8

Typical Industrial Applications

The liquid ring vacuum pump has proved a success for decades, especially with wet processes in chemical process engineering. With water as a liquid compressant it is used for intake pressures between 33 and 1,000 mbar and for suction capacities between approximately 10 m^3/h and approximately 25,000 m^3/h.

However, it is mainly used with suction capacities between 100 and 3,000 m^3/h.

Water is predominantly used as a liquid compressant for the drawing off of water vapor/air mixtures. If fumes arising from the process are to be drawn off, other liquids can also be used and compressed in the closed cycle.

Liquid ring vacuum pumps are non-reactive to liquid accumulation in the suction chamber. The admissible volume of liquid to be conveyed depends on the size of the pump, and can be many times the amount of liquid compressant used.

CHEMICALS AND PHARMACEUTICALS

In this field, large-scale use is made of liquid ring machines as vacuum pumps and compressors. This robust, noiseless pump, which can also easily convey liquids, is highly thought of. As quite often corrosive and poisonous material is processed, pumps of corrosion-resistant materials are used in many cases and special requirements are made regarding the

quality and proofing of the shaft packing. The liquid ring pump, with its flexible choice of materials, shaft packing, and liquid compressants, is ideal for these purposes. Also, the fact that the compressed gases leave the pump in a cold condition is conducive to environmental protection and recycling of materials. Liquid ring pumps are used in the following processes:

Filling. Pastes and cremes are to be filled without gas bubbles, if possible. This is achieved by deaeriation before filling.

Distillation. Numerous chemical substances are obtained by distillation. This often takes place in a vacuum. Liquid ring vacuum pumps are used—according to the pressure required—alone, or as a pre-stage for pumping stations.

Deaeriation. Many natural substances, above all those used in pharmacy, are susceptible to oxidation. Storage time especially would be shortened severely by oxidation processes. The oxygen content of a solution can be diminished by deaeriation using a vacuum pump.

Filtration. During the manufacturing process, many substances are developed as suspensions mixed with liquids. This surplus liquid is drawn off in vacuum filters. In this case, liquid ring vacuum pumps are used for the production of a vacuum and thus for a faster and better filtration of the product. The vacuum filter can also be replaced by the opposite process of pressure filtering. The plant illustrated below consists of two liquid ring compressors for compressing the high-pressure gas to 6 bar. When passing through the material to be filtered, the high-pressure gas becomes enriched with solvent vapors, which largely condense out and can be recovered when compressed in the compressors.

Cooling. Heat can be withdrawn from a liquid rapidly and without much technical difficulty by means of evaporation. This is implemented in the so-called vacuum cooling process. Liquid ring vacuum pumps are used as they are insensitive to vapors and have a very high additional suction speed for vapors.

Crystalizing. For many substances the crystallization process works faster and better in a vacuum. As large amounts of vapors also develop when pumping down, liquid ring vacuum pumps are often used.

Concentrating. Solution concentrations can be upgraded by evaporating the liquid in solid-liquid mixtures or by evaporating the liquid which has

the lower boiling point in liquid mixtures. Liquid ring vacuum pumps are also used here.

Drying. Solid-liquid mixtures need to be dried before further processing or during the final working stage. In order to be able to carry out the drying at low temperatures a vacuum is used. Example: During the drying of a product, isopropanol vapor is to be recovered to as large an extent as possible; also, as isopropanol is covered by the Technical Guideline TA Air and emission levels are limited, the outgoing air should contain as little isopropanol as possible. In the series brine-cooled condenser (see Figure 8-1) most of the isopropanol vapor is condensed and drawn off as a liquid with a periphery pump. The air that escapes is drawn off by a liquid ring pump together with the saturated isopropanol and compressed to atmospheric pressure. Isopropanol serves as a liquid compressant, which is also brine-cooled.

Very sensitive products are dried by so-called freeze drying, i.e., moisture is drawn off the frozen product by sublimation.

The plant shown in Figure 8-2 is used for pumping down methanol vapors.

In a co-condenser, most of the vapor is condensed by cooled methanol. Inerts with methanol as the fraction of saturation are pumped down by a

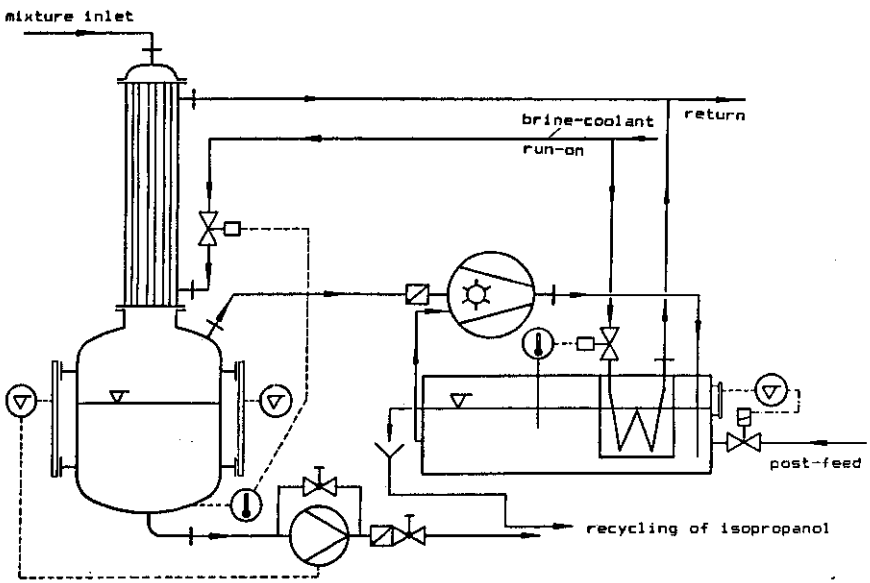


Figure 8-1. Example of a drying plant (Sihi).

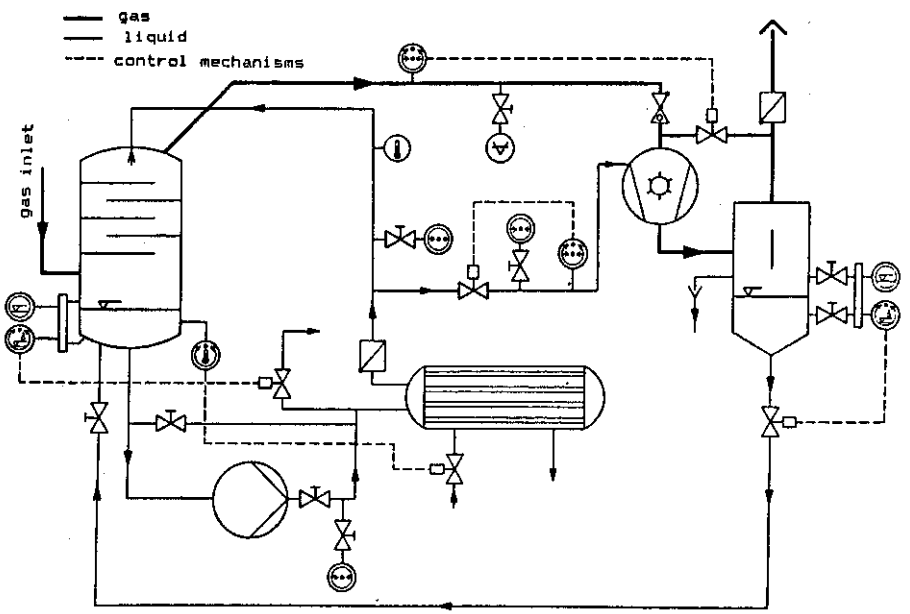


Figure 8-2. Example of a plant for pumping down methanol vapors (Sihi).

liquid ring vacuum pump which works with cooled methanol as liquid compressant.

Exhaust Gas Compression. The solvents arising in the chemical industry are only permitted to enter the atmosphere in the form of vapor in small amounts. The Technical Guideline TA Air prescribes the admissible quantities. Figure 8-3 shows a solvent recovery plant. The content of solvent vapor in an exhaust gas, the so-called saturation concentration, is calculated according to the following formula:

$$m_D = m_G \frac{M_D}{M_G} \frac{P_D}{P_G}$$

Here, the vapor pressure P_D depends on the temperature and the gas pressure P_G of the inert gases on the total pressure.

