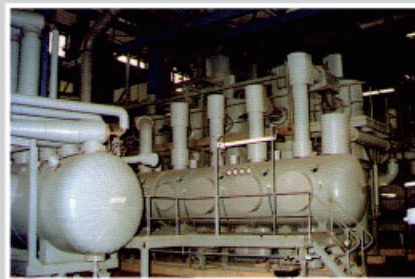


粘胶纤维酸浴回收系统

Spinbath regeneration plants for viscose fibre



南通三圣携手德国EBNER(艾伯纳)在中国粘纤行业掀起一场**节能增效**的革命
Nantong sunshine and Ebner start a revolution on energy-saving and efficiency-enhancement in the field of viscose fibre

- ◆ 新型脱气装置维护简便、长周期运行
- ◆ 一效蒸发取代十一效闪蒸，实现蒸汽零消耗
- ◆ HWM纤维（莫代尔）与普通纤维共用一套结晶装置
- ◆ 全新NMMO溶剂回收技术（莱赛尔纤维）
- ◆ 针对各种新型人造纤维提供特殊解决方案
- ◆ 普通粘胶纤维酸站系统升级改造
- ◆ New style degassing plants with easy maintenance and long-term running
- ◆ Vapour compression evaporation plants with no live steam consumption in place of 11-stages flash-evaporation
- ◆ A common crystallization plant used for HWM fibre and normal fibre alternatively
- ◆ Advanced NMMO solvent regeneration technology (for Lyocell)
- ◆ Special program against every kinds of new-style man-made fibre
- ◆ Conversion for spinbath regeneration plants of normal viscose fibre



南通三圣石墨设备科技股份有限公司
Nantong Sunshine Graphite Equipment Technology Co., Ltd.



艾伯纳有限责任公司
Ebner GmbH Co. KG

南通三圣

Nantong Sunshine

南通三圣石墨设备科技股份有

Nantong Sunshine Graphite

限公司,通过 2008 年科技部、财政部、国家税务总局《高新技术企业认定管理办法》认定的高新技术企业,全球三大石墨设备制造商之一,中国科技创新型中小企业 100 强。

Equipment Technology Co., Ltd. A

hi-tech enterprise certificated according to the "Certification Method of Hi-tech enterprise (version 2008)", is one of the three largest graphite equipments manufacturers in the world, and one of the best 100 small-middle size enterprises in China. Now, the company is going to be a listed company.

公司集石墨材料生产、化工设备设计制造、化工工艺设计、科研开发于一体,是目前国内规模最大、技术力量最强的石墨设备企业之一。公司拥有以多名国内外化工、环保、材料、工程等方面专家为核心的工业废酸资源回收利用工程技术研发中心,共同致力于国内外诸多行业的“三废”环保技术开发和循环经济发展研究,取得了较好的经济效益和社会效益。

The company has the provincial engineering and technology research and development center which is formed the nucleus of chemical, environmental, material and engineering experts at home and abroad. They apply themselves to the development of environmental protect technology for "3w" and the research of the recycle economy development, and receive preferable economical and social benefit.

公司主营产品工业废酸资源化回收利用成套工艺装置和高效换热器,为国家产业政策鼓励和扶持的节能减排产品,作为国家重点节能产品报国家发改委在全国推广。

The main product--the unitized technological devices for recovery of industrial waster acid and the high-efficiency heat exchanger--which are the energy-saving and emission reduction products and promoted as the national major energy-saving products.

公司是 Ebner 在中国惟一总代理,经 Ebner 授权采用其先进技术,承揽酸站设备的设计、制造和安装调试及开车,为国内粘胶纤维生产企业提供交钥匙工程,同时提供各种化纤生产配件并帮助粘胶企业工艺改进,解决酸浴回收中的技术难题。

Nantong Sunshine is authorized as exclusive agent of Ebner in Chinese market. To make use of Ebner's technology we are able to design, manufacture and erect the plants and supply a turnkey engineering totally for the spinbath regeneration during the viscose fibre production. We also provide our customer with some kinds of fitting and help customer improve the process, solve the technical problems of spinbath regeneration.

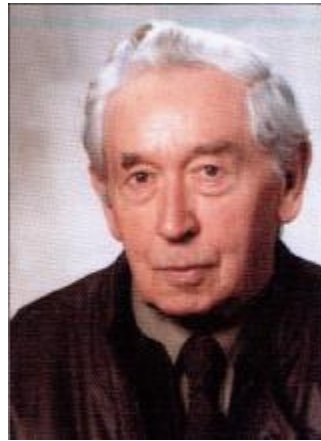
Karl Ebner

Inventor and founder

卡尔·艾伯纳

公司创建者

1902—1994



艾伯纳公司

卡尔·艾伯纳多年担任位于法兰克福的鲁奇公司主任工程师职务，于1965年在艾特菲尔德创建了艾伯纳股份有限公司，旨在提供工程，热工工艺的流程或成套设备。通过对粘胶纤维领域以及之后在通用化学工业领域的技术开发和崭新拓展，他和一大批与日俱增技术过硬的同事们成功巩固了其原有的业务关系网络，并在世界范围内建立了显著的核心用户。在这方面，本公司高效的组织结构有效避免了不必要的间接费用，包括从基础工程到设计和生产制造以及设备安装。始终保持必要的灵活性，通过可靠的分包商提供同等质量的特殊部件，从而推出高价值的成套装置。

史蒂芬·艾伯纳在完成工艺技术工程学业后，于1974年以有限责任公司责任股东的身份加入本公司，他继承父业，以成熟的技术合理的价格来设计和推广其成套装置。

Our company

In 1965 Mr. Karl Ebner established Messrs. Ebner & Co. KG in Eiterfeld after many years of responsibility as chief engineer at Messrs. Lurgi in Frankfurt. It was his aim to supply the engineering, process or plants of thermal process engineering. By new and further development in the field of viscose fibre and later on in general chemical industry he and a growing number of qualified staff succeeded in securing existing contacts and in establishing a satisfied clientele all over the world. In this respect the efficient organization of the company is of great advantage without any unnecessary overhead. Basic engineering, design and fabrication up to erection are in one hand. By keeping flexibility and by choosing reliable sub-contractors for special components plants of high quality are manufactured.

In 1974 Mr. Stefan Ebner joined the company after having finished his studies of process engineering and he continues the tradition of developing plants of mature technology and supplying them at a reasonable price.

粘胶纤维酸浴回收

在粘胶纤维生产企业的酸站中，酸浴中一直在发生着化学反应。氢氧化钠和硫酸反应生成水和硫酸钠。酸浴因为水的稀释浓度不断降低，很早以前厂家都是把它作为废水直接排掉。但是严重的环境污染和高昂运作成本使回收酸浴变得急迫起来。酸浴再生回收重新返回到工艺中，可以回收酸浴中一部分产品。

一般酸浴基本包括以下几个方面：

- 脱气
- 蒸发
- 芒硝结晶
- 焙烧（无水硫酸钠）

艾伯纳可以为粘胶纤维酸浴再生提供从设计制造和安装的一揽子方案和交钥匙工程。

艾伯纳根据主要工艺条件设计每一个工段，因为设计和安装是紧密联系的，现有的装置也可以包括在里面综合考虑。

艾伯纳不仅建造新的装置，也为客户提供现有装置的技改项目。

随着 Model 和 Lyocell 等纤维迅速发展，艾伯纳可以根据客户要求设计最新理念的设备 and 工艺，艾伯纳拥有先进的 NMMO 溶剂的回收工艺，其在国际上已得到推广。

Recycling of salt from

Spinbaths

(Spinbath regeneration plants)

In viscose fibre factories, where a chemical regeneration takes place during the spinning process and sodium sulphate and water develop from soda lye and sulphuric acid, the so-called spinbath is used and diluted. In former times this spinbath was used once and then drained as waster water. This caused enormous environment Problems and high operating costs, and made it absolutely necessary to regenerate the spinbath and lead it back into the process, respectively recover a saleable production from a part of the spinbath.

In a regeneration plant the following process steps are necessary:

- degassing (if necessary)
- evaporation
- crystallization of the glauber's salt
- regeneration of the glauber's salt to sodium sulphate (melting crystallization)

EBNER is also specialized in the planning and construction of complete spinbath regeneration plants. Each plant section is designed according to the prevailing conditions. As the planning and the fabrication are in one hand, existing plant components can be integrated. EBNER not only constructs new plants, but is also engaged in the conversion and extension of existing plants.

EBNER can design and supply the apparatus and process with the newest idea for customer producing Viscose Model and Lyocell. Advanced process of regeneration of NMMO solvent has been applied widely in the world.

脱气装置

在很多化工生产过程中，溶液中由于溶解了有毒有害气体，给溶液的回收利用带来很多的麻烦（例如粘胶纤维的酸浴）。溶液脱气有多种方式，艾伯纳研发的真空脱气装置是最优选择之一。

在单段真空脱气装置中，物料不断地加入到脱气罐中，在此过程中，有毒气体和空气被大量的去除，如果在第一段之后再连接第二段脱气装置，一部分水以水蒸气的形式被脱除，这样使真空脱气的效果更加显著。

艾伯纳装置中脱除的气体如下：

- 空气
- H₂S
- CS₂
- CO₂
- SO₂



Degassing plants

In many processes of the chemical industry hydrous solutions are enriched with gas which is found to be troublesome when reusing the solution (e.g. spinbath in viscose fibre factories). There are different methods of degassing solution. EBNER developed the degassing in vacuum being one of the optimum variants.

