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VERTICAL DESALINATORS - DEMINERALIZERS BY ION EXCHANGE WITH HYDROELECTRIC ENERGY PRODUCTION

Abstract

The state of the art in the development of desalination and demineralization treatment of marine and brackish water has been conditioned, as many other industrial systems, depuration, energy and protective of the environment, by the absence of synergies between the pumps and hydraulic turbines and from the incorrect approach to the gravitational force, which is not to be won by lifting hydraulic but sustained, with a one-way circulation of water in open reservoirs, upper seats that double as hydraulic backflow preventers. With the triple synergy between the dual supply pumps, turbines and recycling of water in an open vessel, applying hydraulic principles known for centuries, such as the principle of communicating vessels, the laws of Bernoulli and Pascal, strategically placing the electric double suction pumps between a high positive hydraulic head and the turbines, dimensioned for the exploitation of the same hydraulic load, the pumps, working with a balanced load, with a small energy consumption, they win the state of inertia, allowing the energy transformation of pressure of the intubate water column overlying the pump, into kinetic energy and transferring it to the turbines, which produce energy. These spheres, floating climbing ion exchanger and descend by gravity, emptying water in downhill tubes. By means of diverters change the path compared to the flow to be immersed in the washing tanks and regeneration of the resins, and reinserted again, indefinitely, in ion exchange circuit without interruption of the desalination cycle and energy production and without costs for heating the water or replace the membranes. The demineralized water serving for the washing of the resins is produced by continuing the process through a mini system completely similar to the main that part from the desalinated water tank. If men want to produce desalinated water in industrial quantities that serve humanity, also desalination plants, as purifiers and water lifting and distribution, must become producers of energy, not consumers, supporting, not opposing gravitational forces. The sustainability of global systems is not based on complicated technology but on synergies between simple and rational systems.

Description

In the present state of the technique of desalination and demineralization are headed three types of installations: by evaporation, permeation through membranes, for ion exchange. Currently, the difference between the three systems, mentioned above, makes it especially the cost of

treatment. That evaporative, produces water free of mineral salts and with acid pH, therefore for the use of water is required a subsequent mineralization and neutralization of the pH.

The filtration with membranes entails high operating pressures, therefore high energy consumption and the high cost of the membranes, which periodically must be replaced.

The one with the ion exchange resins involve a complex filtration, washing and regeneration circuit of the resin, with reverse flows that involves the dispersion of apart of the resins in waste waters of the processes.

All processes are heavy on energy consumption for heating or for circulating pressurized water in filtration and regeneration systems. The operating costs are around 1.5 euro / mc with reverse osmosis plants, which are the most used, but also the investment costs are significant, being about 1000 Euros per m³ / day of desalinated water produced. It 'obvious that with these production and investment costs, the desalinated water can be used only for potable use. It 's impossible to think to use it for industry and agriculture. With the solution that proposes the agricultural and industrial use will become a competitive reality also with wells and other purification systems, which are in any case forced to treat polluted water, or with scarce mineral requirements. In fact, the sea water being rich in mineral salts, If desalination becomes sustainable, can become the best natural fertilizer for land, being able to send the same water can be used as fertilizer treated tailored to the target terrain, both in terms of mineral salts that alkalinity. For transport the desalinated water to considerable distance there is no problem, because with the dual supply pumps coupled to the hydraulic turbines, also the transport and the lifting of the water becomes a source of energy, not of consumption. In fact, the key to solving many environmental and energy problems, including desalination, is to realize Hydraulic and hydroelectric circuits using otherwise the pumps and turbines.

At the state of the art the desalination system least used is the one with the ion exchange, but this system is the most suitable to be used in conjunction with the dual supply pumps and turbines, not having the necessity of high temperatures or high operating pressures than competing systems. Therefore, the high cost of the resins and of the reagents liquid, required for regeneration, can be largely compensated by low energy consumption, energy production produced by the plant and low cost required for plant, and low operating and maintenance costs. Furthermore, with the solution described below, it will also solved the problem of the dispersion of the resins in water and process liquids, being the resins contained and circulating (in water and chemical reagents) in perforated polyethylene spheres with holes pass below the size of the

same. We can say, that the new solution is opposite to the current of ion exchange solutions, where the resins are stopped and the liquid passes through them, both in the reaction phase than in those of washing and regeneration. With the system proposed resins are circulating in the water and in the regenerating liquid, at low speeds, with long contact times, which provide capillaries contacts. For the circulation exploit physical principles, not energy. Over 90% of energy produced in the plant can be transferred to public power networks. Therefore, the facility is composed of a chemical part, an electromechanical and a hydraulic.

The chemistry of ion exchange.

From the scientific literature, one can learn that the ion exchange, is a process in which ions of a given species are replaced on the surface of a non-soluble material exchange (ion exchange resin) by ions of a different species dissolved in solution. It consists of two phases: cationic and anionic. In the proposed plant, which develops vertically, these stages take place separately in large diameter pipes (5) making transit at low speed an appropriate quantity of balls in polyethylene perforated like a sieve, containing granules of anionic resins or cationic in quantity proportional to salts to absorb, selected with a diameter greater than the passage of holes. The ion exchange resins can be natural or synthetic.

The natural resins are zeolites (aluminosilicates) used especially for the softening of the water and for the removal of ammonium ion.

The synthetic resins are formed from phenolic polymers which are generally in the form of small spheres of a diameter between 0.3 and 1.3 mm. With a density of 1.2-1.3 kg / l. They can be of two types:

- a) cell structure: translucent, low elasticity, higher capacity;
- b) macroporous structure: matt, high porosity, lower capacity;

the basic structure of the two types is however identical both being obtained by copolymerization. The realization of synthetic resins is generally through a process of copolymerization between styrene and divinylbenzene. Styrene has the resin matrix function, while the divinylbenzene serves to give consistency to the resin. The main properties of ion exchange resins are:

- the exchange capacity is expressed in meq / L or eq / kg. It is defined as the amount of an ion exchange resin that can lead.

