RAY AGUA UNIVERSAL

RAY AGUA'S TECHNOLOGY

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Introduction



The base of this project is the world wide leading technology application. It originates from a system the Soviet army used to extract the humidity from the missile depot and whose patent has been acquired by the company's managers in Spain then given it a civil application. Since then, a lot of work has been put into designing the products that are now in the market.

All along these years **Ray Agua** has put a mind to improving its systems in order to get high quality low mineralization drinking water that can be obtained under any circumstances and environment. This water will reach you in the easiest way, even under the most difficult conditions. Our challenge is to keep researching new applications and new formulas about these and other products of general interest that make our lives more comfortable.

This project great advantage is the answer of our research team to the present society demands. A team made up of professional scientists of proven efficiency guarantees the development of our products and open immediate growing possibilities with new solutions, new designs and new alternatives. **Ray Agua** is, above all, an intelligent capable, flexible and adaptable company whose main asset is I+D and innovation.

How to understand our technology

The water vapour condensation present in the atmosphere is the natural phenomenon responsible for the formation of clouds in the troposphere which develops into rain or into the formation of dew or frost, thanks to the changes and differences in temperature between the air masses and the earth surface. The artificial reproduction of this natural phenomenon would constitute a radical innovation to satisfy a human basic necessity that, in combination with renewable energy sources would allow preserving the planet natural resources in a sustainable way.

As an actual fact, this phenomenon is artificially reproducible by means of a mechanical refrigeration cycle to produce drinking water of the same quality as rain. The refrigeration cycle energetic efficiency, whether activated by electrical energy or any other energy source, is the key for this technology economical feasibility. Incorporating heat recuperation systems to a mechanically refrigerated circuit activated by electric energy has today given production energetic costs.

We are describing the technology used in the construction of the first drinking water producing commercial models of 200 and 5000 litres a day nominal production capacity, which are finding their first commercial market for the water supply in isolated areas, military camps and oil rigs. Their application is also being considered for the drinking water supply in underdeveloped areas and as an emergency source in places undergoing natural catastrophes.