In case of a single stage vacuum degassing the solution is fed into a vacuum vessel. During this procedure noxious gases and air are expelled to a great extent. If a second stage is connected to the first one in which at the same time water is evaporated, serving as carrier gas for a better degassing, optimum degassing effects can be achieved.

Substances which are degassed in EBNER plants:

- air
- H₂S
- CS₂
- CO₂
- SO₂



2-stages degassing plant in Indonesia/印尼一家二级脱气装置

蒸发装置

将溶液或者浆液中的溶剂（一般是水）以蒸汽的形式去除的过程称作蒸发。由于大部分溶液都是水溶液，蒸发的目的就在于浓缩原溶液，产生的二次水蒸气可以根据其热焓值的高低决定是否回收再利用。因此蒸发一般是通过加热来浓缩溶液或者浆液。

艾伯纳能够规划、设计、安装包括无机和有机溶液的蒸发浓缩装置。这些装置可以在高压、常压、真空条件下进行操作。

Multi-stages evaporation plant with horizontal evaporators/多级蒸发的卧式蒸发器



Evaporation-and vaporization plants

Evaporation is the removal of solvents as vapor from a solution or slurry. For the overwhelming systems the solvent is water. The objectives is usually to concentrate a solution; hence the vapor is not the desired product and may or may not be recovered depending on its value. Therefore evaporation is usually achieved by vaporizing a portion of the solvent producing a concentrated solution, thick liquor or slurry.

EBNER plans, designs and builds evaporation-and vaporization plants for concentration of solutions inorganic and organic substances. Evaporation-and vaporization plants may be operated under overpressure, normal pressure or vacuum.

艾伯纳可以提供以下几种形式的单级，

EBNER offers the following types of construction

多级蒸发装置：

in single-stage or multi-stage design:

- 强制循环或非强制循环蒸发
- 降膜蒸发
- 热泵蒸发
- 闪蒸

- Circulation evaporation with or without forced circulation;
- falling film evaporators
- vapour compression evaporation
- flash evaporators



艾伯纳装置可用于以下物料蒸发：

Solutions which are evaporated in EBNER plant

普通粘胶酸浴	氯化钙溶液	碳酸钠溶液	standard fibre spinbath	sodium chloride solution
特殊粘胶酸浴	煤油	硫酸铵溶液	special fibre spinbath	sodium sulphite solution
粘胶长丝酸浴	氯化钠溶液	己内酰胺	filament fibre spinbath	sodium sulphate solution
波里诺西克	硫化钠溶液	mixed bath	polynosicfibre spinbath	titanium dioxide solution
混合纤维酸浴	硫酸钠溶液	waste water	cellophane bath	zinc chloride solution
粘胶短纤酸浴	二氧化钛溶液	pickling bath	ammonium rhodanide	potash magnesium oxide
废水	氯化锌溶液	oil mixtures	solution	sodium carbonate solution
酸洗废液	混油	ammonium	kerosene	calcium chloride solution
硫酸铁溶液	硫酸铝溶液	sulphate	iron sulphate solution	aluminium sulphate
铝酸盐溶液	碳酸钾氧化镁	solution	aluminat liquor	solution

循环蒸发

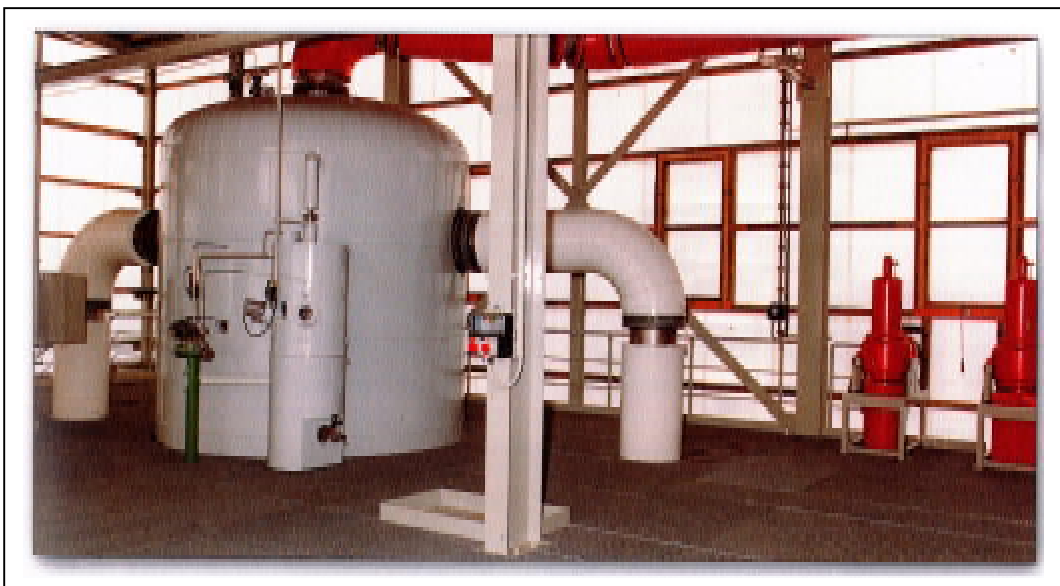
溶液经过一个或者多个加热器加热在每个蒸发段蒸发,加热器一般安装在蒸发器的外面,通常是管式换热器或者板式换热器。溶液循环的方式包括自然循环和强制循环。

艾伯纳的蒸发装置中,加热器的安装高度一般低于蒸发器中的液面高度。溶液的静压阻止了溶液的提前蒸发,不易在加热表面形成沉淀和结垢,而让溶液在蒸发器中蒸发,形成的沉淀只留在蒸发器中。但是对于很容易在加热管形成结垢的溶液,艾伯纳生产的流化床加热器将帮助您解决这个棘手的问题。为了节约蒸汽,对于处理大容量的溶液,一般采取多效蒸发的方式。

Circulation evaporation

In circulation evaporators the solution to be evaporated circulates in each stage through one or several heaters, which are usually located outside the evaporator and designed as tubular heat exchangers or plate heat exchangers. The circulation is effected either by the thermosiphon effect (natural circulation) or by outside effect, i.e. circulation pumps or air circulation (forced circulation).

The heaters of EBNER circulation evaporators are generally located beneath the solution level. By hydrostatic pressure a premature evaporation of the solution is impeded, thus preventing a deposition and caking of substances at the heating surface which may precipitate during evaporation. If the solution nevertheless is susceptible to incrustation a fluidized bed heat exchanger which is manufactured by EBNER, should find application. In order to reduce the steam cost, particular in case of large evaporation capacities, circulation evaporators are also designed multi-stages.



Circulation evaporation with several exterior heaters/带有多个外部加热器的循环蒸发器

降膜蒸发

相对于一般的循环蒸发，降膜蒸发器更适合于处理热敏性物质和不易结垢的物料。

在降膜蒸发器中，加热器顶部设置了一个分布器，物料经过该分布器均匀地从上向下流动，在加热管表面形成一层薄薄的液膜，在向下流动的过程中，物料在加热管中加热。加热蒸汽的流向和物料的流向是一致的，浓缩后的物料和水蒸气在蒸发室分离，蒸发室一般设计成位于加热器的底部。