- The size of the resin spheres: the importance of the dimension lies in the fact that the kinetics, and the rate of ion exchange columns is a function of the same. In general the rate of ion exchange is inversely proportional to the square of the particle diameter.

The ability of stated exchange of a resin varies according to the type and the concentration of substance used to regenerate the resin. Generally, the exchange capacity of a synthetic resin varies between 2 and 10 eq / Kg resin, while the zeolites have a cationic exchange capacity ranging 0.05 to 0.1 eq / kg resin.

Often the exchange capacity of the resins is expressed in terms of grams of CaCO₃ per m³ of resin (g / m³) or equivalent grams per m³ (g eq / m³).

The level regenerative: is the quantity of regenerant (HCl, H₂SO₄, NaOH) considered at 100% required to regenerate a liter of resin. It is expressed in grams per liter of resin regenerant.

The total capacity of exchange: It is the concentration of active sites per unit of measure. It is for unit of volume (Eq / liter) or weight (Eq / g) and is a parameter specified in the data sheets of the resins.

The operational capacity of exchange: is the quantity of ions (Eq / liter or g CaCO₃ / liter) that a given exchange resin under specific working conditions in which it is used.

The process schemes vary depending on the objective of the treatment to be carried out.

Some classic treatment achievable with the ion exchange resins are: softening, decarbonation (partial demineralisation) Full demineralization, removal of heavy metals specify, but substantially, ion exchange, such as ultra filtration, if it becomes sustainable and energy is also a great third party purification system.

As initially said the ion exchange generally involves the exchange of an ion present on the functional group of the resin with an ion of the same charge present in solution.

At the state of the art are distinguished five types of synthetic ion-exchange resins:

1) strong cationic resins, 2) weak cationic resins, 3) strong anionic resins, 4) weak anionic resins, 5) chelating selective resins for heavy metals.

- The strong cationic resins behave in a manner similar to a strong acid and are highly ionized in both their acid form (R-SO₃H) that in that saline (RSO₃Na) in a wide range of pH values.

- The weak cation resins have a weak acid functional group, typically a carboxyl group (COOH). These resins behave as weak acids, and as such have a low degree of dissociation.

- The strong anionic resins are strongly ionized due to strong basic groups such as the hydroxyl anion (OH) and may be used throughout the pH range. Thanks to the hydroxyl OH group are often used for the deionization of the water.

- The weak anionic resins are carriers of the weak basic groups and therefore have a degree of ionization depends on the pH, generally ionize in narrow pH fields.

The selective chelating resins for heavy metals behave as strong cationic resins, however, presenting a high degree of selection in the ability to chelate heavy metal cations.

Note that the ion exchange reactions are real equilibrium chemical reactions and as such reversible. In this regard, the working cycle of a resin is composed of two stages: - the operating phase also called "exhaustion" during which the reactions go from left to right (that is, it has the replacement of the ions present on functional groups with those present in the solution) and that end with the saturation of all functional groups. This phase, in the plant in question, takes place in the ion-exchange tubes (5).

- The step of charging also called "regeneration" in which the reaction is allowed to proceed from right to left by reloading the functional groups with originating ions of the resin. In the proposed solution, the regeneration takes place by passing the polyethylene perforated spheres, with the incorporated resin, in tunnels immersion of regenerating liquid and washing (E), consisting of:

- Basic solutions, typically basic substances type NaOH, NH₄OH, in the case of anionic resins. In that case, recharge the resins with OH⁻ ions.

-Solutions acidic, typically based on strong acids (HCl, H₂SO₄) in the case of cationic resins. In this case recharge resins with H⁺ ions.

The high concentration of H⁺ ions and OH⁻, in the two cases causes, for the law of mass action, the displacement of the reaction to the left resulting in charging of the resins and release of the ions in solution which in the exhaustion phase (5) were It has been absorbed by the resins. This obtains an eluate generally composed of various metals chlorides (if using HCl, the H⁺ ion charging the resin, while the Cl⁻ ion binds to the cation released from the resin) or the various salts of sodium in the case of using NaOH (the ion OH⁻ charging the resin, while at the Na⁺ ion binds to the anions released in regeneration from the resin to give sodium salts).



The ion exchange resins for the fact that exchange hydrogen ions (cationic) and idrossilioni (anionic) are more properly defined cationic resins in acid cycle (RH) and anion resins in the basic cycle (R-OH), owing to the characteristics of the released ions which make the acidic or basic water.

Below are some of the ion exchange reactions for synthetic resins:

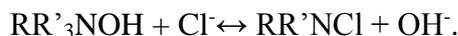
Strong cationic resin:



Weak cationic resins:



Strong anionic resin:

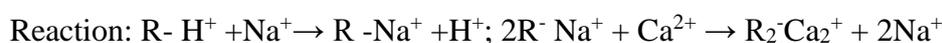


Weak anionic resin:



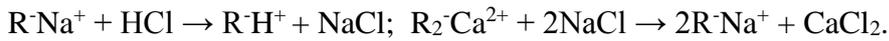
Example of exchange and regeneration.

Removal of sodium ions (Na⁺) and calcium (Ca²⁺) from water using a strong cationic resin.



