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Italian demand patent N. 102015000048789 del 04/09/2015

Abstract

The state of the art in the exploitation of water resources on land and hydropower generation has been conditioned 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 the hydraulic lifting but sustained, with circulation of water one way in open reservoirs, placed in the top which also act as hydraulic disconnection. With the triple synergy between the dual power supply pumps, turbines and water recycling 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 or single inlet between a high hydraulic head positive and the turbines, dimensioned for the exploitation of the same hydraulic load, the pumps, working with a balanced load, with a small energy consumption, win the state of inertia, allowing the transformation of 'pressure energy of the intubated water column overlying the pump into kinetic energy and transferring it to the turbines, which produce energy. The energy hydraulic circuit finishes at the exit of the turbines, where the collector (c) that receives water is connected seamlessly to the upper reservoir (wddr) common with the suction side of the pumps. Therefore, for the principle of communicating vessels, the water must not be raised. We are in the case of a

recycling in an open reservoir. But with dual supply pumps we have the possibility to replace in the recycling circuit almost 50% of the nominal flow of the pump with water from a water reservoir placed at a lower hydrostatic level without the efficiency production is seriously affected, if not for a small decrease in yield. In this way we can produce energy even lifting the water. Today, the water lift plants are by far the largest energy absorbers of the planet and with global warming and the rise the sea level they will absorb more and more energy if the world does not proceed immediately to make this invention. both defense against flooding, both for normal water distribution.

Legend Fig. 8: (acg) alternating current generator; (ai) axial impeller; (C) collector; (oipds) overturned intubated pump with dual suction; (csp) connection systems pipe; (cst) containment system tube; (cv) check valve; (dgh) delivery geodetic height; (dthdc) deviation towards hydraulic drainage canals; (ecpc) electrical current produced cable; (fcp) flange for coupling to the pump; (fdsfs) flanged dual supply and flow separator; (fss) flow separator in sheet steel; (htva) hydraulic turbine with vertical axis; (mpl) probe of the minimum or maximum level; (od) overflow discharge; (sav) supply additional valve; (sgh) suction geodetic height; (sov) shut-off valve; (srip) supporting ring for intubate pump; (srt) supply reservoir tube; (sss) shaped sheet steel; (tcp) tube containing the pump; (tpups) three-phase UPS; (wdn) water dstribution network; (wddr) water distribution and disconnection reservoir.

In these simple systems, the hydrostatic head, measured in meters of water column is chosen after having carefully calculated the load losses in the turbine and in the tubes, to put down the axis of the pump at the exact point where the positive dynamic pressure on pump alone can balance the resistances to the water circulation, including the turbine. The pump has only the task of winning the state of inertia of water inside the tubes that feed the pump and the turbine, consuming very little power, being positioned between two equal and opposite loads. The rotation of the pump, placed in such conditions, produces in full water column overlying the pump, that is separated from the surrounding static water, producing kinetic energy ($1/2 * m * V^2$), derived from ($m * g * h$), which is exploited in the turbine to produce electric energy. Even the loss of pressure in the valves and in the tubes may be charged to the kinetic energy developed by the water that falls from the upper reservoir, if they have been dimensioned correctly the passage sections. Assuming that the overall performance of the turbine and to the coupled current generator is 0.8. The useful power can be supplied by a turbine which fully exploits the payload Hu of 50 m, with a ducted pump which has a flow rate of 1 m3/s, will be Pu = $\eta*1000*Q*Hu/102 = 0,8*1000*1*50/102 = 392$ KW; while to let the pump rotate in conditions of equilibrium between the positive head and the turbine just a prevalence of a few cm of water column. Assuming you work with an electric pump that has the same scope, prevalence 0.2 and 0.7 output, the power consumption is 2.8 kW (1000 * 0.2 / 102 * 0.7). The ratio of energy produced and expense is 392 / 2.8 = 140.

No one has ever thought of being able to produce energy by drawing from static energy sources such as atmospheric pressure and the hydrostatic height on the pumps, although these are, always considered in the hydraulic calculations for determining the prevalence of plant and pumps and then, also saving energy in hydraulic lifts.