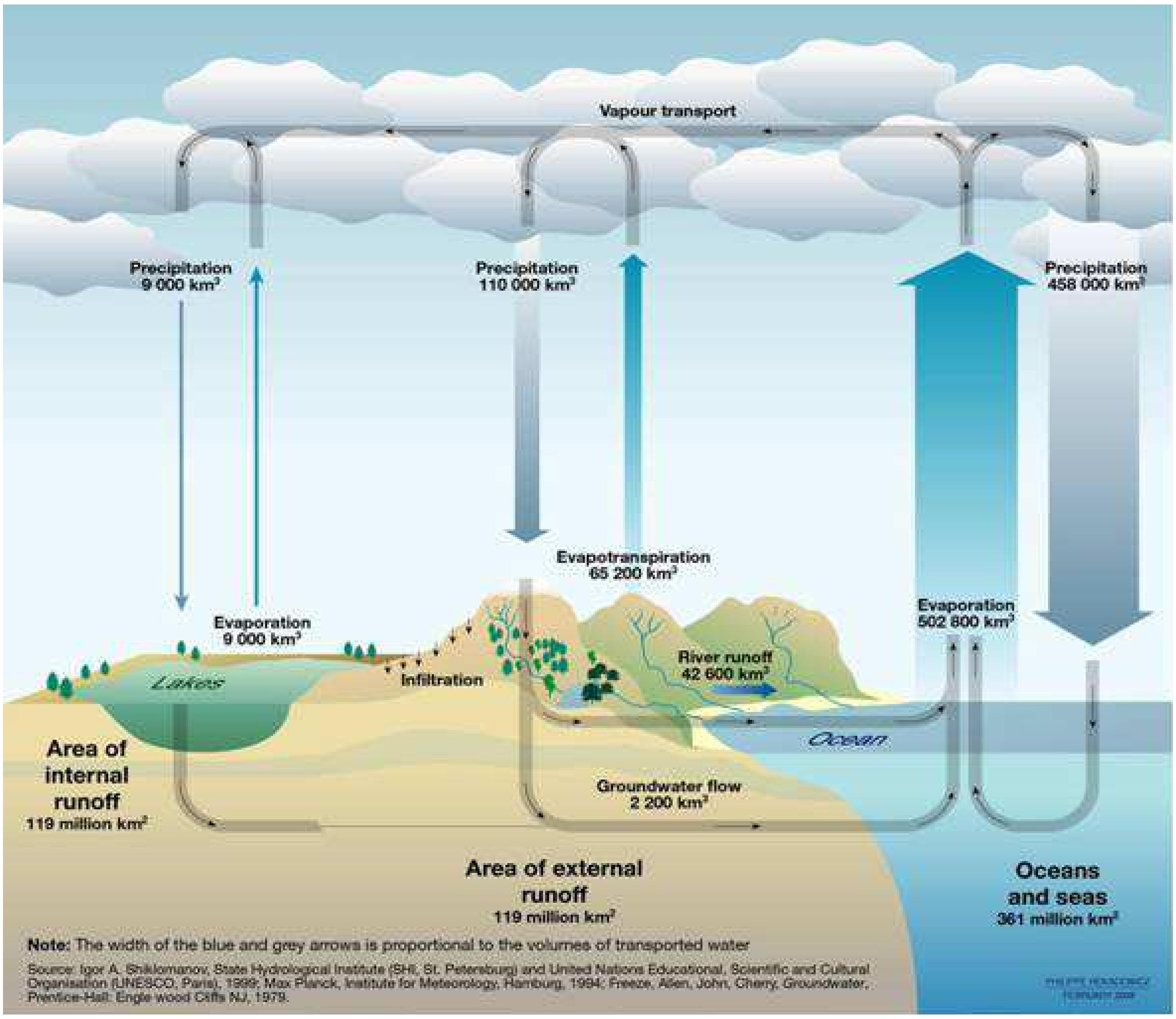
This new refrigeration applied technology for the production of drinking water constitutes a product innovation on the base of a mature technology that has already found its first application. Everything indicates that in combination with renewable energy technologies like the solar or wind, it will have a wider range of application, a large viability and a great future growth potential.

A new drinking water renewable source

The water renewable sources are waters that are completely renewed within a one-year-period. These are mainly water from the rivers and the natural water contribution in the underground aquifers.

Just as the surface waters the water present in the atmosphere is a renewable natural resource. 1% of it is present in the atmosphere as water vapour and also as water drops and ice crystals in suspension inside the clouds.

The water in the atmosphere is in a permanent dynamic balance with the water in the oceans and the surface and earth humidity. This is known as the HYDROLOGIC WATER CYCLE. The renewable period of the water present in the atmosphere is only 8 days, half of the 16-days renewable period that the river water takes and much less than the over 1000-year-renewable period that the underground and ocean waters take (Shiklomanov, 1999).



In the water cycle the sun evaporates the oceans water. The hot humid air rises in the troposphere expanding and cooling as the pressure lowers. The pressure and temperature reduction causes the water vapour in the air to saturate and condensate to form drops or ice crystals. The water vapour condensation is, therefore, the natural phenomenon responsible for the formation of clouds in the troposphere that provokes the rain or the formation of dew or frost on the earth surface.

The artificial reproduction of this natural phenomenon would become a radical innovation to obtain a drinking water source and fulfil a human basic necessity.

It is possible to reproduce this phenomenon artificially by means of a mechanical refrigeration cycle to produce drinking water of the same quality as the rain. The main challenge is being able to extract this atmosphere humidity even when the environmental conditions are not favourable.

Starting of the 5000 litters/day model with demonstration purposes in Doha (Qatar) in November de 2010

After seven years' investigations in order to develop a refrigeration machine especially designed and optimized for this purpose, two models have been realized. Two drinking water production models for a nominal capacity of 200 and 5000 litters a day.
The previous photograph corresponds to the starting of a 5000 litre a day production activated by a diesel power generator and whose field tests and demonstration trials were carried out in Qatar last November.
A window was made in the first prototype in order to visualize the water condensation in the cooling battery. It, literally, "rains inside the machine". The water produced is collected on a tray and pumped into a tank where it is stored. Immediately afterwards it is possible to incorporate a filtering phase with either activated or mineral coal.

