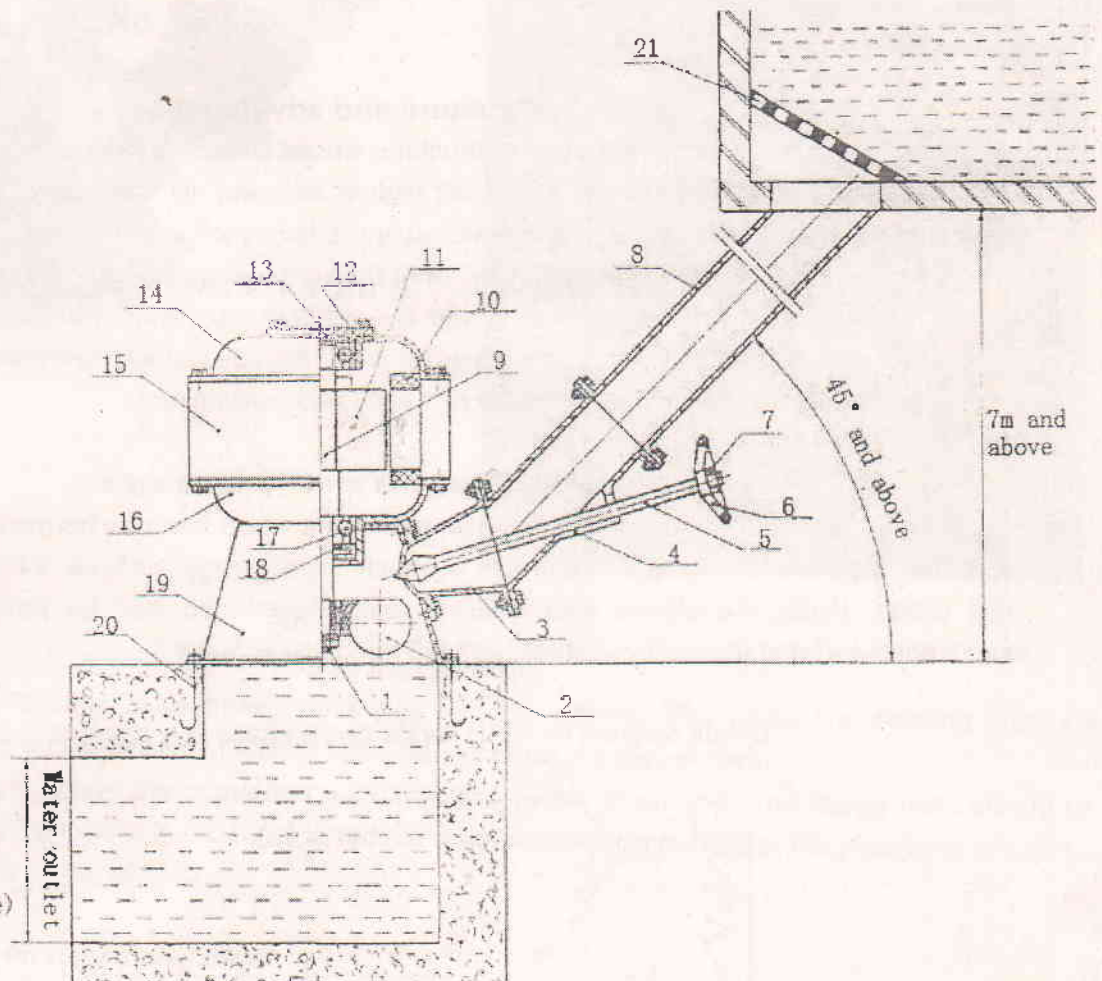


Installation Instructions

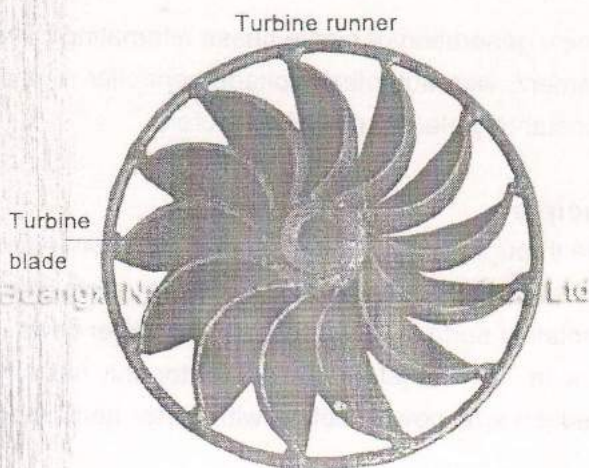
Our Inclined-jet hydro turbine generator unit (HC-SO3) is a new generation of single phase alternating current (AC) generator, which is suitable for hot and humid environment, with automatic voltage controller regulator (A.V.R.). It applies to inland waterways, household lighting or standby electric power for motors.

