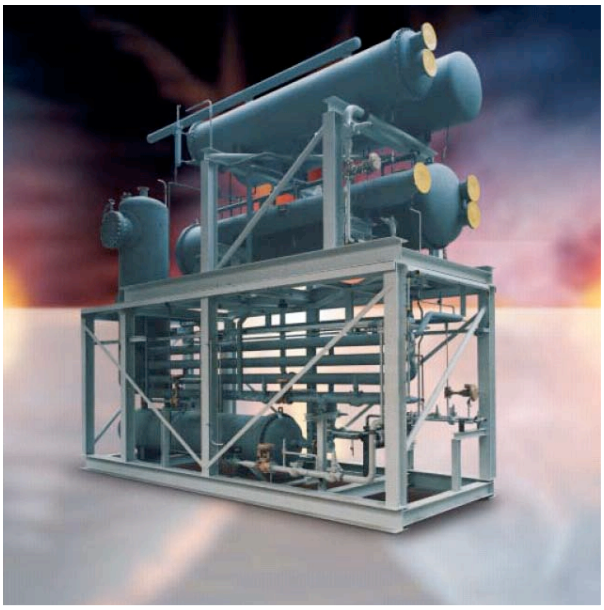
colibri bv

EXPERTS IN ABSORPTION REFRIGERATION

colibri b.v.

Ammonia Absorption Technology



Contents

1. Features of Absorption Plants (ARP) Working with Ammonia and Water

Heat as a Driving Energy

ARP's are using heat as the main source for the driving energy. Apart from the cooling towers they need only 5% of their energy as electricity. Any fluid or gas with a certain minimum temperature can be used as a source for the driving energy. Most common are steam, hot water or directly fired plants.

Ammonia as a Refrigerant

All plants delivered by Colibri b.v. are working with ammonia as a refrigerant. That means they can produce cold down to -60 °C. For cooling temperatures higher than +3 °C ARP's with other working fluids are more preferable. Ammonia is natural refrigerant which is environment-friendly.

High Reliability and Availabilty

Because most of the components of an ARP are heat exchangers the plants are very robust and are not susceptible to trouble. That is why industries with high requirements to availibilty like chemical or freeze drying industries prefere ARP’s for their process cooling.

Low Maintenance

ARP’s need very little maintenance. Only the liquid pumps and the pneumatic valves have moving components which are susceptible to wear. Maintenance works are simple, for which no specialist knowledge is necessary.

Easy Integration into Existing Systems

The plants can easily be integrated into an existing refrigeration installation. For the different possibilities look under: “Integration into refrigeration system“.

Minimum Work and Time for Erection

The plants with refrigeration capacities below 2,000 kW are delivered in prefabricated modules, which leads to minimum installation efforts on site. For the features of our standardized plants look under: “ Products and Services“.

Automatic Operation

The plants are equipped with an automatic control system based on a PLC which provides trouble-free operation. The operation mode can be adapted to the customers demands. The process data can be visualized on a PC in remote distance.

Excellent Partial Load Behaviour

By decreasing refrigeration demand the plants change automatically and continously to partial load operation. Partial load operation down to 20% of maximum load is possible with nearly constant coefficiant of performance. If desired the plants can be equipped so that driving in zero-load is possible.

Efficiency of the Plants

The efficiency of an ARP is expressed by the coefficient of performance (COP) which is the refrigeration capacity divided by the thermal energy input. The value of the COP is strongly dependent on the temperatures of the cold (evaporation temperature) and the cooling water. The lower the temperature of the cooling water and the higher the evaporation temperature, the higher is the efficiency of the ARP (see figure below).

