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SOLUTIONS FOR RECOVERY RIVERS ENERGY WITH REDUCED HYDRO POTENTIAL

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Abstract: *The paper refers to the conversion of hydraulic energy of rivers with a reduced hydroelectric potential in the micro hydropower stations. It presents a new type of unit which has an efficiency conversion of hydraulic energy much higher and with a much improved environmental impact due to lack of accumulation dam.*

Key words: *micro hydropower, micro hydropower stations, hydraulic turbine, development, vortex.*

1. Introduction

Approximately 70% of land area is covered with water, a resource that has been exploited for several centuries. Using this energy source was characterized by a continuous technical development, is now the second most used renewable energy sources in the world.

Population growth, the joint quality of modern daily life has led to an unbearable increase in energy demand. Producing thermal energy increased of greenhouse gases in the atmosphere. Research shows that in pre-industrial period the concentration of carbon dioxide was 280 ppm and has now reached 360 ppm [2], and accelerated growth will continue unless measures are taken to halt.

This situation has generated profound changes in the balance of our planet. There are three ways to remedy the current situation: the reflection of solar radiation, energy saving, increasing yields, and use “Renewable Energy Sources" (RES).

In this respect there was an EU directive which requires increased use RES from 14 to 21% by 2010. Romania has proposed that in the same year to increase the use of RES from 28 to 33%. Hydraulic energy is quite important share in the RES and passed to an inventory of hydropower resources.

Inventory of the micro hydropower resources seeks to determine the amount of energy that can be obtained, the variation in time and its geographical location. This is made through studies on each river in part, based on physical, geographical, technical and economic dates, considering the specific of the region or country.

Further is analyzed the global and national micro hydropower development, are presented examples of micro hydro facilities, the current development of the micro hydropower station and a new micro hydropower station, proposed by the authors.

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2. Micro hydropower global and national

Currently there are concerns to recover the micro hydropower potential both in our country and at international level, where in many countries it has already been fully arranged.

Producing electricity through micro hydropower stations has a 16,6% share of the world and 92% of total renewable electricity generation [5].

There is no international consensus on the definition of hydraulic small hydropower. In China, they are the hydropower plants with up to 25 MW, in India up to 15 MW and in Sweden to 1.5 MW. However, a capacity of up to 10 MW total should become generally accepted rule by ESHA, the European Commission and IUPDE (International Union of Producers and Distributors of Electricity).

Asia (China in particular), is ready to become a leader in hydroelectric power generation. Currently developing in Australia and New Zealand are focusing on micro hydropower. Currently developing in Australia and New Zealand are focusing on micro hydropower. Canada, a country with a long tradition in the use of hydro energy, is growing the production of electricity as a substitute for expensive oil for power generation in isolated communities without electricity by the central energy system. Countries such as South America, the ex Soviet Union and Africa, also has a good potential, but unused.

The World Energy Council (WEC) advocates that the current policies, installed in micro hydropower stations will increase to 55 GW by 2010, the largest increase is in China.

In 2000, the capacity installed in micro hydropower stations in the world was about 37 GW. All regions of the world are faced with significant developments in the production of electricity through micro hydropower stations, with China in the first place.

Promoting the production of electricity from renewable energy sources (E-RES) is a priority at present motivated by environmental protection, energy independence to increase imports by diversifying energy sources. Romania was among the first EU candidate country which has brought its legislation in the directive 2001/77/EC of the European parliament and Council on the promotion of electricity produced from renewable sources (through 443/2003) and has set an indicative target for 2012 , representing 33% share of E-RES of gross domestic electricity.

In Romania, the hydropower potential of the main rivers is high (fig. 1) in fitting high power and low power (below 10 MW / hydro unit), so [3] fitting high power (34,000 GWh / year); arrangements of small power (6,000 GWh / year).

Micro hydropower potential arranged at 31.12.2005 amounts 380 micro hydropower stations with installed power of 502 MW and average power project 1153 GWh / year.

Micro hydropower stations in Romania are distributed as follows: 71% are in service, 13% are running 9% not work, 7% are sold.