Working Principle

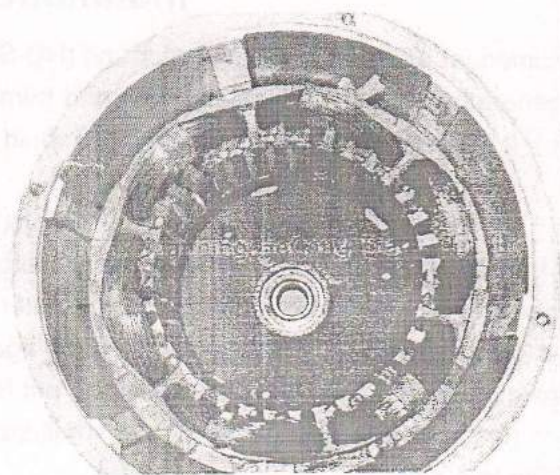
Water from the pressure forebay flows into the turbine nozzle through pipe. Its potential energy is converted to kinetic energy by the nozzle. The high speed water jet comes out from the nozzle strikes at the buckets (blades) at a certain angle (not in a tangential direction) against the rotating surface of the runner. The water flows into the buckets (blades) from one side and flows out from other side. Inclined-jet turbine generator only has single buckets (blades). It is applicable for the small-size and medium-size power station with water head ranges from 20m to 400m.



- | | | |
|-----------------------------|------------------------------------|-------------------------------|
| 1. Runner nuts | 8. Water diversion pipe/steel pipe | 15. Generator case |
| 2. Runner | 9. Main bearing | 16. Bottom cover of generator |
| 3. Spray nozzle | 10. Stator line group | 17. Bearing |
| 4. Nozzle connection joints | 11. Rotor | 18. Water lock/Water seal |
| 5. Needle valve | 12. Bearing cover | 19. Frame |
| 6. Hand wheel | 13. Bearing | 20. Anchor screw |
| 7. Nuts | 14. Top cover of generator | 21. Pressure forebay |



Buckets (Blades)



Generator stator coil

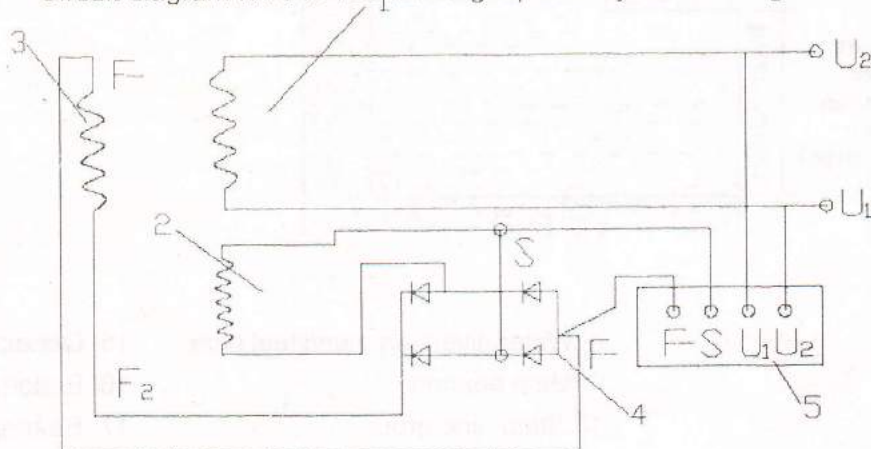
Structure and advantages

Our generators are in protected horizontal structure, whose protection degree is IP22, with rotating magnetic field and steerable excitation. Small in size but high in accuracy. Its frame and cover are all casted by iron, strong and durable. The iron coil of generator stator is laminated with 0.5mm thickness high-quality silicon-steel sheets. The pole coil is laminated by 1mm thickness electric steel. Conductor wire is made of high strength enameled wire with insulation grade B, and has went through special treatment of anti-mold, anti-moisture and anti-salt, etc. All of the materials are of high quality with low mammalian toxicity. The whole set is simple in structure, strong and durable and easy to be maintained.