Afterwards this saturation concentration can be decreased by diminishing the exhaust gas temperature and by raising the compression pressure. Figure 8-4 shows a plant for high-pressure gas compression at a pressure-rotary filter.

Liquid ring pumps compress with a lower exhaust gas temperature and in most cases can also compress against higher back pressures. Combina-

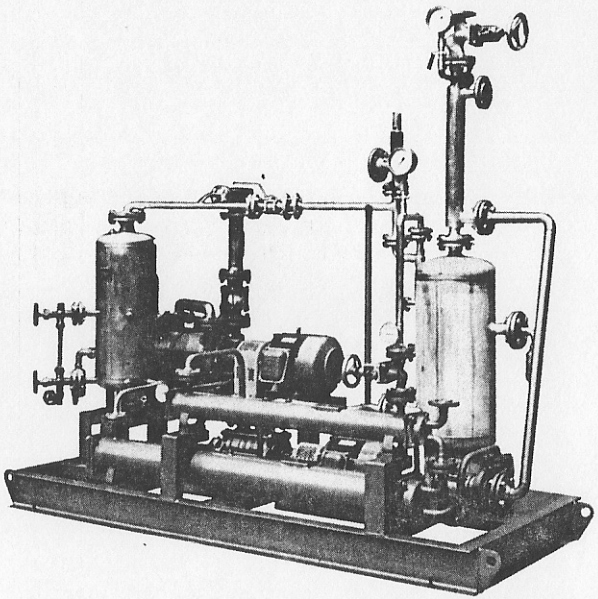


Figure 8-3. Solvent recovery plant (Sihi).

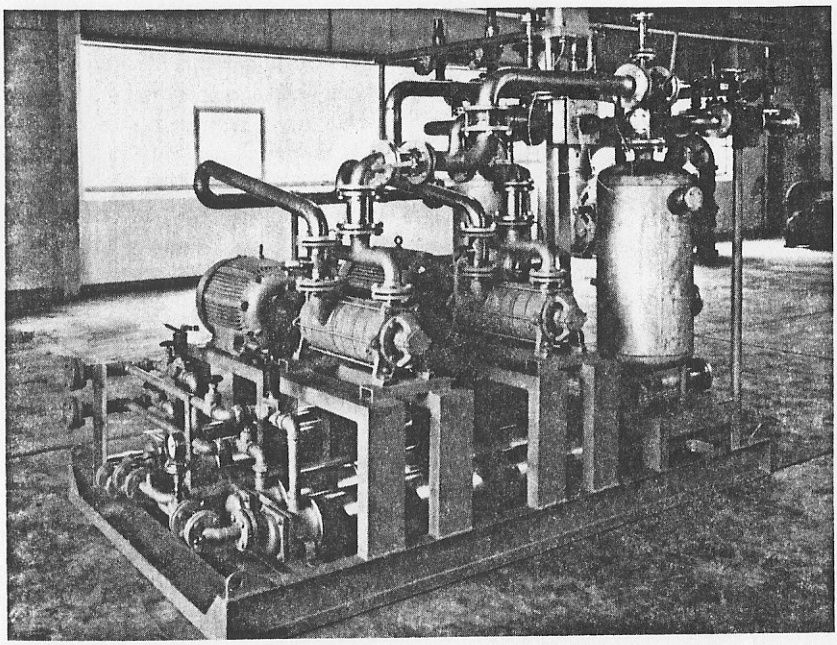


Figure 8-4. Plant for high-pressure gas compression at a pressure-rotary filter (Sihi).

tions which consist of liquid ring vacuum pumps with a subsequently added liquid ring compressor are also used quite successfully.

A plant which consists of a liquid ring vacuum pump and jet compressor is used for the pumping down of carbon tetrachloride vapors. 2 kg/h of air and 6 kg/h CCl_4 are compressed from 40 mbar to 8 bar. The exhaust air contains less than 0.1 kg/h CCl_4.

The jet compressor was used as the suction volume for the compressor was only 1.7 m^3/h; such a small liquid compressor is not on the market. Cold CCl_4 serves as liquid compressant for both compressors.

Chloric Gas Compression (Figure 8-5). Due to its aggressiveness, chloric gas can only be compressed with great difficulty. Liquid ring compressors have become the standard plant here. Since the aggressiveness of chloric gas depends on the water content, humid chloric gas can only be delivered with titanium or ceramic compressors. During the compression of dry chloric gas, concentrated sulphuric acid is used as a liquid compressant.

Central Vacuum Plants (Figure 8-6). Above all in pharmacy a vacuum is needed at various processing stages. In order to meet sterility conditions, the vacuum pumps are located in separate rooms.

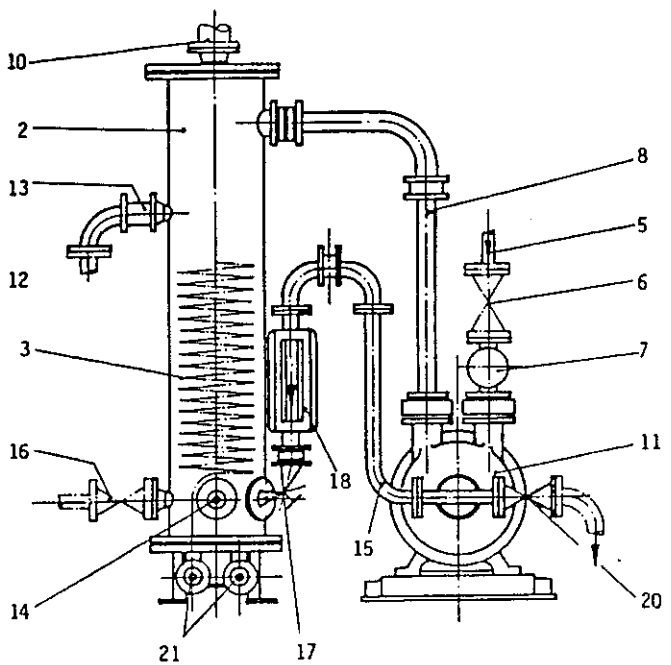
In such central vacuum plants, solvent vapor develops as well as air. In the following, a photo and diagram of a plant is shown, with which gases and solvent vapors, which cannot be dissolved in water or can only be dissolved to a very small extent, are pumped down. In this procedure, the solvents separate in the subsequently added separation container and can be drawn off because of their varying specific weights.

FOOD INDUSTRY

Degasification of Mineral Water. Mineral water coming from the spring contains carbonic acid, other gases, minerals, iron etc. The iron dissolved in this water needs to be separated out as otherwise, with air contact, it would oxidize and also produce an unpleasant taste. This procedure is called "deferrization." For this, however, the CO_2 in the water needs to be pumped down. Afterwards (after the deferrization procedure) it is added again in order to obtain the bubbling stimulating effect. Deferrization takes place at a pressure of approximately 50 mbar. Liquid ring vacuum pumps are used.

Bottling. The filling of beer, lemonade, wine, champagne, and juices into bottles and tins needs to be done without creating froth. Before filling, the bottle to be filled is evacuated as the air it contains disturbs the

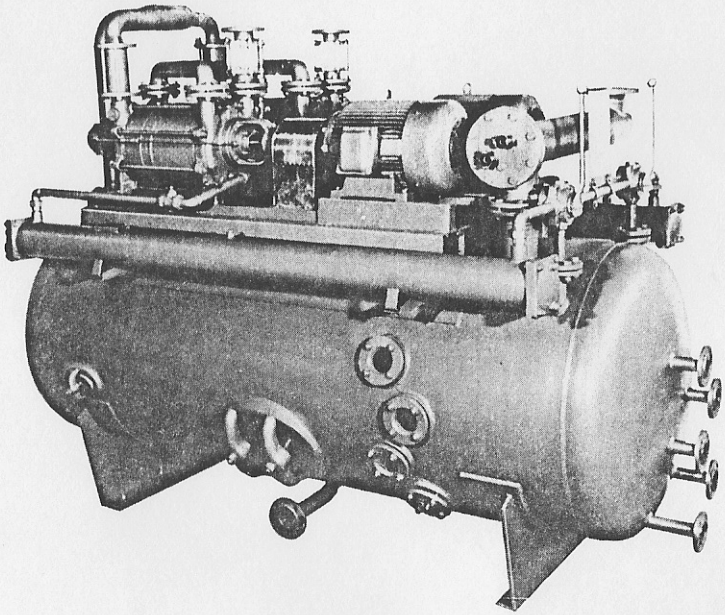
filling procedure. Afterwards the liquid can be filled into the vacuous bottle quickly and admitted with a protective gas. This prevents frothing and the filling procedure takes place quickly and controllably. Figure 8-7 illustrates this process. Liquid ring vacuum pumps are ideal in this case as they work without oil and are insensitive to liquids.



