LINGENHÖLE TECHNOLOGIE

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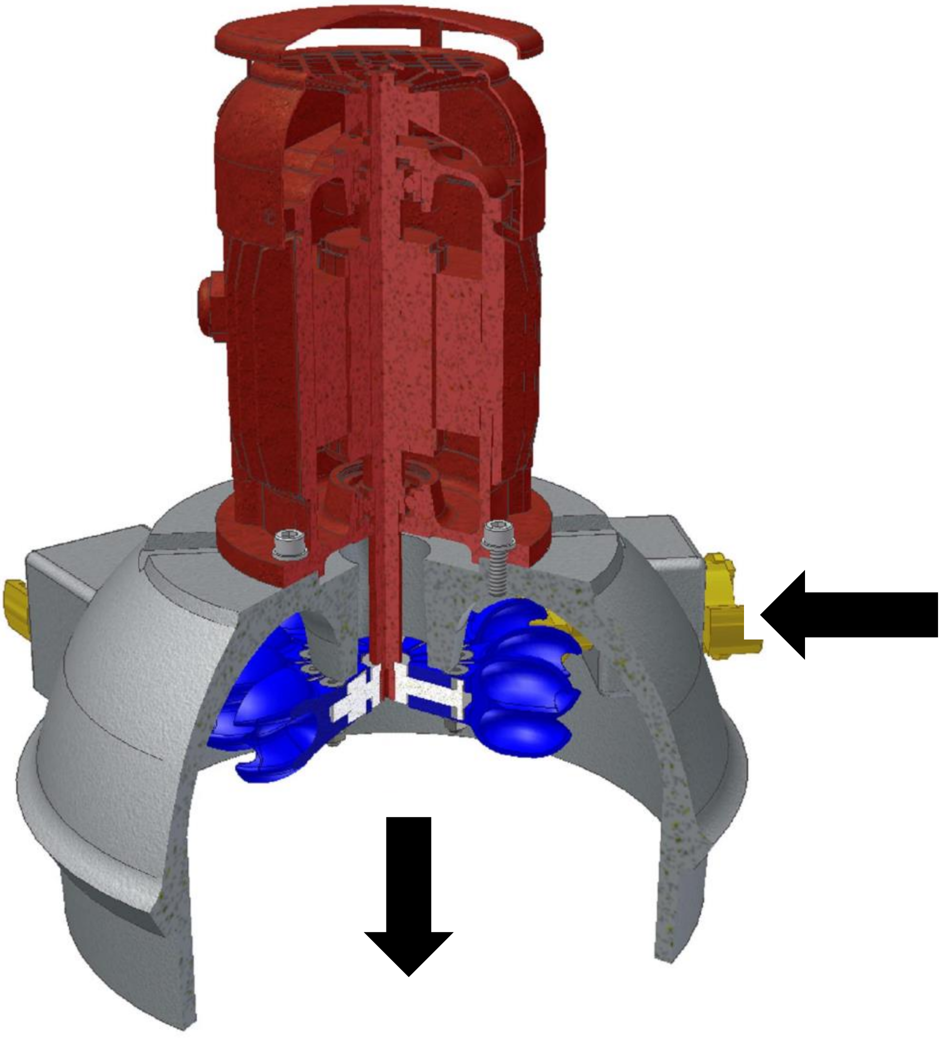
Portable Micro Hydro Power Plants
KT100/KT340/KT1000 (100 - 1000Watt)



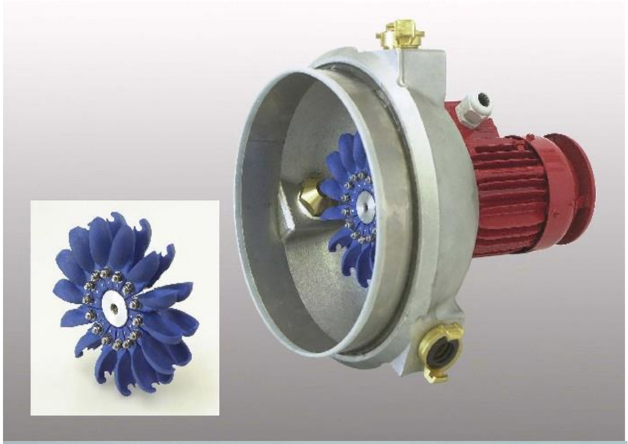
Local environmental friendly energy generation

Portable Micro Hydro Power Plants (Pelton turbine)

Portable Micro Hydro Power Plants (PMHPP) are used for generating electric power in areas, which are not connected, to the grid of an energy supply company (stand alone solutions).
The suggested application of such micro hydro power plants is with the use of a buffer battery, which accumulates even small amounts of energy over a period. This mode of operation allows the temporary provision of power, which is a multiple of the continuous output of the system. The preferred voltage for the operation of these micro hydro power plants is 24 V.
Thus, the line for transmission is kept in certain limits. The use of a 12 V battery system is also possible. With 12 V the maximum charge current must not be exceeded. We recommend 12 V only for smaller capacities, because it requires large cross sections of the line. An alternating-current converter provides 230 V AC. Smaller units with only a few Watt power output should operate the lighting directly from the battery thus avoiding power loss caused by the no-load consumption of the converter.
For minimum hydraulic requirements, please refer to the performance diagram.