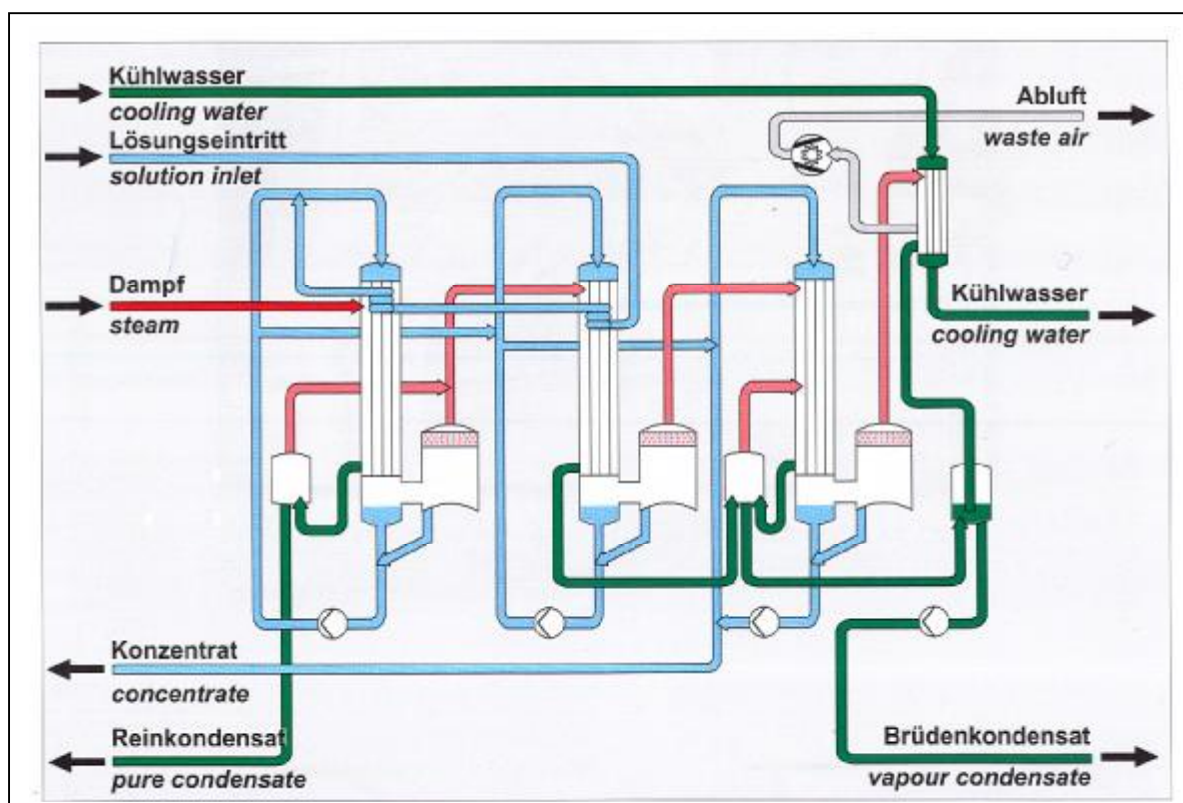
降膜蒸发器既可以单效运行也可以多效运行，也可以将二次蒸汽压缩利用连在一起使用。

Falling film evaporation

compared to circulation evaporation falling film evaporators preferably find application at evaporation of heat-sensitive solutions and solutions which are not susceptible to incrustation. In falling film evaporators the solution flows downwards. In the head of the evaporator the solution is evenly distributed through a proper device over each heating tube and is led on the inner surface of each tube and flows as a thin liquid film downwards.

The tubes are heated with steam and the evaporation takes place. The vapour the solution run in parallel flow downwards. The concentrated solution and the vapour are separated in the vapour chamber in the bottom by means of separators of special design.

Falling film evaporators may be designed single stage or multi-stages. Vopour compression finds application as well.



闪蒸

传统的蒸发装置一般是一个蒸发器单独连接一个加热器，而一个闪蒸装置却有多段蒸发和多个加热器。这样的设计能大幅度降低操作费用，是非常节能的蒸发装置。当然，它的投资建设费用较高，更加适合处理量大于 5 吨/h 的情况。

物料在多个预热器中连续预热，然后在多段蒸发器中蒸发，蒸发产生的二次蒸汽全部用于预热器的蒸汽供应。

物料可从蒸发器的任一进口加料，同样也可以从任一出口排出。艾伯纳设计的闪蒸装置允许出口温度高于进口温度。

闪蒸装置的蒸汽消耗量是非常小的，蒸汽耗量取决于两个因素，一是闪蒸的段数多少，二是蒸发过程中的温差高低。



11-stage flash evaporation plant/十一效闪蒸装置

Flash evaporation

Unlike conventional circulation evaporators each stage of which has its own heater circuit, the flash evaporators has several stages and heaters which are installed circulatory. At present this type of evaporator is the most cost-effective one regarding the operating cost; however, the investment cost are quite considerable, and this type of evaporator is suited for evaporation capacities of more than abt. 5t/h.



Evaporator and heaters/蒸发器和加热器

The solution being in circulation is heated in a heater, after having prewarmed in several stages, and after that flashed in several evaporator stages. The solution is prewarmed in several stages in the reboiler by the vapour which results during flashing.

The solution may be fed into any stage of the evaporator and also drained from any stage, i.e. in EBNER plants the outlet temperature is allowed to be higher than the inlet temperature.

The specific steam construction of flash evaporation plants is low. The consumption depends on both, the number of stages and the total temperature drop in the evaporator stages.

蒸汽压缩蒸发

如果规定加热介质和物料之间的温差必须小，为了避免物料过度受热，必须采用蒸汽压缩。根据电价和蒸汽价格的具体情况，有以下两种方式：

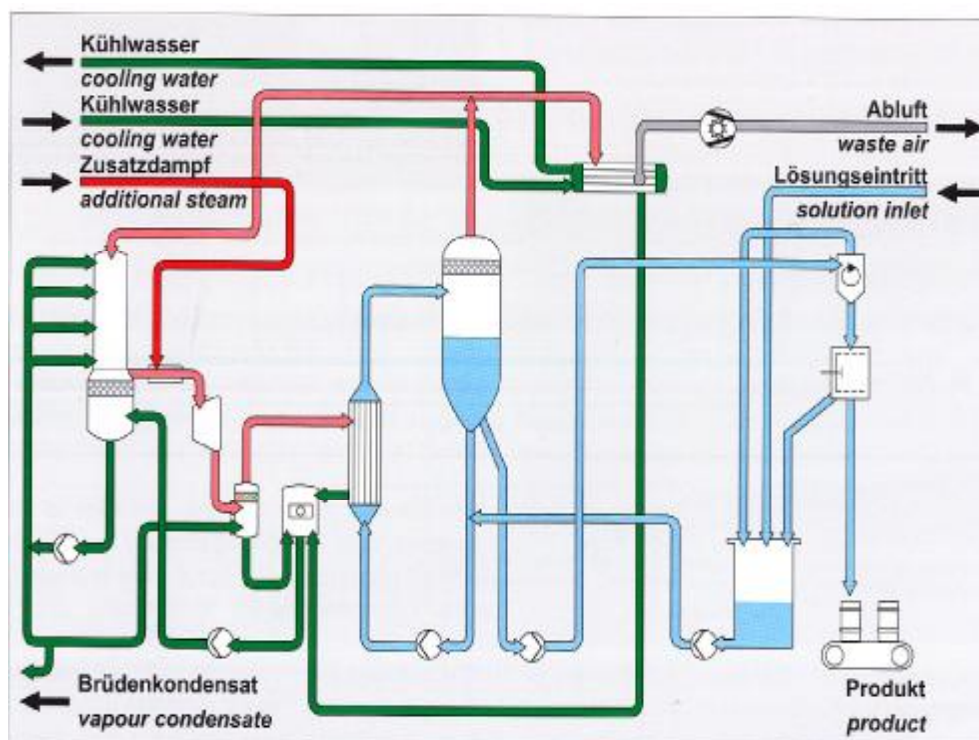
一是热泵压缩，二次蒸汽被蒸汽喷射泵吸进去，经过生蒸汽的压缩，得到较高的温度和压力，然后再回到加热器中给物料加热使用。这样就减少了生蒸汽的使用。

Vapour compression evaporation

If the temperature difference between the heating medium steam and the solution to be evaporated shall be low, in order to avoid an overheating of the solution, the plants should be operated with vapour compression. Depending on the cost ratio between steam and electric power, the following methods may be applied:

Thermal vapour compression:

A steam ejector sucks in a part of the vapour which develops during evaporation, compresses it by the aid of live steam to a higher pressure and temperature and leads it back into the heater of the evaporator to serve as heating steam. Thus the heating steam consumption can be reduced under the steam consumption of a two-stage circulation evaporation plant.



二是机械压缩，如果电价比蒸汽价格低，机械压缩比较适用。增压涡轮机将二次蒸汽压缩再利用，只有在开车时才会消耗生蒸汽。

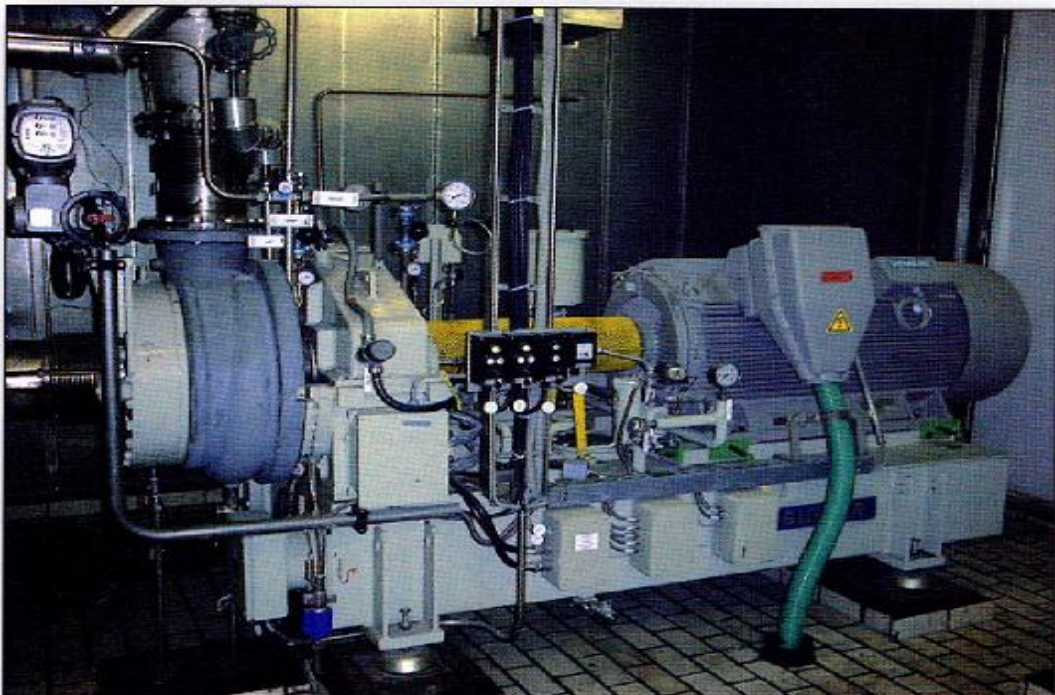
蒸汽压缩在多效蒸发和多段结晶中也有应用。

Mechanical vapour compression:

If the cost of electric power are lower than the cost for the production of steam it is advisable the operate the vapour compression by means of electric power.