Specifications and Performance

HC-SO3 belongs to ST-H series single-phase generators which are also harmonious wave excitation brush synchronous generators. Its adjustment rate of steady-state voltage is $\pm 1.5\%$. 240V rated voltage, 1500 r/min rated speed. (Note: Generators with different rotary speed can also be provided according to clients' requirements.). Rated frequency is 50HZ, with 0.6 rated power factor.

Circuit diagram for ST-H series single-phase synchronous generator



1. Main stator winding
2. Trio-time harmonic secondary winding
3. Excitation windings

4. Rectifying circuit bridge
5. Automatic voltage controller/regulator (A.V.R)

After the pier is completely solid, maybe a week later, place the unit and tighten the anchor nuts (follow the order of diagonal line) and fix the unit with wood or steel cross arms. Then pour concrete again to connect closely the unit and turbine pier. Any gap between them must be sealed with concrete, and water leakage is definitely not allowed. A leveling instrument should be used to measure levelness when install the unit to make sure it's fixed in a horizontal position. After the unit has been installed, check again and rotate the runner shaft of the turbine by hand. If it rotates flexibly, the installation is completed.



Pipe Installation

Water from pressure forebay flows through the pipe into the turbine. The pipes are installed after the downstream of forebay and upstream of turbine valve as a connector between them.

Steel pipes welded with flange are commonly used in micro hydro power unit. The flange pads should be placed in the up-straight position, in order not to reduce water cross-section. Nuts of the pipe joints should be tightened gradually in a diagonal order.

Basic Requirements on Pipe Installation

Buy pipes according to the required diameter by the unit. Smaller diameter than the required diameters is definitely not allowed! They should be straight and avoid any crooked part. The angle between pipe and horizontal level of ground should not be less than 25° . If not, the pipes will be longer and the water head will be decreased, which will lead to inadequate power output. It is better to use a horn-type mouth pipe as the water inlet pipe which is installed in the wall of reservoir or forebay. The distance from the lower edge of horn-type mouth to the bottom level of reservoir or forebay should be larger than 0.2 meters. The Inner diameter of expansion joints should be the same as pipe diameter. But too many joints will cause loss in water head.

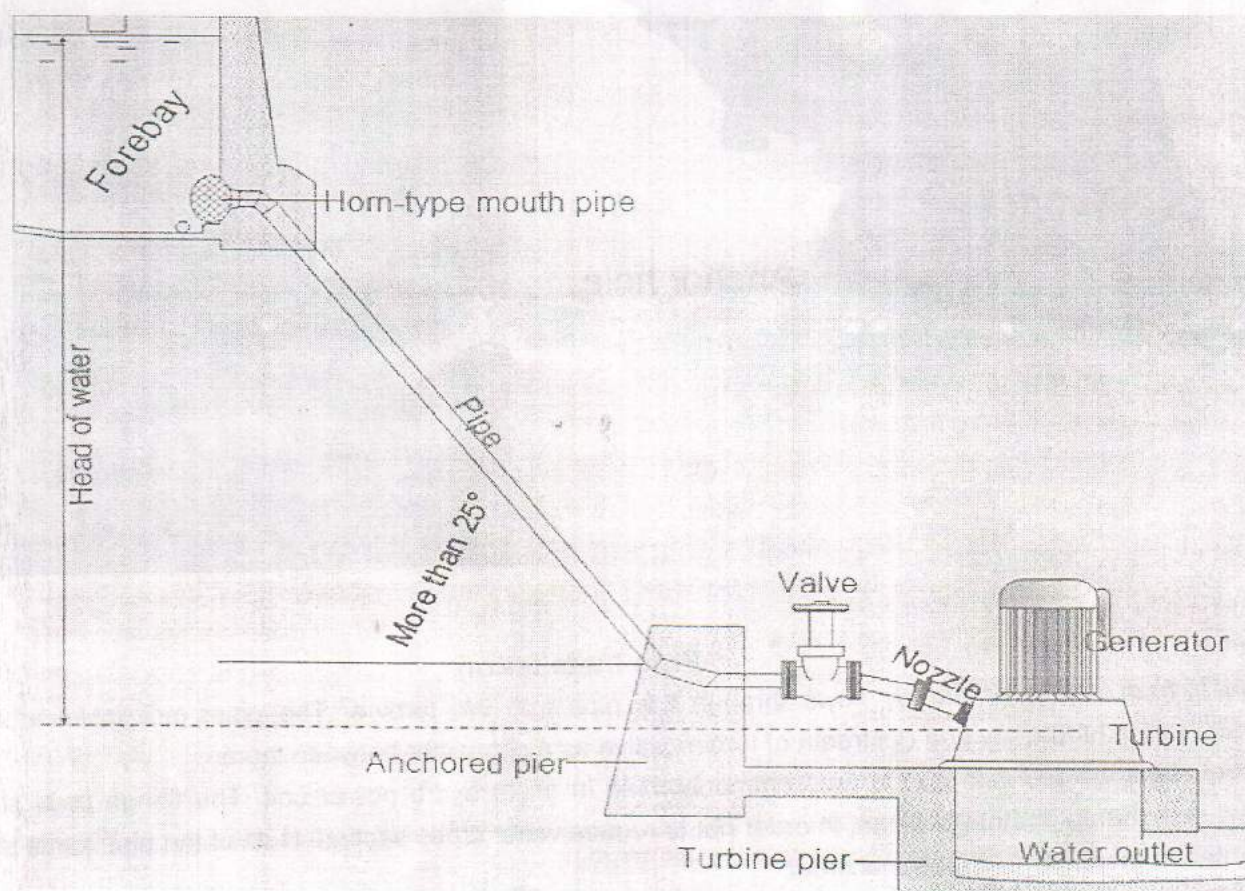
✓ Anchoed pier: Pressure is the highest in the joints of water inlet pipe and turbine nozzle, so anchored piers made by stones or concrete are needed to be built to fix the metal pipe.