Infact, If it is possible to exploit the hydrostatic head to save energy by pumping water up to win the atmospheric pressure, it is also possible to transform the hydrostatic head favoring the atmospheric pressure into energy, not raising but pushing the static waters down, after intubation of the same and starting from the surface of water. As seen from Fig. 8, the collector (c), which collects the water outlet of the turbines, can be considered, such as the bottom of the tank (wddr), while the vertical tube (srt) the extension, therefore, the load loss to consider is that of an outlet in an open vessel, such as in submerged installations, in addition to only the load losses in the pipes, not those to overcome the difference in level. The laws of hydraulics are clear, both as regards the exploitation of Hga in the suction of the pump, both with regard to the loss of pressure in a hydraulic circuit in the open vessel, from which start the aspirated water and return those pumped. The positive hydrostatic head to be carried on the pump shaft is the sum of the useful height (Hu) request from the turbine plus the pressure losses in the pipes (pdc) and to the outlet (pds). Even the length of the water network that connects the tanks (wddr) may be charged to the hydrostatic head. In fact, if we increase the distance between a basin and the other, we need not increase the prevalence of the pumps but the hydrostatic head on the pumps that costs much less. Increasing the diameters of the tubes we reduce the height of the plants and the operating pressure. The prevalence to be assigned to the system and to the pump "H" is equal to the algebraic sum of: (+) Hgea (-) Pdc (-) pds, where:

Hga (m) = (sgh) geodetic suction: distance between the upper level of the water intake and pump axis. Hga, in our case, for energy purposes, is positive since the pump is subjected to the water level.

Pdc (m) = sum of all the system pressure drops, which, for the absorption of pressure energy purposes are to be considered with a negative sign. In our case, are represented by the descent tube, the special pieces, the resistance to the rotation of the turbine, the speed in the pipe (rst) of connection to the vessel.

Pds (m) = pressure loss at the outlet in the manifold and in the upper tank (V^2 / 2g)

Never exceeding with the tube (rst) the level of the basin (wddr), by pumping in the direction of the atmospheric pressure, the prevalence of the plant tends to zero by balancing the loss of pressure with the hydrostatic head. Obviously, to have the maximum energy produced should concentrate the load losses in the turbine reducing the other, by expanding the diameters of the tubes and reducing the lengths. In fact, the collector (c) and the tube (rst) is represented of large size compared to other tubes to indicate the volumetric continuity of the reservoir.

In these systems dynamically we exploit the principle of Pascal: using the hydrostatic pressure of the upper reservoir to raise the water flow in the lower basin fed into the recycle loop thanks to dual fuel pump, without consuming energy. Besides the principle of Pascal, this possibility is confirmed by artesian wells where groundwater comes directly on the surface without the aid of pumps. It is not the pump to raise the water, but without the dual power supply of the pump the water could not have been inserted in the recycling circuit to be raised. In fact, the closing of the valve (sav) that feeds the left side of the pump, allows to feed such side of the basin with the water placed in the lower level, the mixing and the sum of the two flows, which occur in the pump, enable recovery of the maximum hydrostatic level of the reservoir without appreciable energy consumption. Reached that level, it closes the water supply to be lifted (sov) and opens again power supply with the recycled water of the upper basin (sav), until the water level is lowered again and requires a new lift of water. Obviously, this system can be used for large and small flows and large and small differences in height. Observing Fig. 5, the dynamic pressure that circulates in the right side of the pump it is also transmitted to the one that enters from the left side. The water with a lower hydrostatic pressure is inserted in the upper basin of the recycling circuit and therefore raised, but the turbine continues to produce energy almost to the maximum level if the water passage sections are adapted to the transmission of dynamic pressure of the upper reservoir. At the the exit of turbine water comes into the collector (C) which is also the bottom of the open vessel, which provided water, the static and dynamic pressure to produce energy in the turbine.