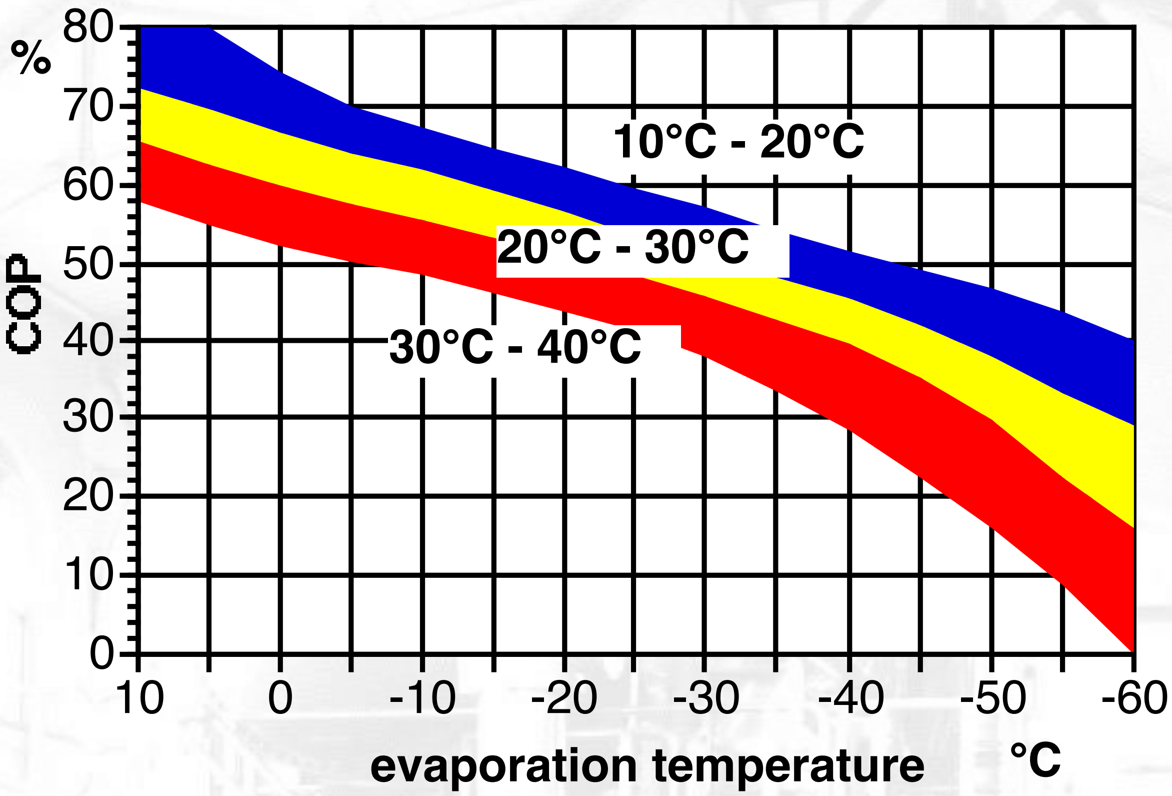


FIG.: EFFICIENCY OF SINGLE STAGE ARP

This diagram is only for orientative use. It indicates the relation between the COP and the evaporation temperature for different cooling water temperatures

(in ranges from 10°C-20°C, 20°C-30°C and 30°C-40°C)

Minimum Temperature of Driving Energy

To achieve a certain temperature for the cold (evaporation temperature) a minimum temperature of the driving energy (steam, hot water or other hot gasses or liquids) is required. This temperature is dependent on the desired evaporation temperature and the temperature for the cooling water (for the absorber and condenser). The grafic below shows this relation. On the .y-axis you can read the minimum outlet temperature (out of the ARP) if hot water is used as heat supply. The inlet temperature of hot water should be approximately 10 °C higher. If steam is used as heat supply, the temperature where the steam condenses should be also approximately 10 °C higher than the outlet temperature of hot water shown in the diagram.

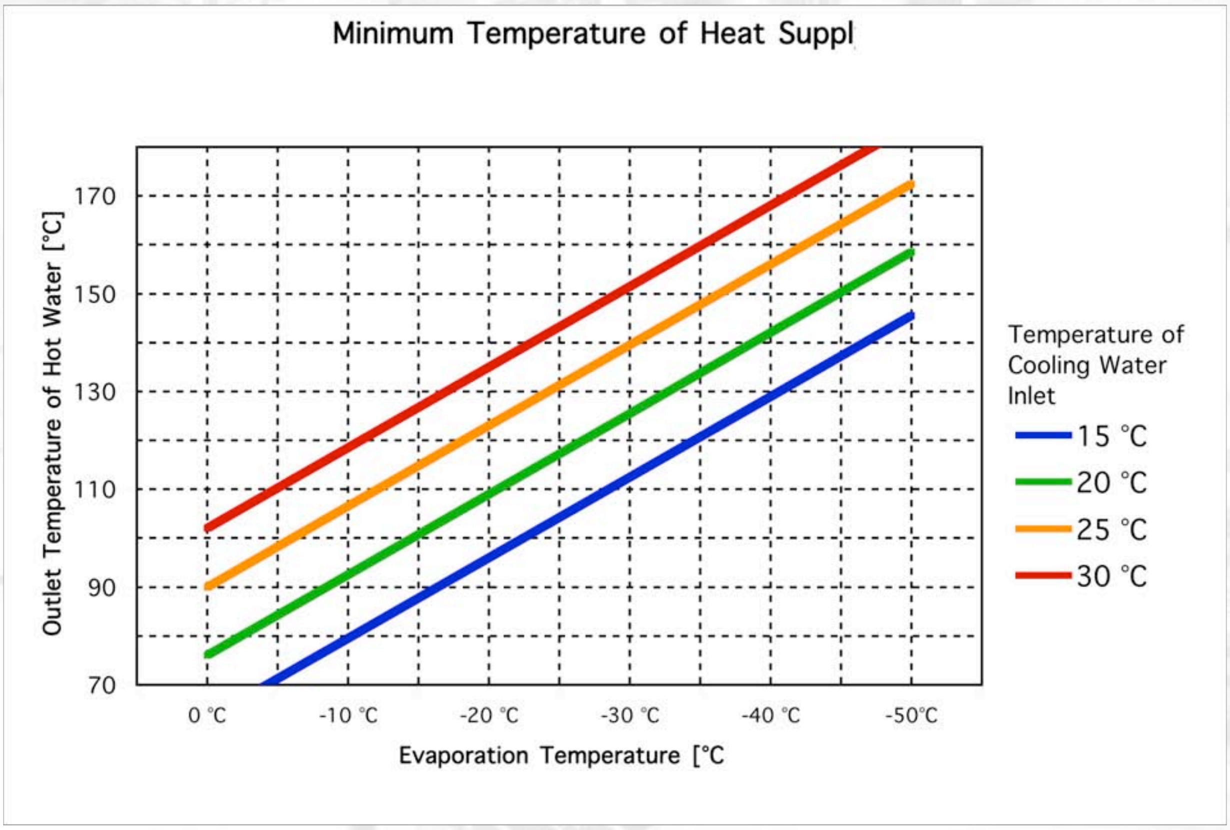


FIG.: MINIMUM DRIVING TEMPERATURE OF A SINGLE-STAGE ARP

This diagram is only for orientative use. More precise calculations will be done by us individually for each project.

2. ARP - How does it work?

An absorption refrigeration plant (ARP) consists of a high-pressure and a low-pressure part. Just like in a compression refrigeration plant (CRP), the refrigerant (here: ammonia) is liquefied under high pressure in the condenser and evaporated under low pressure in the evaporator.

