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# Attention to Environmental Protection of Small Hydro-power Stations

Yu Jianjun, Li Xueming

Sichuan Institute of Hydraulic Technology, Chengdu, China

**Email address:**

951300395@qq.com (Yu Jianjun)

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**Abstract:** In this paper, some problems commonly encountered in the construction and production process of small hydro-power stations in China are analyzed and explained, and the solutions are provided as well. Existing problems we have are the shortage of Eco-flow discharge, the Oil pollution in downstream river course caused by power generation production at the station, the cooling water supply of hydro-power station and the problem of eliminating pollution, electromagnetic and noise pollution of station, the resident's dispute around the power station caused by the increase and decrease of the groundwater level at the location of the station, the flood control problem of the water diversion hub, the pollution of the river channel, and the danger caused by the height of trees under the transmission line. The author, who based on many years of practical experience in hydro-power stations, and combined with relevant state policies and regulations, and puts forward practical methods and ideas to solve the problem in close connection with the actual situation of the project.

**Keywords:** Ecological Flow, River Pollution, Electromagnetic and Noise Pollution, Down Wetland, Flood Control Management, Eliminate the Danger of Transmission Lines, Sustainable Development

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## 1. Introduction

Hydro-power is a kind of renewable energy as well as a kind of clean energy. Theoretically, the production process of small hydro-power stations will not cause pollution to the environment. But if the management of small hydro-power stations is lax in the production process of station, it may have a certain impact on the river and the surrounding environment, and which will bring safety risks to the surroundings. The author, who according to the experience in design, operation and management of hydro-power stations, and summarizes the following environmental protection issues for small hydro-power stations for the reference of the peers. [1]

## 2. Existing Problems and Solutions

### 2.1. Issues of Ecological Flow

After the power station takes to generate electricity, the original river channel is dry, that causing the river channel below the water intake of the power stations to be cut off, the

water current to be turbid and the dirt to be numerous. This is a typical failure to discharge ecological flow of the river as required, resulting in the cutoff in the downstream river, or the lack of ecological flow discharge, and in this condition, the water intake below the river to form a reflux section or duo to the flow is too small, the river channel loses its "Activity" [2].

**Solution:** According to regulations, 10% of the average flow rate of the river channel is discharged as the ecological flow; The above problems can be completely solved after the river keeps flowing. The design organization should accurately determine the ecological flow data, using permanent engineering measures, such as putting permanent gears on the lower part of the gate, to keep the gate permanently open (which can be determined by the design organization), so that the corresponding discharge flow is greater than or equal to the ecological flow.

**Monitoring Measures:** A fixed network camera is installed behind the gate, align the camera with the ecological flow discharge behind the gate, and upload ecological flow discharge monitoring picture of the water intake to the designated website of the monitoring department continuously

through the network camera [3].

## 2.2. Issues of Oil Pollution at Tailrace

Theoretically, the production process of hydro-power station will not produce oil pollution, but some hydro-power stations often find oil traces, which will pollute the downstream river.

The reason for the analysis of the oil trace is that the waste oil is directly poured into the water body during the maintenance; Second, the production facilities such as oil leakage from each oil basin of the unit, or oil spillage from the oil basin caused by the breakage of the cooling water pipe in the oil basin will be discharged to the sump along the drainage channel and the oily waste water will be pumped to the polluted water body of the tail water channel by the sump pump. In another case, the oil leakage from the axial flow paddle type adjustable paddle oil receiver and wheel body. Duo to the old-fashioned propeller type paddle oil receiver and the wheel body oil leakage is large, and each power station needs to replenish 1-2 barrels of oil every month, which is "continuously" discharge into the river and seriously pollutes the water body [4].

