Recrystallisation

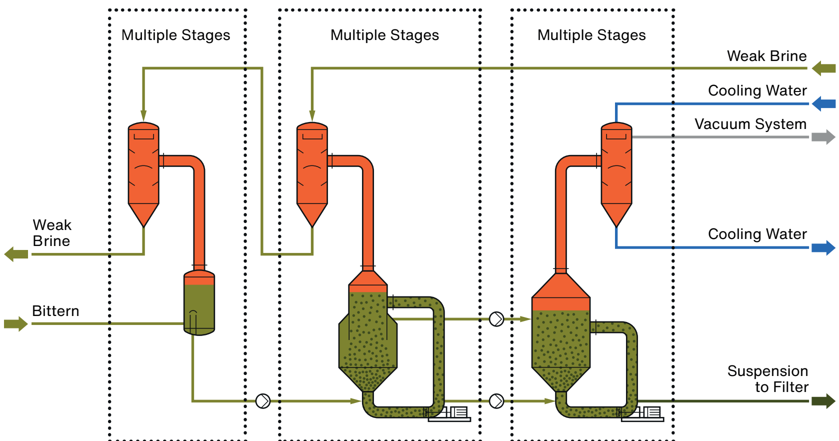
Value

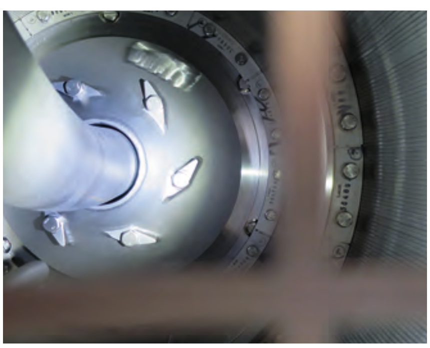
- Broad range of feed compositions can be processed successfully
- Product purity greater than 99%
- Narrow crystal size distribution with minimal fines
- Low cooling water requirements
- High plant availability

Process

- Multiple stage cooling crystallisation of epsomite
- Heat recovery by using direct contact condensers
- Conversion of espsom salt to magnesium sulphate monohydrate (Kieserite)

Flow Diagram





Insight of a Pusher-Type Centrifuges

Elbow-Type Circulation Pump

Chemicals

Fractional Crystallisation

Defined as the selective separation of different compounds which may co-exist in an aqueous solution, fractional crystallisation increases the recovery efficiency of a plant. The separate production of sodium chloride and sodium sulphate, or of sodium chloride and potassium chloride, are examples of fractional crystallisation.

Related Tools

- **Multiple Effect Evaporation (MEE)**
- **Mechanical Vapour Recompression (MVR)**
- **Thermal Vapour Recompression (TVR)**
- **Flash Evaporation / Crystallisation**

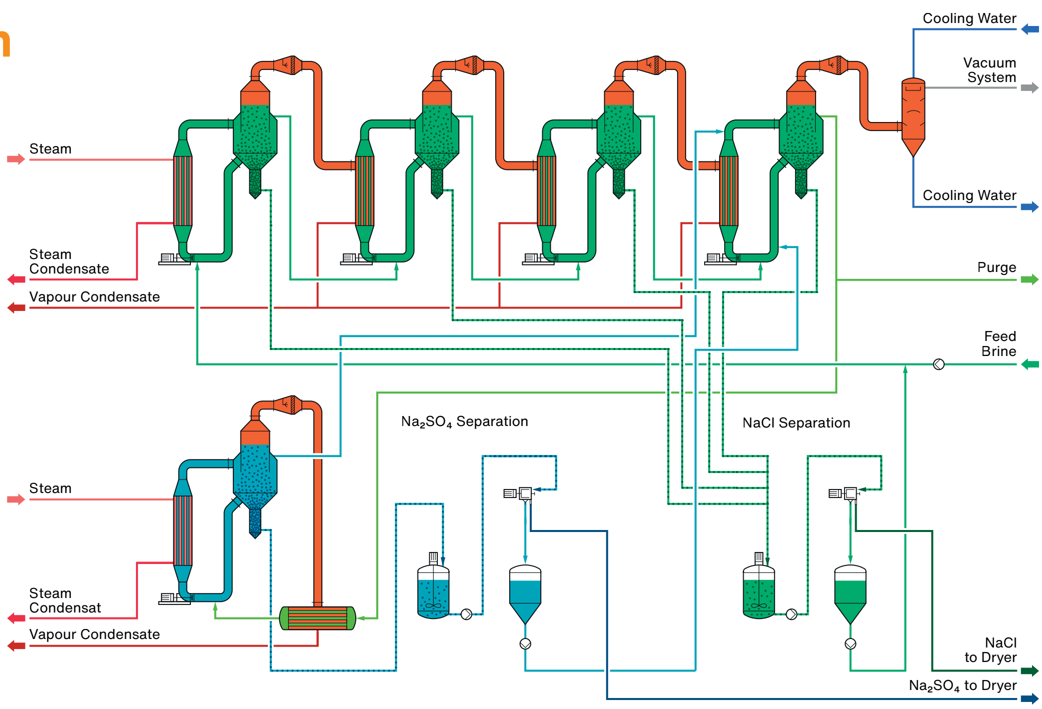
Value

- Generation of high-quality end products from the purge of the main sodium chloride production plant maximises revenue (for example the recovery of sodium sulphate in a salt plant)
- Processing of sulphate removal system purge liquors to recover sodium sulphate and recycle sodium chloride
- Applied to solution mining, Fractional Crystallisation reduces mining and feed treatment costs
- These processes also result in reduced chemical consumption and smaller plant size, lowering the overall plant costs
- The application of advanced concepts drastically reduces final purge output and disposal costs