Reproduction of the artificial rain inside the 5000 litre/day model. (pictures taken during the first prototype tests and trials in Lucena).

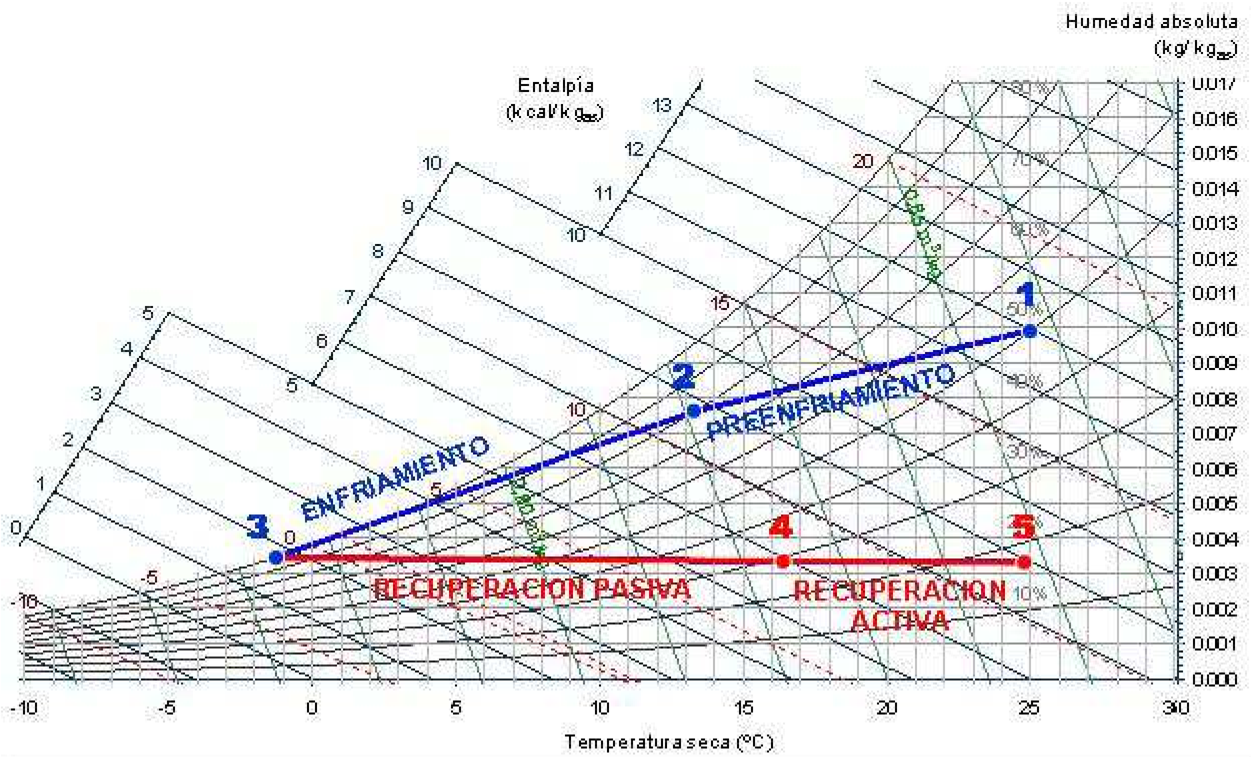
The water is obtained at about 0º C. It is of great purity and very low mineralization. The water obtained is registered in the Spanish Health Registry.

The environment humidity extraction process

There are several techniques to extract the humidity from the air. The better known technique is an air flow dehumidification process by cooling it in a cold battery at a superficial temperature inferior to air dew point. This is the technique that most accurately reproduces the natural rain phenomenon.
Alternatively we can wash the air by rerunning water that has been cooled at a lower temperature than the air dew point.