A mechanical turbocompressor does the compression work. In this case live steam is needed only for starting of the plant. Besides single-stage radial compressors also multi-stage machines and axial compressors may find application.

Vapour compression may also be applied in multi-stage evaporation plants and evaporation crystallization plants.



Mechanical vapour compressor/蒸汽压缩机

结晶装置

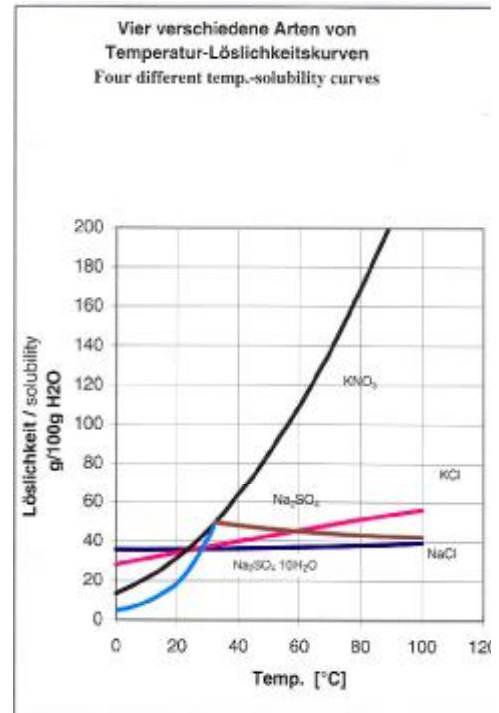
结晶用于从溶液中得到晶体产品，通过蒸发或者是降温，从而降低了晶体在溶液中的饱和度达到结晶的目的。根据溶液的溶解性决定是蒸发结晶还是冷却结晶。

真空结晶常用于随着温度的降低盐分的溶解度也降低的溶液，而蒸发结晶则用于随着温度的降低盐分的溶解度没有明显降低或者是上升的溶液。

结晶装置用于分离溶液或者废水中的盐份，比如浸酸槽和酸浴的再生或者通过重结晶提纯盐分。结晶装置可以连续操作或者间歇操作。

结晶物质：

氯化钠	七水硫酸铁
硫氰化钠	芒硝
硫酸钠	六亚甲四胺
硫化钠	氯化钾
有机盐	硫酸钾
硝酸铈	硫酸镁
硫脲	金属盐
七水硫酸锌	混盐
氯化铵	碳酸钠
硫酸铵	



Salt crystal/晶体

Crystallization plants

The crystallization serves the purpose of getting a crystalline product from hydrous solution. By evaporation or reduction of temperature the saturation line of the substance to be crystallized is exceeded and thus it crystallizes. Whether the crystallization is effected by evaporation (evaporation crystallization) or by cooling (cooling crystallization) depends on the solubility behavior of the salt to be crystallized.

Vacuum crystallization is applied at decrease of the solubility with dropping temperatures, evaporation crystallization is applied at very slight decrease or increase of the solubility with dropping temperatures.

For example crystallization plants find application for the separation of salts or salt constituents from solutions and waste water, for regeneration of pickling baths and spinbaths of for the purification of any sorts of salts by recrystallization. Crystallization plants may be operated continuously or discontinuously.



Crystallization plant for Glauber's salt with NH₃-cooling/芒硝结晶



8-stage cooling crystallization plant/8 段结晶

蒸发结晶

当溶液的溶解度随温度变化很小时，更加适合采用蒸发结晶，结晶的过程就是给溶液加热从而蒸发溶剂（一般是水）。

艾伯纳特殊的蒸发室设计使蒸发结晶装置可以将晶体分类操作。根据晶体的颗粒大小分类，大的颗粒经由一个排出口排出，剩下较小的颗粒继续留在溶液中。

增加一个搅动装置可以增加溶液在蒸发室的湍流度。蒸发结晶装置既可以是单效也可以是多效的，既可以有二次蒸汽压缩也可以没有。



Evaporation crystallization

If the solubility of the salt changes only a little at fluctuating temperatures the evaporation crystallization preferably finds application. This process is the crystallization of a solution by vaporizing the solvent with the supply of heat.

The special design of the evaporation chamber makes it possible to operate the evaporation crystallizer as classifying crystallizer. In this case the crystals are separated by classification according to size in a sedimentation zone. The coarse portion may be discharged through a separate outlet while the fine portion remains in suspension.

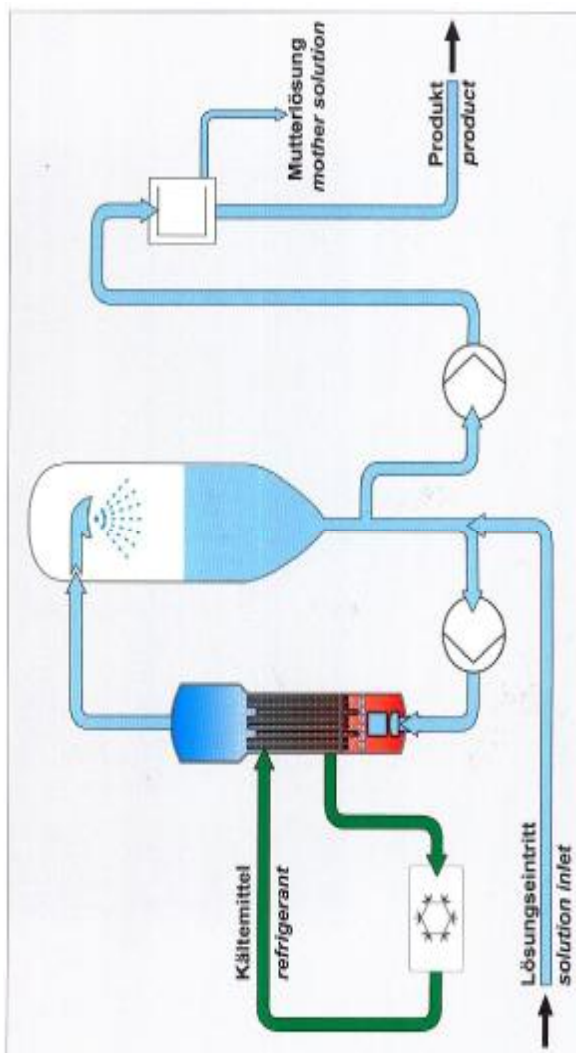
By the aid of an agitation system the turbulence in the evaporation chamber can be enhanced. Also evaporation crystallization plants may be designed single-stage or multi-stage, with vapour compression or without.

Left: evaporation crystallization and vapor pipelines

左边：蒸发结晶装置及其蒸汽管线

冷却结晶

溶液的冷却可以通过真空闪蒸或者冷却介质的换热。通过冷却介质换热冷却的弊端之一是换热管表面容易形成污垢，可以采取的措施是安装立式换热器或是间歇操作。艾伯纳拥有自动清洗功能的流化床热交换器专利技术，后面将重点介绍。



Cooling crystallization

The solution may either be cooled by flashing under vacuum or through cooling surfaces.

A drawback of cooling through cooling surfaces is that the cooling surfaces incrust in case saliferous solutions are cooled. Hence in most cases remedial measures are necessary by means of a stand-by heat exchanger, or a discontinuous operation has to be accepted.

An alternative is the application of a self-cleaning heat exchanger. EBNER has the licence of manufacturing the so-called self-cleaning fluidized bed heat exchanger, which was developed by the Technical University Aachen, and its sale all over the world.

By the fluidized bed technique the incrustation of the heat exchanging surfaces is prevented to a great extent.