Process

- The method of separation depends on the mutual solubility of the compounds involved
- All types of crystallisation equipment may be employed (Multiple Effect Evaporation, Mechanical Vapour Recompression, Thermal Vapour Recompression, Flash Evaporation/ Crystallisation)
- Generally, the separations occur in series; the purge of the first separation may be the feed to the second
- Centrifuges or filters are utilised for separation of the product crystals

Flow Diagram



Lithium Salts

Lithium salts are produced from spodumene ore, from pre-concentrated natural brines, or recovered by concentration of wastewater.

Related Tools

- Multiple Effect Evaporation (MEE)
- Mechanical Vapour Recompression (MVR)
- Thermal Vapour Recompression (TVR)
- Flash Evaporation / Crystallisation
- Rising Film Evaporator
- Forced Circulation Evaporator / Crystalliser (FC)

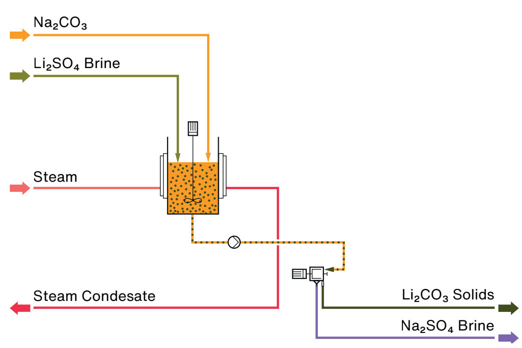
Value

- Reduction of reagent consumption
- Reduction of CO_2 footprint
- Generation of clean water
- High purity product
- Possibility to utilize renewable energies

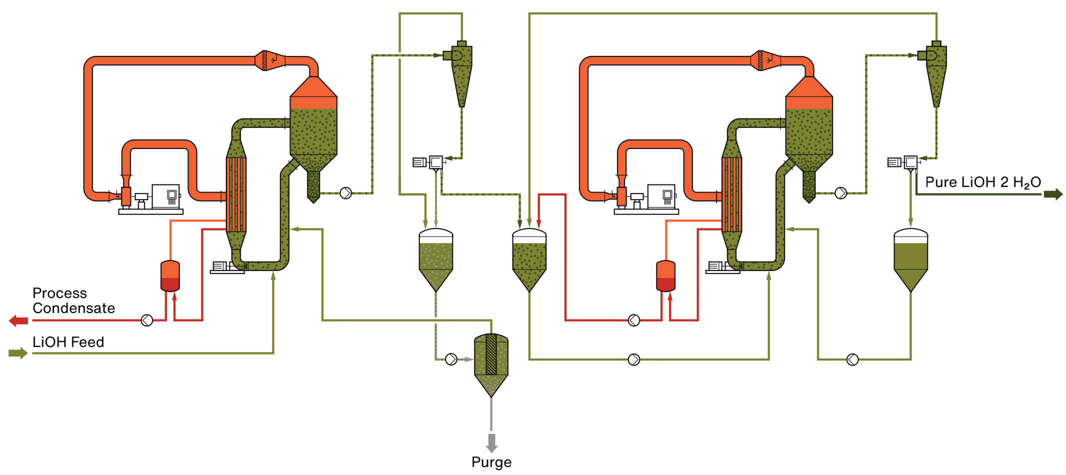
Process

- The method of production depends on the solubility of the salt
- Evaporative or reaction crystallisation
- All types of crystallisation equipment may be employed
- Centrifuges or filters are utilised for separation of the product crystals
- Upgrade product quality through recrystallisation

Lithium Carbonate Production Flow Diagram



Lithium Hydroxide Production Flow Diagram



Chemicals

Magnesium Chloride

Magnesium chloride is extracted from solar pond or other brines by concentration, and then converted to flakes or granules. Rarely, Bischofite may be produced by crystallisation.

Related Tools

Multiple Effect Evaporation (MEE)