1. gas pump
2. separator cooler
3. heat exchanger
5. suction line
6. shut-off valve
7. through-flow-gauge-glass with screen
8. discharge line (gas and liquid compressant)
10. discharge line (gas and liquid compressant)
12. overflow pipe emmersed
13. gauge-glass for liquid compressant
14. temperature measuring nozzle
15. liquid compressant line
16. fill-up valve for liquid compressant
17. regulating or shut-off valve for liquid compressant
18. rotaty gauge for liquid compressant volumenometer
20. relief valve for liquid compressant
21. water coolant, inlet and outlet

Figure 8-5. Chloric gas compression (factory drawing: Friedrichsfeld).

Deodorization of Salad Oils and Fats. If oils and fats are exposed to oxygen for some time, an oxidation process sets in which leads to an unpleasant taste and smell. Before the final processing, the oxidation products have to be removed. This is done by injecting vapor, which serves as an entrainer, and by then pumping down the vapor and the entrained oxidation products at pressures of some mbar.



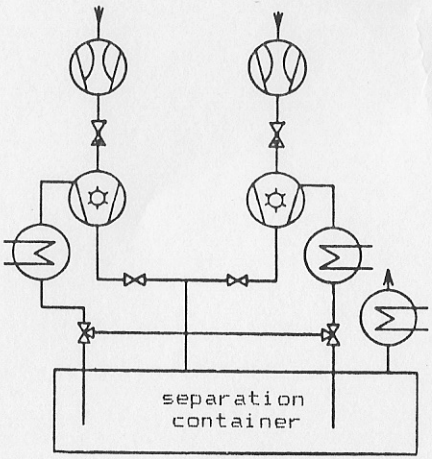
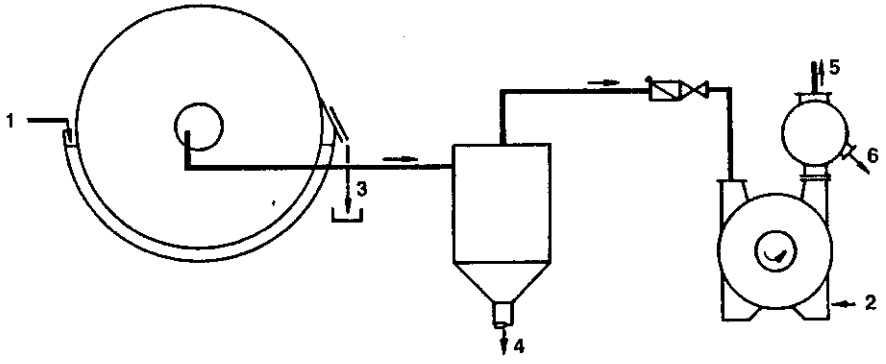


Figure 8-6. Central vacuum plant.



1. sludge-juice intake
2. liquid compressant intake
3. separated sludge discharge
4. juice discharge
5. exhaust air
6. water discharge

Figure 8-7. Vacuum pump for juice filtration (Siemens).

Because of the very large gas and vapor volumes, vapor pumps or Roots pumps serve as vacuum pumps. Liquid ring pumps are forepumps for these machines.

Sterilization of Tea and Spices. Tea and spices come primarily from tropical countries. The goods delivered in bulk very often contain insects, bacteria, and fungi which have to be destroyed before processing. This is done in the following way: Tea and spice bales are conveyed into a large vacuum container. Then, by means of a liquid ring vacuum pump, a vacuum is produced of approximately 50...100 mbar in order to pump down the enclosed air as much as possible. Afterwards vapor or a sterilization gas which can fill all the hollow spaces is blown into the container.

Liquid ring vacuum pumps are ideal for this process as they can also easily pump down liquids or larger volumes of vapor from the subsequently added condenser at higher temperatures.

Production of Sweets. The sweet base mixture consists of sugar, water, glucose, and aromatic substances. Before it is processed into a hard sweet, the water has to be withdrawn. The mixture is evaporated as much as possible by heating at a boiling station (Figure 8-8). A vacuum can accelerate this process and achieve lower ultimate moisture.

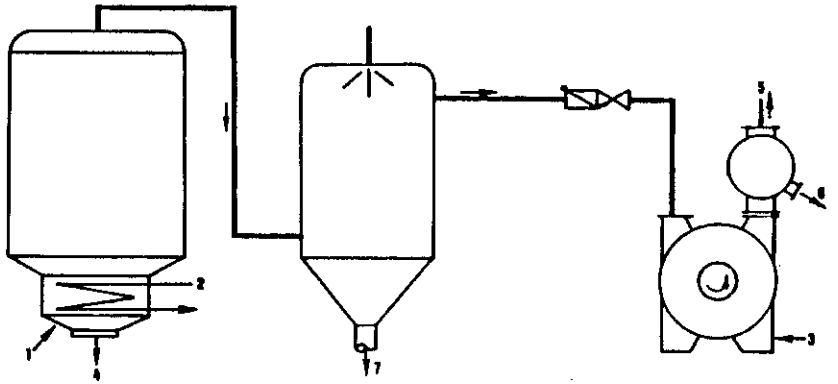


Figure 8-8. Boiling station at a sugar plant (Siemens).

In most cases, the water vapor is condensed by spraying cold water into a simple added condenser, and then pumped down by the liquid ring vacuum pump.

Sausage Production. Sausage meat is produced by mixing cut meat, spices, and various additives. Before filling, air should be withdrawn from the mass as it leads to oxidation of the meat and thus to a change in appearance.

Therefore the so-called cutters are evacuated at a vacuum of approximately 100 mbar and the quality is improved considerably.

Here, too, liquid ring vacuum pumps are used because of the absence of oil and indifference to bits of entrained meat and liquids.

Ham production. In most cases ham is no longer dried and smoked in a chimney. Today, ham is saturated in a curing solution. Air is pumped down from the meat pores so that curing solution can permeate them deeply and thus shorten the curing time considerably.

Liquid ring vacuum pumps also serve to create a vacuum in this case.

Tobacco Humidifier. Tobacco is delivered in large dried bales. In this condition tobacco is brittle and would fall to dust before being processed. Therefore it needs to be humidified in order to guarantee perfect cutabil-

ity and good processing. The raw material is delivered and evacuated in a large container and afterwards admitted with vapor and perhaps with aromatic substances. The vapor permeates the tobacco bales and thus moistens the interior uniformly.

Jets with subsequently added liquid ring vacuum pumps are used to achieve a vacuum of approximately 10 mbar.

Sugar Production. In this part of the world, sugar is made from sugar-beet. For this, sugar-beet is chopped and pressed. The resulting juice is divided into clarified juice and sludge by vacuum rotary filters. Liquid ring vacuum pumps ranging from 200 to 600 mbar serve as vacuum pumps for the rotary filters.

Afterwards, the clarified juice is crystallized in vacuum-pan houses at approximately 200 mbar.

Again liquid ring vacuum pumps serve to create a vacuum.

Lime-milk and carbonic acid are needed for the carbonation process. This is produced by lime burning. The resulting gas is pumped down with liquid ring compressors and compressed to a pressure of about 2 bar.