Supporting pier: Due to the weight of steel pipe itself and water, and pipes are long, they are easy to bend or

After the generator is spun, depending on the stator residual magnetism, after the trio-time harmonic secondary winding senses the residual magnetism voltage, circuit is rectified through the single-phase rectifying circuit bridge into direct current (DC) to provide excitation current to the exciting winding through brush slip ring, which finally establishes the main rotor magnetic field. When the generator's rotary speed reaches at a certain value, no-load voltage is established.

When trio-time harmonic wave excitation generator is running on load, it has self-excited function to keep generator terminal voltage at a constant value. Furthermore, generator with automatic voltage controller/regulator which adjusts the excitation current will lead to more accurate generator voltage output. At the same time, the automatic voltage controller/regulator can also replace the regulating resistance to stabilize the voltage.

Unit Installation Instruction



Installation Requirements

There should be no space between turbine base and turbine pier. Any water splashing or water leakage is definitely not allowed in their connection surface.

Installation Procedure

1. Based on the rated head and water flow required by the unit, choose a good and ideal installation location. Inspect the whole turbine generator unit before installation, and check whether the size of tailrace (water outlet) and reserved holes for unit footing fulfill the designed requirements. If not, it should be amended before installation.
2. Then, use concrete to pour turbine pier. When making the pier, the water outlet should be 3 times larger than the water inlet. Reserve places on the pier for anchor bolts according to the size and situation of anchor holes on the turbine. After these, put the anchor bolts into the reserved holes for unit footing, then pour with concrete.

operation should be flexible. For unit with electric control device, its wirings of the electric control device should be firmly and correctly.

Open the valve slowly to allow water flows into the turbine. Water pushes the runner to rotate, and voltage of the generator will slowly rise to the rated level (Note: The valve must be open to maximum position). If maximum power output is 20 percent larger than units' rated power output, water flow should be turned down to change the maximum power output to 105% of the unit's rated power, in order to prevent the unit works in overload condition for a long time. If power output is less than rated output, you should check whether the water inlet is submerged deeply enough in the forebay, whether there's air screwing in the inlet, whether the pipe or channel is blocked, whether there is jam and friction in unit's operation and so on. Try the unit again after checking all the problems above.

Stop Operation

First, discharge all electric loads, first shut the valve, and then turn off the switch.

Attentions When Operating

Inspection Before Operation

When using a 500V megger to test the insulation resistance between stator winding/rotor winding and ground, or inter-insulation resistance between stator winding and rotor winding. It shall not be less than 2 MΩ at normal temperature, and shall not be less than 0.5 MΩ at hot conditions. If it is low than these value, the motor windings should be processed with insulation drying treatment until the insulation resistance reaches required standard.

The output cables (phase line) should be connected with column U1 and U2 in the connection box of the generator. But please pay attention that output cables should have adequate section to ensure safe electricity transmission.

The anchor bolts in the generator frame should be effectively connected to the ground. The grounding wire should have enough conduction section and should be effectively connected with metal objects, which ensure the safety of people when the electric leakage occurs.