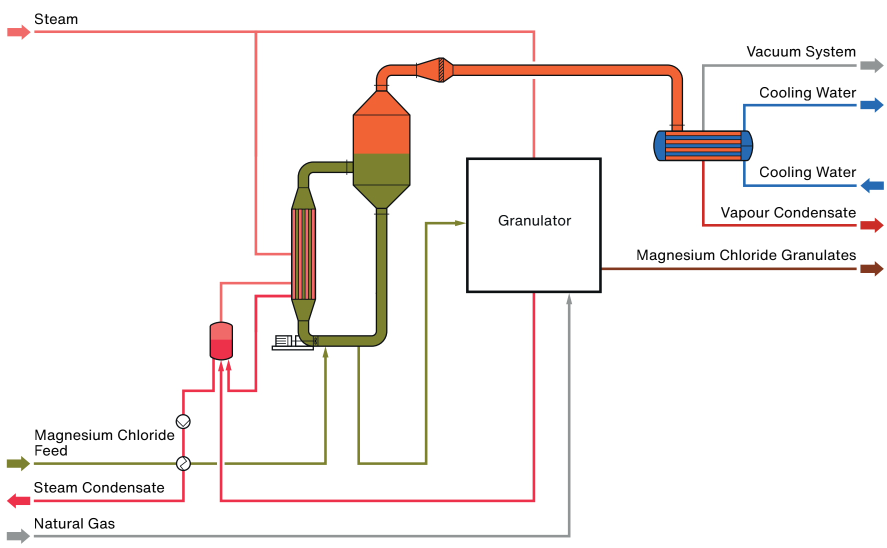
Value

- Proven material of construction for high temperature operation
- Multiple Effect Evaporator achieves high energy efficiency

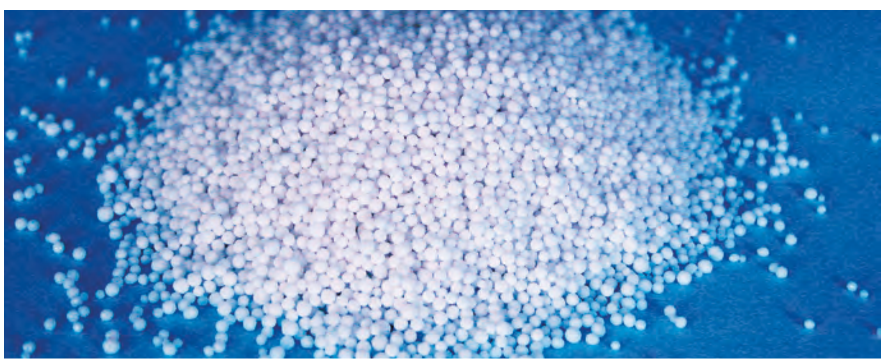
Process

- Concentration in field-proven evaporator equipment
- A variety of evaporator types may be applied

Flow Diagram




Product Flakes


Product Granules

Recovery of Waste Sulfuric Acid

A significant amount of TiO_2 pigments in the world is produced from Ilminite ore or Titania Slag using the sulfate process.
Waste products are weak sulfuric acid, iron sulfate and heavy metal sulfates.
SEP provides technology for recovery and recycling of sulfuric acid and for crystallization and separation of sulfates from sulfuric acid.
Using SEP's evaporation and crystallization technology, pigment producers improve their ecological footprint by using less raw materials (sulfuric acid) and reducing waste streams.

Related Technologies

Multiple Effect Evaporation (MEE)

Forced Circulation Evaporator / Crystalliser (FC)

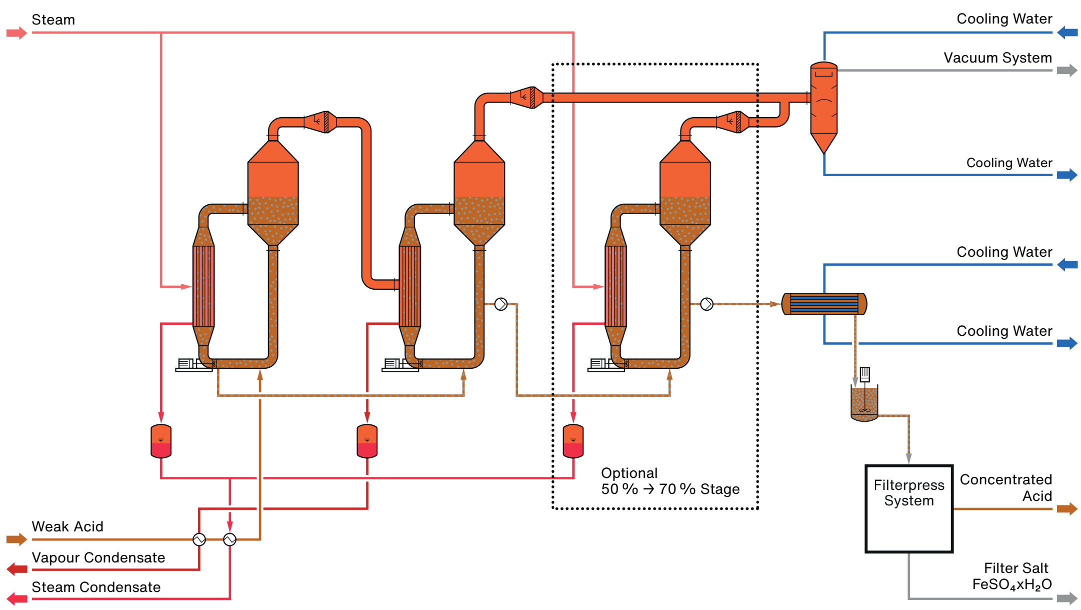
Value

- Low concentration of impurities in product sulfuric acid at 70%
- High sulfuric acid recovery yield
- Minimized scaling resulting in minimum downtime
- Low steam and electrical energy consumption
- Consideration of client-specific physical properties of waste acid

Process

- Reliable solids separation and handling
- Appropriate materials of construction considering temperatures, concentrations, and the highly corrosive nature of sulfuric acid
- Robust Forced Circulation Evaporators and Crystallizers
- High efficiency droplet separators
- Separation of sulfates by reconcentration as $FeSO_4$ x H_2O (Brown Salt) or by cooling crystallization as $FeSO_4$ x 7 H_2O (Green Salt).