Other dehumidification techniques by absorption of the water vapour in a concentrate salt solution (calcium chloride or lithium chloride), or by absorption in a hygroscopic solid (like silica gel, o aluminium activated), do not allow us to obtain direct pure liquid water. (Duminil, 1982)
The first method is more suitable for mass production and it is frequently used in HVAC and air conditioning stations. As the technology used is well known it has been the method used in the water production machine. The main difference regarding the dehumidification processes in HVAC stations lies in the optimization of the water, which is our only interest. In order to obtain this we need to condensate a great amount of the vapour that the air flow contains.

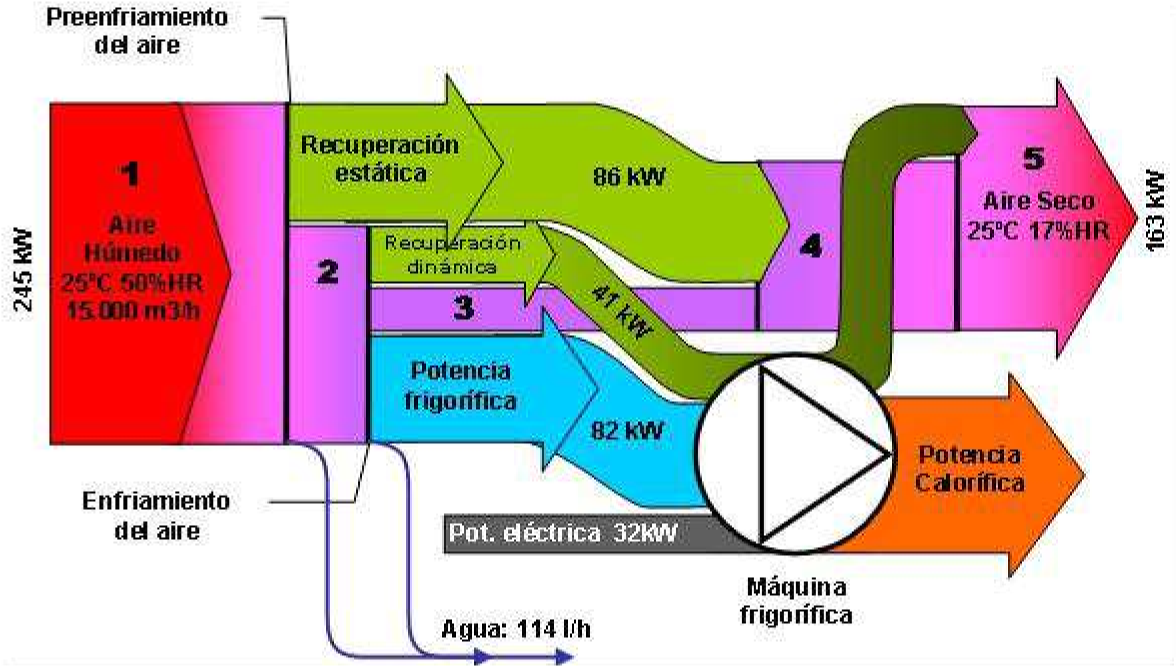
Chart of the air flow evolution in the humid air diagram (source: own elaboration).



Engineers usually use a psychometric diagram to represent the humid air thermodynamic processes. Such diagram represents the water vapour saturation degree depending on the temperature and the total humidity as well as the enthalpy or amount of heat the humid air contains which is very useful to measure the thermal energy amounts involved in every process. The following diagram represents the cooling process and dehumidification that would be produced in an air flow at 25ºC and 50% RH starting environmental conditions from starting stage 1 to the final stage 3 to end up at 0ºC temperature having lost 70% of its water content.

In our machine this process is produced in 2 stages: 1st: air pre cooling stage (points 1 to 2) where the air cooling is carried out by means of a heat recuperator (or rather cold recuperator) and a 2º stage of cooling (points 2 to 3): where a refrigeration circuit or a mechanical compressor heat pump has been used for generating cold. In this pre-cooling and cooling process for every m^3 of processed water about 8 gr of water is obtained. The resulting cold and hot air is a residual product. Nevertheless it has a valuable thermal state. To make the most of this it is introduced in the heat recuperator of the first stage (points 3 to 4). – This is a typical cross flow recuperatorwith 50% thermal exchange efficiency. The outgoing air temperature in point 4 is still lower than the environmental air and it can go to a second phase of heat (cold) active recuperation in the refrigerant fluid in the heat pump. This active heat recuperation can increase the frigorific effect in a 50%.
For a better understanding of the cooling process and dehumidification, and later heating of the air, as represented in the diagram, it is important to know the heat flow magnitude involved in each stage.