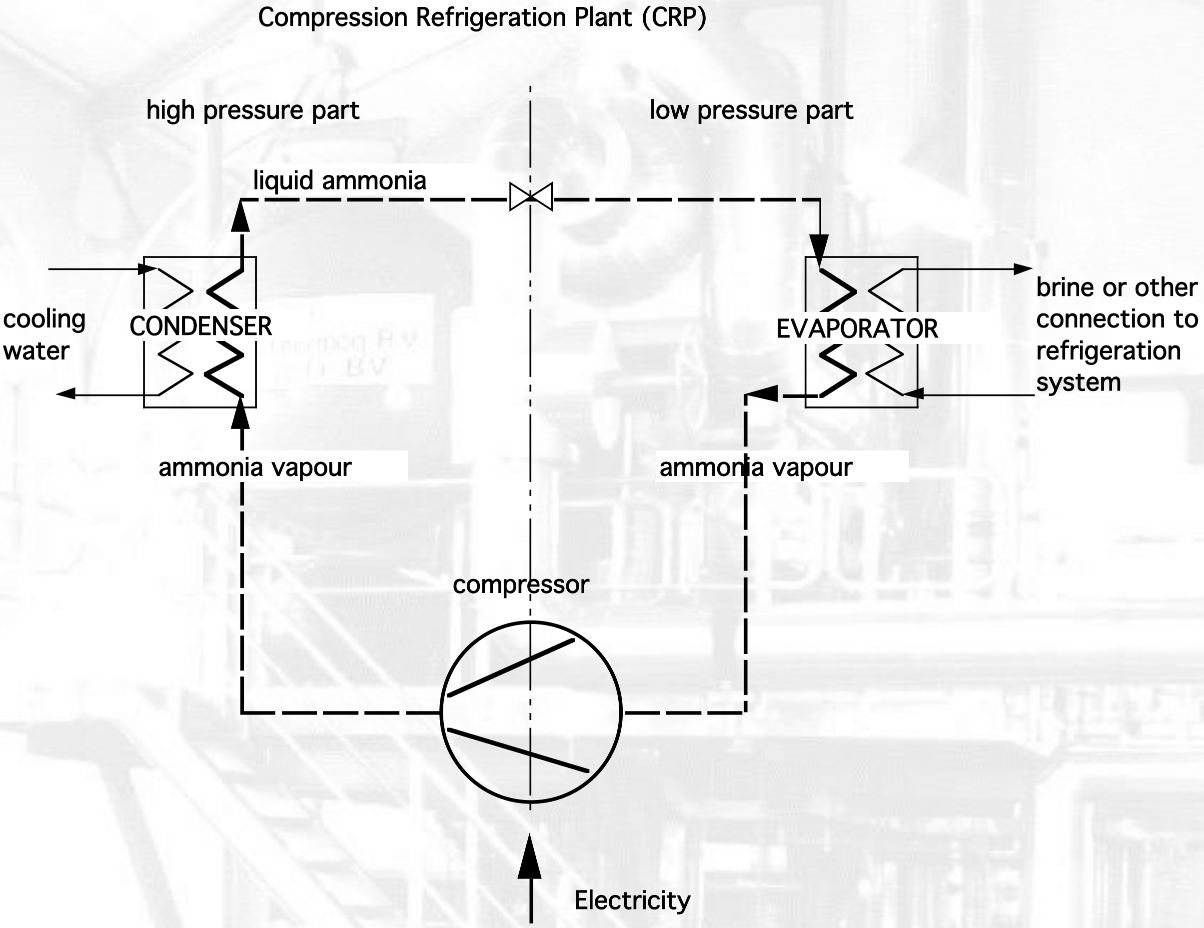


FIG.: COMPRESSION REFRIGERATION CYCLE

To transport the refrigerant vapour from the low pressure to the high pressure, a CRP uses an electrical driven compressor, whereas in an ARP a thermal driven solution cycle is used.

This solution cycle can be called a “thermal compressor“, because it uses mainly heat as a source for the driving energy. The main components of the solution cycle are the absorber, the desorber and a liquid pump. The cycle uses the ability, that ammonia vapour can be absorbed by water, forming a solution of ammonia and water. This process takes place in the absorber, which works on the same pressure level as the evaporator (low-pressure level). The watery solution entering the absorber (the “poor solution” with a low ammonia concentration) sucks the ammonia vapour coming from the evaporator and dissolves it. The so formed “rich solution“ (with a high ammonia concentration) is pumped to the desorber, which works on the same pressure level as the condenser (high-pressure level).