Flow Diagram



Fertilizer

Potassium Chloride

Potassium chloride, commonly known as Potash, is produced by vacuum cooling saturated brines of various compositions and is a key fertilizer for the agricultural industry. Coarse crystals are produced in multi-stage Draft Tube-Baffle crystallisers which ensures a narrow particle size distribution.

Related Technologies

Flash Evaporation / Crystallisation

Draft Tube-Baffle Crystalliser (DTB)

Recrystallisation

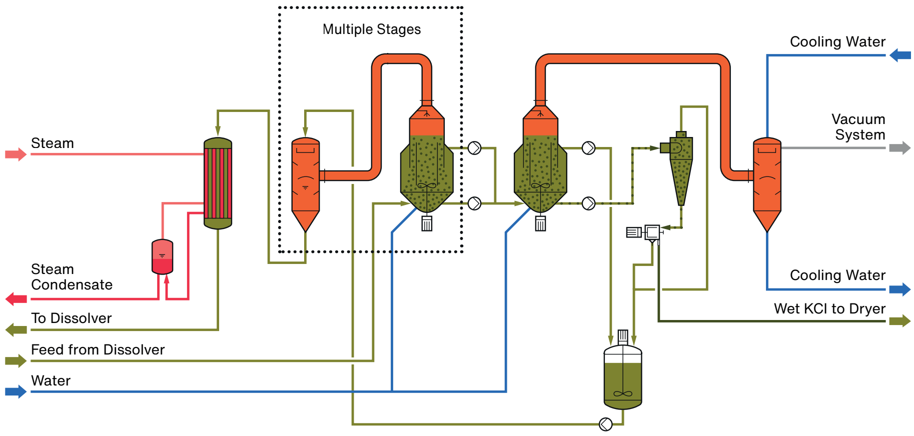
Value

- Multiple stage arrangement improves heat recovery
- High quality steam condensate recovered (in recrystallisation applications)
- Control of magma density leads to longer on-stream availability
- Slow moving internal circulation propeller in the DTB minimises attrition of the crystals
- Simple controls minimize co-crystallisation of Sodium Chloride

Process

- Hot saturated feed is flash cooled stage-wise
- FC or DTB configuration used depending on crystal size requirement
- Centrifugation separates the crystals from the end brine
- Dryer / cooler achieves desired moisture level in product
- In some cases product compaction is employed

Flow Diagram



Internals of a Heating Chamber

Heating Chamber for a Potassium Chloride Crystalliser

Ammonium Sulphate

A high-nitrogen fertilizer usually produced through the neutralization of waste sulfuric acid using ammonia, ammonium sulphate is manufactured either by direct reaction or by evaporative crystallisation.

Related Technologies

- Mechanical Vapour Recompression (MVR)
- Forced Circulation Evaporator / Crystalliser (FC)
- Draft Tube-Baffle Crystalliser (DTB)
- Multiple Effect Evaporation (MEE)
- Thermal Vapour Recompression (TVR)

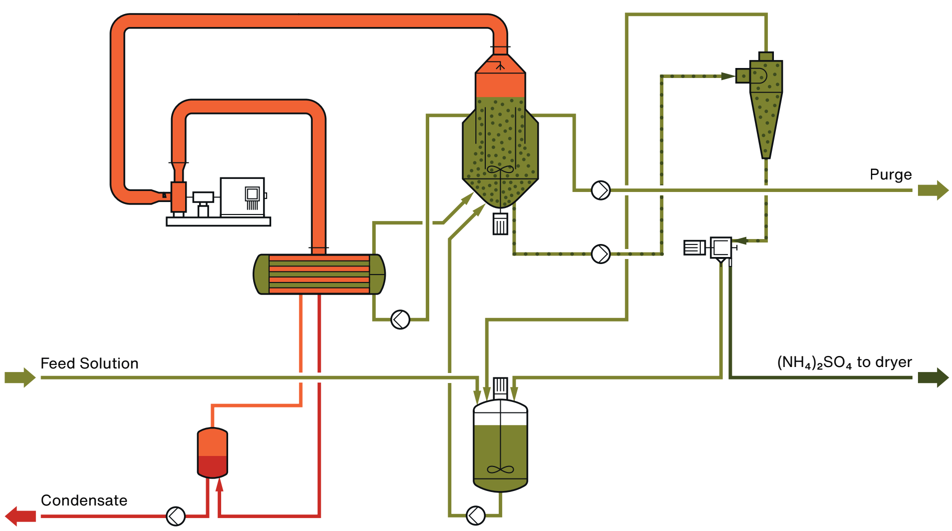
Value

- Multiple stage arrangement improves heat recovery
- High quality condensate recovered (in recrystallisation applications)
- Control of magma density leads to longer on-stream availability
- Slow moving internal circulation propeller in the DTB minimises attrition of the crystals
- Simple controls minimize co-crystallisation of Sodium Chloride

Process

- Hot saturated feed is flash cooled stage-wise
- Surface condensers used to recover heat from flash vapours
- FC or DTB configuration used depending on crystal size requirement
- Centrifugation separates the crystals from the end brine
- Dryer / cooler achieves desired moisture level in product
- In some cases product compaction is employed

Flow Diagram



Fertilizer

Potassium Sulphate

Potassium sulphate is a high value product of potash production from natural brines or mining operations and can be recovered by evaporative and reaction crystallisation from aqueous solutions.