Robustness, extensive performance capacity, oil-free operation, and indifference to entrained sand particles and crystals apply to all vacuum pumps and compressors used in the sugar industry.

PLASTICS INDUSTRY

Plastic is used in almost all areas of life. During production and processing a vacuum is used extensively. The following are some typical applications:

Drawing Off and Compressing of VC-Gas (Figure 8-9). PVC is one of the most frequently used plastics. For its production, vinyl chloride (VC-gas) is used. This gas used to be regarded as relatively harmless. A few years ago, however, it turned out that it is extremely carcinogenic and has to be handled with suitable care.

PVC is produced as follows: In an autoclave, liquid vinyl chloride with additives is converted to polymerize under pressure. After the reaction is complete, pressure is released and the remaining monomeres (these are non-polymerized VC-molecules) are drawn off as gas. Liquid ring vacuum pumps are used in this process. The gaseous vinyl chloride is stored in a gasometer and compressed and liquidized to a pressure of about 7 bar by means of a liquid ring compressor. The liquid VC is stored in a container and used for further reactions.

Water serves as a liquid compressant for vacuum pumps and compressors. Because of the dangers connected with VC, the sealing of the

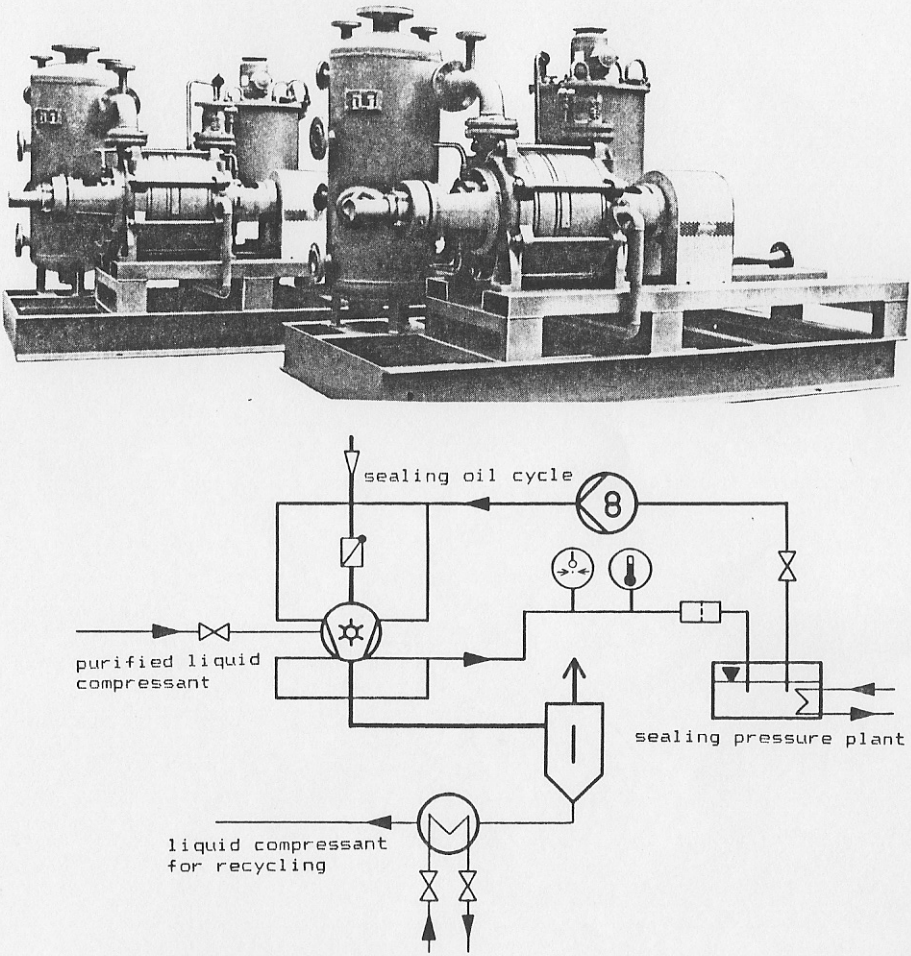


Figure 8-9. Liquid ring compressors for compressing vinyl chloride gas (Sihi).

pumps has to meet high requirements. Therefore, double axial face seals are standard practice.

Extrusion Degasification (Figure 8-10). Plastics are processed in the widest range of mixtures. In most cases, various additives such as coloring and fillers are admixed to a raw material. A so-called extruder serves as a mixer.

The mixture is delivered through a heated casing by means of worms. The plastic mass melts at temperatures of approximately 300°C.

By mixing and melting, the various components distribute uniformly.

In the so-called degasification extruder, the melted mixture passes through various pressure stages, among others one or more vacuum stages. During this process the melted plastic degasifies and large quantities of moisture and remaining monomeres are released.

Occasionally water is injected into the mold as an entrainer to enhance expulsion of the remaining monomeres.

For the drawing off process, liquid ring vacuum pumps are used either individually or in combination with Roots pumps.

Vacuum Calibration. Plastic profiles are used to a large extent for the production of windows, rollers, blinds etc. The profiles are produced as follows: The plastic mixture from the extruder is shaped in jets and then given an exact form using a calibrating tool. Water is used for the cooling and lubricating of the tool. The resulting water has to be drawn off as the whole process takes place in a vacuum.

The vacuum is used to improve the exactness of the form and to increase the drawing speed. Since a large amount of water is drawn off in

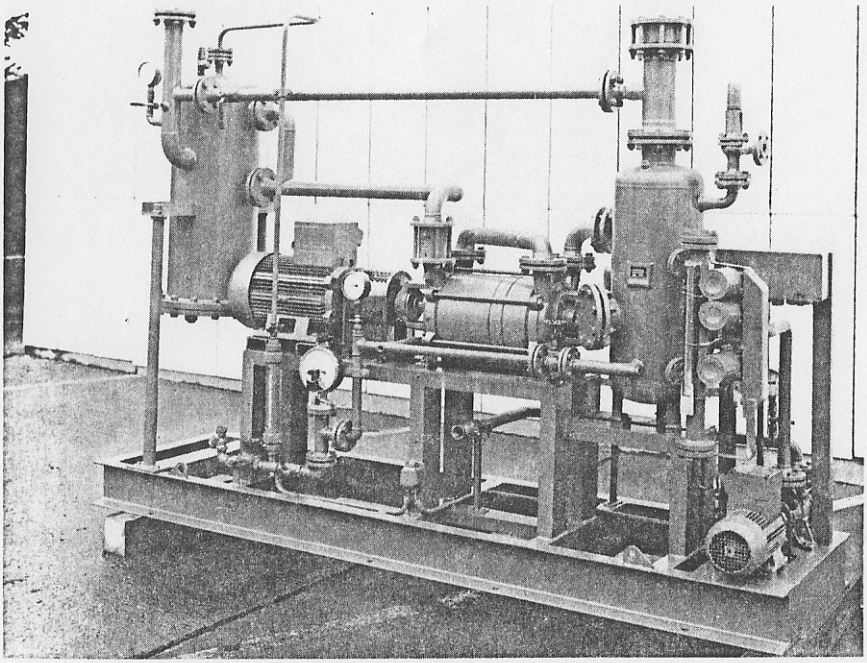


Figure 8-10. Sihi extruder degasification plant.

this process, the liquid ring vacuum pumps do not receive extra liquid compressant; instead, the drawn off water is used to form the liquid ring.

TREATMENT OF WATER

Aeriation of Waters. If the oxygen content in lake, river or sea water sinks below a certain value, all organisms die off—the water "collapses." High contamination levels, and excessive growth of algae caused by excess fertilization and high temperatures lead to a lack of oxygen. As an emergency measure air, and thus oxygen, is blown into the water with liquid ring compressors, whereby the water is also used as liquid compressant. In the case of disturbances in the compressor, there is no danger of oil contamination due to the oil-free operation.

Flushing of Filters (Figure 8-11). Water used for the drinking water supply very often contains very fine particles, or else it is so acidic that it can lead to corrosion of the supply conduits.