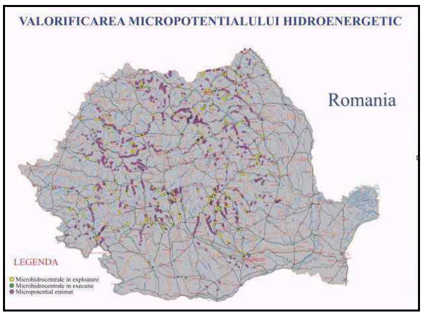

Fig. 1. *Micro hydropower potential energy distribution in our country* [3]

The 502 MW installed in micro hydropower stations are prepared as follows: 66% are installed in the MHS in use by Hydroelectric; 25% are installed in the micro hydropower stations running; 2% are installed in the micro hydropower stations that does not work, 7% are installed in privatization MHS.

3. Examples of micro hydro facilities

Micro hydropower stations may be located in high areas (mountain), where the rivers are fast, either in low areas with large rivers [3].

For large and medium fall, is using combinations of channel and pipe forced (Fig.2).

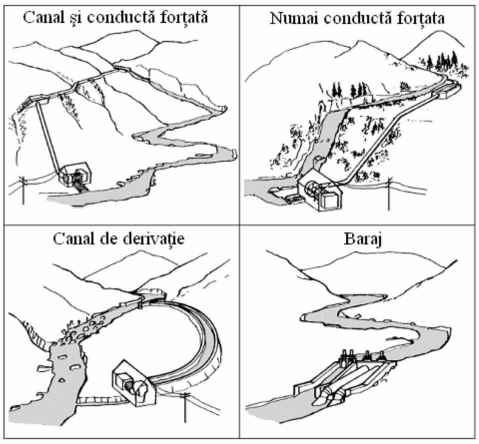

Fig. 2. *Options for placement of MHS*

In type fittings dam turbines are placed in the dam body or near it, so close that you do not have the channel or pipeline. Another option is placement the micro turbine using flow from the cleaning stations or dewatering water.

4. Development of current MHS

In a fairly radical departure from the principles that normally govern hydroelectric power generation, Austrian engineer Franz Zotlöterer [4] has constructed a low-head power plant that makes use of the kinetic energy inherent in an artificially induced vortex (fig. 3). The water's vortex energy is collected by a slow moving, a hydraulic turbine surface. This type of micro hydropower stations we proposed to develop in what follows.

Fig. 3. *Franz Zotlöterer's model of micro hydro facilities*

5. Micro hydropower stations with stepwise turbine

The micro hydropower stations [1] in Fig. 4 consists of a foundation from shore, in the form of a spiral housing (1) of reinforced concrete coupling of tangential inlet (2), which diverted a portion of the river and a room (3) training water flow in a vortex gravity. In the bottom of the chamber (3) is executed a central hole (4) leakage of water, positioned over a channel of escape (5). The MHS may contain a hydraulic turbine (6) with vertical axis, positioned at the center of the chamber (3) and connected with a cinematic power generator (7).

Spiral casing (1), into the upper chamber (3) is equipped with a device manager (8) with fixed blades (9) with adjustable tilt type Fink. Normal range of each axis (9) is jointly with a winch connected by a connecting rod at a command ring, rotated by a hydraulic servomotor (the drawings are not shown).

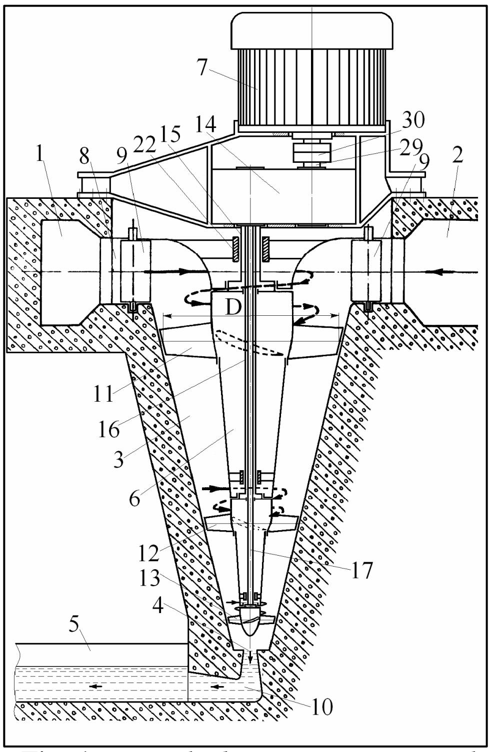

Fig. 4. *Micro hydropower stations with stepwise turbine*

The camera (3) is performed as a frustum cone positioned with the high top.