Related Technologies

Mechanical Vapour Recompression (MVR)

Multiple Effect Evaporation (MEE)

Reaction Crystallisation for Potassium Compounds

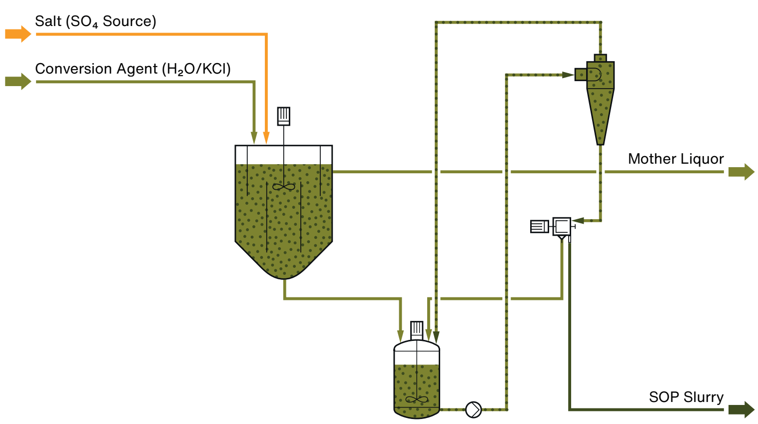
Value

- Broad range of feed compositions can be processed
- Product purity greater than 99%
- Narrow crystal size distribution with minimal fines
- Low cooling water requirements
- High plant availability

Process

- Multiple stage cooling crystallisation
- Reaction crystallisation
- Heat recovery by using direct contact condensers

Flow Diagram



Pusher-Type Centrifuges

Waste Water

Shale Gas Produced Water

Concentration of produced water from unconventional gas production by hydraulic fracturing recovers clean condensate and high-quality, valuable sodium chloride and/or calcium chloride. Other compounds in the produced water are either removed upstream of the evaporation plant (heavy metals) or can be further concentrated for minimum liquid discharge.

Related Tools

Mechanical Vapour Recompression (MVR)

Forced Circulation Evaporator / Crystalliser (FC)

Brine Pre-Treatment

Value

- Conversion of waste into saleable products (sodium chloride, calcium chloride, lithium, and bromine, among others)
- Design features minimize scaling and increase on-stream availability
- Use of energy efficient systems
- Plant operational flexibility allowing wide range of turn-down
- Liquid purge is minimized
- Smaller capacities can be processed by mobile units
- Process can handle high levels of contaminants

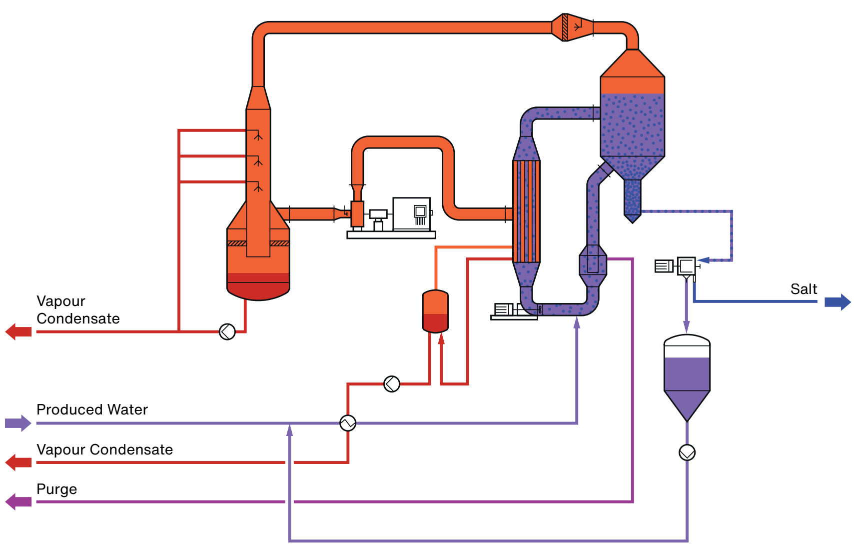
Process

- Feed purification through chemical pre-treatment, such as elimination of scalents and heavy metals
- Filtration to remove precipitated heavy metals and other impurities
- Forced circulation evaporators to handle suspended solids
- Centrifugation to separate sodium chloride
- Filtrate can be further concentrated to produce calcium chloride

NaCl Crystalliser for Produced Water Concentration

First Recovered clean NaCl out of Produced Water

Flow Diagram



Waste Water

Industrial Waste Water

Industrial Waste Waters containing inorganic (e.g. metal sulphates or chlorides) and/or organic contaminants (e.g. from the production of MDI, TDI or epoxy resins) are concentrated for minimum discharge or ZLD and recovery of valuable salts which can be marketed.