Regeneration:

the regeneration is carried out with hydrochloric acid (HCl) and sodium chloride (NaCl)



The selectivity of a resin, namely the fact that an ion present in solution in active sites, exchange with those rather than another, depends on the nature and valence of the ion, the type of resin, by its saturation, as well as by the concentration of one specific ion in solution. Generally such selectivity remains valid in a narrow pH range. Typically the selectivity scale or if we want to affinity of the cationic resin exchange turns out to be:

$\text{Li}^+ < \text{H}^+ < \text{Na}^+ < \text{NH}_4^+ < \text{K}^+ < \text{Rb}^+ < \text{Ag}^+ < \text{Mg}^{2+} < \text{Zn}^{2+} < \text{Co}^{2+} < \text{Cu}^{2+} < \text{Ca}^{2+} < \text{Sr}^{2+} < \text{Ba}^{2+}$;
while for the anionic resins it is: $\text{OH}^- \lll \text{F}^- < \text{HCO}^- < \text{Cl}^- < \text{Br}^- < \text{NO}_3^- < \text{ClO}_4^-$

In current of ion exchange systems the operating phase provides, generally, the passage of water in a resin tank filled and a flow rate of water that must be kept within certain limits to ensure adequate exchange times. The characteristic data are highly variable in function of the amount of salts and ph: operating flow rate of between 5 and 50 liters / h / liter resin. It 'very difficult to manage and control the complete process, especially if you need to desalinate large flow of water. Even the regenerative phase, currently, it is not easy to handle. It is divided into three sub-phases.

a) Washing in countercurrent (backwash): water in upward flow, the flow velocity equal to 10-15 m / h, 50-70% of the expansion of the resin bed. This washing serves to eliminate any preferential paths formed during the exchange phase and to remove impurities that may have possibly formed in the bed during the exchange phase. The duration of this phase, in existing plants, is around 15 minutes.

b) The regeneration can be acidic or basic depending which relates to a cation exchange resin or anion respectively. The solutions are dilute solutions of acid or base whose percent dissolved depends on the strength (degree of dissociation) of the same. For example, to recharge a cationic resin can be used acidic solutions such as:

5 – 10 % di HCl with flow of 3 -4 l/h/l of resin.

1 – 3 % di H₂SO₄ with flow of 10 – 15 l/h/l of resin.

c) Final washing which is carried out with demineralized water in a down flow in two phases:

a first phase to the flow of the regenerative phase to wash the residual acid;

a second phase to the operating conditions for a total volume of water equal to 6 - 9 volumes of resin.

The new electro-mechanical and hydraulic systems of ion exchange.

The long introduction, above, who summarized the state of the art of chemical and physical processes that govern the complex ion exchange system is essential to understand the reasons why it is born this invention. In fact, the work cycles of the current systems that use the ion exchange are the starting point for the design of these new plants, which must not distort the basic principles, but should only make them cheaper, especially, by combining the production of energy hydroelectric, low cost, that sold to operators, of fact, lowers the cost of desalination. In fact, hydropower produced without the classical hydraulic jump, is much cheaper than the current hydropower, not requiring the construction of dams and reservoirs. Just only the utilization of positional energy of water placed in the high position of a water system remained always full to take advantage of favorable hydraulic condition for energy purposes. Therefore, the plants, with ion exchange, combined with the production of energy, in addition to the desalination and demineralization, may also have other cleansing applications, so that even the sweet water, in many cases, even when they are extracted from the subsoil, must be deprived of undesired substances because of the numerous infiltration due to the chemicals used in agriculture, in industry, in urban activities, infiltration of solvents and radioactive metals freed near drilling with the system of fracturing water with solvents and inert materials at high pressure. Certainly, even the ultra filtration can be combined with the production of hydroelectric energy, reducing operating costs, but most of the energy would be consumed in the same facility, while the cost for the replacement of worn membranes would not be solved. In addition, it is necessary to clarify that state of the art, not desalination sea water but only brackish waters because desalination the sea water would cost about 3.5 times the current costs, which already are not sustainable for large jobs ladder. In fact, in the process for reverse osmosis, the water by desalination is put in communication with fresh water through a membrane permeable only to the solvent; applying on the side of the saline solution a pressure higher than that which is generated by osmosis, it reverses the normal direction of spread and the solvent tends to leave the solution with higher content of salts. The process is not yet used for the desalination of sea water, since, being the osmotic pressure between sea water (salinity medium: 35 g / l) and distilled water equal to approximately 22 bar, the corresponding pressure

required to obtain a appreciable flow of solvent through the membrane may even exceed 100 bar. The process is, instead, application for the desalination of brackish water with a salinity less than 10 g / l. In the same proportion they will also increase the energy costs of evaporative processes, while with the ion exchange proposed only increases the cost of the chemical additives and of the amounts of resins required.

Before starting the description of the process should bring the legends of the figures illustrating the plant.

Alphabetic legend: (A) arrival basin of salted water; (B) salt water inlet filter with built-in check valve; (C) Water recirculation tube and dynamic or kinetic pressurization of the electric pump; (D) Nominal upper basin level; (E) washing and regeneration circuit of ion exchange resins; (F) upper reservoir mixing and overflow desalinated water; (G) Mini implant of deionized water production; (H) desalinated water storage basin; (I) desalinated water distribution network; (L) demineralized water accumulation tank; (M) regenerating liquid tank.

Numerical legend: (1) overturned dual supply pump on the suction side; (2) submerged turbine with incorporated alternator; (3) nominal level of the water basin to desalinate; (4) pipe for supplying water to desalinate; (4.1) special piece for introduction spheres with resins in the ion-exchange tube (drilled in the lower part); (5) tube of ion exchange; (5.1) perforated truncated cone embedded in the tube 5; (5.2) special piece to eject spheres from the tube 5 (perforated on the entire outer surface and connected to the tube 6 by means of the slide 5.3); (5.3) metal sheet slide for the guidance of the spheres in the tube 6; (6) tube of descent spheres for the emptying; (6.1) special piece for the deviation of the spheres from the ion exchange circuit to the regeneration circuit (drilled at the bottom for water drainage); (7) automated guillotine valves for stopping movement spheres (are always open when the minimum level probe indicates that the tube 6 is empty of water; (7.1) automated guillotine valves for stopping movement spheres (open one at a time); (8) first tunnel for immersion wash of the resins; (9) guided route of the spheres in the immersion tunnel with an open frame of stainless steel rods by ascents and descents with slides for the collection of the of the spheres emptying liquid; (10) tunnels for regeneration of the resins in immersion; (11) second washing immersion tunnel of the resins; (12) pump suction sludge from arrival reservoir; (13) electric pump suction of resin washing sludge; (14) electric pump suction of resins regeneration sludge; (15) Support frame demineralisation plant; (16) supply pipe demineralized water; (17) float valve for feeding demineralized water; (18) float valve for regenerating liquid supply; (19) motorized shut-off

valve; (20) Manual shut-off valve; (21) check valve; (22) salinity control probe; (23) PH control probe. (24) minimum water level control probe of spheres emptying tube; (25) submerged agitator.