*Solution: How To solve this system situations: First, the replaced engine oil will be recovered by using special waste oil barrels. It is forbidden to pour waste oil, wiping cloth and cotton yarn into tail water. Second, strengthen the equipment maintenance management, annual overhaul thoroughly check each oil cooling water pipe joints, governor tubing connector, replace the sealing rube pads in the sealing pipe joint. After loosening the bolts, the oil-water pipeline fastened by the threaded connection shall be wrapped with hemp thread and coated with white thick paint before tightening the bolts to make the white thick paint extrude to form a paint film to seal the threaded oil immersion channel. (The sealing effect of this method is terrific, but every time the screw is loosened, the paint film is destroyed and soaked with oil, so it must be resealed after each bolt loosening).*

It is an effective monitoring measure to check oil pollution in sump regularly. If there is oil in the sump, the oil leakage point should be identified to stop fundamentally oil, and then the sump oil should be salvaged before the the sump drain pump can discharge the clean water that has reached the discharge standard into the tail water. Check the oil-receiver circuit and runner body seal of the axial-rotating propeller unit, and gradually eliminate the old-fashioned propeller-type unit's pitching circuit oil receiver and runner body sealing method. It is recommended that a new type of automatic paddle vane regulation system [5] for high oil pressure electro-hydraulic of turbine, which completely solve the problem of oil leakage in the blade regulation circuit of the rotary paddle unit.

The power station should formulate strict production management measures to prevent oil, gas and water system pipelines and oil basins from "dripping, running, escaping, leaking" and fundamentally ensure that the hydro-power production process is "Clean".

## 2.3. Issues of Cooling Water

During the production of the hydro-power station, the heating of bearings and stator windings is carried away by cooling system. Generally, cooling water is used to take away heat through the cooler installed in each oil basin and the air cooler mounted on the stator frame of the generator, which is water cooling oil, oil cools and lubricated bearing pads. In this production process, cooling water as an intermediate medium, only takes away heat.

Generally, in the plain areas, groundwater is extracted from wells around the plant as a cooling water source, and then a water tower or a constant pressure water supply system without a tower is established for cooling.

A hydro-power station with thousands of kilowatts requires about 30~50m<sup>3</sup>/h of operation. Groundwater has the characteristics of high-quality cooling water, warm in winter and cool in summer. However long-term extraction of groundwater can lead to the reduction of ground water level and other adverse geological disasters. Most of power stations switch to direct pumping of river water for cooling water. but direct pumping of river water for cooling carries a large amount of sediment and garbage in the river water during the summer flood season, and in the mountainous winter water, it carries a large number of suspended ice particles (i.e. soaking ice) are in the river. These sediments and soaking ice seriously block the cooler, and the particulate impurities enter the cooling water pipe to block the cooling water pipe, causing serious wear to the cooler tube in the bearing to the damage of the cooler pipe and then the oil mixed water accident was triggered, and a new cooling water pollution tail water body accident was formed.

Some developed countries in Europe, no matter where your unit cooling water comes from, as long as once had water from the unit to exclude all considered contaminated water and it is not allowed to discharge to the downstream channel without treatment. In order to solve the problem that the cooling water of hydro-power station does not pump groundwater and water from river, the method of circulating water supply can be adopted. In this way, a clean water tank of about 200 ~ 300m<sup>3</sup> is built at the side of the tail pool. The water pumped from the clean water tank is connected to the cooling water header of the unit after being installed in the tail water cooler, and the cooled water is drained into the clean water tank by itself. This method is suitable for power stations that cannot pump groundwater and cannot use natural river water as cooling water, especially in cold regions and those with heavy sediment load in river channels.

However, for the old power station needs to be repaired with hundreds of cubic water pools, tail water coolers and pumps are needed, and power is also needed to pump water during operation. Economically, the high cost to the private power station is too difficult to pass through.