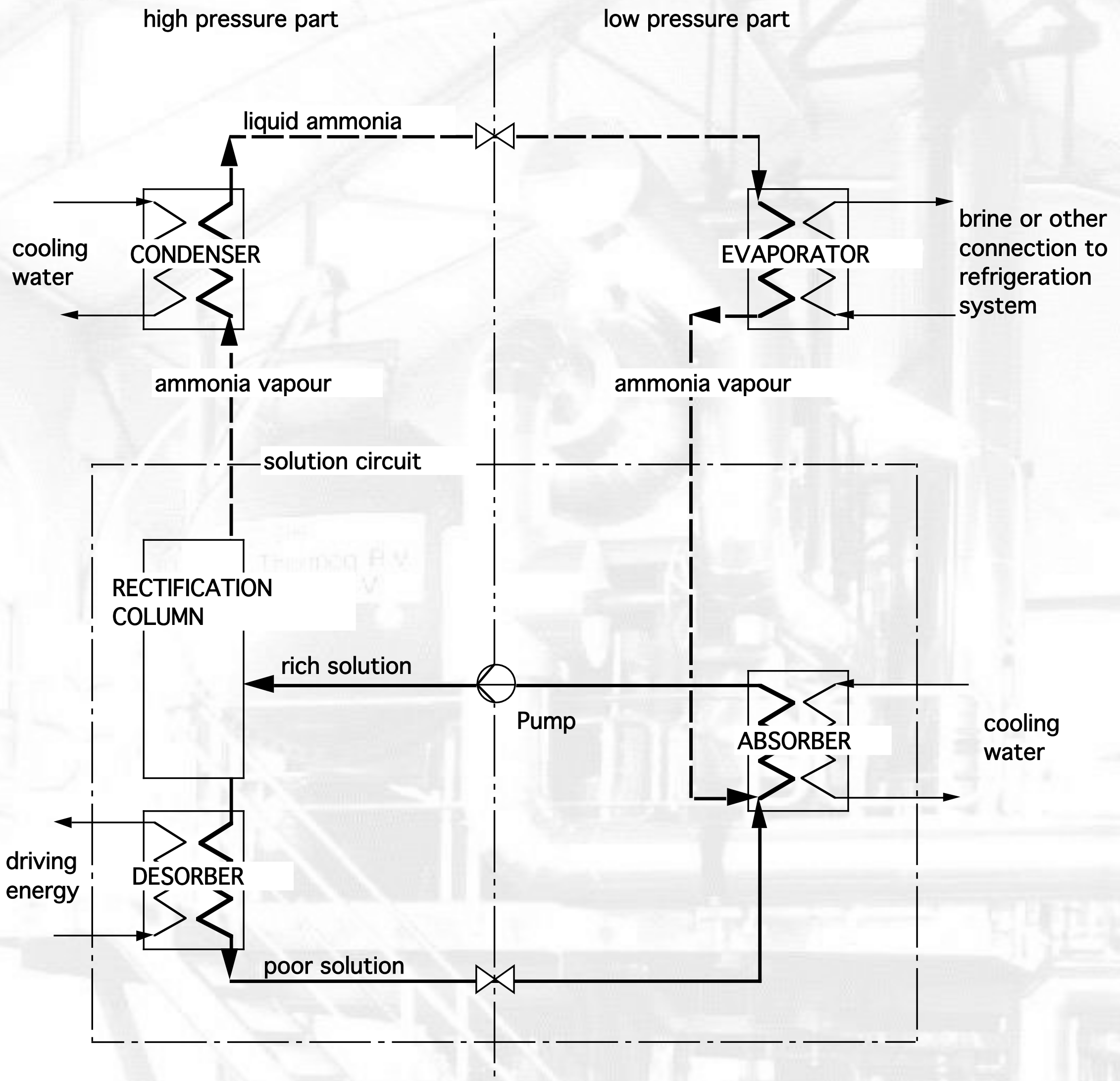


FIG.: ABSORPTION REFRIGERATION CYCLE

Through heating up in the desorber, this solution is separated again in vapour, which consists mainly of ammonia, and a ”poor solution“, which consists mainly of water. The poor solution flows back to the absorber and the vapour is purified in the rectification column, so that nearly pure ammonia vapour enters the condenser, where it is liquefied.

The main difference between a CRP and an ARP is that a CRP is driven 100% by electrical energy (for the compressor), whereas an ARP only needs 5% of its energy as electricity (for the pump) and 95% as thermal energy (to heat the desorber). Whereas a CRP only needs cooling from the environment for the condenser, in an ARP the amount of environmental cooling is more than the double because in addition to the condenser, the absorber needs cooling as well.

3. Products and Services

Colibri b.v is an engineering office which offers the full range of products and services on the field of absorption refrigeration plants (ARP) which are working with ammonia and water.

- ARPs with refrigeration capacities from 200 kW to several Megawatt
- consultancy and advice
- engineering
- research and development
- project management

ARPs with refrigeration capacities from 200 kW to several Megawatt

- turn-key delivery possible
- automatic operation mode with remote distance control
- condenser cooling by cooling water or evaporative condenser
- steam, hot water, flue gasses or other hot media for driving energy

a) S–series

- refrigeration capacity from 200 kW to 600 kW
- refrigeration temperature to -30°C
- build up in one module

This type of plant is completely prefabricated in the workshop.

On site only the connections to the customers system (hot water or steam, cooling water, refrigeration medium, electrical connection) and the innitial filling have to be done.

b) M-series (two modules)

•refrigeration capacities from 500 kW to 1000 kW

•refrigeration temperature to -30°C (-50 °C)

•build up in two modules

These plants consist of two modules which are prefabricated in the workshop as far as possible. Thea are standing one on top of each other. On site the connections between the two modules (piping and wiring), the connections to the customers system and the innitial filling have to be done.

c) M–AD–series

•refrigeration capacities from 500 kW to 1000 kW

- refrigeration temperature to -30 °C
- build up in one module plus cooling towers
- cooling towers included in scope of supply

The concept of these plants include the evaporative coolers (cooling towers) for the condenser and absorber. Both are directly integrated into the absorption process. The absorption module is completely prefabricated in the workshop. On site the connections to the cooling towers, to the customers system and the innitial filling have to be done.

d) M–series (three to five modules)

- refrigeration capacities from 1000 kW to 2500 kW
- refrigeration temperature to -50 °C (-60°C)
- build up in three, four or five modules

The number of modules depend on the refrigeration capacity and the customers requirements concerning equipment and space. The plants can be adjusted very detailed to the customers demands. All modules are prefabricated in the workshop as far as possible. On site the piping and wiring for the connections between the modules have to be done, the connenctions to the customers system and the innitial filling.

e) C-series

•refrigeration capacities larger than 2500 kW

•refrigeration temperature to -60 °C

•build up in prefabricated modules or delivery of components

These plants are specially designed for the demands of the customer. The extent of prefabrication is depending on the demands of the customer and the circumstances of working on site. If desired only the components (vessels, heat-exchangers, valves, pumps, instruments, etc.) will be delivered. The assembly can be done by local companies with the supervision of Colibri.

f) Plants with Two- or More Stages

ARP's working with ammonia can produce cold down to -60 °C in a one stage plant. For special purposes it can be useful to design plants with two or more stages.