Figure "1" shows the general scheme of the plant in a vertical, where you can see in section the elements reported in the legends, while Figures 2, 3, 4, report the sections to altimetric plans A, B, C.

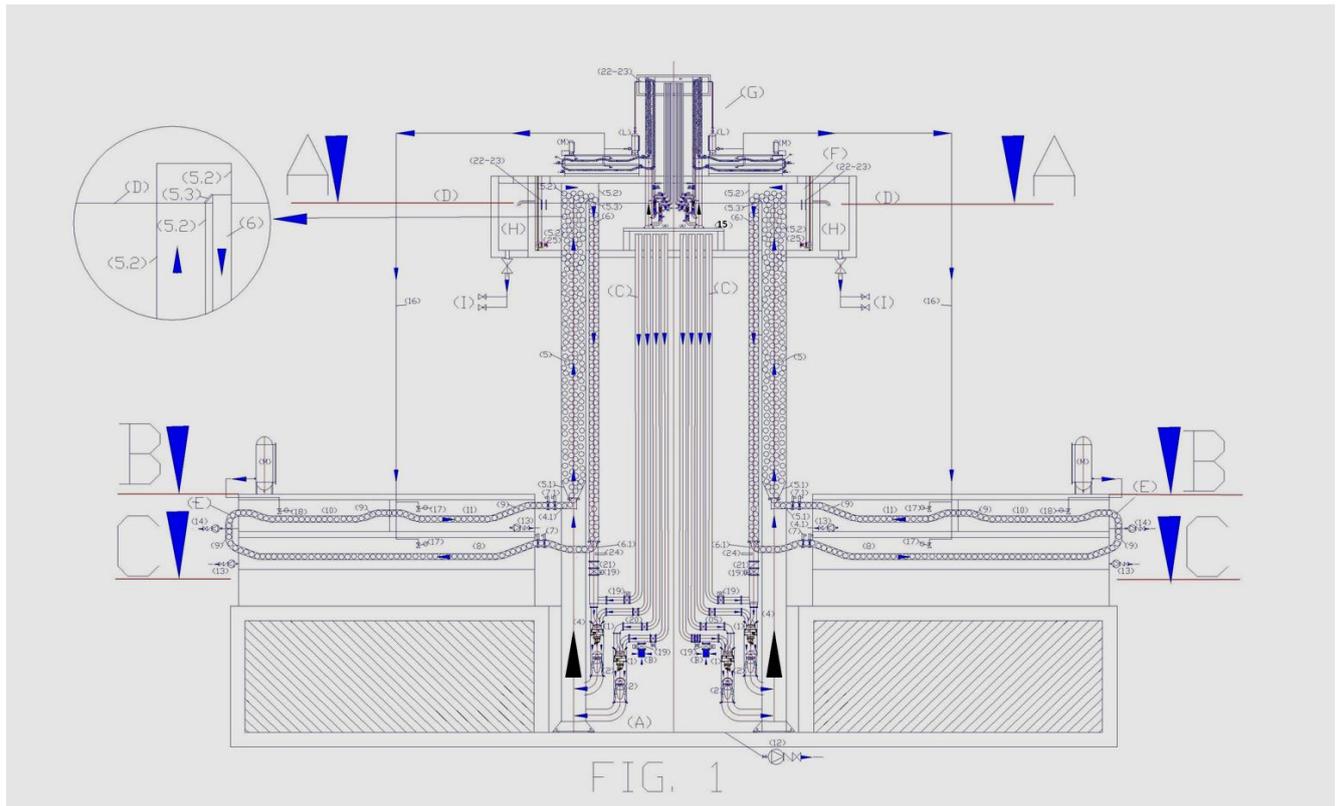
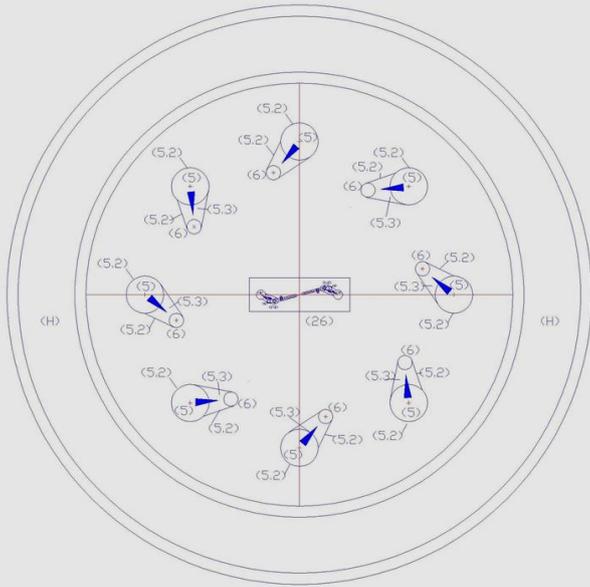
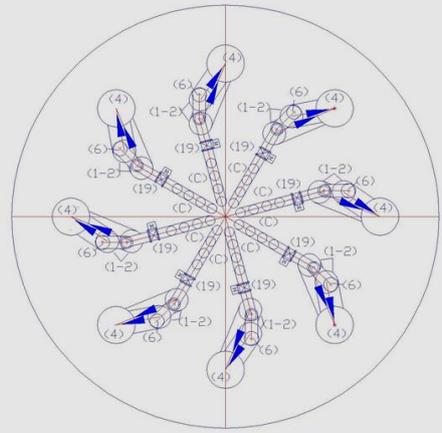