Related Tools

- Rising Film Evaporator
- Falling Film Evaporator (FFE)
- Forced Circulation Evaporator / Crystalliser (FC)
- Multiple Effect Evaporation (MEE)
- Mechanical Vapour Recompression (MVR)

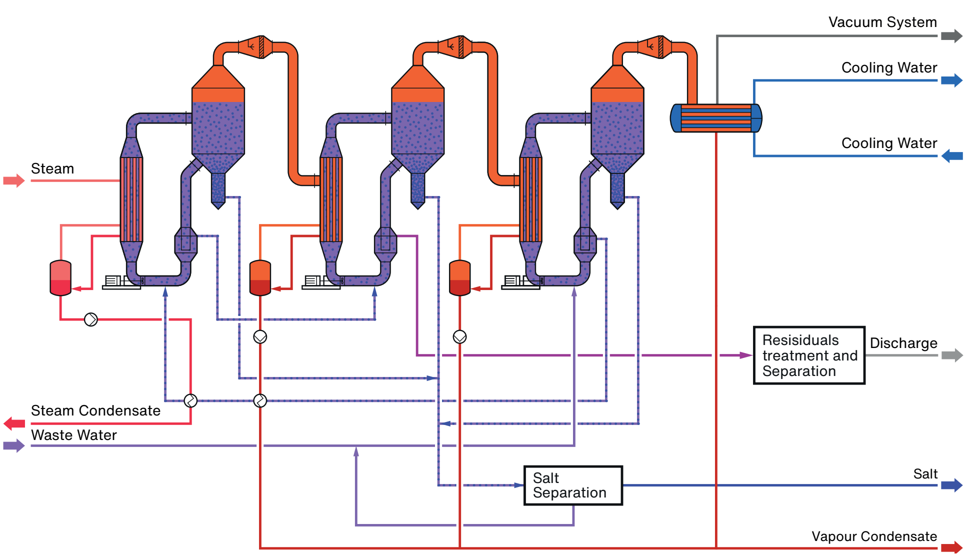
Value

- Multiple Effect Evaporation (MEE) or Mechanical Vapour Recompression (MVR) systems optimise energy costs
- Plant designed to minimise scaling
- High contaminant loadings can be handled
- Liquid purge can be eliminated (zero liquid discharge)
- Crystallisation of valuable salts

Process

- Chemical pre-treatment to remove scalents and heavy metals
- batch or continuous pre-treatment similar to brine treatment on page 8
- Filtration to remove precipitated heavy metals and other impurities
- Pre-treatment using stripping for CO_2 or NH_3 recovery, pH adjustment and/or filtration
- Concentration of waste water and recovery of process condensate
- Crystallisation of target salts

Flow Diagram




Waste Water Pretreatment Tank

Calcium Chloride from Waste Water

Through this process, valuable calcium chloride can be recovered from waste waters produced by mining and waste incineration, among others. This reduces the amount of waste that goes into landfills and creates added value for the plant.

Related Tools

Mechanical Vapour Recompression (MVR)

Multiple Effect Evaporation (MEE)

Rising Film Evaporator

Value

- Wide range of feed compositions
- Variable product configurations
- High steam economy results in low fuel consumption
- Utilization of gypsum slurry process minimises scaling
- High purity calcium chloride product and sodium chloride > 99 %
- High final calcium chloride concentration increases energy efficiency of calciner or granulator

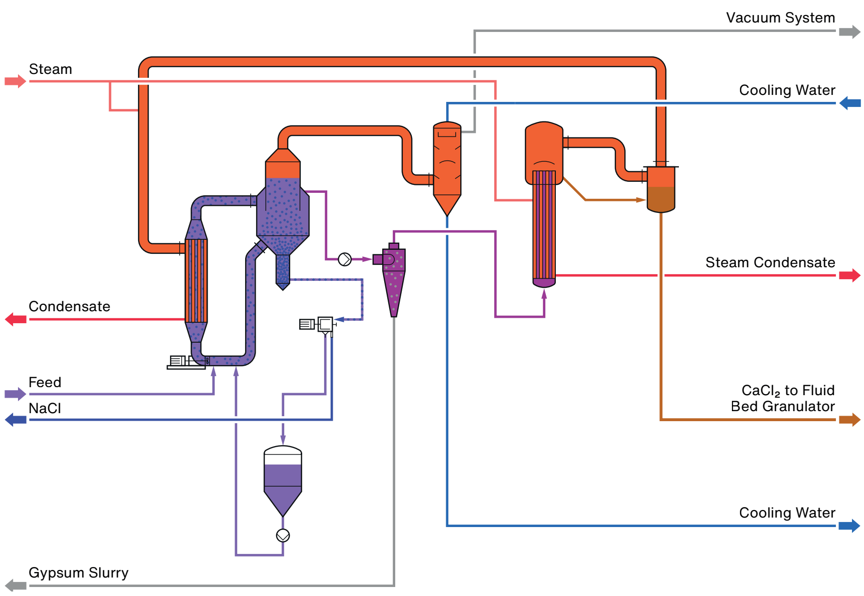
Process

- Feedstock can be sodium carbonate (soda ash) waste water, or waste water from waste incineration flue gas cleaning plants, waste to product processes - all concentrations
- Mechanical Vapour Recompression or Multiple Effect Evaporation depending on utility costs
- Selective crystallisation of sodium chloride
- Drum flaker and calciner for flakes
- Fluid bed granulator for granules