1. ARP's with two or more absorption stages

If there are several refrigeration demands on different temperature levels an ARP with two or more absorption stages can be designed. Depending on the relation between the different refrigeration capacities and temperatures such plants can be advantageous in the field of energy consumption and investment costs in comparisson to a one stage plant fulfilling the same refrigeration demands.

2. ARP’s with two desorption stages

If the temperature of the driving energy is too low for the demanded refrigeration purpose an ARP can be designed with two desorption stages. The energy consumption of such plants is much higher than the one of a one stage plant. A second desorption stage increases the investment costs of the plant, so that it makes only economical sense, if the costs for the driving heat are very low in comparisson to the electricity of an alternative compression plant.

Consultancy and Advice

Colibri delivers every kind of consultancy and advice dealing with the subject of absorption cooling, for example: Feasibility studies, solving of technical problems, system integration, revision of exisiting plants and so on.

Engineering

Colibri delivers every kind of engineering works dealing with the subject of absorption cooling, for example: Process simulation for ammonia-water plants, improvement, enlargement and repair work for exisiting plants, calculation and design of components (for example heat exchangers), drawings for plant lay out and so on.

Research and Development

Since 1982 members of Colibri are doing research and development (r&d) works in the field of absorption technology. Doing own r&d works or taking part in international projects enables Colibri to develop new ideas and being on the most recent level of technology.

4. Equipment on Customers Demand

There are many options to design an ARP for the individual demands of the customer:

Driving Energy

Depending on the choice of the fluid or gas for the driving energy the type of heat exchanger for the desorber has to be chosen.

Cooling Water

An ARP needs cooling for the condenser and the absorber. If no cooling water is available the ARP can be equipped with cooling towers or evaporative coolers. If it is not possible to run cooling towers an ARP can also be dry air cooled. Dry air cooled plants are much more expensive than water cooled plants and are running with a lower coefficient of performance.

Integration of an ARP into an Existing Refrigeration System

The different possibilities for the integration of the ARP into an existing refrigeration system are described under. “ Integration into Refrigeration System“

Lay Out of the Plant

The design of a plant can be adapted to the customers demands, depending on the ground floor and height which is available. If demanded the high pressure and the low pressure part of a plant can be split and installed on different locations with a certain distance inbetween. The high pressure part near the place of heat supply and the low pressure part near the place of refrigeration demand.

Control System

The ARP can be equipped with a fully automatically control system. Signal exchange with external systems are possible or even the integration of the control system of the ARP into a central control computer is possible. The control system of the ARP can be operated from remote distance via modem connection.

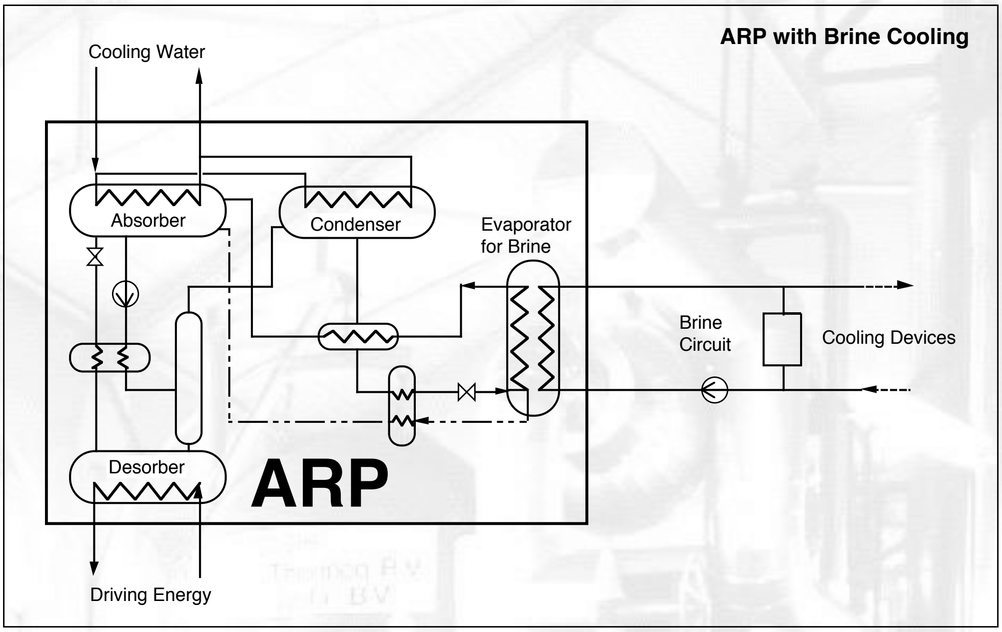
Indoor, Outdoor, Accessability, Coverings

Depending on the customers demands the plants can be equipped for indoor or outdoor erection sites. Stairs, platforms and coverings of the plants can be designed for the customers demands.