Fig. 1



SEZ: A - A
FIG. 2



SEZ: C - C
FIG. 3

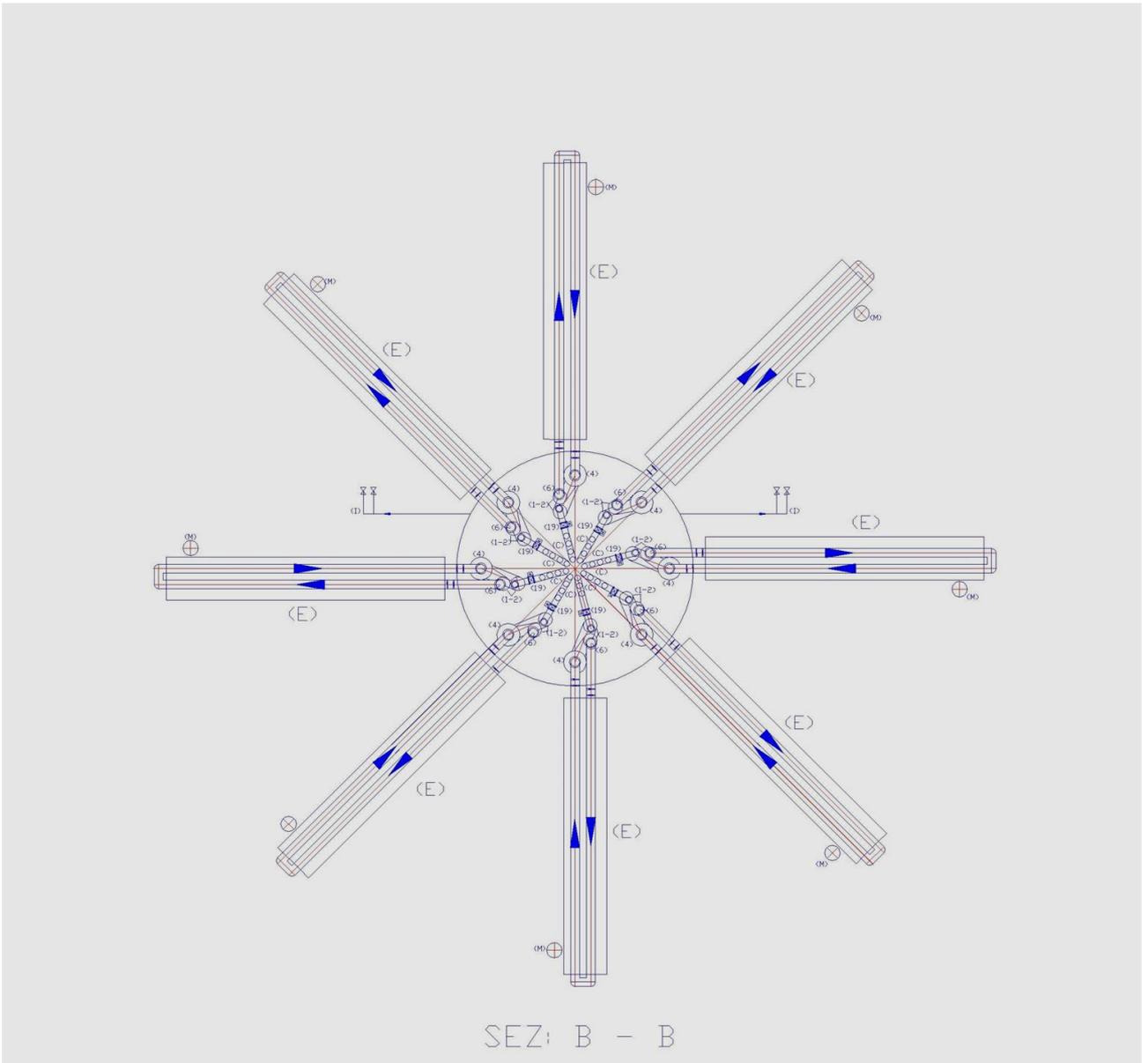


Fig. 4

Annotations on hydraulic principles and fluid used.

So that it produces the maximum energy kinetic energy in a pump-turbine group, place under a head, which discharges the water in depth, within the same basin, it is necessary that the water is drawn from the highest point of the ' plant and arrives directly on the pump placed in the lowest point of the system. In fact, it is known that a moving body (including water), increases its force ($F = m * a$), both if it moves horizontally or vertically. Obviously, in the case of water,

if it moves in the horizontal acceleration must provide all the pump motor, if it moves vertically, in the direction of the gravitational force, to the acceleration provided by the pump, it also adds the acceleration gravitational ($g = 9,81 \text{ m/s}^2$) But it is not sufficient only to orient the pump downwards and exploit the hydrostatic head, because the mass of water that would move without the vertical intubation, would be only that is around the pump, therefore, the turbine would produce very little energy. The surface water intubation is essential to provide the entire water column above the pump energy of movement. Therefore, it is necessary to use a descent tube (c) for each pump-turbine group. On the other hand, this need is intuitive, since even the turbines that exploit the hydraulic jump to the atmospheric pressure are connected individually to the upper reservoir. Contrary to what one might think is not the flow rate combined with pressure drop to produce in traditional hydroelectric energy, but the flow of water transformed into kinetic energy (or dynamic) realized in the path that feeds the turbine ($P = \eta * 1000 * Q * H_u / 102$).