In the central hole (4) leakage of the chamber and escape channel (5) is coupled to a vacuum cleaner elbow (10).

Hydraulic turbine (6) is performed in at least two steps of speeds, for example, steps (11), (12) and (13) with characteristic diameters (D) of mobile palettes downward along the chamber (3) of the entrance to the hole (4) drain directly proportional to the decrease of cross-sectional diameter of the chamber where these are located.

Hydraulic turbine (6) is linked with cinematic electric generator (7) through a mechanism of reduction and multiplication (14) to speed steps (fig.5). Each step (11), (12) and (13) of the hydraulic turbine (6) is mounted on its own axis of rotation (15), (16) and (17). These are all telescopic and are coupled to driving gears (18), (19) and (20) question (fig.5) the mechanism of reduction and multiplication (14).

Hydraulic turbine (6), electric generator (7) and the mechanism of reduction and multiplication (14) are mounted on the metal has a strong axial camp - pallet (22).

The mechanism of reduction and multiplication (14) to speed steps (fig.5) is composed of a number of pairs of gears involved between them equal to the number of steps of the turbine (6), in our case of three pairs of wheels notched (18) - (23), (19) - (24) and (20) - (25), which, depending on the speed turbine stairs, some pairs (20) - (25) are used to reduce and others (18) - (23) and (19) - (24) for multiplying speed up to rated speed electric generator (7).

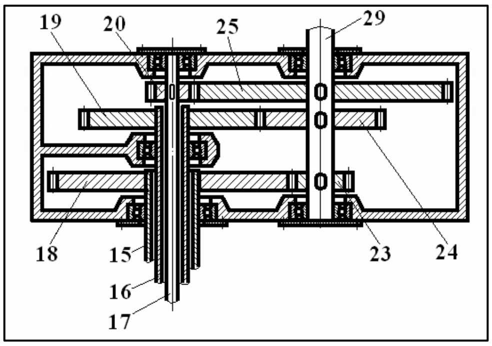

Fig. 5. *Mechanism reduction and speed multiplication steps*

It is known that the spiral flow of water through a conical channel, such as camera (3), the linear velocity of flow in a cross-sectional radius of the chamber (3) is a constant size:

$$v \cdot r = const\,. \qquad (1)$$

Given that $v = \omega \cdot r$, where ω is the angular velocity in the swirl chamber (3) with radius r , we obtain the angular velocity of the vortex gravity will increase inversely as the squareof the radius board (3), namely:

$$\omega = \frac{const}{r^2} \tag{2}$$

Therefore, steps closer to the hole (4) of the camera (3) will have greater speed than the rungs above them.

Thus, if the speed of the turbine stages (6) exceeds the rated speed of the electric generator (7), most likely step (13), the axis of rotation (17) thereof is coupled to driving wheel (20) of pairs (20) - (25) which reduces the speed to the rated speed of the electric generator (7). If the speed of the turbine stages (6) is below the rated speed electric generator (7), most likely step (11), the axis of rotation (15) thereof is coupled to driving wheel (18) of the pair (18)-(23) that multiplies the speed up to rated speed electric generator (8).

There may be cases when the speed of all steps are under rated speed of the generator (7) and then the mechanism (14) will be a multiplier in steps or a different number of steps were below the nominal speed and others across the face and then mechanism (14) will be a combined mechanism of reduction and multiplication. Concrete type of mechanism (14) is chosen depending on the number of steps of the turbine (6) and the spectrum of values of their speed.