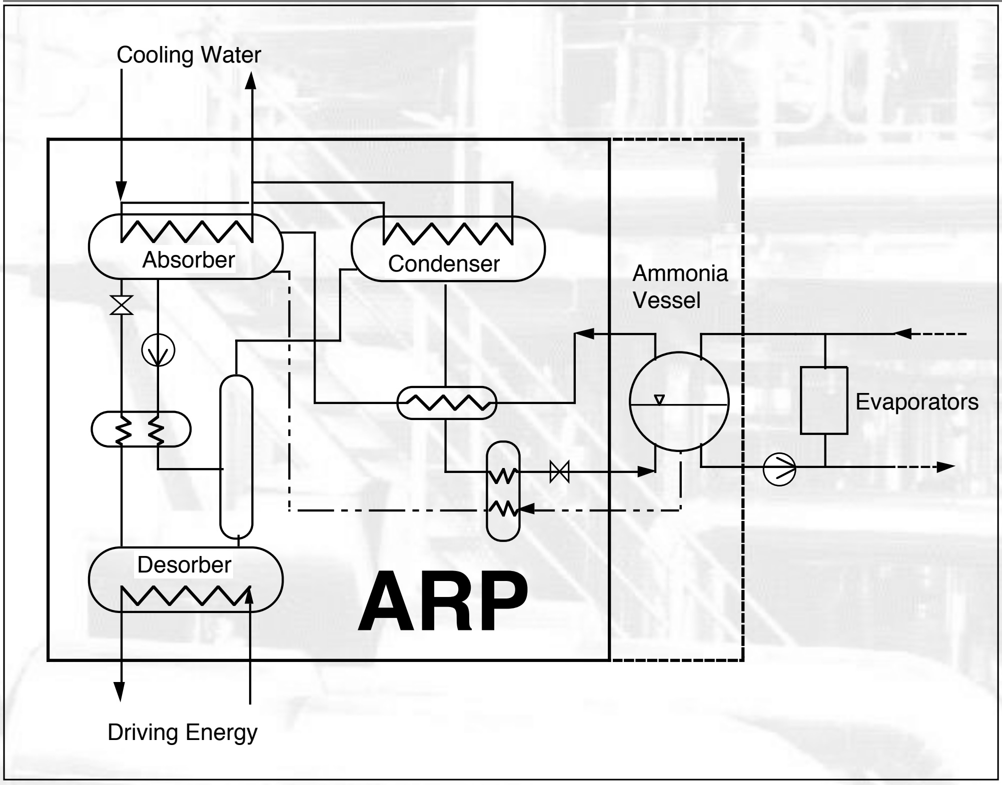
5. Integration into Refrigeration System

Depending on the customers refrigeration system the ARP can be equipped with different evaporators or vessels.

The ARP can be equipped with an evaporator for the cooling of a brine. The brine is pumped to the locations where the cooling is needed.



ARP WITH EVAPORATOR FOR BRINE COOLING



DIRECT USE OF THE AMMONIA OF THE ARP IN THE EVAPORATORS OF THE CUSTOMER

In combination with flooded evaporators the ammonia of the ARP can be used directly for the cooling purposes.

Combination with a Compression Refrigeration Plant in the Same System

The ammonia of an ARP must not be mixed with another refrigerant of a compression refrigeration plant (CRP), even if it is ammonia as well. Therefore the ARP can be equipped with an condensing evaporator (a cascade system), where on one side the ammonia of the ARP is evaporated and on the other side the refrigerant of the CRP is condensed.

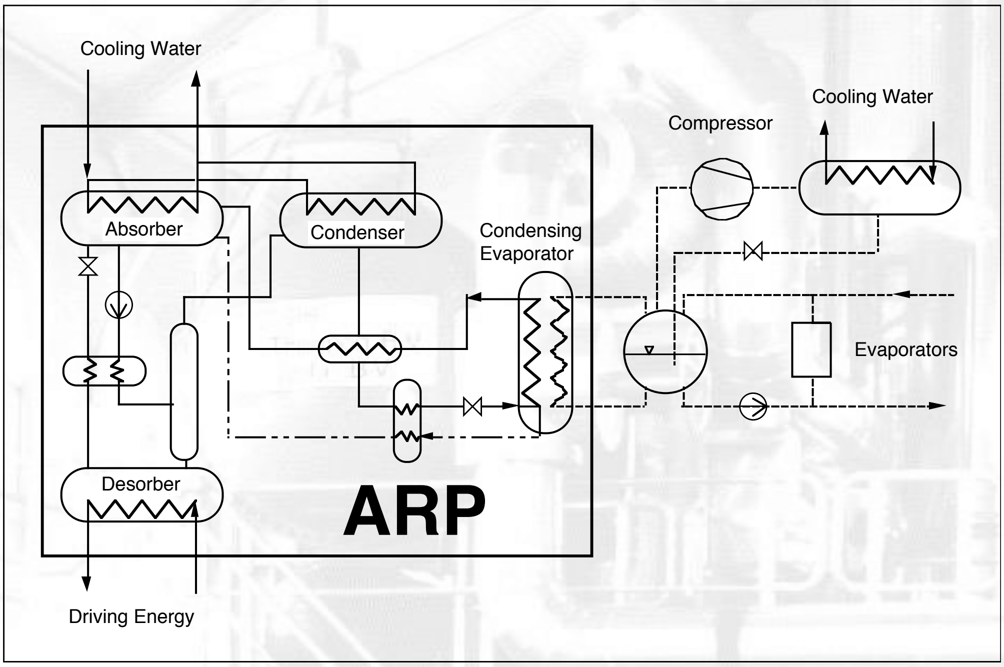


FIG.: ARP IN COMBINATION WITH A COMPRESSION CYCLE

6. ARP and Combined Heat and Power Systems (Trigeneration)

Cogeneration (CHP) provides both power and heat. Absorption refrigeration plants (ARP) can make use of this heat in order to produce cold for refrigeration purposes.