Left: Principle flow sheet of a cooling crystallization plant for production of $\text{CuSO}_4 \times 5 \text{H}_2\text{O}$ / 左边是 $\text{CuSO}_4 \times 5 \text{H}_2\text{O}$ 的冷却结晶流程简图

真空冷却结晶

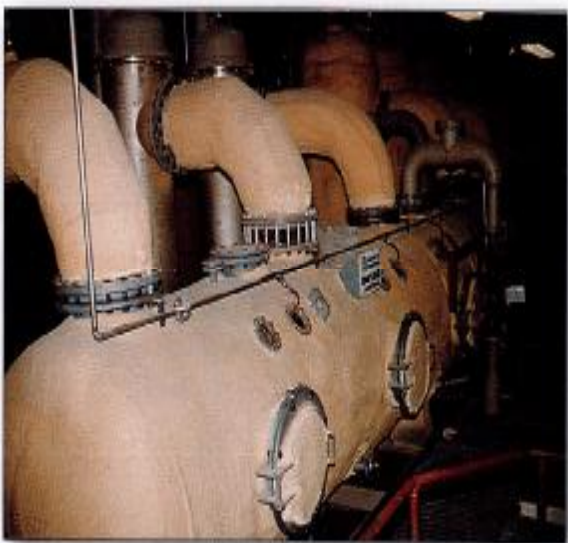
溶液冷却得到结晶或者在压力下降情况下晶体加热熔融蒸发水分。进行换热的表面不能形成污垢，否则不能将盐分离，装置的运行效果也就大打折扣了，随之而来的是需要大量的清洗操作。

真空结晶既可以设计成单效的也可以设计成多效的，效数越多则晶体的停留时间也越长，晶体的颗粒度取决于停留时间的长短。

真空冷却结晶可由以下几种途径得到：

- 蒸汽喷射泵
- 冷冻机
- 使用硫酸或者氢氧化钠作冷凝剂

应用领域：



Vacuum cooling crystallization plant for production of $\text{MgSO}_4 \times 7\text{H}_2\text{O}$ / 真空冷却结晶生产 $\text{MgSO}_4 \times 7\text{H}_2\text{O}$

Vacuum cooling crystallization

In this type of crystallizer the crystallization is effected by cooling a solution or melt by the adiabatic evaporation of the solvent at pressure decrease. Hence no surfaces to serve the heat exchange are needed which are susceptible to incrustation in case solutions from which salts are separated are handled, and thus the performance of the plant is decreased. Consequently the demand for an operation with large cleaning intervals is met.

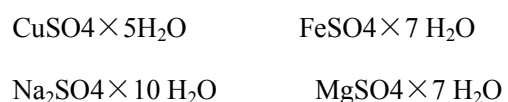
Vacuum crystallization plants may be designed single-stage or multi-stage. By installing more stages and a longer retention time of the crystals are size of crystals may be determined.

Depending on energy cost the vacuum cooling can be achieved in different ways, e.g.:

- application of steam effectors
- use of refrigerating agents (refrigerating machine)
- use of sulphuric acid or soda lye as condensation agent

Specific fields of application:

Salts with adherent water molecules such as:l



焙烧

结晶过程中，如果结晶盐中还包含了一部分结晶水，这些水分子必须除去才能更好地利用回收盐。

一个典型的例子就是芒硝 ($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$)。在常压温度 33°C 条件下，芒硝加热熔化。芒硝熔化后溶解在自身的结晶水中。一部分不溶于水的晶体就沉淀下来，经过蒸发，更多的盐结晶沉淀。结晶水则在蒸发过程中

蒸发去除，加热器安装在蒸发器的外面。这些结晶装置既可以设计成单效也可以设计成多效，既可以有二次蒸汽的压缩也可以没有。

艾伯纳除了传统的单效或者多效结晶，还发明了更加经济的装置，该装置在它的操作压力范围内，能够明显减少换热管表面的沉淀，二次蒸汽还可以作为过压废蒸汽被别的装置继续利用。



Melting crystallizer designed as evaporation crystallizer/熔融结晶器

Melting crystallization (calcination)

During crystallization a number of salts which precipitate contain crystal water, i.e. water molecules are included in their crystal system. These molecules have to be removed to allow a further utilization of the salt.

A typical example is glauber's salt ($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$). Under normal pressure it melts already at abt. 33°C in its own crystal water. This led to the idea of developing the melting crystallization (also called calcining). In this case the glauber's salt is fed into a melting tank and is dissolved in its own crystal water. By doing this a part of the anhydrous crystals precipitate. During evaporation the remaining salt crystals precipitate. The water is evaporated in evaporation crystallizers which are equipped with exterior heaters. These crystallizers may be designed single-stage or multi-stage, which vapour compression or without (mechanical or thermal).

In addition to be conventional single-stage or multi-stage plants EBNER developed another

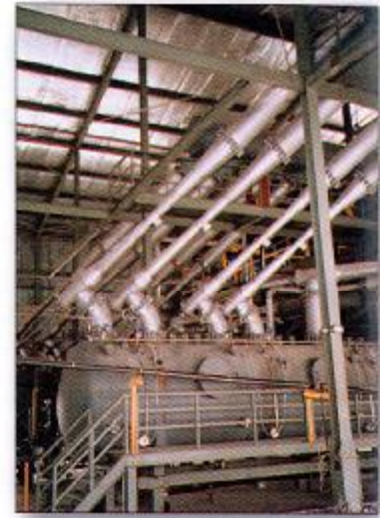
type of plant to meet the economic requirements. This plant works in pressure range. By this development EBNER succeeded in minimizing the problem of incrustation in the heater tubes. The vapor which develops in the crystallizer may be utilized as waste steam with overpressure by other users.



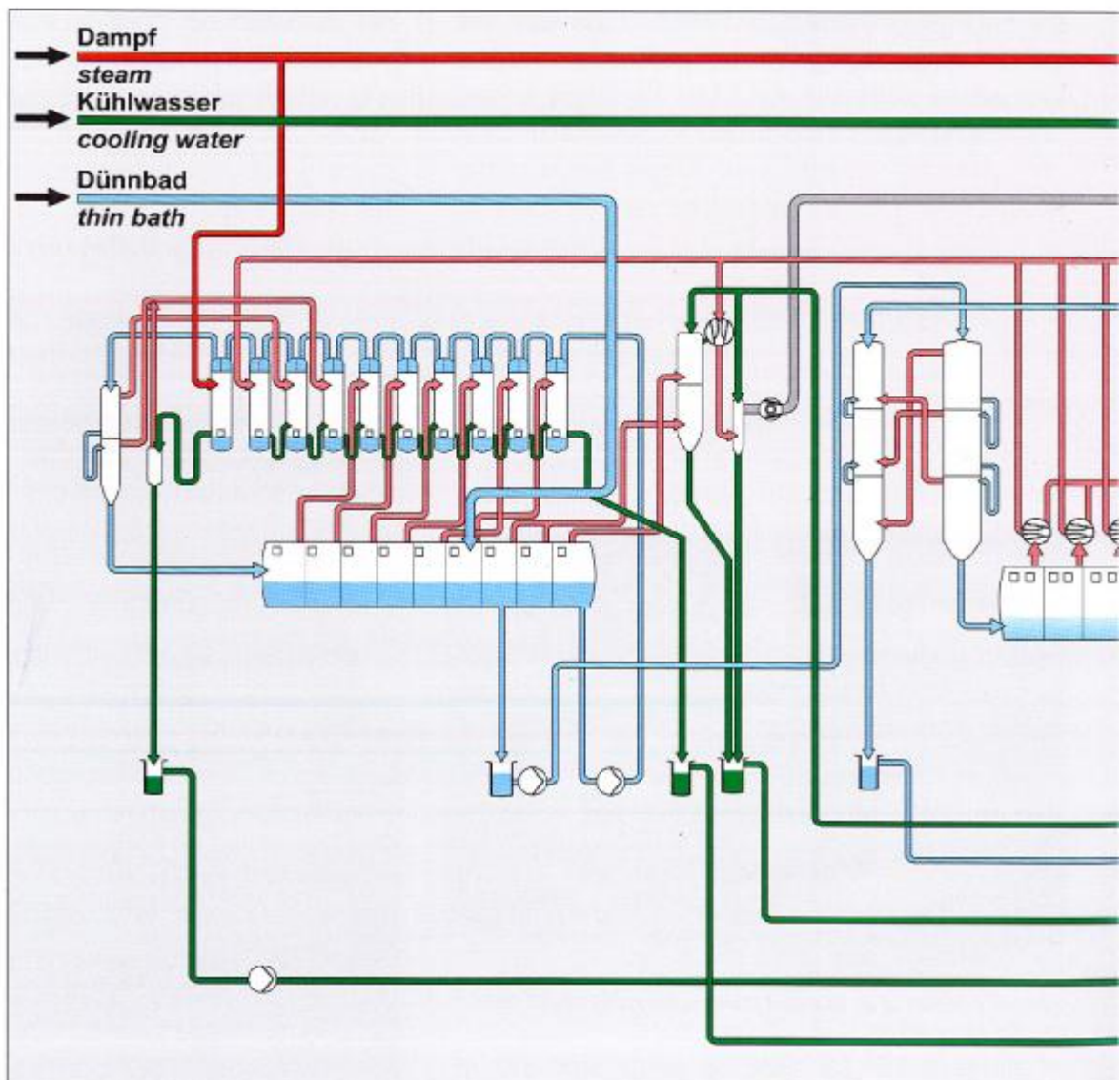
*Melting crystallizer with exterior heaters and condenser/
帶有外部加热器和冷凝器的焙烧装置*