No-load operation

When the rotary speed of generator is 70% higher than rated value, that is to say, no-load voltage frequencies is among the rated value 51.5 ~ 52.5 Hz while voltage is at its rated level, the unit is on No-load operation. (Note: The generator voltage setting range is generally $\pm 5\%$ of the rated value, and it has been adjusted at the rated value by the manufacturer when the generator is sold.)

When the power factor is 0.8 on full-load, the voltage is around the rated value, and adjustment rate of stabilized voltage is $\pm 1.5\%$.

On-load Operation

After the voltage in electric supply circuit and generator is at rated value, switch on the load switch, the electricity will be supplied from the generators to the load.

When the generator is on load operation, the value of generator current and excitation current shall not exceed the rated value marked on the name plate, or else to avoid the unstable voltage or heat caused by overloading single phase, or even burn out of the generator.

Maintenance and Overhaul

When the generator is not in use, it shall be kept at a dry place. It shall be placed on mud or cement court. It should be blocked to avoid rain water. It should be covered with a cloth, to avoid any moisture or damage.

become deformed, so supporting piers must be added in their middle parts. The best installation place is the joints between steel pipes.

Inspection after Pipe Installation

1. Whether there's water leakage in the pipes or joints. If any, find out the reason and process it immediately.
2. Litters left while installation should be cleaned up to make sure water is unblocked.
3. Whether the pipes will become bended or deformed and whether they are firm enough after they bear the water pressure. If any problems, it should be dealt with in time.

Valve Installation

Making a sluice door (namely the gate) in the water diversion channel with wood or cement. Close the valve when the unit is out of operation.

The valve should be installed on the pipe end which near the unit, 1 meter away from the nozzle or directly on the nozzle, according to specific situations. The valve size should be consistent with pipe size. It can be gate valve or ball valve, but definitely not globe valve (stop valve) which will reduce the water cross-section and affect the output of turbine.

Two points should be paid attention to when install valve:

1. The center line of runner shaft of turbine and tailrace (water outlet) must keep in the same perpendicular line.
2. The flange pads should be placed in an upright position. Screw bolts should be connected firmly to reduce loss in water head and prevent water leakage.

Machine Room

The Machine room for micro turbine units can be like civic building. But it should guarantees ventilation, no water leakage or seepage. Its area depends on the size of unit. The distance between unit and wall shall be not less than 0.8 meters, which will be convenient for installation, maintaining and operation.

Debugging

Before the unit's trial run, inspection is very important. The inspection aspects include quality of installation, the unit and electric system, etc.

Installation Quality Inspection

1. There should be no water leakage in channel and pipes. No litter blocks the water inlet. The valve can be operated flexibly.
2. Water level of forebay should be kept at the designed water level.
3. Tailrace should be covered tightly.

Unit and Electrical System Inspection

1. Whether the connection of the brush and slip ring in the generator control box is good enough.
2. All connection fittings are tightened.
3. Rotation of runner shaft should be flexible without swaying and abnormal sound. Each running parts should have enough lubricants.
4. Wiring for electrical appliances is reliable. The total electric load (such as home appliances) shall not exceed the generator's rated power output. Unit with voltage regulators or equipped with mechanical regulator device can temporarily work without load, but wiring for voltage regulators should be firm enough or mechanical regulator device should be sensitive enough.

Trial Operation

Inspect the switch position of all appliances before operation. For unit with mechanical control device, its

operation should be flexible. For unit with electric control device, its wirings of the electric control device should be firmly and correctly.

Open the valve slowly to allow water flows into the turbine. Water pushes the runner to rotate, and voltage of the generator will slowly rise to the rated level (Note: The valve must be open to maximum position). If maximum power output is 20 percent larger than units' rated power output, water flow should be turned down to change the maximum power output to 105% of the unit's rated power, in order to prevent the unit works in overload condition for a long time. If power output is less than rated output, you should check whether the water inlet is submerged deeply enough in the forebay, whether there's air screwing in the inlet, whether the pipe or channel is blocked, whether there is jam and friction in unit's operation and so on. Try the unit again after checking all the problems above.

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When using a 500V megger to test the insulation resistance between stator winding/rotor winding and ground, or inter-insulation resistance between stator winding and rotor winding. It shall not be less than 2 MΩ at normal temperature, and shall not be less than 0.5 MΩ at hot conditions. If it is low than these value, the motor windings should be processed with insulation drying treatment until the insulation resistance reaches required standard.