Below there is an enthalpy (or heat amount) flow chart for a water producing machine that processes an airflow of 15000 m^3/h, with a production capacity of between about 2500 and 5000 litres a day. For a better appreciation of the importance of each process stage the proportion has been kept in the energy and heat flows.



Enthalpy flows in the water producing machine for 25ºC 50%HR environmental (source: Own elaboration).

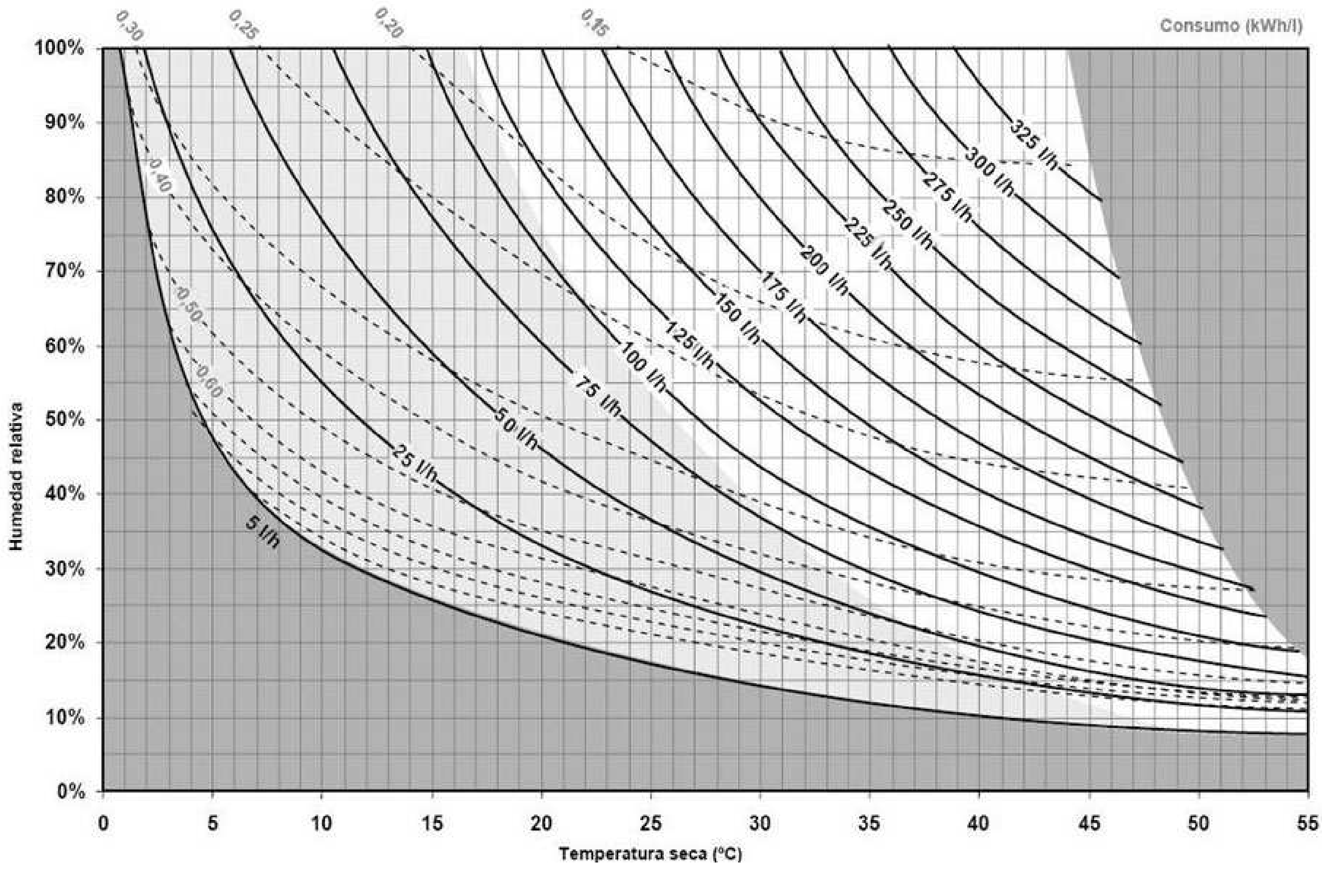
This flow chart shows how the air pre-cooling phase is freely produced by the heat static recuperation whereas the frigorific power for the air cooling phase comes from a frigorific machine where the heat dynamic recuperation has also been integrated in order to improve the cycle efficiency.