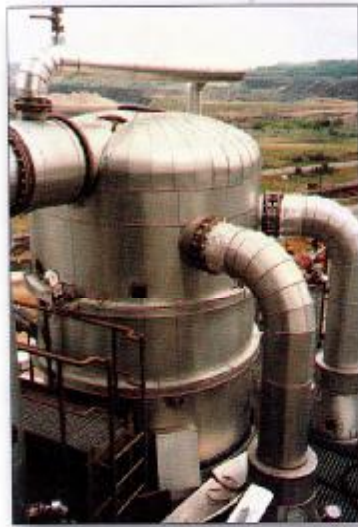


Entspannungseindampfung / Flash evaporation



Vakuunkühlkristallisation / Vacuum cooling crystallization

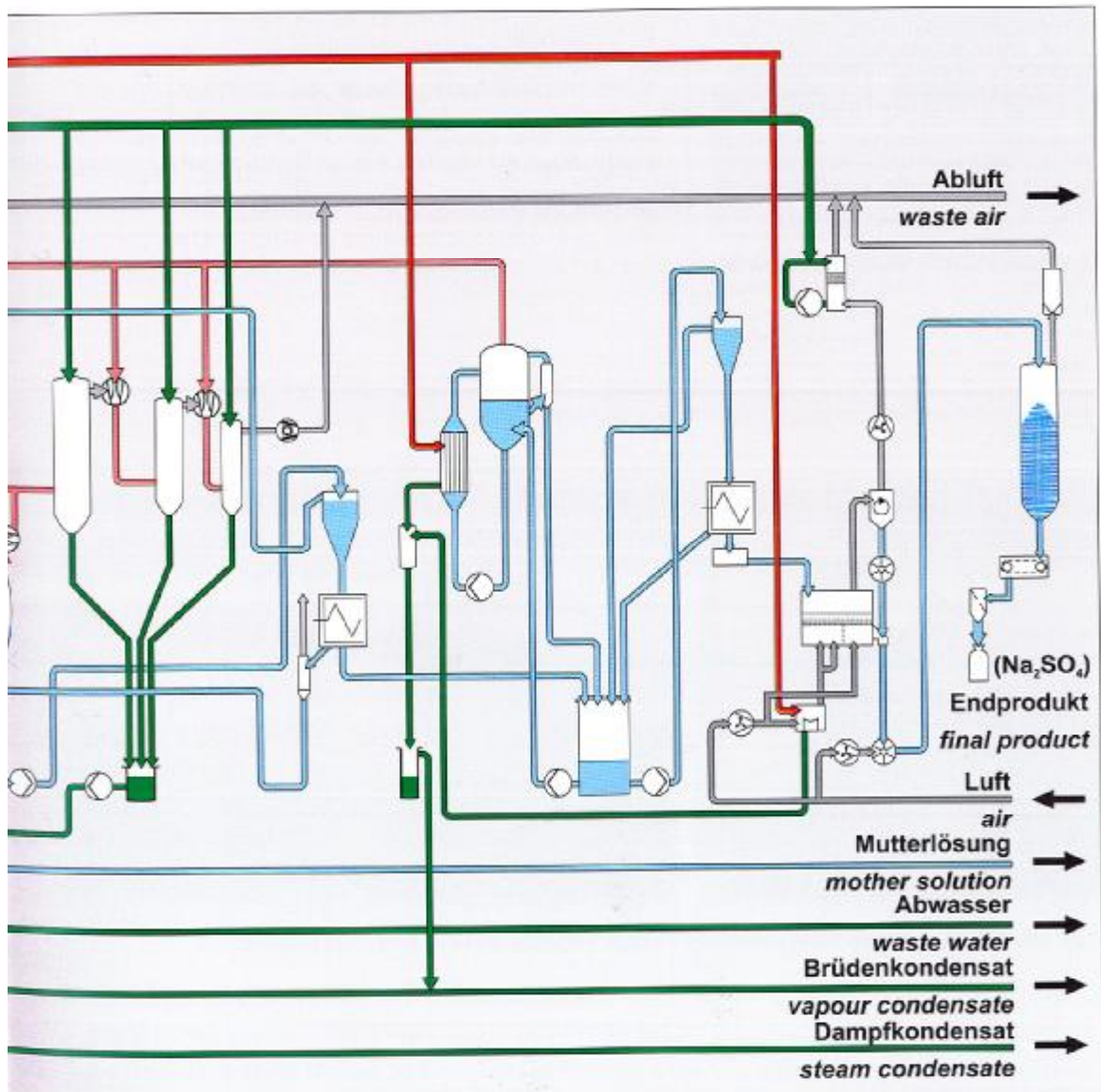


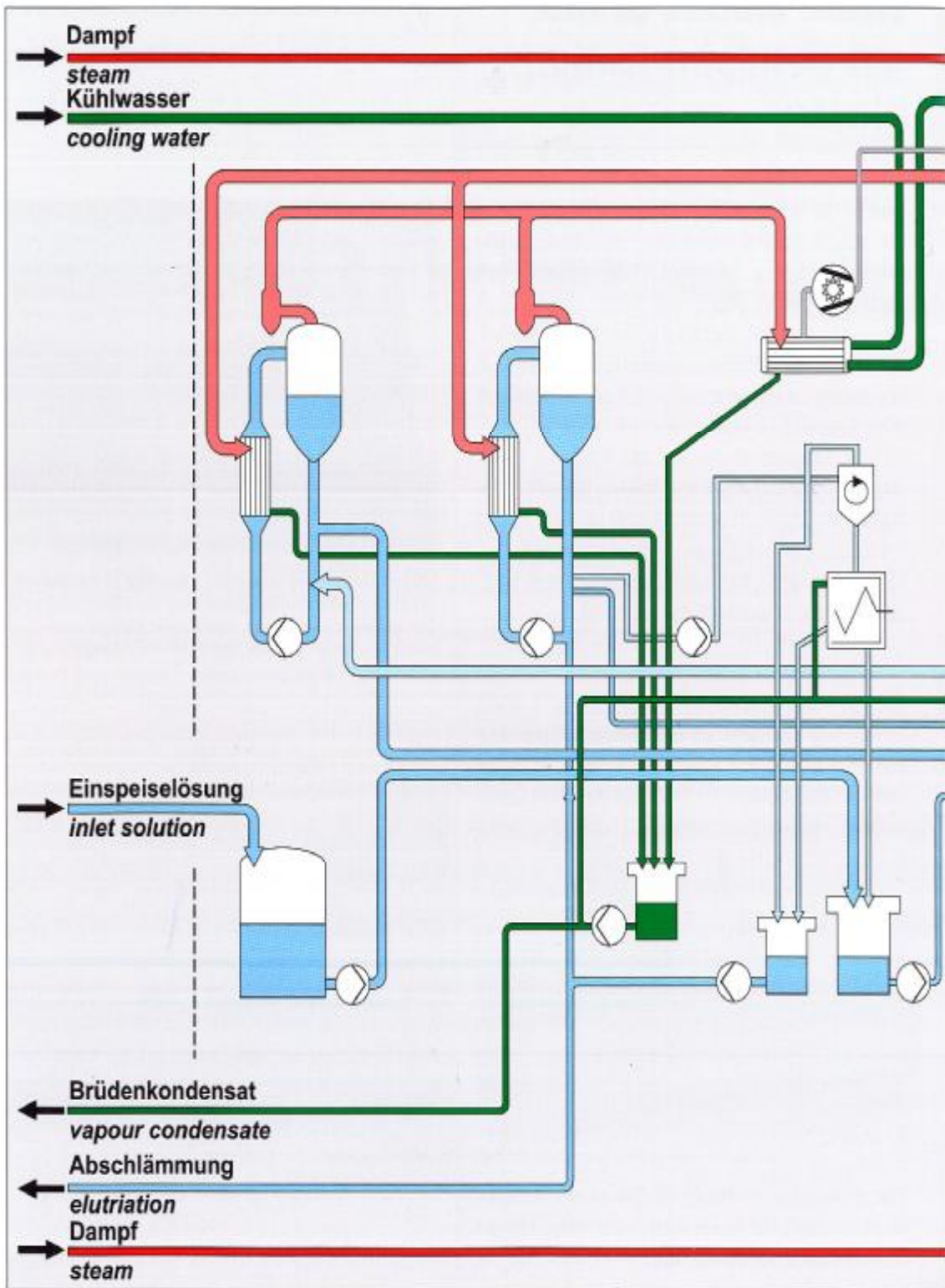


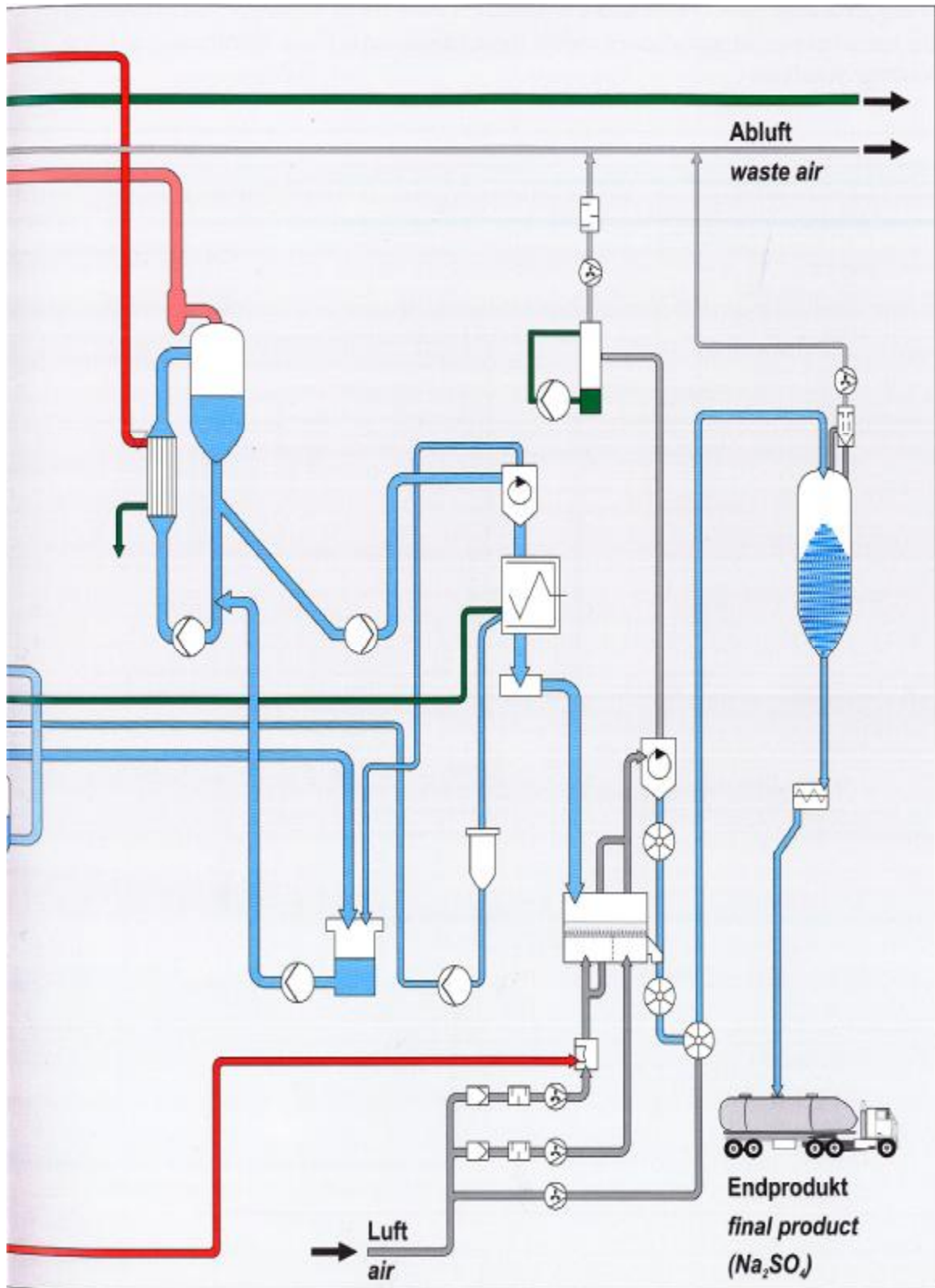
Verdampfungskristallisation /
Evaporation crystallization