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When the rotary speed of generator is 70% higher than rated value, that is to say, no-load voltage frequencies is among the rated value 51.5 ~ 52.5 Hz while voltage is at its rated level, the unit is on No-load operation. (Note: The generator voltage setting range is generally $\pm 5\%$ of the rated value, and it has been adjusted at the rated value by the manufacturer when the generator is sold.)

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On-load Operation

After the voltage in electric supply circuit and generator is at rated value, switch on the load switch, the electricity will be supplied from the generators to the load.

When the generator is on load operation, the value of generator current and excitation current shall not exceed the rated value marked on the name plate, so as to avoid the unbalance voltage or heat caused by overloading, single phase, or even burn out of the generator.

Maintenance and Overhaul

When the generator is not in use, it should be kept at a dry place. If it is placed on mud or cement ground, it should be blocked with wooden blocks to prevent it from being damaged by any moisture.

2. Avoid any invasion of dirt, water, metal scraps or other objects into the generator.
3. Do not cover clothes or other things on the generator when it is operating, in case of any block in heat dispersion.
4. Avoid any overload.
5. If there's spark on slip ring or abnormal noise when generator is operating, it should be adjusted immediately.

Overhaul

The unit should be overhauled once half a year.

1. Open the cover plate. If there's dust inside the generator, it should be cleared. It's strongly suggested that compressed air is used to blow off the dust. Pressure for compressed air should be no more than 4×10^4 Pa. Clean the surface of slip ring. First, use coarse cloth (not thrum or cotton fabrics) dipped with a few drops of kerosene to wipe the surface, and then use other dry coarse cloth to dry it up.
2. Open the bearing cover to check if the lubrication grease is clean, if the color is uneven, which means the lubrication grease should be replaced.
3. Check the friction condition of brush, and adjust the pressure of brush spring. If the brush is over-worn, it should be replaced.

Notes When Maintaining

1. When removing connection line, they should be well marked. They should be reinstalled to the original places. Any wrong installation is prohibited.
2. When opening the bearing cover, the bearing and bearing cover should be well covered by clean coarse cloth in case of dust invasion.
3. The brush should be installed at the right place, and make sure it is perfectly connected with slip ring.
4. After the turbine generator unit installation is completed, rotate the runner slightly by hand to check whether the rotation is flexible.

Maintenance on Turbine

1. All fasteners of the turbine should be always tightened and fixed, and all rotating components can run flexibly.
2. After the turbine has been operating for 50 to 100 hours, the rolling bearing should be lubricated with #2 or #3 sodium (calcium) grease (Note: Different types of lubrication grease should not be mixed and used together in case metamorphism).

After 300 to 500 hours' operation, new grease should be added into the bearing cup. Its amount is better to be $\frac{2}{3}$ of the total volume of bearing chamber. If the gap among bearings is too big or pockmarks appear, new components should be replaced.

The grease should be replaced after the bearing has been working for 1500 hours. The old grease should be replaced with new grease at least once a year. The amount of new grease is about half volume of the bearing box.

After for 2500 to 3000 hours' operation, check the coupler and replace the vulnerable components such as rubber gasket, belt, etc. and also repaint the rust components.

3. Check regularly the reliability of water seal cage and water fender. A big overhaul should be done after the unit has been operating for 2-3 years. During the big overhaul procedure, check the runner welding situation and replace the bearing, coupler and rubber gasket.

Maintenance on Electricity Transmission Line

Failure during using, and voltage decreases or voltage is not stable. The second one is abnormal situations when machine is operating. For example, over-heat of generator or abnormal noise of turbine. Once the malfunction is found, close the switch or valve immediately, and stop the turbine generator to inspect. During the inspection, the faults should be cleared by following the order listed below. Only after the faults have been all cleared, the generator can be restarted.

Failure on Electricity Production of Generator

Description: After the valve or sluice gate is open, the generator does not generate electricity, the electrical appliances cannot work (For example, light bulb cannot be lit up).

Processing methods

1. Check whether the diversion channel and diversion switch is blocked. This can be observed by checking the water condition in the water outlet. If the outlet water quantity is less than that when unit is normally operating, they must have been blocked. If the obstruction cannot be removed, the flange plate which connect the turbine generator unit to the pipes or other connections should be dismantled, and then remove the obstruction from the pipes.
2. Ask electrician to check whether there is short-circuit or breakage in the electric equipments and wiring.
3. Check whether there is short-circuit or burnt out in the generator windings. If it is burnt out, replace with new coil.
4. If the generator is capacitance excitation induction generator, maybe the residual magnetism has disappeared or the capacitance has been penetrated. Connect a #1 dry battery in series to any winding and clash the magnetism for a few seconds. If the generator still cannot generate electricity, the electricity capacitor should be replaced.