Type of pallet used in each step (11), (12) and (13) are chosen according to its speed, calculated with the formula of similarity of hydraulic turbines (1).

At speed 40 ≤ NS ≤ 450 is used for turbine blades Francis type: slow (26) for 40 ≤ NS ≤ 150, normal (27) for 151 ≤ NS ≤ 250 or dial (28) for 251 ≤ NS ≤ 450.

At speed NS ≤ 300 ≤ 1200 are used for turbine blades screw type: slow (11) for 300 ≤ NS ≤ 600, normal (12) for 601 ≤ NS ≤ 800 or dial (13) for 801 ≤ NS ≤ 1200.

Electric generator (7) is coupled to the output axle (29) of the mechanism of reduction multiplier (14) by coupling.

The micro hydropower station described above operates as: a part of the river water is dischargedand is admitted into the tangential inlet (2) spiral casing (1) with total intake. In spiral casing (1) in the device manager (8), water source movement combined negative (removal of part of water through the central hole (4) Leak) and vortex (due to tangential admission), which leads to flow by logarithmic spirals. This will form vortex gravity. Slope fixed palettes (9) of the director (8) will be adjusted according to the energy needs to be converted. Thus, the lower angle of inclination of palettes (9) is the channel narrows between blades and decreases the flow of processed water and electrical power produced.

Due to the fact that the camera (3) has a tapered cross-sectional area decreasing from the device manager (8) to the central hole (4) leakage, power lines in the vortex of water will be gravity screw axes along the vertical (15), (16) and (17) of steps (11), (12) and (13) of the hydraulic turbine (6), coming from the vertical axis (15), (16) and (17) as the movement towards hole (4) leakage.

The water will interact with palettes stairs (26), (27) and (28) Francis type the effect or reaction with helical stairs palettes (11), (12) and (13) having a wing-bearing. Thus, the angular speed of rotation of the vortex of water will depend on the angular cross-section radius of conical chamber (3), according to relationship (2). Consequently, the speed steps (11), (12) and (13) or (26), (27) and (28) are different, namely:

$$n_{11} < n_{12} < n_{13} \text{ or } n_{26} < n_{27} < n_{28} \tag{3}$$

The mechanism of reduction and multiplication (14) reduce or multiply the values of these speeds up to rated speed of the electric generator (7). Thus, the axes of rotation speeds (15), (16) and (17) are brought to the same value of the speed of the electric generator (8),and the torsion moments of the axes (15), (16) and (17) is sum the axle (29) output mechanism (14) increasing the power generator (7), and hence efficiency of converting hydraulic energy into electricity. Hydraulic turbine in steps (6) acting in this way the mechanism of reduction and multiplication (14), which in turn, coupling (30), electric generator (7), which produces electricity.

The water, out of the drain hole (4) will be sucked into the vacuum cleaner elbow (10), which has three roles: lead the water to the escape channel (5) ensuring continuity of fluid lode; allows placing the turbine (6) above the downstream channel of escape (5), avoiding the danger of flooding the engine room, recovered most of the residual kinetic energy, energy that rises in value relative to the speed and thus increase the conversion efficiency further.

By its splayed configuration, the vacuum (10) leads to a gradual decrease in water velocity, increasing their pressure. Because the area to flee channel (5) is the atmospheric pressure, that the exit of the conical chamber (3) is void. This artificially increases difference of the pressure processed in hydraulic turbine (6) on the residual kinetic energy. This contributes to increasing efficiency, effectiveness with increasing rapidity. Since the last steps the speed is greatest, this is substantial.

After vacuum cleaner (10), the water is discharged into the channel of escape (5) and came back in the river downstream the micro hydropower station.

6. Conclusions

In terms of environmental and social impact, more efficient use of hydraulic energy is the conversion of kinetic energy of flowing water of rivers without dam's construction. In this respect, concluded that the proposed micro hydropower station meets these conditions and particularly its development.

Micro hydropower station proposed, because the processing power of water in steps yields a high conversion of the available hydraulic energy into electricity.

This presents the following advantages:

- can adjust electrical power produced;
- does not require construction of expensive dams that power station and have a negative environmental impact.

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