A few years ago, the author thought of a way out of the small hydro-power stations dose not need cooling water, which is to make a double layer in the main channel of the hydro-power station, such as the penstock near the unit side,

and inject a liquid medium similar to refrigerator cooling Freon or other liquid medium with small viscosity and large specific heat into the interlayer. during operation, a large amount of water in the main channel takes away heat to greatly reduce the temperature of the medium in the interlayer, and then introduce the medium liquid into the unit cooling system. if necessary, a small power pipeline pump will circulate the medium liquid to take away the heat of the unit bearing bush and winding, thus realizing the hydro-generator unit without cooling water and thoroughly solving the cooling water problem of the hydro-power station.

Unfortunately, the author has not been able to carry out trial production and promotion [6]

#### **2.4. Issues of Electromagnetic & Noise Pollution**

There are few domestic studies on hydro-generator units and high-low voltage power distribution devices. We believe that the hydro-generator units and high-low voltage power distribution devices must have certain electromagnetic radiation, but whether the magnitude of the electromagnetic radiation can reach the level of damage to human body is depends on the state authorities to study and publish relevant conclusions.

*Solution: However, regular manufacturers should be chosen as far as possible when ordering hydro-generator units and high-low voltage electrical equipment, so that the magnetic flux density and current density of the electrical equipment they produce are within the limits prescribed by the state, and the voltage and current waveforms and harmonics of the electrical energy produced by generators meet the requirements.*

Some irregular small factories use large magnetic flux density and current density to reduce the production cost of the unit. Generally, the unit can generate electricity, but once the unit load is slightly larger, the iron core will soon enter saturation state and the winding will also be seriously heated. On the one hand, the heating of the winding causes accelerated aging of the insulation of the unit to affect the service life of the unit; on the other hand, the deep saturation of the iron core causes serious changes in the waveform, serious asymmetry in the air gap magnetic field, a large number of higher harmonics in the electric energy, greatly increased electromagnetic radiation, and even seriously affects the operation of the unit protection monitoring system, temperature measurement system and synchronization system. The detection voltages of these systems is completely submerged by harmonics and cannot work properly. The asymmetry of air gap magnetic flux also causes serious high-frequency noise (i.e. whistle sound) in the unit, causing serious interference, which is noise pollution. To solve this problem, it is mainly necessary to rely on the host and electrical equipment manufacturers to strictly control the quality of the products, and no electromagnetic noise or noise pollution occurs as little as possible [7].

#### **2.5. Issues of Down WetLand**

Small hydro-power stations in plain areas generally get a certain water head by dam diversion at the water intake, and a certain water head is obtained by digging down more than 10 meters downstream of the powerhouse. The water level inside the channel embankment in the area above the powerhouse is about several meters higher than the surface outside the dike to form an above ground river. Due to the high water surface in the dike, the underground water level in a certain area outside the dike is high, even the surface water seepage, some farmland outside the dike forms "down wetland". The temperature of the wetland is low, crops grow slowly, and even other dryland crops can not be planted except rice, and farmers have great opinions.

*Solution: On both sides of the intake embankment, there is a 1 meter - wide and 1 meter - deep side ditch to drain the leakage water from both sides of the embankment to the downstream of the intake gate dam. If there is a large area of wetland under the embankment, several more drainage ditches can be dug vertically on both sides of the side ditch to form a drainage pipe network system and introduce leakage water into the downstream of the dam as far as possible.*

Pay attention to the water accumulated in the outer back channel of the river bank at the intake inlet channel side, and wear a concrete drainage pipe to drain below the intake gate dam at the appropriate position. In the same way, the water diversion channel side should also pass through the bottom of the water intake channel to the channel side because the channel blocks the surface water drainage channel, and the drainage culvert should be designed here according to the catchment area of the water intake channel blocking the drainage channel, and there should also be a trash rack, and people should be sent to clear the trash rack during heavy rain, otherwise the trash rack will be easily blocked in summer and the drainage in the area will not be smooth, resulting in waterlogging, flooding large areas of farmland and villages.

#### **2.6. Issues of Steel Pips Wells Do Not Work**

The underground water level in a certain area on both sides of the tailrace below the factory building was lowered due to the downward excavation of the tailrace pool and tailrace, which prevented the steel pipe wells of the surrounding people from pumping out water and caused disputes among the residents.