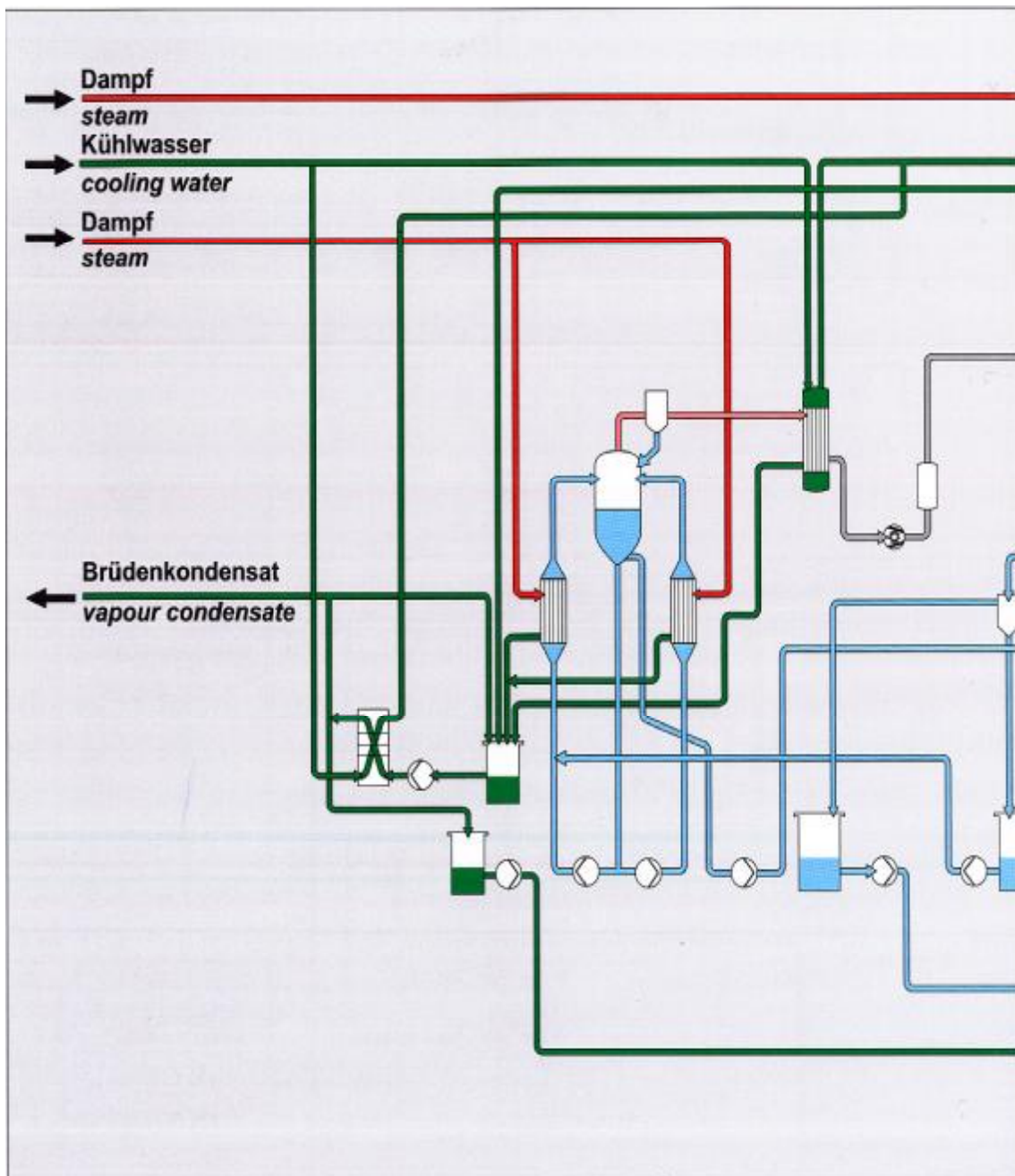


Trocknung des Produktes / Drying of the product



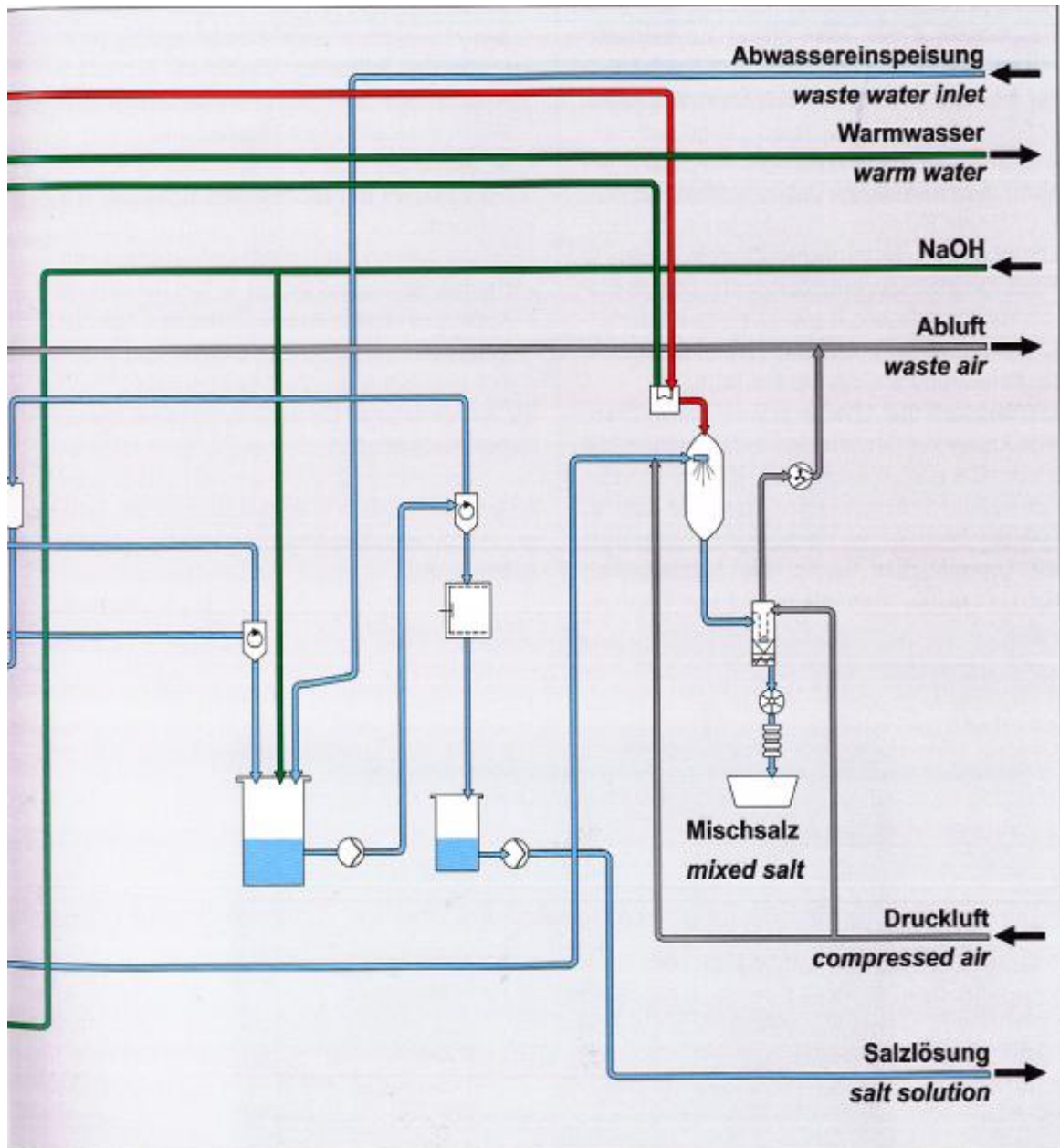






Principle flow sheet of a salt recycling plant

Inorganic salt is recycled as main product. It is dissolved again and is available as salt solution. The unwanted salt components are elutriated and treated in a spray drier to solid mixed salt.



盐回收流程简图

无机盐作为主产品回收，盐溶于水后得到的溶液可以继续使用。不能利用的组分经清洗干燥得到混盐。

蒸汽喷射泵

艾伯纳生产制造的蒸汽喷射泵不管在艾伯纳负责的项目还是在别的项目上都能得到广泛应用。蒸喷的工作原理是吸入低压的蒸汽或者二次蒸汽，将其压缩至更高的压力。蒸喷主要由三部分组成：喉管，文丘里管和扩散器。一般情况下使用生蒸汽做推动力，有时也会采用其他气体。



Steam ejectors installed at a cooling crystallizer/冷却结晶装置上的蒸喷

生蒸汽以超音速的速度喷出喉管，造成吸入口真空，与吸入口连接的气体被吸进来。在扩散器中，混合气体的动能转化为静压能。所有蒸喷都能克服一定程度的压降，如果需要造成高真空，可以将多台蒸喷串联使用，前段蒸喷产生的蒸汽经过冷凝后进入后段的蒸喷。

Steam ejectors

Steam jet-pumps

EBNER manufactures steam ejectors and steam jet pumps which find application in their own plants and in plants of other plant constructors. Steam ejectors suck in steam or vapor at low pressure and compress it to a higher pressure. They mainly consist of three parts: the power nozzle, a head piece and a Venturi-shaped pipe, the diffuser. In general steam serves as propellant. But other gases may also be used.

The propellant flows with supersonic velocity out of the nozzle, thus a sucking effect develops and the gas particles existing in the head of the steam ejector are entrained. In the diffuser the kinetic energy is recovered to potential energy resulting in an increase of pressure.

Any steam may overcome only a certain pressure drop. In case of larger pressure difference several steam ejectors are connected in series (steam jet pumps) in which case condensers are installed between the stages in order to condensate the power steam of the in front connected steam ejector.

单管密封换热器

艾伯纳生产制作列管式热交换器用于工程项目，除了普通的金属热交换器艾伯纳也制造石墨换热器。艾伯纳的单管密封石墨换热器有以下特点，所有列管通过特殊密封件与管板密封，管板为碳钢衬胶。较薄的管板和有余量的填料箱达到很好的密封效果，能够承受管束的热膨胀。

Tubular heat exchangers

EBNER manufactures tubular heat exchangers which find application in their own plants and plants of other plant constructors.

Besides heat exchangers with metal tubes also heat exchangers with graphite tubes are built. Every single one of these graphite tubes is inserted with sealing rings in rubber-lined steel tube sheets so that each tube can expand freely. This makes a sealing of the lower tube sheet by means of a stuffing box superfluous which would have to bear the expansion of the whole tube bundle.



流化床换热器

在诸如废水、盐溶液等介质中，热交换器中的热量传递一直是一个令人头疼的问题，这些介质在加热或者冷却表面结垢常常引起装置停车，以及由此引起的清洗安装等都花费甚巨。

德国亚琛大学基于多年的研究之后，发明了流化床形式的换热器，该换热器具有自动清洗的功能，使其能够减少换热表面的污垢和沉积。

在流化床热交换中，热传递（加热或冷却）在垂直列管中进行，热量通过壳体流进排出。待处理（加热或降温）的流体在加热管内和一种流态化固体颗粒混合，该颗粒随着流体流动不断的冲刷换热管表面，从而达到自动清洗的作用。这样的设计可有效防止结垢，提高传热系数。艾伯纳拥有此项发明的专利，而且这样的设备已经在全世界得到推广。

Vacuum cooling crystallization

Ever since the transfer of energy to complex fluids(waste water, salt solutions etc.) has been a great problem in the heat exchangers. The heating or cooling surfaces incrust and this results in a standstill of the plant and considerable expenditures(cleaning, installation of stand-by heat exchangers etc.)