In traditional hydroelectric energy it is not commit calculation errors because flowing the water to atmospheric pressure and not recycling it, the whole static pressure energy, reclaimed from the load losses, is transformed into kinetic energy. But the traditional hydropower should have been the exception that proves the rule, however, for the experts, it has become the rule, and no one wants to deepen the utilization of surface energy of water location within the same volume of water, which can be done anywhere without building dams and large hydraulic basins. In fact, in the case of installations always filled with water, not having, a hydraulic jump to exploit, to produce kinetic energy is necessary to take advantage of the relative position difference within the same volume of water, thus the plants and the pumps must be designed otherwise. It 'necessary to intubate the surface water to take advantage of his energy of position with respect to the pump location and the turbine, which connected in series, function as one single machine: the pump wins the state of inertia and keep the motion in time allowing the acceleration of gravity to produce more kinetic energy than it spends the pump, while the turbine uses the total energy to produce electricity through the built-in or connected alternator. It 'obvious that if only ponessimo the ducted pump under a swing of 10 or 20 m of water column, there being no hydraulic resistance in the flow, it would create a large hydraulic imbalance, since all the kinetic energy developed by the water column , due to the acceleration of gravity on the pump, finding no contrast, apart the friction of the water molecules, it would be dispersed into heat. In fact, the static pressure of water, to the fact that the liquid is incompressible does not oppose to the kinetic energy. Therefore, the velocity would increase in the permitted limits and the pump would be damaged in a short time, failing to control the flow of water that it would have started.

Insert a turbine after the pump, in addition to being a rational energy solution is also the balancing element of the forces generated. Therefore, with the proposed system we can produce energy in the turbine by the energetic flywheel constituted by the masses in movement in the direction of gravitational force, discharging the water in the open basin, or in an open section connected to the upper reservoir, with small residual velocity at the exit of the turbine. The load loss to be calculated for this discharge is more or less the same that would have with the discharge of the water in the atmosphere ($V^2/2g$). It is 'equally obvious that without the water intubation that part from the surface we could not produce the kinetic energy that is used to produce electricity, since the water that would power the pump would be surrounding the pump, equipped with only one static pressure. These are the reasons why in the diagram of Fig. 1 each pump is connected with a suction mouth to the upper reservoir and for which this tube has been called dynamic pressurization tube. In fact, the static pressure in a closed circuit can be transmitted with a small tube (Just think of the famous experiment of Pascal that with tube full of water placed vertically, smashes a wooden barrel), while in order to give at a flow rate of the water pressure dynamic (or kinetic), it is necessary that the unitary pressure is multiplied by the water passage section (10 m column of water equivalent to 1 kg / cm²). If we have a passage section of 100 cm² and we want transmit dynamically the entire pressure of the ten meters of water column, this section must be maintained and extended considering the load losses for not to lose kinetic energy. This must cover the entire circuit path, including the body of the pump. So if we want a dual supply pump sends water fed from the lower basin (always with a positive swing) the dynamic energy of the water coming from the reservoir (F), the passage in the pump sections must be adapted to the sum of the two flows. In such conditions, at the pump outlet we will have a single flow and a single pressure, which will approach the sum of the flow rate and the maximum inlet pressure, plus that provided by the pump, minus the pressure losses of the circuit. This application is also confirmed in Torricelli's theory that showed that the output speed of the water to a hole made on the wall of a water tank under a hydraulic head (h) is calculated with the formula $\sqrt{2 * g * h}$, regardless of the actual depth of the tank. Obviously, this confirmation should be interpreted only as the certification of existence of surface water energy location. But to harness that energy for electricity generation in the same volume of water or in plants always full, recycling water, is necessary modifications to the pumps and hydraulic circuits currently used, since at the current state of the art, no one has done the right technical and scientific reflections. The same patent offices, in previous applications of the undersigned, have declared such applications contrary to the principles on energy conservation, not distinguishing the difference between simple and complex circuits. In fact, the hydraulic

principles of the Energy Conservation legislated do not include complex hydraulic circuits made within the same volume of water, which can feed endlessly internal circuits, considering the basin always full, therefore, respecting the principles legislated. With the surface water intubation and the coupling under the head of the pumps with the turbines, of fact, are realized within the same volume of water many hydraulic systems separate from the static water, as there are pump-turbine groups realized. Each group produces electricity, by the difference between the energy consumption and spending, independently from the other groups, drawing on common energy source, which are the energy of surface water location and atmospheric pressure. The system can also produce energy by lifting water from a basin to another as long as the circuit is always full and the water to be lifted is inserted into the recycling circuit of upper reservoir by means of a feeding of a pump with double mouth placed under the head, dynamically pressurized by hydrostatic height of the upper basin on the second suction inlet.

Obviously, in a basin always full, even the static pressure is dispersed. These considerations do not need to be demonstrated with prototypes because if they were true, they would not hesitate sea currents and underwater pipelines may not discharge the water in the deep seabed with small kinetic energies. If this happens it is precisely because the exhaust pipe part of the surface, the internal static pressure and external to the tube are balanced, while the energy developed inside the tube with the insertion of the pump under the hydrostatic pressure contained in the same tube, communicating with the upper reservoir and with the atmosphere, finds no opposition, apart from the famous $V^2/2g$.