The linkage between the cogen plant and the ARP can be realised in the following ways:

Indirect

Flue gases are used to produce steam or hot water in a standard boiler. The ARP is driven with steam or hot water coming from the boiler. The advantage of this system is that steam or hot water need not to be used exclusively to drive the ARP, but it can also be used additionally or alternatively for other purposes.

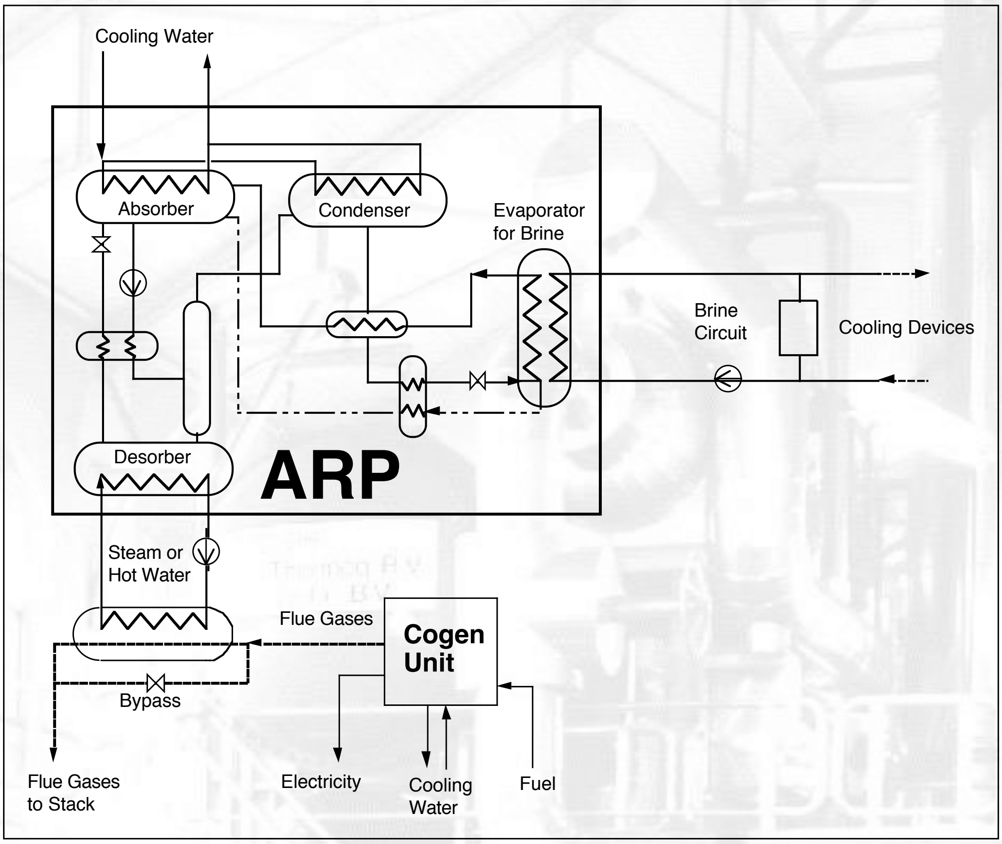


FIG.: ARP IN COMBINATION WITH A CO-GENERATION UNIT

Direct

The flue gases are used directly to drive the ARP. The advantage of this is that it saves an extra boiler, making it cheaper in investment and maintenance terms, as well as being a more compact system.