On basis of many years of research work at the Technical University Aachen a self-cleaning heat exchanger was developed which is based on the fluidized bed technology. This makes it possible to reduce the incrustation to a minimum.

The heat transfer (heating or cooling) is effected in a vertical tubular heat exchanger; the energy is fed in or led off shell side.

The fluid to be treated is inside the tubes and is mixed with solid particles(fluidized particles) and kept in turbulence. These solid particles have an abrasive effect at the heat transfer surface thus achieving a self-cleaning, i.e. a caking is impeded and the heat transfer is improved.

EBNER has the license of manufacturing fluidized bed heat exchangers with metallic tubes and the sale all over the world.



Solid particles in the inlet chamber of the fluidized bed heat exchanger/ 流化床换热器列管中的固体颗粒

三圣石墨管材

A 酚醛树脂石墨管

酚醛树脂石墨管是由石墨粉和酚醛树脂按一定比例配制、混合，经 500 吨挤压成型，300℃ 高温热处理而成，具有良好的化学稳定性、热稳定性、耐腐蚀性和物理机械性能，材料允许最高使用温度为 170℃。

B 改性酚醛树脂石墨管

改性酚醛树脂石墨管与酚醛树脂石墨管相比，具有更好的耐腐蚀性能和更高的使用温度。

C 碳纤维加强管

碳纤维加强管与普通石墨管相比，抗蒸汽冲击和抗超极限的工作能力更强。材料许用最高压力和温度分别是 1.2MPa 和 200℃



D 石墨化浸渍管

石墨化浸渍管为经过高温石墨化工艺处理后的石墨管，经合成树脂浸渍，热处理后成型。其传热系数、许用温度和许用压力均比普通酚醛树脂石墨管高 15~20%，可根据不同的使用介质选用不同的合成树脂浸渍，具有更强的耐腐蚀性能。

E 石墨带翅片管

石墨带翅片管分为外翅片和内翅片两种结构形式。与普通合成树脂石墨管相比，其传热面积显著增加，换热效果明显增强。



Graphite tubes

A Phenolic resin graphite tubes

Through mixing process (graphite powder and phenolic resin mixed in certain proportion) and extrusion process, (500T extrusion machine and 300°C heat treatment). Nantong Sunshine can get final products with good chemical stability, physical mechanical character, anti-corrosion character and stable heat stability. The allowable temperature is 170°C

B Modified phenolic resin

graphite tubes

Compared with phenolic resin graphite tubes, modified phenolic resin graphite tubes have better anti-corrosion character and higher allowable temperature.

C Carbon fiber

reinforced graphite tubes

Compared with synthesis resin graphite tubes, carbon fiber reinforced graphite tubes have better strength, the Max. application pressure and temperature is 1.5MPa and 200°C respectively.

D Graphite and impregnated tubes

Through graphitization process, impregnation process, and heat treatment process, Nantong Sunshine can get graphitized and impregnated tubes. The data of heat exchange efficiency, allowable temperature, and working pressure is 15-20% higher than that of phenolic tubes. Different synthesis resin will be selected for different media.

E Wing-structure graphite tubes

There are two kinds of structure: internal wing-structure and external wing-structure, through the modification of the structure, the heat exchange area enlarged, the heat exchange efficiency increased.



南通三圣石墨设备科技股份有限公司

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