The untreated water is pumped over gravel and limestone filters for filtration and deacidification. During this process, filtration particles are retained and the water is neutralized. In the course of time the filter contaminates, thus resistance increases. The filter needs to be flushed. This happens in three phases:

1st phase = loosening up of the filter with air which is pumped through against the direction of flow
2nd phase = flushing with air and water
3rd phase = flushing with water

The filter is now free of mud and can be used again. Oil-free air is used for the flushing process and is produced by liquid ring compressors.

Water Degasification. Water always contains a larger or smaller amount of dissolved gases. This gas either produces a bad taste or it disturbs the treatment process.

Example: In sea water, for desalinization by means of membrane diffusion (osmosis), a very low oxygen partial pressure is required in the water in order to protect the membrane. The water is degasified in a large degasification container by means of a vacuum. A combination of a Roots pump and a liquid ring vacuum pump serves as a vacuum pump. Figure 8-12 illustrates a seawater degasification plant.

Today, in sewage treatment plants so-called biological stages have been installed almost everywhere; this means that the sewage water is cleaned by means of bacteria. The bacteria used for this process need oxygen for

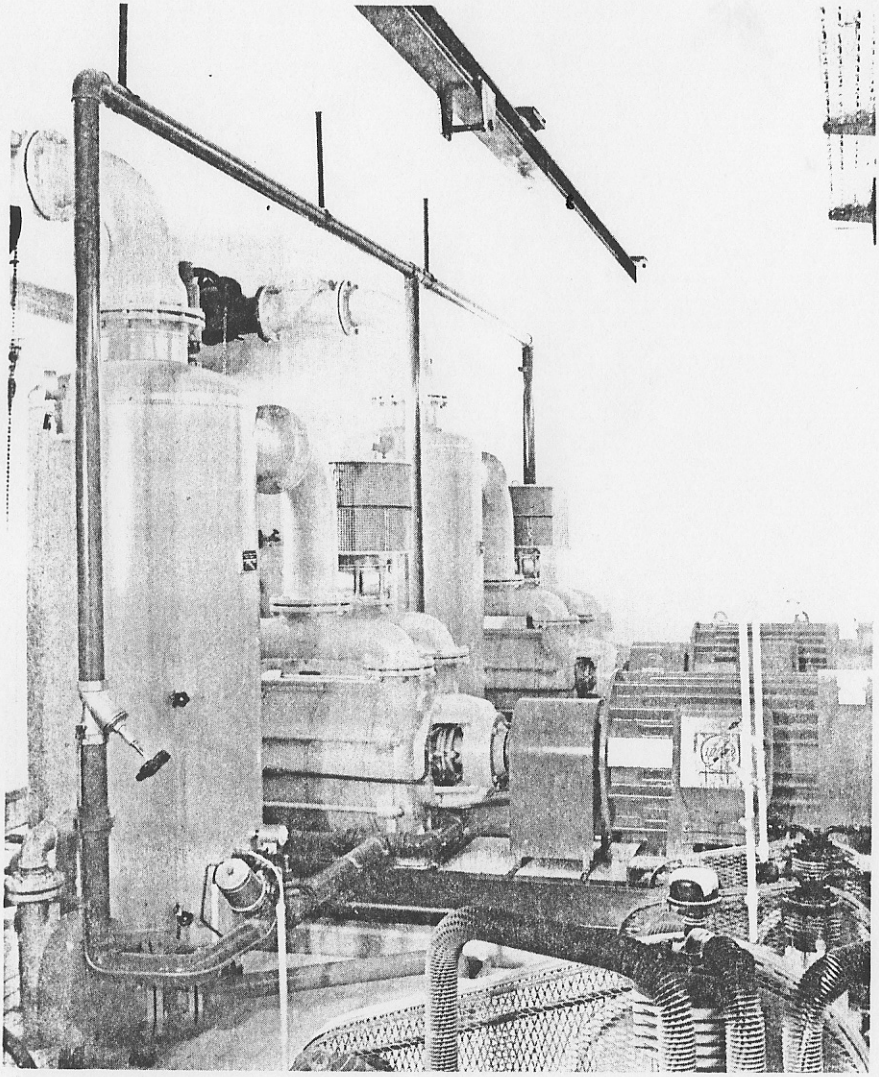


Figure 8-11. Filter flushing plant of the municipal works, Frankfurt/Main (Sihi).

their metabolism. Oxygen is blown into the sewage water by means of compressors. Due to their absolute oil-free operation, air liquid ring compressors are employed for this process. With particularly obstinate impurities ozone is used instead of oxygen from the air. Figure 8-13 shows the sewage recycling process.

The ozone produced in an ozonizator is compressed by a liquid ring compressor to a pressure of about 6 bar and fed against the flood through a packed column with the sewage water to be cleaned. Due to the intensive matter interchange, oxidation of even very obstinate impurities takes place in the column.

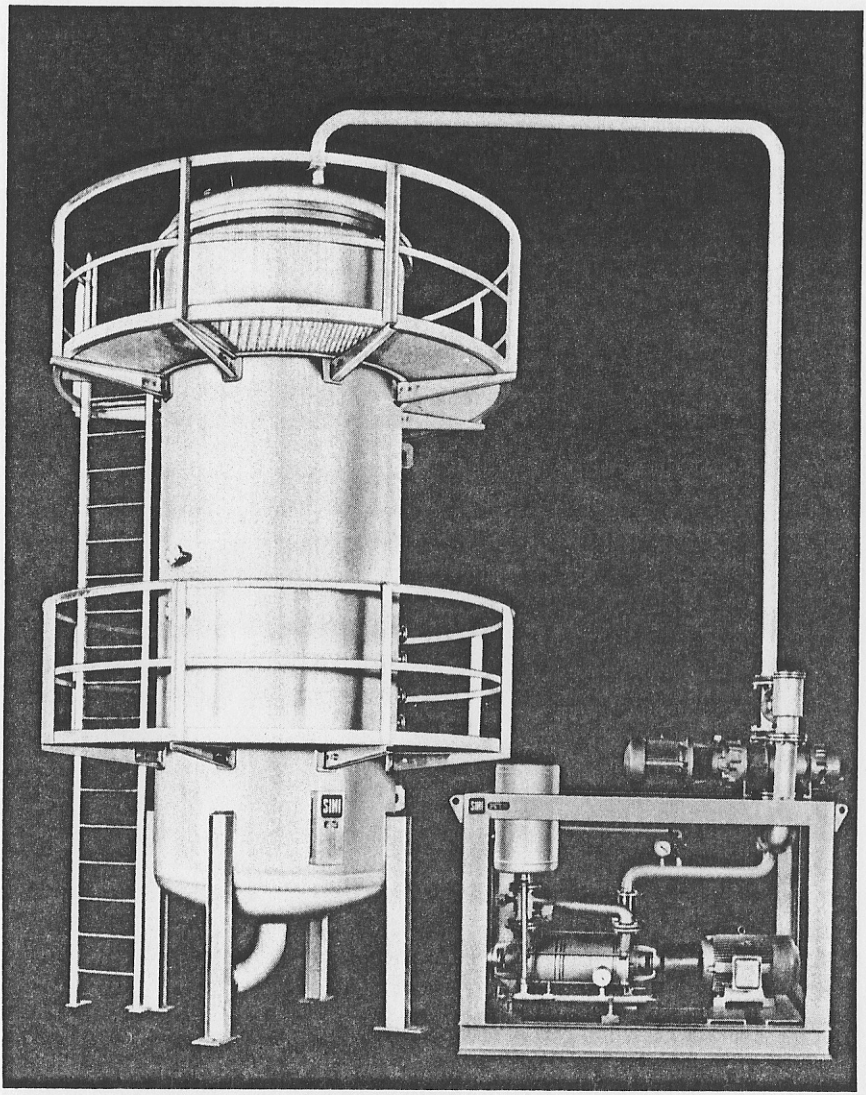


Figure 8-12. Illustration of a seawater degasification plant.