It is important to note that in these plants we realize synergies not only between the pumps and turbines, but also between the hydraulic principles on which they are based. Il vantaggio energetico lo abbiamo facendo la differenza tra l'energia prodotta nella fase di discesa delle acque e quella consumata nelle perdite di carico, escludendo quelle della risalita delle acque perché nei bacini sempre pieni, a volume costante, l'acqua non deve essere sollevata; disproving also the myth of back-pressure at the exit of turbine because the static pressure is not opposed to the kinetic energy, except for the friction between the molecules, due to the speed difference (V2 / 2g). The representation is symbolic and shows only one pump per plant, but as in the current lifting systems, there can be many groups of pumps – turbines in parallel, as long as each group has at least one orifice connected directly to the upper reservoir with the dynamic pressurization tube. With the symbol (c) indicates the delivery manifold that may be common to more than one pump-turbines groups in parallel, as long as a large cross section to reduce frictional pressure losses with the walls of the tube. However, only the collector (C), the feeding tube (srt) and that in connection with the next facility (csp) are in common. In fact, each pump, pumping down, producing kinetic energy in its own tube, which dissipates into the turbine, specially dimensioned, therefore, the rise of water to the tank (wddr) occurs without energy, just based on the principle of communicating vessels. Also the connection between the various tanks (csp) must be of large cross section, having to feed the dual power supply of the next lifting pumps, which can be placed at many kilometers away. When there is no withdrawal from the water network (wdn), which consumes the water, there is no need of lifting water, so the system only serves to produce energy. In this case, also the left side of the pump is fed from the upper reservoir through the remotely controlled valve (sav) and we have the maximum of the energy produced. When, instead, because of the network levies the level of a tank (wddr) lowers, the control system, based precisely on tank levels, closes the valve (sav) of that tank and automatically, the left side of the pump is fed from the bottom basin (wddr) through the check valve (cv). Obviously, the operation involves the lowering of the lower basin level, and the control of the level of that basin, in turn, closes the valve (sav) and the water that feeds the left side is taken from the place at a basin still lower level. All this takes place while the pump and the turbine are always in rotation producing energy. Therefore, while in the current based on the levels of the automatic water lifting systems puts into operation a number of electric pumps increasingly higher to compensate the withdrawal from the network, in the plants in question the electric pumps are always in operation. Are valves (sav) that determine where to get the water that feeds the left side of the pump. The number of the valves (sav) that are closed, and the closure time, depends on the time it takes to restore the nominal level that corresponds to the exhaust infinity share of overflow (od). As can be seen, in the hydraulic connecting circuit between the initial reservoir (wlb) and the first basin (wddr1) the valve (sav) is positioned on the exhaust pipe (od). In fact, the level of the reservoir (w ddr1) must be maintained always at maximum water level (mpl), providing the water that comes from the overflow. When lowering the (wddr1) level, closes the (sav) and opens the (sov), allowing the water supply directly by left side of the pumps through the initial basin (wlb) through the check valves (CV).