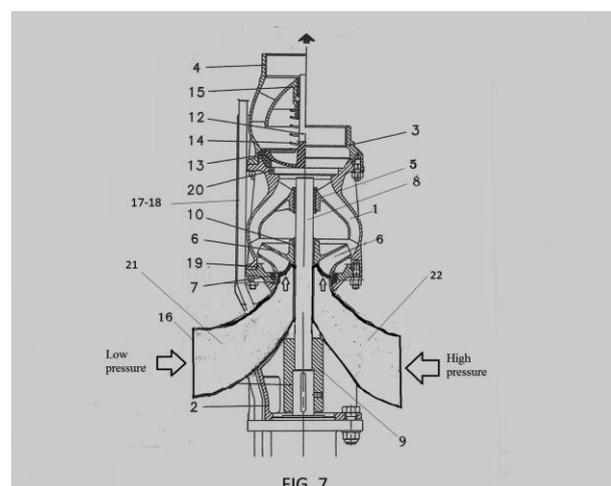
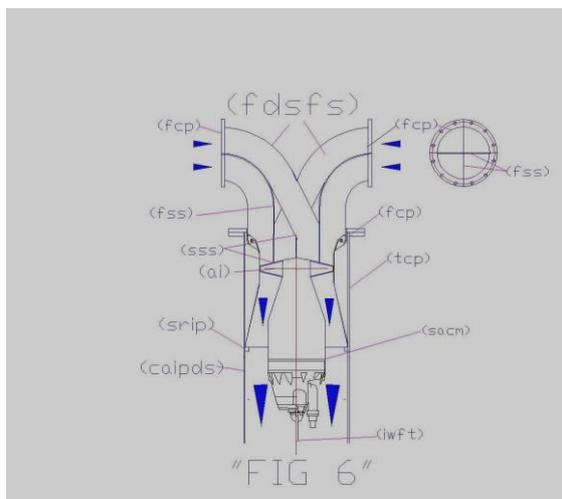
Another authoritative confirmation comes from the famous scientist Albert Einstein, who with his theories of relativity showed that matter and energy can be considered as a unit, since the one can become the other according to a precise mathematical relationship. A practical confirmation of this statement we can find in the action of the wind can generate electricity through wind turbines but can also break the inertial balance between the troposphere and hydrosphere, creating kinetic energy in ocean currents. This, for myself, is the energy aspect underrated in the world, because even we can break this balance, artificially, by means of intubation of a small stream of water, a pump placed in the depth of the water and concentrate all kinetic energy produced on the blades of a hydraulic turbine. There is no law of conservation of energy that can prevent it and no energy balance to do, except that between the energy used and that produced, because we take energy from an endless source. The difference between expenditure and energy produced is immense, in favor of the energy produced, because we are not in an isolated system as the pendulum of Newton. In fact, all the weight of the water column

intubated ($m * g * h$) gains kinetic energy ($1/2 mv^2$) braked by the blades of the turbine, which produces electricity by alternator connected, under the weight of the water masses conveyed on the turbine to the effect of gravity and atmospheric pressure, once moved the masses of water below by means of the pump. In fact, Einstein says that the energy provided it does not increase the speed of the body, but its mass: the body becomes more and more "heavy". This is also reflected in the practical calculations of the prevalence of lift pumps which is subtracted from the positive head on the suction side, being considered an energy in all respects. This energy becomes even more important if instead of raising the water we use pumps to produce energy. In this case, it is convenient that pumps orient the flow of the flow in the direction of the force of gravity and atmospheric pressure. Using this system the difference between the energy used and that produced becomes huge because the surface water has the same density as water below, and therefore does not need to rise to the surface, if we are in a small basin (The water simply changes position). The energy production is huge, as realized in terrestrial hydroelectric, at atmospheric pressure, because the exit of the turbine the hydrostatic water pressure cannot oppose the kinetic energy remaining. In fact, because water is incompressible, at any depth is on the outlet, the hydraulic resistance to the output is always the same ($v^2 / 2g$). Therefore, energy expenditure may be multiplied by a hundred, two hundred, etc. It depends only on the water column, which weighs on the pump and on the turbine.

The dual supply pumps on the suction side (italian demand patent N. 102015000048796 del 04/09/2015).

The dual supply pumps on the suction side, used in this system do not exist, as described above, for the wrong interpretation of the fluid dynamic principles, which have resulted in enormous waste in all areas of human activity, but are simple to realize by changing the supply of current pumps, not the construction technology of the same. In fact, by feeding the impeller from the outside by two confluences (curves or grafts with different angle) channeled internally, so that the two flows cross each other and nourish the pump impeller into four separate sectors, arranged diagonally, two fed with ' water to be lifted and two fed with the recycled water from the top, equipped with high hydrostatic pressure. Balancing in the above manner the hydraulic thrust on the impeller and on the bearings, and by getting its flows deep into the impeller, so that they are not in contact before being dragged by the impeller itself can transform all existing hydraulic systems from energy absorbers to producers of the same, of course, also modifying plants and inserting the turbines in series to the pumps.

We start from the heart of a pump that is the impeller, which can produce an axial flow, radial or axial seeds and can be opened, closed or semi-closed, in function of the pump body in which is mounted. There are also pumps with twin impeller, with horizontal shafts and double feed at the same pressure, which have excellent performance, but we do not take them into account, since the pumps that we propose, to simultaneously take advantage of the hydraulic principles of communicating vessels and Pascal, who allow increments of flow rates and low energy cost pressures, they must be supplied with different hydrostatic pressures. All pumps can be changed and fed with different pressures. Obviously, with different performance and returns in function of the characteristics of the impellers that are currently mounted. With high flow and small increments of pressure will be used axial or half axial impellers, with small flow and more pressure will be used closed impellers and more precision of the workmanship, as happens in the current pumps. The important is to understand that these pumps should never work in suction but only under the head and that dividend flow which reaches into four sectors that arrive directly at the entrance of the impeller, with the rotation of the pump, in each sector is alternated l' entry of water into high and low pressure, which have the same direction, therefore the flow rate with greater pressure transmits its pressure to the flow with lower pressure inside the same impeller, which as is known is designed to increase the water pressure starting from the center to the periphery of the rotor itself. Obviously, at the pump outlet we will have only a single stream with the sum of the flow and the greater pressure. This is nothing but the dynamic application of the principle of Pascal, that with current technology it is simple to implement. Figure 6 shows the change of a pump with axial impeller, Figure 7, that of a pump with closed impeller.



Description of the operation of desalination and demineralization.