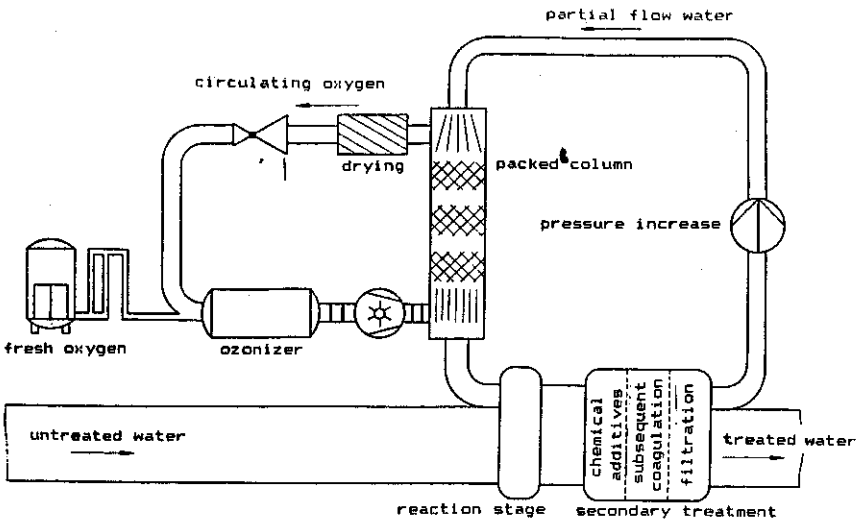


Figure 8-13. The sewage recycling process (Aquodrei method of Hoechst AG, obtainable from Messer Griesheim).

WOOD INDUSTRY

Before or after processing, wood must be protected from the destructive effect of environmental influences such as heat and dampness, from microorganisms like fungi and bacteria, and from damage due to insects. In former times—and in many cases even today—this was achieved by painting it with or dipping it into a wood preservative. For special demands such as railway sleepers, however, this method is insufficient, as the preservative enters only a few millimeters into the wood. If the wood is degasified and dried in the vacuum, the saturant can now enter the emptying pores. The protective effect reaches much deeper layers.

Tar oil or special impregnating fluids are used as saturants. In many cases, the liquid ring vacuum pumps for the evacuation of the plant are operated with the impregnating fluid as liquid compressant.

Wood Drying Plants. Wood always contains a higher or lower level of dampness. Fresh wood contains a lot of water. Before being processed, it needs to be dried as carefully as possible in order to avoid cracks and warping. This can be done either by long storage in the open air under a roof, by careful warming and drying in a wood drying plant, or very quickly and carefully in a vacuum drying plant. Liquid ring vacuum pumps are also in use here.

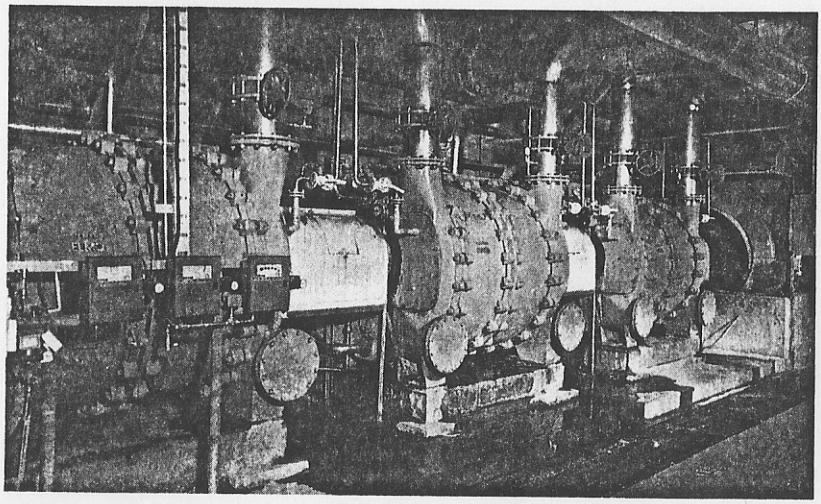
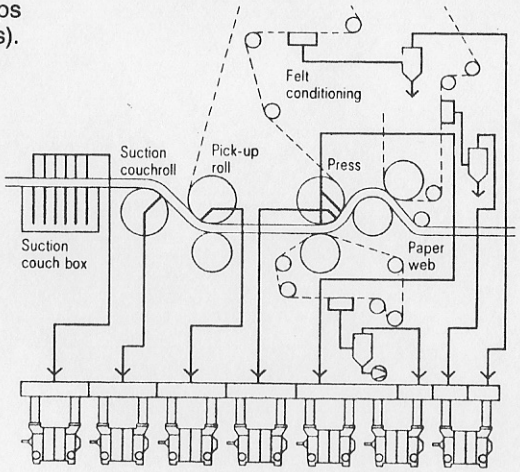


Figure 8-14. Vacuum pumps in a paper factory (Siemens).



PAPER INDUSTRY (FIGURE 8-14)

In paper production a vacuum is needed as a means to dehydrate the paper webs. Liquid ring vacuum pumps are used for this process because of their indifference to water delivery as well as to entrained paper fibers. Another advantage is that oil-free compression takes place, i.e., without contamination.

ENERGY PRODUCTION

Evacuation of Turbine Condensers. In steam turbine plants the condensation process should take place at as low a vacuum as possible so that there is a large drop in usable temperature. Before the condenser is admitted with steam, it has to be evacuated. Liquid ring vacuum pumps are used for this so-called starting operation.

Due to leakage, air enters the condenser and has to be pumped down by a vacuum pump. Large liquid ring vacuum pumps are used for this so-called condensation operation or holding operation, which takes place at a pressure of 30 to 60 mbar.

The advantage of the liquid ring vacuum pump compared to other vacuum systems such as jet pumps is that both the starting and holding operations are completed by the same pump. Liquid ring pumps have a very high suction speed even at atmospheric pressure. At lower pressures, the percentage of steam rises in the medium to be pumped down due to saturation. Here the additional suction capacity, the condensation effect, of a liquid ring vacuum pump has a positive effect.

Figure 8-15 shows a plant which can be used in the holding and starting operation. The jet pumps do not work in the starting range, i.e., over 100 mbar; due to the diminished cross section they act as a throttle. In the

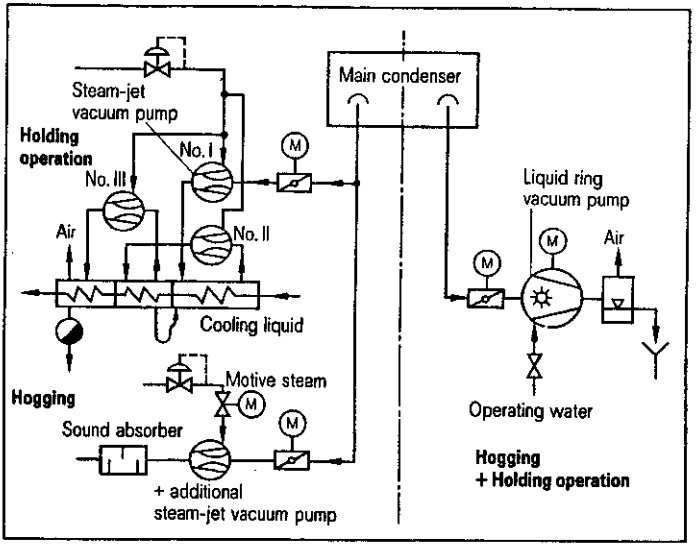


Figure 8-15. Diagram of a condenser venting plant.

plant they are bypassed by a combination of valves. As soon as the condenser is evacuated to about 100 mbar, vapor is let in and the condenser starts to work. The combination of liquid ring vacuum pump/gas jet pump takes over the continual drawing off of the air leakage, i.e., the so-called holding operation.

MINING

Drawing Off of Pit Gas. All coal ledges contain gas in larger or smaller quantities, predominantly methane. This gas, which develops during extraction, has to be pumped down continuously in order to prevent an explosion ("firedamp"). The gas is primed by a vacuum pump, compressed, and delivered to the boiler house for burning. A typical liquid ring vacuum pump for this kind of application has a suction capacity of about 7,000 m^3/h and works at a prime pressure of approximately 300 to 400 mbar.