Screen for Calcium Chloride Granulation

Circulation Pipe of Calcium Chloride Evaporator

Flow Diagram



Technology

Our Innovative Process Design

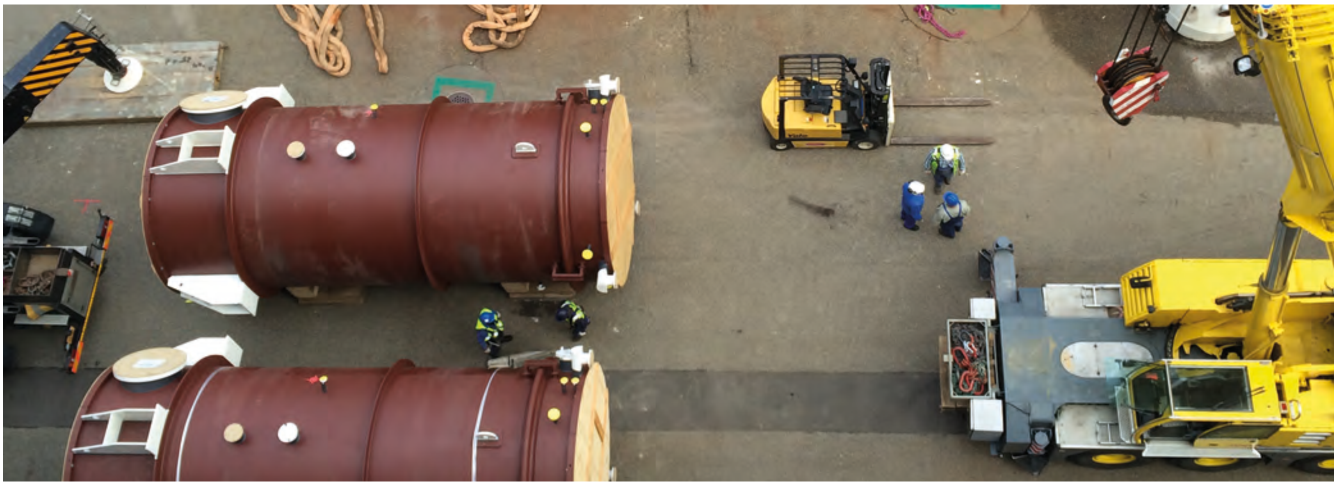
SEP owns and continuously develops its extensive and critical know-how in evaporation, crystallisation, solids/liquid separation and drying. We optimize and tailor solutions to client needs focusing on energy efficiency, operational robustness and product quality.

We approach every project with fresh eyes

We recognize that each installation is unique in significant ways, and we approach each project with fresh ideas, combining creativity and the latest related industry information and project experience. The result is highly customized to the specific requirements and embodies the way we work – innovative, thorough and pragmatic.

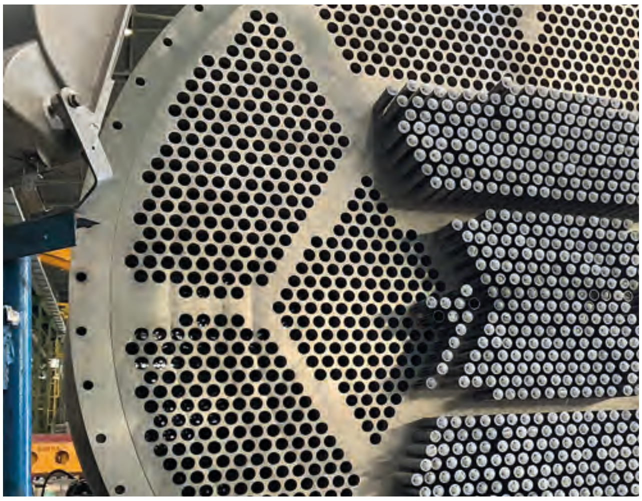
We consistently generate new ideas and solutions

Our work has great variety and often a broad range of unique challenges. Our process of diagnosis and analysis generates new ideas and solutions. Being small, we are agile and free from the creative inhibitions that larger bureaucratic organizations often instill. Our clients are one step away from the vital problem solvers and decision makers in the company.



Equipment Design

SEP's extensive experience in process equipment design combined with the innovative approach we take is the key to developing optimum solutions for our client's needs. Our clients receive state-of-the-art evaporation and crystallisation technology as well as access to a wide range of evaporator and crystalliser types.



Our Tools

We use the latest in computer technologies, Autodesk Inventor, Autodesk AutoCAD P&ID, Autodesk AutoCAD Plant 3D, Autodesk Navisworks Manage, Microsoft Project Pro and Office 365 programs for the realization and visualization of our process and plant designs, further aiding in the clear communication of proposed options and solutions to our clients and resulting in a better end result.

Our Technology

Multiple Effect Evaporation (MEE)

MEE is used when a large amount of water has to be evaporated and steam is inexpensive. The first effect is steam-heated, and vapour from the first evaporator heats the following (second) effect. The second effect vapour heats the third effect, and so on. By utilizing MEE, the specific energy consumption falls significantly.