The water to desalinate contained in the basin (A) (always maintained at the highest level by an appropriate hydraulic level regulator), is drawn through the filters (B) and a motorized gate valve (19) from one of the two suction mouths of the pump with double feed (1). The other suction mouth is fed from the recycling tube and dynamic pressurization (C) that comes from the upper reservoir (F). position. Therefore, in this condition, the turbine (2) produces the maximum energy allowed by the system. In any case the output of the turbine is connected to the tube (4) of wide section from which the water rises to the ion exchanger (5) where float suspended in the water of perforated polyethylene spheres as sieves in which floating of the resin granules synthetic ion exchange, selected with a diameter greater than the holes of the passage of water. Therefore, the output of the ion-exchange tube reach the upper reservoir (F), the water and the spheres with the resins. The principle for which the polyethylene balls circulate together with the water in the ion-exchange tube (5) is based on the polyethylene density which is slightly lower than pure water (950 kg / m^3). So assuming to realize holed spheres that weigh 950 grams, equipped with a threaded plug, we can insert up to 50 grams of resin that has a density of 1.2-1.3 kg / the dry, in order to circulate freely in the resins' pure water and having them float in the marine. Whereas the volume of wet resin increases by 50 - 70%, the specific weight of the resins becomes (0.7 to 0.8 kg / l), therefore, we can assume that the resins of the float inside polyethylene spheres, also in pure water. This condition is ideal for the ion exchange with the volume of water contained in the sphere, certainly more effective than a flow of water that passes through a compact bed of resins. This implies a considerable saving on the amount of resins required.

To properly operate the plant, in the basin (F) the spheres that lead the resins must be emptied of water and sent to the regeneration circuit (E). Therefore, in the tank (F) as you can be seen from a detail extracted from "Fig. 1 ", and in plan view in" Fig. 2 ", a special piece (5.2) is upwardly connected to the ion exchanger (5) drilled on the entire outer surface and connected, by connection slide in plate of steel (5.3) to the entry hole of the descent pipe and emptying of spheres (6), placed above The overflow altitude of the tank F (D). Therefore in the tube (6) the spheres are emptied of water and carrying the resins only. The water recovered from the spheres descent tube (6) and is reinserted in the plant through the check valve (21) and a motorized gate valve (19) from one of the two suction mouths of another pump with dual power supply (1). The other suction mouth is fed from the pipe (C) that comes from the upper reservoir (F). When the tube (6) is empty of water the minimum level probe (20) closes the valve (19) and open another connection (C) which also comes from the tank F. Therefore, also in this case, both suction mouths are fed with water coming from the basin F, with the maximum hydrostatic

level and produces maximum energy in the turbine 2, until the water level rises in the tube (6), which detected by another sensor (20) opens the drain valve and closes that of the pipe (C). Obviously, the flush water by the spheres is essential to pass from one stage of the process to another. It can not be interrupted even when salt water enters from the suction filter (B), therefore we use two separate circuits, both equipped with pumps and turbines.

This does not penalize the performance of the ion exchange, but increases the combined energy plant performance. The desalination plant can also be realized with the recycling of the spheres and with normal pumps, but the two new products are put together to build systems with higher performance and multidisciplinary. In fact, the plant also being designed to generate energy, it is necessary the use of dual fuel pumps and always ensure, at least on one of the two connected suction mouths with a recycle and dynamic pressurizing pipe (C), by equipping both connections of a motorized interception valve (19). With this system we allow the pressurization of the pump (1), and then the energy production, also during the step of charging the water to desalinate and when there is no water to be recovered from the emptying of the spheres. The spheres, empty of water but containing the resins, accumulated vertically in the tube (6), through special piece (6.1) are transferred, one at a time, to the washing and regeneration circuit (E). In fact, by observing Fig. 1, it can be noted that the spheres by gravity are pushed against the first guillotine valve (7), which opens with the consent of the minimum level probe (20), letting through the spheres (the second valve is for reserve and it always leaves open). The spheres circuit crosses seamless the first washing (8), the regeneration (10) and the second washing (11), which take place by simple immersion, being spheres guided by a simple open frame, made of stainless steel rods. At the end of the second wash, the spheres are pushed against the first slide valve (7), which lets it pass one at a time, as the second slide valve must prevent reverse flow of water from the tube (5). Therefore the spheres stationed for a time between a gate and the other and after the closing of the first opens the second inserting the ball in the flow of water coming from the pipe (4) through the special piece 4.1, specially drilled in the part infer. Even the concentric cone is perforated over the entire surface to allow the passage of water without pressure losses from the pipe (4) to (5).

The entire system must be managed globally, both from the chemical point of view, to dilute the incoming water salinity, both electromechanical and hydraulic, to exploit the available hydraulic pressures, and thus produce the maximum energy. In steady state operation, the desalinated water is produced on the base of the lowering level of the water accumulation tanks (H), which by gravity distribute water to the consumption network (I). When these require

water, the precedence of the sectors to be fed with priority from the suction filter (B) depends on the water quality detected by the control probes (22 -23) of the salinity and pH, while the potential of the plant depends by the number of ion exchangers, the size of the same, the amount of resins in circulation in the spheres. As regards the electrical energy produced by the plant, as seen from Fig.1, each ion exchanger is equipped with two pump-turbine groups, which can have any size, working with very low operating pressures. In Figures 2, 3, 4, it is seen that the proposed plant as an example is divided into eight sectors, but may also be more or less, according to system requirements and the required flow from the territory. Each sector, as mentioned in the introductory phase, can be specialized in the following versions: 1) strong cationic resins, 2) weak cationic resins, 3) strong anionic resins, 4) weak anionic resins, 5) chelating resins selective for different heavy metals. So, we have a wide managerial choice to desalinate and to purify, producing and distributing energy instead of consuming it.

The radial arrangement of the vertical ion exchange tubes (5) and relative regenerations, around the storage tank and recycling (F), allows to mix the treated flow, by each plant, also helped by some submerged agitator (26). It is important above all, the fact that the desalinated waters leave from the highest point of the system. Therefore, they can be transferred to tens of kilometers of distances by gravity. Suffice it to say that a piping DN 1000 with a flow rate of 1000 L / s and a water velocity of 1.27 m / s according to the tables calculated with the formula of Bazin-Fantoli has a load loss of only 1.5 m / km. So with a plant height of 15 meters, we can transfer the desalinated water at 10 kilometers away. But what is equally important is the fact that using the same hydraulic system in the subsequent lifting equipment, with dual supply pumps coupled to the turbines (as shown in Figure 8 of the next chapter), the desalinated water can be transported to hundreds of kilometers away, even lifting it up in the hills and mountains, along the way producing a lot more energy than is consumed for water transport.