Liquid ring vacuum pumps are used because of their robustness, their quiet operation, and their safe form of compression.

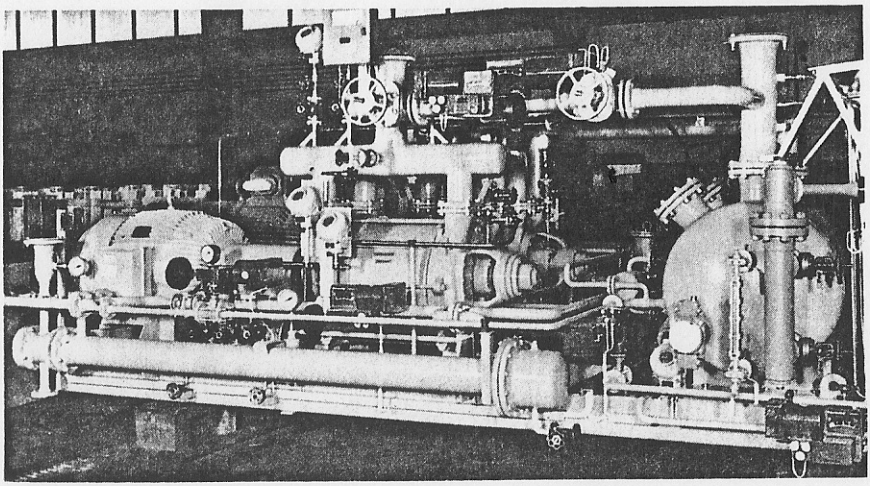
REFINERIES (FIGURE 8-16)

Energy Recovery from Flare Gas. The conditions for the burning off of hydrocarbons have become stricter for reasons of environmental protection.

The utilization of the energy contained in flare gas can replace up to 80,000 barrels of oil per plant, depending on the quantity and composition of the gas. In energy production from flare gas the gases are drawn off, compressed, and fed back to the plant as effective energy. The compressors have to meet high requirements, not least because of the composition of the gases (corrosion). Liquid ring compressors are very suited for this application, as they are safe and almost maintenance-free. The compression with the liquid ring compressors employed takes place virtually isothermically at temperatures of about 50°C. Thus, the polymerization of hydrocarbons is avoided.

Petrol Production. Liquid motor fuels are made mostly from crude oil. Due to the high suction capacities required, steam ejectors were usually used in former times; today, they are being replaced by liquid ring pumps because of their low operating costs and for reasons of environmental protection.

The different hydrocarbon fractions are separated by distillation in the vacuum. Figure 8-17 shows a distillation plant.



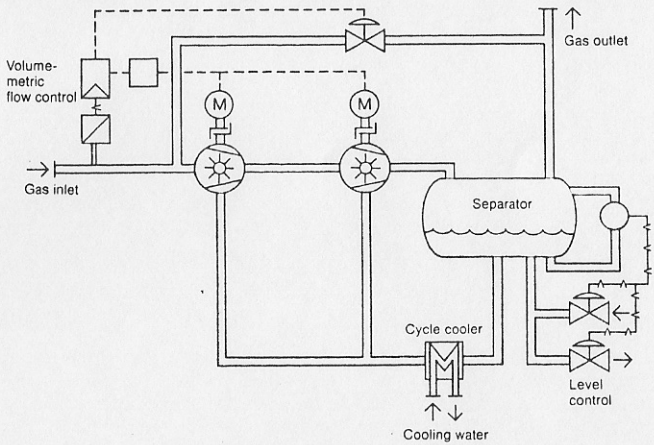


Figure 8-16. Package unit installed in a refinery in Great Britain for the conveyance of processed gas. Intake pressure: 1.15 bar abs; intake volume: 1,820 m^3/h; final pressure: 4.1 bar abs.

Solid Propellants. Solid propellants are used for rockets. For this, a mixture of water, butadiene, and other chemicals are reacted together using heat in a reactor. A liquid ring compressor pumps down the excess of butadiene and compresses it to approximately 6 bar for reuse. Afterwards, the non-combined vapor is pumped down with a liquid ring vacuum pump. The now dry polymer can be used after shaping.

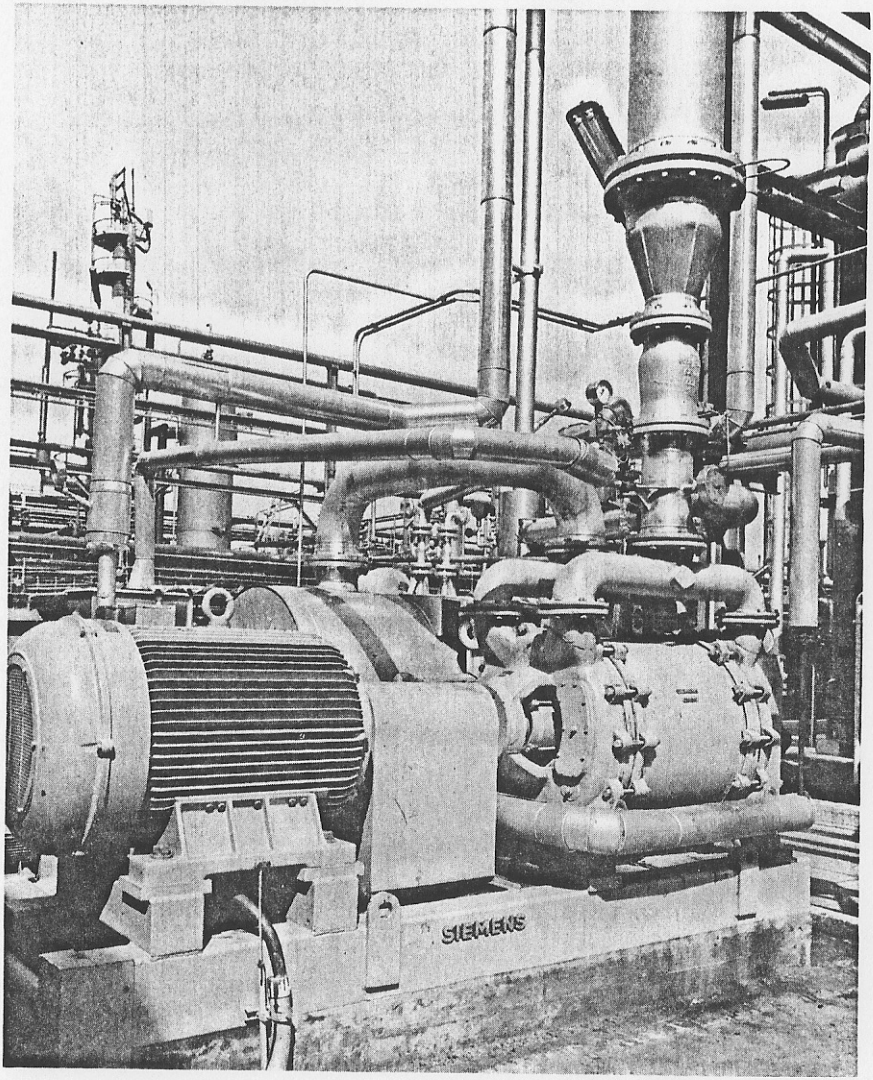


Figure 8-17. Siemens vacuum pump at a distillation plant.

ASBESTOS AND PLASTER BOARD INDUSTRY

In the construction industry, fiber plates are frequently used for quick interior work. They are produced as follows: A mixture of fibers (asbestos/rock wool/wood shavings) is dehydrated over felt as a thin suspension layer together with water and a binding agent (plaster/cement). This procedure is improved and accelerated with a vacuum.

Depending on the construction of the sieve, either the liquid ring vacuum pump draws off the developing water, or it is precipitated in a separate container and pumped down by a centrifugal pump. Due to the entrained fiber and binding agent particles and water, high demands are made on the robustness of the pump.

