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Test run of an EXMORK Turgo Turbine 500W at KWK hydro laboratory

Technical turbine datas:

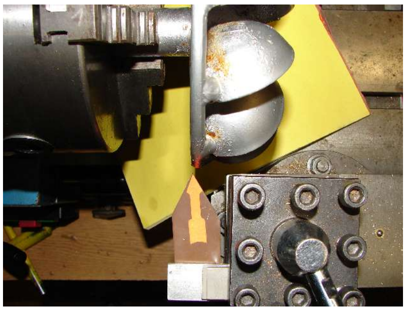
Manufacturer:	**EXMORK New Energy Company, China**
Type:	CJ-500W
Water head:	12 – 18m
Water flow:	5 – 7 l/s
Nominal power:	500 Watt
Power output:	230V / 50 Hz / 1-phase
ELC:	voltage dependent load controller with watercooled resistor
Turbine:	single jet Turgo turbine; Runner ∅120mm; fixed nozzle
Generator:	single phase, permanent magnet synchronious, 4-pole, aircooled;
Control box:	mounted on the generator with voltage gauge, main switch, warning light, ELC and socket
Pressure hose connection:	pipe thread 1 ½ “

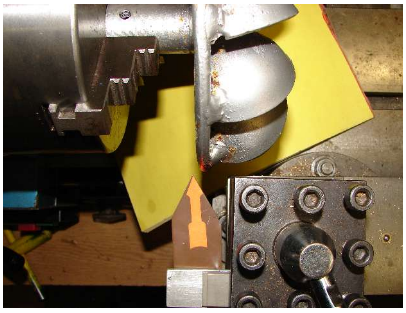
Included parts:

- Ready to use System with turbine, generator and ELC
- Connector for the socket in the control box
- 1 ½“ Ball valve
- 1 ½“ adaptor for ∅75mm pressure hose, hose clamp

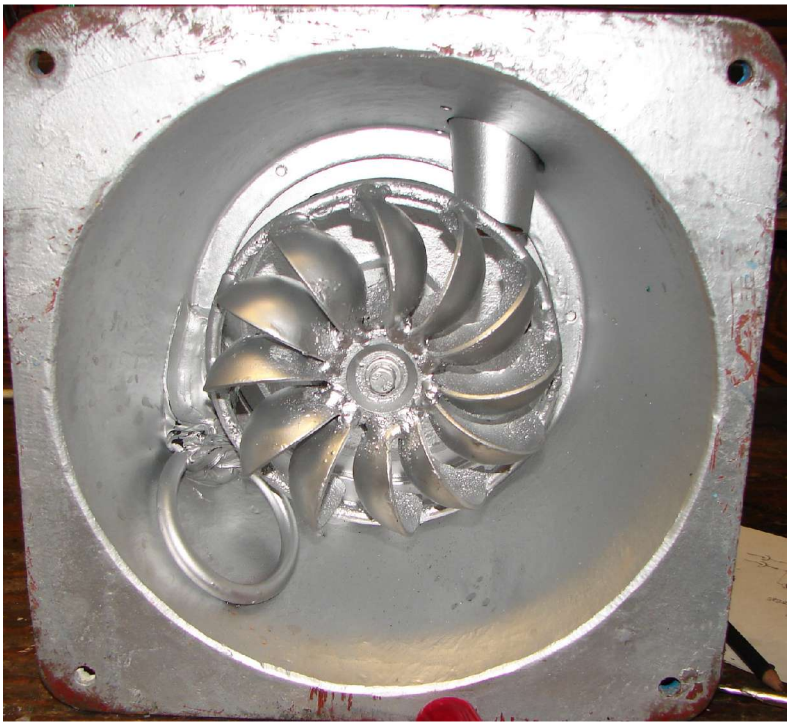
The turbine technology:

A distinctive feature of the turbine is the Turgo runner. The runner (120mm diameter) is welded from 12 sheet metal buckets onto a hub. On the outer diameter, a metal ring is welded on the buckets for stabilisation. The runner is manufactured a little bit inexact and turns non-circular.