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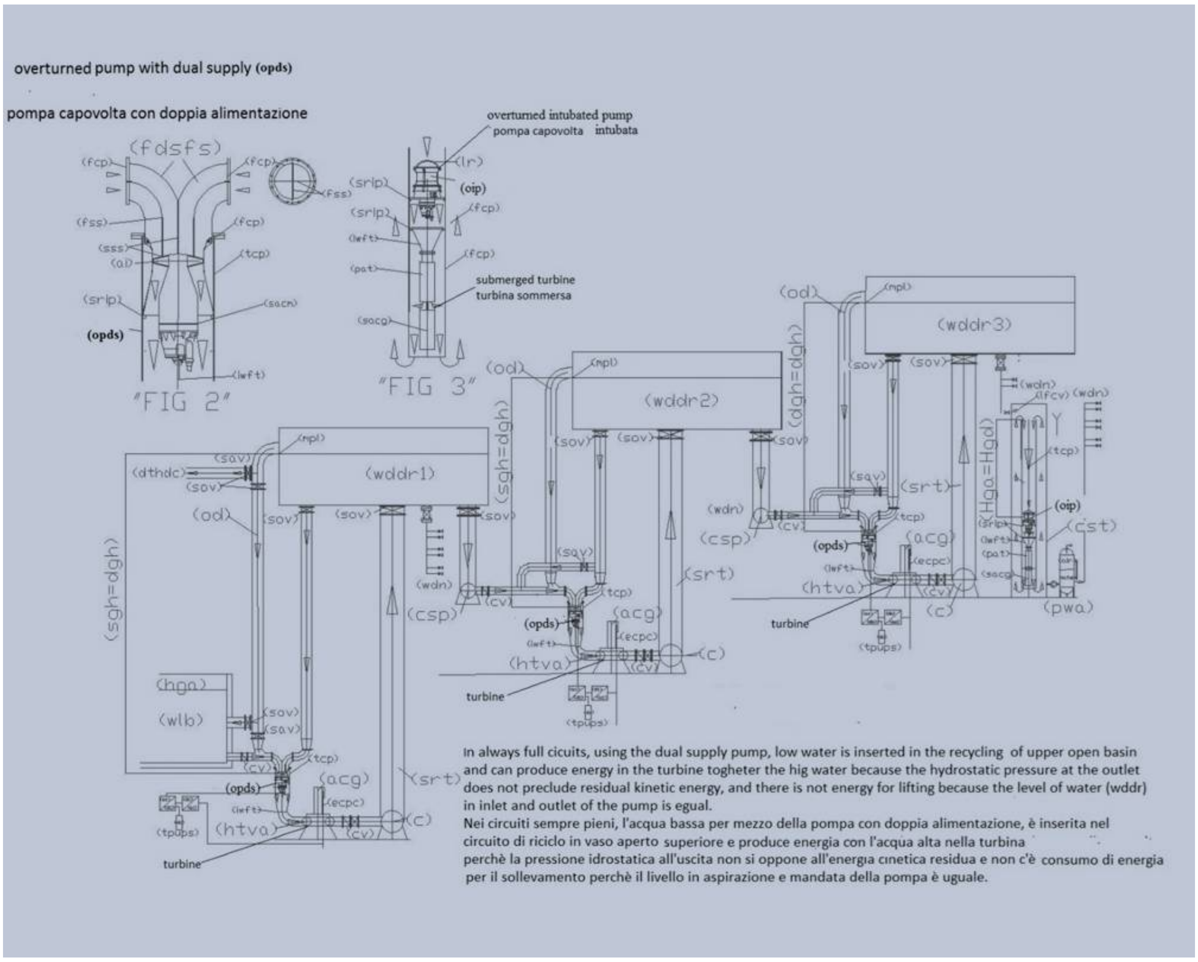
overturned pump with dual supply (opds)
pompa capovolta con doppia alimentazione
overturned intubated pump
pompa capovolta intubata
submerged turbine
turbina sommersa
"FIG 2"
"FIG 3"
(fdsfs)
(wddr1)
(wddr2)
(wddr3)
(sgh=dgh)
(dgh=dgh)
(Hga=Hgd)
(dthdc)
(hga)
(wlb)
(csp)
(srt)
(acg)
(ecpc)
(htva)
(tpups)
(cst)
(pwa)
turbine
In always full cicuits, using the dual supply pump, low water is inserted in the recycling of upper open basin and can produce energy in the turbine togheter the hig water because the hydrostatic pressure at the outlet does not preclude residual kinetic energy, and there is not energy for lifting because the level of water (wddr) in inlet and outlet of the pump is egual.
Nei circuiti sempre pieni, l'acqua bassa per mezzo della pompa con doppia alimentazione, è inserita nel circuito di riciclo in vaso aperto superiore e produce energia con l'acqua alta nella turbina perchè la pressione idrostatica all'uscita non si oppone all'energia cinetica residua e non c'è consumo di energia per il sollevamento perchè il livello in aspirazione e mandata della pompa è uguale.