CLAY AND CERAMICS INDUSTRY

Brick Production. In brick production, clay is improved with various additives and mixed and kneaded in a so-called plodder or worm extruder. The clay is then distributed in small chips over a sliver knife in a vacuum room. As a consequence, gaseous substances are released, which are drawn off by a liquid ring vacuum pump. Afterwards, another worm shapes the clay and pushes it out as a finished brick via an extrusion die. The vacuum used is approximately 100 mbar. Occasionally a better vacuum is required. Roots pump stages are used here, consisting of a Roots pump and a liquid ring pump.

Porcelain Pressing. Before burning, the porcelain mass needs to be degasified as much as possible, as otherwise there will be cracks and bubbles in the finished product.

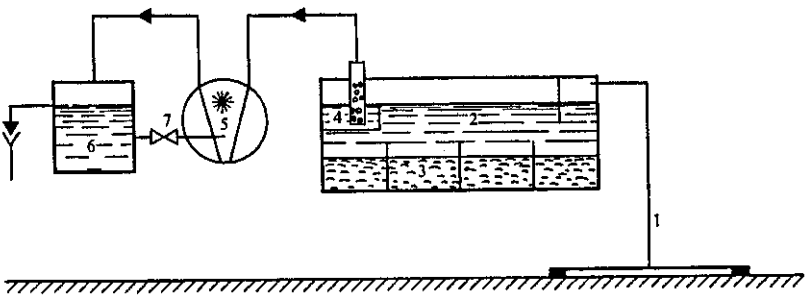
The porcelain mass which is mixed and combined with additives is kneaded in a worm and delivered to a vacuum room via an orifice plate. Due to the large surface area, the porcelain degasifies and is afterwards formed into a strand by means of another worm via a compression head with extrusion die. This strand is then processed into finished utility or electrotechnical porcelain and afterwards baked.

Drying and Degasification of Concrete (Figure 8-18). A covering plate with various suction devices is put over the freshly cast concrete slab. Gas and air inclusions as well as excessive water are drawn off using a vacuum. Thus, the firmness of the concrete is increased and the drying time is reduced.

STEEL INDUSTRY

Steel Degasification. Before casting, liquid pig iron contains larger or smaller quantities of gases, such as nitrogen, which are very disturbing in later processing.

For degasification, the liquid pig iron is either cast in a vacuum container, where it pulverizes, or the contained gas is pumped down with a vacuum lance.



1. suction device on the concrete with suction pipe
2. water
3. concrete/water mixture
4. intake apparatus
5. liquid ring vacuum pump
6. ring water container (30 l) with overflow
7. ring water pipe with regulating valve

Figure 8-18. Principle of a concrete drying plant.

Steam jets serve as vacuum pumps because of the high gas quantities which develop within a range of a few mbar. For reasons of economy, a liquid ring pump is used as a fore-pump for the steam jet, which takes over the gas precompressed by the jet at about 100 mbar and compresses it against atmospheric pressure.

AUTOMOBILE INDUSTRY

Filling of Radiators, Brakes, Hydraulic Systems. Today, automobiles are produced on a conveyer belt. This requires as short clock times as possible. Radiator, brake, and hydraulic systems need to be filled with liquid.

In former times, the air contained in the system was displaced in the filling process. In order to ensure that the air was totally removed from the system, part of the liquid always escaped via the degasification orifice. This was expensive, time-consuming, and resulted in unpleasant working conditions due to liquid splashing around.

Today, the system is deaerated with liquid ring pumps, checked for tightness, and then filled with degasified liquid without overspilling.

ELECTRICAL ENGINEERING INDUSTRY

With electric components such as transformers, condensers, measuring transformers, cables, etc., great emphasis is placed on the insulation capacity of the paper or oil dielectric used. Therefore it is essential that the

paper or oil is absolutely dry and processed without air inclusions. The oil used is dried and degasified in so-called oil concentration plants. This takes place in a vacuum. Liquid ring vacuum pumps which are operated with transformer oil as liquid compressant are used.

In the course of time, the oil used in the transformers becomes enriched with gases and dampness due to paths of leakage. It has to be reprocessed from time to time using a portable plant.

MEDICINE

Disinfection. In hospitals and consulting rooms, beds, clothes, instruments, and other articles have to be sterilized after usage. This happens in so-called sterilization or disinfection chambers. The item to be sterilized is placed in a vacuum chamber and treated alternately with a vacuum and vapor or a disinfecting agent. Here again liquid ring vacuum pumps are used due to their indifference to the entrainment of condensate and vapor.

Central Vacuum Plants. In hospitals, consulting rooms, and medical laboratories vacuums are used for the drawing off of liquids, for holding objects, etc. In order to guarantee sterility, the pumps are set up outside the actual room in use.

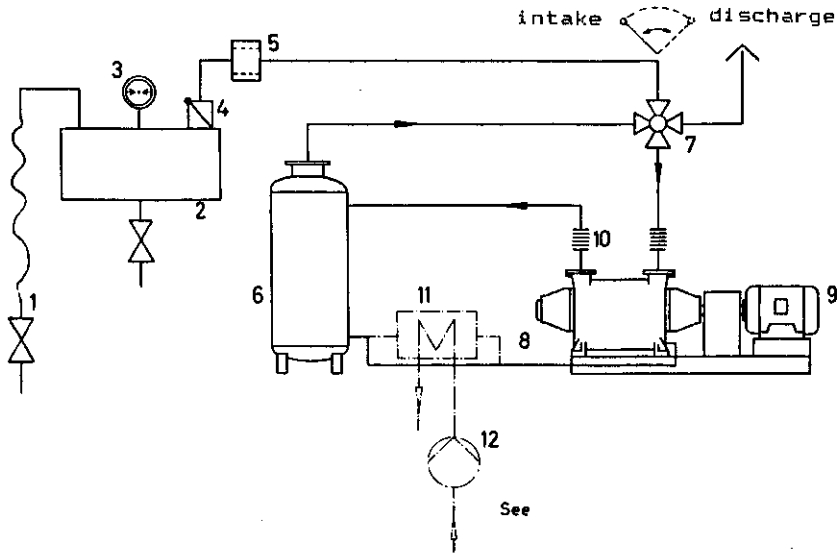
Central vacuum plants with liquid ring pumps have proved a success because of their robustness and smooth operation.

OTHER APPLICATIONS

Filling of Centrifugal Pumps. A centrifugal pump mounted above its intake level is kept in operational readiness by being topped up with liquid. However, a back pressure valve is not used. Instead a low pressure is produced in the pump casing. The vacuum system is created by a liquid ring vacuum pump; it is connected with every single centrifugal pump via a vacuum sealing valve. This valve—a float valve—closes as soon as the liquid in it rises. For the drawing off of air at all higher points of the suction chamber and the casing, various connections are necessary in certain cases. Figure 8-19 illustrates a suction plant.

Drawing Off Plants. In the drawing off process of liquids and solid substances in accidents and for the cleaning of tanks and canals, the product to be drawn off is sucked off using a vacuum.

For the precipitation of the products, separators are mounted in front of the vacuum pumps. Example: Cleaning and drawing off plant for ship's tanks.



1	suction tube	7	four-way cock
2	tank for contaminated oil	8	pump
3	mano-vacuummeter	9	drive motor
4	float valve	10	compensators
5	filter	11	cooler for approx. 48,300 kJ/h (water operation)
6	pressure-liquid-separator	12	water coolant pump
_·_·_	No. 11 and 12 not necessary if operated on diesel oil		

Figure 8-19. Diagram of a suction plant (Sihi).

Lowering of Ground Water. In deep-level operations, work is frequently carried out below ground water level. In order to keep the excavation dry, the ground water is pumped down via a pile drive filter and a ground water lowering plant.

This plant consists of an undercarriage onto which a separator is built in order to separate the drawn off water and drawn off air. A liquid pump for the maintenance of the vacuum and a liquid pump for pumping down the water are linked up to the separator.

Textile Industry. In all textile processing procedures such as steaming, finishing, mercerising, impregnating, sizing, dyeing, and dehydrating, the basic material needs to be admitted uniformly. If there are gas bubbles inside or in between the material, defects are the result. A uniform admission of the material is achieved by pumping down the air. Liquid ring pumps are used as vacuum pumps which produce a vacuum of 40 to 350 mbar depending on the procedure.