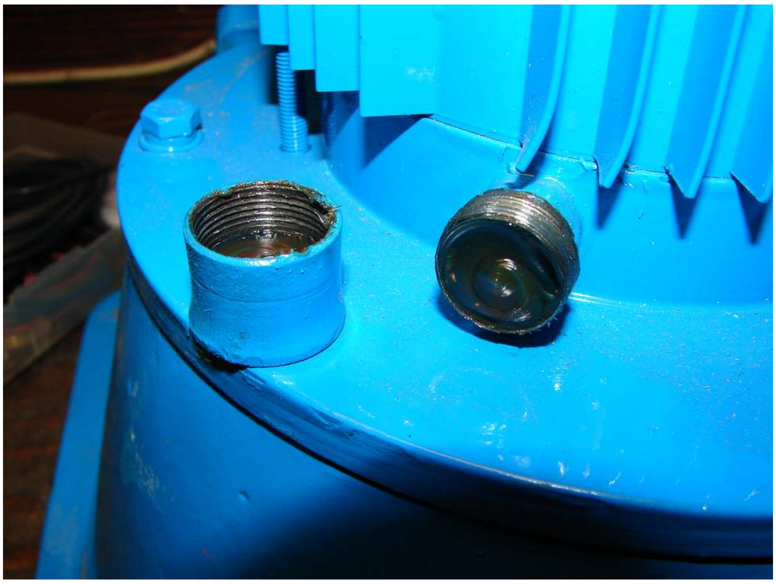


The included fixed nozzle has a diameter of 24mm. The water jet hits the runner in a flat angle of about 15 – 20°. A short look into the opened nozzle shows, that the water jet will hit mostly three buckets at the same time. A short test with pressure water results a quite smooth running without vibrations.



Greasing device:

A very interessing detail on this unit is the greasing device. Just fill up the “Grease Cap” with fresh grease and than you can press the grease into the bearing by screwing the cap onto it´s nipple. This is a very easy but effective way to grease the lower bearing without grease gun and without dismantling the unit.

Generator:

The direct drive, permanent magnet synchronious generator completes the turbine housing on it´s upper side. The lower generator bearing shield is directly connected on the turbine housing. Due to this design, a mass of the produced heat by the generator can be dissipate to the splash water in the turbine. To avoid water in the lower bearing, a shaft seal is mounted between bearing and turbine.

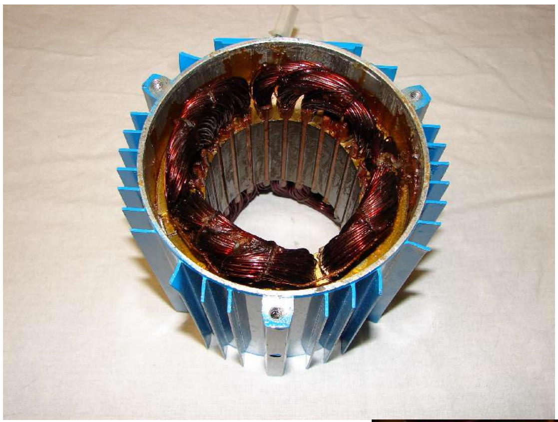
The stator body is made from a aluminum-alloy. The precise casted, thin cooling fins can dissipate the heat to the air. The dimensions of the generator body depends on the international IEC norms.

The upper bearing shield of the generator is made of cast iron. It picks up the upper bearing of the generator. The lower bearing shield, the stator and the upper bearing shield is mounted together by using long screws. On the upper side of the generator, a fan for the active air cooling is mounted.

The generator has been dismanteled after the test run to look for wear in the bearings. The dismantling was very easy due to the very little parts of the unit. We haven´t found any wear in the unit.

The lower bearing shield can be pull off the generator body after dismantling the turgo runner from the shaft and loosen the three long screws. The lower generator bearing (6204Z) remains on the generator shaft. The shaft seal remains on the bearing shield. After dismantling, the details of the greasing device can be seen in the shield. The grease will be pressed through a small copper pipe directly between seal and bearing.

The generator stator is made of an aluminum-alloy case with a pressed in and secured lamination stack. The stack is secured against rotation with a small screw. The windings seems to be three phase and are epoxy impregnated. The lamination stack has 24 nuts.



Stack securing screw

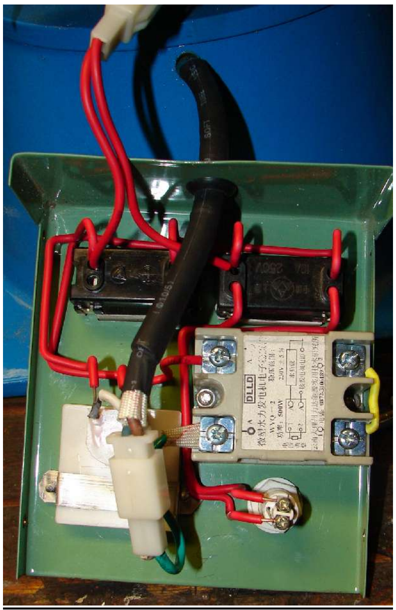
The generator rotor / shaft is an one turning workpiece in steel. The barrel is attached with four permanent magnets (rare earth). The magnets are glued as well as screwed on the barrel. The lower, bigger bearing has a size of 6204Z, the upper bearing has 6202RZ.