*Solution: By properly compensating the residents around the factory building and deepening the original steel pipe well by about 8~10m, the problem of pumping water from the steel pipe well of the people in the lower reaches of the factory building can basically be solved.*

#### **2.7. Issues of Water Intake Flood Control**

Due to the fact that the water surface above the intake is higher than the surface outside the embankment, the "river on the ground" formed has a higher water surface. Once the rains rise sharply in the river, if the water intake is not effective, it

may cause the riverbanks on both sides of the water intake to affect the safety of life and property of the surrounding people. It is a larger potential safety hazards in production of the hydro-power station.

Solutions: *Strengthen the management of the water intake of the power station, manage the personnel management system, make full use of advanced computer monitoring technology to achieve remote automatic control of the water intake gate, which can automatically and reliably lift the flood discharge sluice gate according to the water level of the water intake, and ensure the flood prevention of the water intake and the river embankment above* [8].

### 2.8. Issues of River Garbage Pollution

In order to ensure that the power generation water entering the unit does not cause jamming due to the inclusion of various floating objects, a trash rack is generally set up in front of the inlet of the water intake or pressure forebay unit to prevent floating garbage from entering the unit, and the garbage attached to the trash rack surface is removed every certain time.

The method of cleaning up can be carried out by manual cleaning or by using a cleaning machine. Due to the huge amount of dirt removed by the trash rack, it is difficult for the power station to handle the garbage. Many of power stations can only push the waste collected from the spillway back down the river channel, so the downstream power station has to carry out the garbage collection and disposal again.

Solution: *Strengthen publicity and education to persuade the people of the water intake of the power station not to push the garbage down the river; The local government should actively guide the power station to centralize the garbage disposal, and give appropriate transportation subsidies and help to set up the garbage disposal site so that the pollution of river garbage can be effectively controlled* [9].

### 2.9. Issues of Transmission Lines

The transmission lines are the power supply facility that the power station must have. The transmission line runs out of sight of the power station all the year round and is a greater danger source. Many villagers plant tall crops or bamboo trees under the power transmission line of the power station. When these crops grow high, they are easy to get close contact with the power transmission line under the effect of high winds, which will easily cause malignant electric shock accidents and short-circuit damage of the electromechanical equipment of the power station. residents of the harm of planting tall crops under the line, to publicize the regulations on the protection of electric power law and facilities, and to introduce the corresponding regulations for the protection of power supply facilities, and to clarify the methods of reward and punishment; power stations should regularly inspect the lines, pay special attention to inspections after thunderstorms. Early detection of broken

transmission lines, porcelain bottle rupture, tower tilt and tall crops touch lines and other safety hazards,. Cleaning up the power transmission channel, to ensuring that no vicious safety accidents such as falling poles, broken lines, tall crops contact lines, etc.

Solutions: *To strengthen publicity and inform the surrounding*

## 3. The Small Hydropower Station Should Be Carried out Urgently at Present

At present, environmental monitoring work is being stepped up all over the country, and small hydropower stations should fully cooperate with the work of environmental protection declaration, water resources and water access permit verification, and complete the relevant approval procedures of power stations. Each hydropower station should manage a section of river where each power station is located, pay close attention to river ecological restoration and flood control, and contribute to sustainable development!

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## Biography



**Yu Jianjun** for army, male, sichuan water conservancy vocational and technical college senior engineers, college of electrical engineering teacher, retired former sichuan water conservancy vocational college receives power plant factory director, for teaching and scientific research in sichuan college of water conservancy engineering since retirement survey and design institute of mechanical and electrical engineer, institute of technology of profession of sichuan water kam hin general engineering supervision co., LTD.



**Li Xueming** (born 1972) is a teacher, associate professor, senior engineer, and dean of the department of resources and environmental engineering, sichuan polytechnic.