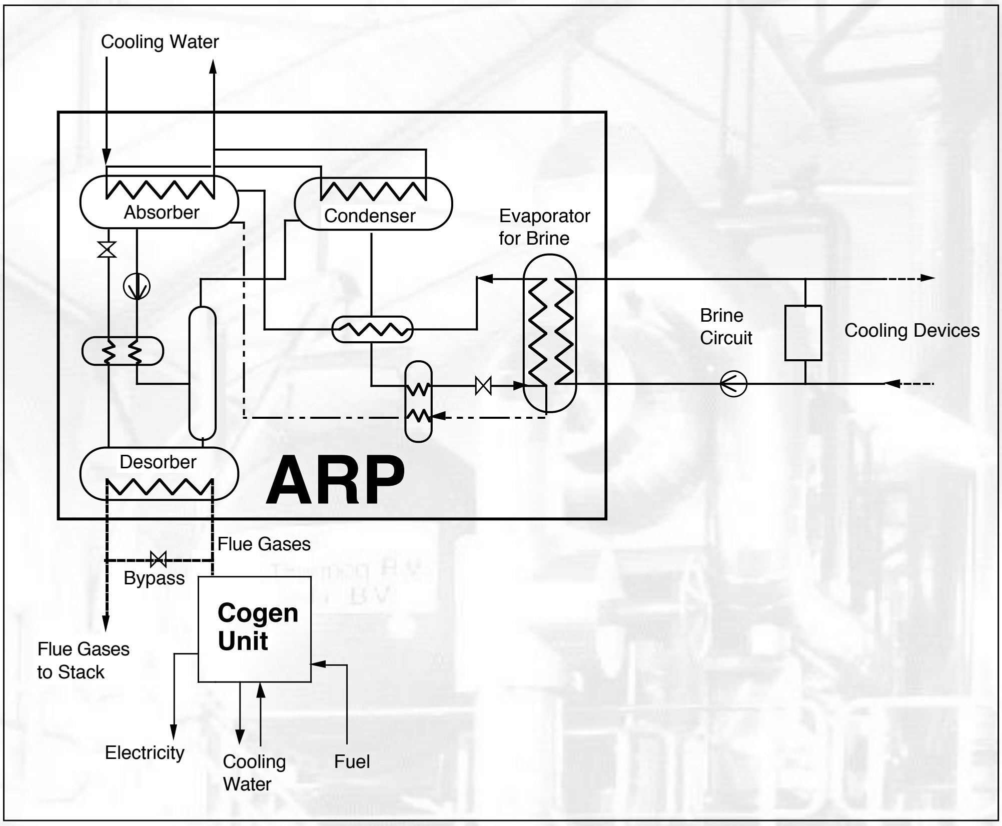


FIG.: ARP IN COMBINATION WITH A CO-GENERATION UNIT, DIRECTLY CONNECTED

A link without interference

There is no feed back effect from the ARP to the engine of the cogen plant. The ARP does not need continuity of heat supply. There are no requirements concerning the start-up, shut-down or partial load modes of the ARP. The control system of an ARP is independent from the cogeneration control system. if there is no refrigeration demand, and the cogeneration must continue, there is a bypass for the flue gases to the ARP.

Reliable supply of refrigeration

Industries which need process cooling in areas with a weak electricity supply or high electricity costs do have a reliable alternative with trigeneration plants. It makes the user independent from the grid, providing safety from power failures and rising electricity tariffs.

Smoothing refrigeration demands with an ice buffer

Production processes which have varying cooling and steam pattern requirements over time can be optimized by using an ARP in combination with an ice buffer. Where there is a surplus of steam, the ARP charges the ice buffer, and when the production needs steam, the ARP goes to partial or zero load. This system guarantees a constant operation for the cogen unit.

Turbine Inlet Air Cooling with ARP

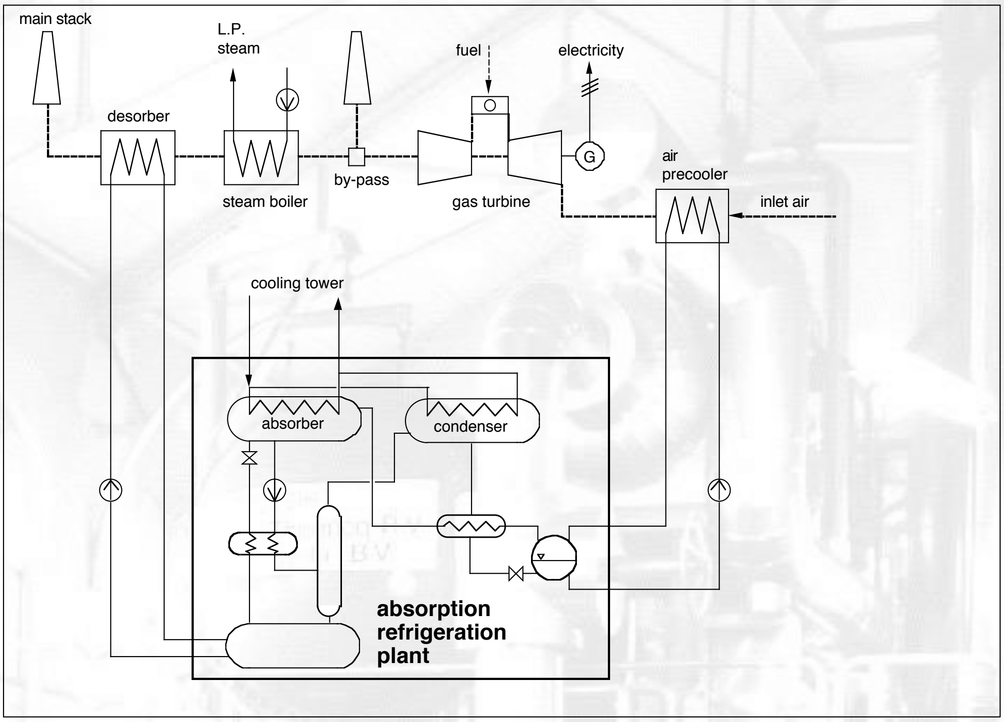


FIG.: ARP IN COMBINATION WITH A CO-GENERATION UNIT, DIRECTLY CONNECTED

With lower temperatures of the inlet air the electrical efficiency of a turbine is increasing. An ARP that is driven with the heat from a turbine's exhaust gases can provide the cooling for the inlet air with very low electricity consumption. As a consequence there is a strong increase in electricity output for the cogen unit.

7. ARP and Air Conditioning

Absorption refrigeration plants working with ammonia as a refrigerant can produce cooling for temperatures down to -60°C. To produce cooling for temperatures down to +3°C plants working with other refrigerants (for example with water and lithium-bromide) are in most cases lower in terms of investment costs. For air conditioning purposes which demand cooling from 12°C to 6°C ARP‘s working with lithium-bromide and water are more preferable to those which work with ammonia and water.

Colibri does not deliver ARP's working with lithium-bromide and water. For air conditioning purposes please ask other suppliers.

8. colibri b.v. - The Company

Colibri b.v., founded in 1991, is an engineering office which is specialized in absorption technology. The engineers of Colibri b.v. have long years experience in all subjects for the development, construction and implementation of absorption refrigeration plants working with ammonia and water. Colibri b.v. supplies ARPs with refrigeration capacities from 200 kW up to 500 kW by its own. Plants for larger capacities are supplied together with its partner Stork-Thermeq.

Contact:
Colibri b.v.
Tentstraat 5a
NL 6291 BC Vaals
The Netherlands
Tel.: +31-43-3066227
Fax: +31-43-3065797
e-mail: info@colibri-bv.com
internet: www.colibri-bv.com