Control box:

The directy screwed on control box is made of 0,8mm sheet metal, coated on both sides. The control box includes the following components:

- Main switch
- Voltage gauge
- ELC (casted completely into a four pin silicon switch)
- Control lamp
- Socket (two pin without ground)

as well as the connection to the generator and the connection to the load resistance. The load resistance itself is mounted inside the turbine housing and cooled by splashed water. Due to the electric circuit, the generator is permanently controlled by the ELC. The ELC controlls the system voltage. The unit is not frequency controlled. The main switch turns the socket on and of. The switching status is shown by the contol lamp. There is no ground connection avaiable in the socket.



Buildup for test run:

The turbine system was mounted onto the in-house test stand to check the hydraulic and electric functionality of the turbine system. The supply for pressured water occurred by using a 50mm diameter “C”-size hose with “C”-size “Storz” coupling. Due to the existing ball valves at the water terminal of the test stand, the included valve was not mounted. The water, after passing the tubine, falls directly into the supply basin. A flow gauge was not mounted in this test setup.

The electric connection was made by using an adaptor cable to connect the socket of the control box to an testing device. This testing device allows to read out simultaneously the voltage, frequency and amperage of the system. On the output socket of this device, an electronic energy monitor (Conrad, Energy Monitor 3000) was connected. This energy monitor allows, in addition to the voltage, amperage and frequency, to read out the power (Watt), the apparent power (VA) and the reactive power factor (cos phi).

At the output socket of the energy monitor, different consumers have been connected to test the unit:

- Light bulbs 60 Watt + 150 Watt
- Neon lamps (different sizes)
- Energy save light bulbs
- Induction motors
- Collector motors
- Power supply packs
- Battery chargers (different sizes)

The sense of testing different consumers on this generator system is to find out how the unit works with other consumers (inductive and capacitive) than the normal resistive loads.

Units of other manufacturers have caused heavy generator heat problems, when inductive and capacitive consumers are connected. So we tried to show the thermal limit of these system by using heavy inductive loads.

Day 1:

The first day of testing was to check out the hydraulic of the tubine. For this, we try out many test runns to find out, how the water goes through the tubine. Also we check out the system for unusual noise and vibrations. At this test run, the turbine was not connected to any sort of consumer. It only runns with the build in ELC on 230V.

The turbine began to run at a head of 6m. After reaching a head of 8m, the voltage of the generator reaches 230V and load can be connected.

The behaviour of the running system seems to be quite and without complications. Against the fact of an unprecise manufactured turgo runner, the unit has no big vibrations while running. Also the listen to the bearings by using an technical stethoscope dosn´t show noisy bearings.

The drainage of the water after passing the turbine seems to be easy. A good sealing between turbine housing and baseplate is necessary, because the water is quitting the turbine and the housing in a more tangential way with a sometimes very low slope.

The noise emmision of the running unit seems to be normal. 95% of the noise emmisions comes from the turbine, where the pressured water will be deflect in the turbine runner and leave the housing with high velocity.

Day 2:

On the second day, we supply the turbine with different heads. By reaching a head of 8m, loads can be connected to the turbine. At a head of 12m, around 300 Watt of power is avaiable. The primary target of this testing day is to supply standard AC consumers (home appliance and DIY consumers) to show how applicable the unit is. Among other, we connected light bulbs, neon bulbs, energy saving bulbs, induction motors and collector motors until the system reaches a point where the voltage steady fall below 230V.

The build in ELC works very well. The control response time, when load changes, is very short and the controller will not swing heaviely. Also by provocated, short but heavy load changes, the ELC will not begin to swing over. The norminal output voltage will be constant after around 0,5 – 1 sec after load changes. The overshooting voltage will not rise above 245V.

We try to block a used drill machine (350W) to overheat the generator. We have no demage on the generator, it turns further will a lower RPM as long as we blocked the machine. The Generator temperature will not rise above 32°C.

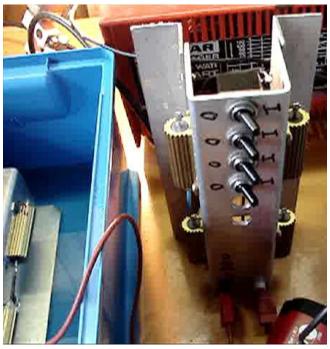


On summary, all standard home and DIY appliance can be supplied with this turbine system without any problems.

Day 3:

On the third day, we build a setup, that is likely used here in Europe with small powerplants. This setup uses the plant power to charge a big battery bank for storage. We install this setup by using a big battery charger (600 Watt), who charges a 12V / 50 Ah acid battery. Than we connect 400W of resistive consumers to the battery to provide a heavy load on the DC side. Also we connect a light bulb with 60W on the AC side. While running, the energy monitor shows a reactive power factor of 0,72 (cos phi).