Power Failure during Using

Description: Sudden power losing happens during using the electrical appliances. Those appliances cannot be used.

Processing methods

1. This malfunction may be caused by short-circuit in the electrical appliance or power transmission line, which results in the burning out of the fuse. If so, replace the fuse with new one.
2. For turbine generator unit with air switch, maybe the switch is tripped because of short-circuit caused by overload. Check the lines or turn off some electrical appliances.
3. Check whether there is blockage in the trash rack, water pipes or valves etc.
4. Check whether the wiring of electrical devices and lines are well connected.
5. Check whether the generator windings are in open circuit or have burned out, if it is burned out, the coil should be replaced with new one.

Voltage Decreasing

Description: The voltage is obviously low when using the electricity appliances.

Processing methods

1. Maybe the unit is working overload. Check whether the load is more than rated value which is indicated on the nameplate. During the inspection, turn off some electrical appliances. If the voltage rises, it means that the unit is working overload.
2. Check whether there are litters in the water inlet. Litters will block part of the water flow and affect the turbine's power output, which will lead to low voltage.
3. For turbine generator unit with belt driving device, check whether the belt is over loose. If so, the belt is easy to slip, which lead to the power shortage and voltage decreasing.

1. The maintenance of electricity transmission line should be carried out according to operation situation as well as different seasons. On thunderstorm season, the thunderstorm has great effects on electrical insulation, therefore, preventive tests should be carried out on electric devices in advance. Take lightning protection measures, eliminate any faulty line insulation, and replace defective components. For porcelain bottle with lightning flashover, it should be fixed.
2. On flood and typhoon season, it will easily cause falling down of poles, breaking on lines and washing out to the pole base. Therefore, the pole base should be reinforced, replace the rotten poles, tighten each parts of screw bolts and tighten or replace the binding wire and stay wire.
3. On frost season, the conduction wire is under great pressure and will easily break down. According to the damage condition, new conduction wire of same type should be used to strengthen the old conductor wire.
4. On dry season, it's very easy for the porcelain bottles to have dust and dirt inside, and wood poles and components become loose. They should be tighten and clean in time.
5. Except carrying out appropriate maintenance on different seasons, it's also necessary to regularly check whether the poles are crooked, whether the folder of porcelain bottles drop down, whether the lowest falling point of conductor wire is less than 5 meters, whether switches on the conductor wire are crossed, whether there is objects hanging on the conductor wire (such as clothes), whether the wiring is firm, whether the connection surface between knife switch and switch base is deformed or burnt, etc.

Maintenance on Water Conservancy Facilities

1. People who are in charge of the unit management should be familiar with the cross-section dimensions of diversion channel, the longitudinal gradient and the water flow capacity through each section of channel, and should protect the plants around the channel and make sure water can flow smoothly.
2. Check regularly whether the channel leaks, sinks, slips or is in other conditions. Generally, the remedial measure for these problems is called Replacing Soil. That is, to dig a larger water cross-section, replace the soil with clay (20-30 cm thickness) and compact it. Another remedial measure is called Surface Protection Method, which lines the surface of water cross-section with pebble, stone, slab stone or lime.
3. Remove the mud, stones, and weeds in the channel timely and reduce the water resistance. In addition, if the longitudinal gradient difference becomes smaller, it will lead to deposition in the channel. Therefore, the channel gradient should be kept at the original designed level.
4. Periodically clear the desiltings and floaters at the end of diversion channel to prevent them flow into the forebay.
5. Before and after heavy rain, rainstorm or mountain torrents, the desilting should be clean in time.

Maintenance on Pressure Forebay

1. Check regularly the water level condition in the forebay to make sure the lowest water level is 0.6 meters higher or above than the top position of pipe inlet. The distance from the highest water level to the top of forebay should be kept at 0.3 meters.
2. The deposit in the bottom of forebay should be removed regularly. The sand should be regularly flushed out and clean up promptly after heavy rain or flood.
3. Clear trash or rank grass on the trash rack every day, check whether the rack is intact, and repair the damaged parts or replace the trash rack with new one.
4. Check whether there's leakage on the walls, base and other parts of the forebay.