The number of effects ranges from 2 to 10, and is typically limited by the temperature difference between the heating and cooling media on the one hand and the optimum between investment cost vs. energy savings on the other.

Thermal Vapour Recompression (TVR)

In TVR systems, part of the vapour generated in the evaporator is combined with high-pressure steam in the Thermal Compressor ("booster"). The resulting vapour stream is the evaporator heating medium. TVR can be combined with MEE, to increase the operation's energy efficiency.

Theoretically, a TVR single effect unit has, approximately, the energy efficiency of a double effect evaporator, at significantly lower CAPEX. However, TVR contaminates the boiler steam it uses, and the steam condensate is usually not returned to the boiler.

Recrystallisation

Recrystallisation is a purification process, in which impure crystals are dissolved in a clean solvent, and then recrystallized, to produce crystals that are significantly purer than those used for the feedstock.

The actual method of crystallisation can be that of evaporation or cooling, depending upon the solubility of the product; usually the recrystallisation operation is a repetition of the first crystallisation unit. Recrystallisation is typically used for products that require high levels of purity (usually >99.9%), such as pharmaceutical grade or reagent grade components.

Reaction Crystallisation for Potassium Compounds

Reaction crystallisation requires that the feedstocks be mixed with the slurry in the crystallizer. The slurry consists of various potassium salt crystals and mother liquor. The content of the crystallizer is continuously mixed by the internal circulator (the agitator in the draft tube) to enhance the required reaction.

Mechanical Vapour Recompression (MVR)

MVR technology utilises compression of the vapours generated in the evaporator to a higher pressure/temperature level, and are subsequently reused as the heating medium. High-speed centrifugal compressors, or a number of fans (operating in series at significantly lower speed than compressors) provide the compression.

Flash Evaporation / Crystallisation

Flash evaporation or crystallisation is used to cool a hot brine (and precipitate a compound) without heat exchangers coming into contact with the process liquid or slurry. It provides longer operation cycles for the evaporator or crystalliser, as the scale formation in equipment is reduced substantially.

Feedstock is exposed to low pressure, and flashes (boils) under controlled conditions. The flash generates vapour is condensed separately. The removal of water concentrates and cools the feed and leads to precipitation of product crystals. Forced Circulation or Draft Tube Crystallisers are used for this operation as well as Flash vessels.

Brine Pre-Treatment

Industrial wastewater (including from fly ash) and shale-produced water can be pre-treated to remove heavy metals, ammonia, magnesium, sulphates, carbonates, and TOC. The Pre-treatment includes pH adjustment, or precipitation reactions (with acids or bases), and activated carbon filtration.

The pre-treatment eases the subsequent evaporative concentration of the brine, and allows for recovery of saleable products, clean condensate, and a greatly reduced plant purge.

Rising Film Evaporator

Rising film evaporators, also known as Natural Circulation, or Long-Tube Vertical (LTV) Evaporators, are the oldest and simplest of Evaporators used today. They have no moving parts, and have the advantage of very stable and reliable operation. This type of evaporator is well suited for the concentration of solutions that are not saturated upon concentration, and have low viscosity. However, to obtain natural circulation, higher steam-to-process temperature differences are needed, and this limits their use in some MEE arrangements.

Forced Circulation Evaporator / Crystalliser (FC)

The FC is the workhorse of the crystallisation industry and is used for operations that require large amounts of evaporation. A pump is used to mix the slurry in the FC. While an FC provides little latitude in crystal size control, good design is crucial for the crystal size produced. Similarly, optimization of the operating parameters of the FC can minimize scale formation and substantially increase its on-stream time.

Occasionally, FC's are used for non-crystallizing, but severely scaling evaporation applications, in an effort to prolong the unit's operating cycle.

Falling Film Evaporator (FFE)

The FFE is the most common type of non-precipitating evaporator. It is named from the fact that the liquid to be concentrated cascades down the inside of the heater tube walls as a film. It usually has a pump to circulate process liquid to the top of the vertical heating element, and ensure wetting of the tube walls (in some cases, recirculation is not necessary). FFE's are suited for MEE applications, as they work well with low steam-to-liquor đT's. This, and the low residence time of the concentrate, make this evaporator a good choice for thermos-sensitive materials.

SEP has extensive experience in designs that minimize scale formation on tube walls, and extend the operating cycle of the plant.

Draft Tube-Baffle Crystalliser (DTB)

The DTB crystalliser is used when larger particles are desired. It combines a clarifier and a mixed tank in a single vessel. The mixed-tank part (utilizing a draft tube) provides improved crystal growth conditions. The clarifier section (Baffle) allows selective removal or destruction of smaller crystals, thus increasing the average product size. Smaller particles are destroyed by heating or by diluting the brine containing them. DTB's are also used successfully for reaction crystallisation because of the good internal mixing and reactant introduction into a high-turbulence zone. A variation of the DTB, the Draft Tube (DT) crystalliser, contains only the mixed-slurry feature of the DTB (no baffle).

Innovation

At SEP we are personally vested in the ownership of the company itself feeling collectively responsible for the success of every project.

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