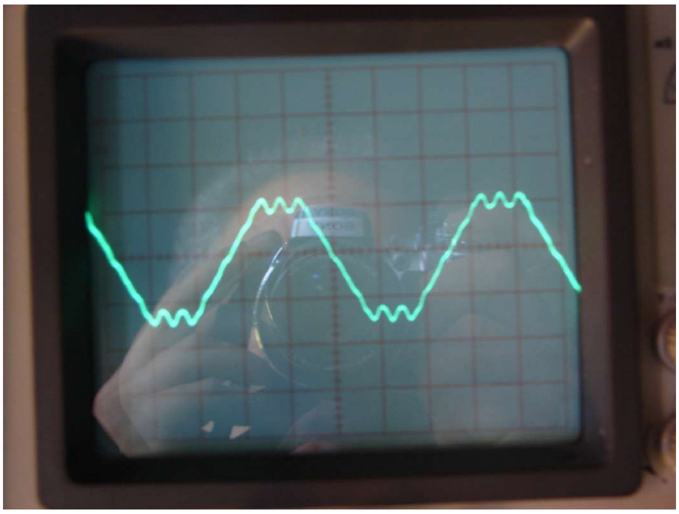


Setup with battery, load and battery charger; resistive loads: 8 x 50W

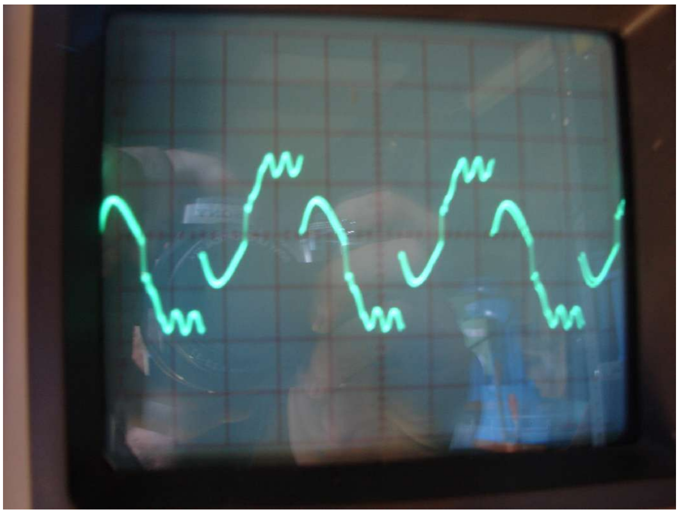
Also on this typical european setup, the system works very well. The generator seems to have no problems to supply the heavy reactive power for the transformer. We measured no generator temperatures above 30°C. As a result, we can say that the used generator can supply setups with heavy transformers, maybe up to a reactive power factor of 0,7. The active cooling of this generator avoids an thermal overheat absolutely reliable.

Day 4:

On the fourth day, we measured out the type of voltage the generator supply. The used generator is build as a single phase, permanent magnet generator, and should supply a sinus wave. By using a voltage sensitive ELC, who has normally a build in “triac” silicon switch, the sinus wave can be distorted. We measured the voltage with an analog oscilloscope (HAMEG) and a 100:1 sensor head (TESTEC) between phase and neutral.



sine wave without ELC



sine wave with working ELC

Concluding results of the test run:

The manufacturer presents the turbine series CJ-XXXD as a lightweight, simple to operate and priceworth Micro-Hydropower plant. The plant can supply households in mountain areas. This series is avaiable with a power between 100W and 10kW.

The technical construction and design of the unit is easy. Due to the surrender of a variable nozzle system, the unit can be easy connected on many pressure pipe applications by using the 1 ½ " pipe thread. The installed fixed nozzle is changeable. So the unit can be installed on many sites with different head and flow conditions. To reach a limited controllability of the water flow, the mounting of an gate valve instead of the included ball valve is possible on the 1 ½ " pipe thread.

Also, the technical design of the generator is professional. Due to the easy to use and integrated greasing device with the "Grease Cap", maintenance is much more easier than on other systems. The active cooling with an radial fan allows to load the generator with different consumers, and the emerging heat can be fastly dissapate at the cooling fins of the generator body. Due to this, the generator stays quite cool while normal operation. The professional design promise a long life of the unit. The permentent magnets are glued AND screwed on the generator rotor and the lamination stack is a reliable workmanship, pressed into the generator body and secured against rotation with a screw.

After the hydraulical installation, the unit can be start up directly, because all components for the voltage stabilisation are build into the control box. So after opening the ball valve, the unit is ready to use and can supply any consumer up to the unit´s power on the intergrated socket.

As we know the results of this test run, it is equal what kind of consumer is connected. The turbine can support consumers directly on the AC side or can supply a big battery charger to charge the battery bank of a household. With the storage technology, much higher loads can be supplied by using a DC/AC inverter.

Be careful when using the AC socket to support home appliances. Due to the voltage stabilisation, the frequency of the turbine is not stable. Do not connect appliances, who needs a stabilized frequency.

Munich, 28.08.08

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Turgo turbine dismantled