Processing Methods for Common Malfunctions for Turbine Generators Unit

There are two common malfunctions for micro hydro power turbine generator. The first one is that, abnormal situations when users are using the electricity. For example, the generator doesn't produce electricity, power

Unstable Voltage

Description: The voltage fluctuated when using electric appliances. For example, the light bulb is flickering.

Processing methods

1. Check whether there are high power electric appliances are being use.
2. For turbine generator with mechanical voltage regulators, maybe the controlled device have been stuck.
3. For open-flume turbine generator unit, the water spark too much in the cement scroll case.

Over-heat of Turbine Generator Unit

Description: When the turbine generator unit is operating, its shell is too hot to touch by hands, and hands can hardly stay on it for just a few seconds.

Processing methods

1. Inadequate ventilation. Check whether there are objects covered on the unit. Covering any object on the unit when operating is definitely prohibited.
2. Overload work. Some appliances should be turned off.

Abnormal Noise of Turbine

Description: When the turbine is operating, there is significantly different sound from the turbine. Check whether the running parts are rubbed together. If the bearing is loose, it should be replaced with new one. And check whether there are other objects inside the turbine.

Processing methods

1. Inadequate electricity output. According to the required water head, check whether the flow reaches the required level. If not, raise the water head or widen the water pipes to increase water flow.
2. When the water head and water flow are in the required level, if the generator's rotary speed is not quick enough, the spray nozzles' angle and height can be adjusted to enable the jet-flow comes out from the nozzles can strike at the most proper position of the runner, which can increase the rotary speed.

Malfunctions on Generator and Processing Methods

| Malfunctions | Reasons | Processing Methods |
|---------------------|--|--|
| Electricity Failure | The residual magnetism has disappeared. | Using 3-12V DC to charge the silicon rectifier pole and connect "F+" with "F-". |
| | Silicon tube has been damaged. | Using a multi-meters to check the reverse resistance, and changing the damaged components. |
| | Electric brush is stuck in the brush box. | Check whether the brush box has rotten. If so, use #00 sand papers to clear the inside part of the brush box and empty some space for brush working. |
| | The electric brush is not well connected with the slip ring. | Using #00 sand paper to clear the slip ring and make it shiny with no dirt. |
| | Rotary speed is too low. | Adjusting the rotary speed around the rated value. |
| Inadequate Voltage | The harmonic windings and excitation windings are broken. | Using multi-meter to check, and connect the breaking point correctly. |

| | | |
|------------------------|--|---|
| | There is short-circuit or open-circuit of a rectifier components in the rectifier bridge. | The unload voltage has reduce 20% or more than the rated level. Using multi-meter to check, and replace the components with new one. |
| | Rotary speed is too low. | Adjusting the speed to the rated value. |
| Over high Voltage | Rotary speed is too high. | Adjusting the rotary speed to not higher than 5% of rated speed. |
| | The fuse of A.V.C. is burn out. | Replacing the fuse. |
| | The wiring of A.V.R. is wrong and cannot adjust voltage automatically. | 1. The terminal U. and V. A.V.R. should be connected in parallel with terminal U. and V. of the generator armature line group. 2. A.V.R. terminal S should be connected in parallel with S pole (AC side) of secondary harmonic windings. 3. A.V.R. terminal F should be connected in parallel with the negative pole (—) of output terminal of the circuit rectifier.(see the circuit diagram of single-phase or three phase above) |
| | A.V.R.is damaged. | Replacing the A.V.R. |
| Over-heat of Generator | Overload operation | Long-time overload operation is not allowed. |
| | High ambient temperature. | When the ambient temperature is higher than 50°C, Change the ambient or reduce the load. |
| | Inadequate ventilation | Changing the ventilation condition. |
| | Power factor of load is too low. | When the load power factor is too low, reduce the generator's KVA outputs, and the generator should be operated within the scope of excitation rated current. |
| | Inclined blades for some generators which rotate in opposite direction will reduce air quantity. | Check the blades and operate the generator in the specified direction. |
| Over-heat of Bearings | The bearing wear is worn. | Replace bearing. |
| | The specification of lubrication grease is not the required one. | Cleaning with grease, and add #2 industrial sodium base grease with half volume of the total bearing bore. |
| | The transmission belt is too tight. | Loose the belt a little. |
| | Wrong installation | Re-adjusting and reinstall |

Warranty

Since the purchasing date of our products, if there's any quality problem occurs, and this problem is not artificial and not caused by incorrect use, we will provide free repairing service and only require cost on raw materials and postage. Our factory warranty period is one year.