To measure the thermodynamic systems efficiency a COP performance index is normally used that shows the relationship between the utility and the effort. That is to say, the relationship between the frigorific power and the electric power absorbed by the machine.

In the mentioned working conditions we would deduce that our frigorific machine has a COP of about 2,5. This is a usual value for a heat pumping air cooling system like the ones used in air conditioning units. Nevertheless, if we take into consideration both the recuperated power and the frigorific power in our machines to calculate its COP performance we would obtain a value of 6.5.

In conclusion, the use of the heat recuperation systems allows a 50% water production increase and reduces to half the energetic cost of each litre of water produced.

Logically, the production capacity of such a machine will closely depend on the environmental conditions. It is to be expected that in hot humid weather conditions, with higher content of water vapour, our machines production capacity will be greater than in cold and dry environmental weather conditions. In fact, the chart bellow shows the production capacity at different temperature humidity conditions as well as the electric energy cost of every litre of water produced.



Production and energetic cost according to the temperature (ºC) and environment Relative Humidity for a 15000 m3/h machine

The chart shows two working limit areas: a high temperature and humidity area where the refrigerant working pressures are excessive and a very low humidity area where the machine is unable to produce water.

The machines wide working range of temperatures is amazing. In fact, the unit has been designed to work in environmental temperatures even over 50ºC. This was a requirement for the design of this unit as it would have to perform in really hot weather conditions that correspond to the geographic markets that would demand this product.

A third shadowed area corresponds to the working conditions where the superficial temperature of the cooling battery is bellow 0ºC. The water vapour on its surface becomes then frost. Under such conditions the machine's control must alternate between refrigeration and defrosting cycles slightly affecting its production capacity.

The ideal working area is that where the temperatures are over 20ºC and the humidity is over 40%. Most part of the geographic regions considered as potential markets are hot coastal areas with high environmental humidity. In such good conditions production rates over 5000 litres a day can be expected at energetic costs close to 0, 25 kWh per litre of water produced.

Ray Agua's technology solutions

Nowadays two commercial drinking water producing models have been developed with 200 y 5000 litres a day nominal production.
The first one was developed for demonstration purposes and as a domestic water source. The second model has been optimized for larger production and as a portable water source. These models are in the first place being commercialized for supplying water in isolated areas, in scientific base, military camps and petrol installations. Its application is being envisaged for the supply of drinking water in underdeveloped areas and as an emergency source in areas affected by natural catastrophes.
The present production energetic costs that have been obtained with the actual technology already allow their marginal commercialization as an alternative resource to the transportation of drinking water in tankers.

The technology used leaves room for improvement of the energetic performance and the reduction of the unit cost in itself. In such circumstances it is to be considered that the system viability can come from the saving of the infrastructure costs.
That is to say, a potential technology application can be materialized in medium-size production units of about 200 a 500 litre a day capacity, powered by , lets say, photovoltaic panels that permit the production of drinking water for domestic supply. This system would be feasible as long as the costs of this installation are lower than those needed for the infrastructure to obtain drinking water by any other means.
The lack of water for domestic, industrial or military use has become a pressing problem in many places throughout the world and, in general, it is hard to find a solution.
Ray Agua Universal provides solutions of easy establishment, both because of the little space it takes and because it is easy to use, which allows solving the problem at specific scales.

The technology developed by RAY AGUA is based on the environmental air dehumidification principle to produce very high quality drinking water of low mineralization.