Fields of application

- Power supply for mountain cottages
- Hunting lodges
- Cabins, holiday homes
- Data measuring stations
- Developing countries
- Areas not connected to the electric grid



Available Types

KT 100 Performance: 15 to max. 100 Watt
KT 340 Performance: 100 to max. 340 Watt
KT 1100 Performance: 150 to max. 1000 Watt
(Other types on request)

Advantages:

- Available 24 hours a day
- Easy installation and handling
- Maintenance free
- no parts subject to wear and tear
- Can be used with drinking water
- Light weight
- Excellent performance
- Reasonable price

Construction

The construction of the PHMPP is simple and robust. The main components are the turbine and a synchronous generator with three-phase winding. The generator is driven by a Pelton wheel on a common shaft. The impeller consists of an aluminium hub and abrasion-resistant buckets made of a special plastic (polyamide with 30% fiber glass).
The synchronous generator is permanently agitated, brushless and has lifelong lubricated bearings.
By this the generator requires hardly maintenance and is highly efficient.
The housing made of cast aluminium has a collet. This allows the connection without further fastening to a plastic socket or a concrete pipe.

1 – 3 jets allow a flexible adjustment to various water quantities.
A manual jet needle adjustment (available as extra) can limit the water quantity.

A MPPT (Maximum Powerpoint Tracker) charge controller will search for the best working point of the turbine (ideal speed related to net head).

These turbine systems can be adapted to various water quantities and heads and cover therefore a wide range of applications. Further details can be found in the data sheet "turbine type".

In place of a charge controller you may use a regen-capable mains inverter to feed the produced energy directly into the public grid. In this case you have to observe the regulations of the local power supply company, also the generator voltage has to be adjusted to the inverter.
Another possibility is the use of an asynchronous generator instead of a permanently agitated generator. This option may be cheaper, but the degree of efficiency is lower.
IMPORTANT NOTE: The asynchronous generator cannot be used for stand-alone systems!

The recommended applications are as local energy supply systems for mountain cottages, hunting lodges, cabins, data measuring stations and developing countries.
With only 2 to 3 meter head the turbine can provide a few Watt power.

Project Planning

Penstock

For a new penstock the diameter of the pipe should be calculated in a way that the pressure loss at maximum water quantity does not exceed 10 %.
It is very important that the water can flow whirl-free inside the pipe. Tight radius corners and narrowing of the penstock should be avoided.
We recommend putting the penstock underground in order to avoid any damage. The inside of the pipe should also be as smooth as possible (e.g. plastic pipes) to keep friction loss inside as low as possible.
The flow rate inside the penstock should be low to keep friction loss low (guide line about 1m/s).
Calculation example with Q = 2 l/s; v = 1 m/s = 10 dm/s

$$Q = v * A$$
$$Q = v * r^2\pi$$
$$Q = 2\ l/sec$$
$$v = 1\ m/\sec = 10\ dm/sec$$

$$2 = 10 * r^2\pi$$
$$r^2 = \frac{2}{10\pi}$$
$$r = \sqrt[2]{\frac{2}{10\pi}}$$
$$r = 0{,}25\ dm = 25\ mm$$

In this case the inside diameter of the penstock has to be 50 mm minimum.
We will be pleased to assist you with the calculations!
We need the following parameters: maximum water quantity; length of pipe; material of the penstock to do this.

Please take also into consideration that the penstock has to be constructed for a minimum of 1.5 times of the pressure! Up to a pressure level of PN16/PN25 pressure-resistant plastic pipes e.g. PE80 or PE100 are available. Such plastic pipes in smaller diameters are available in rolls, which allow easier installation.

Calculation of Power

For the calculation of the achievable power, we need net head and water quantity.

Gross head: maximum available vertical fall in the water, from upstream to downstream level
Net head: gross head less friction losses when transferring the water into and away from the machine

$$P = g * Q * \rho * Hn * \eta$$

Where:

- P is the mechanical power produced at the turbine shaft (Watts)
- g is the acceleration due to gravity (9.81 m/s²)
- Q is the volume flow rate passing through the turbine (m³/s)
- P is the density of water (1000 kg/m³), η is the hydraulic efficiency of the turbine
- Hn is the net head (m)

Rough calculation
Power (Watts) = net head (m) * water quantity (l/s) * hydraulic efficiency *10
e.g.:
Hn = 20 m; Q = 1 l/s; hydraulic efficiency = 60%
P = 20 * 1 * 0,6 * 10=120 Watts

Efficiency

For micro hydro power plants in the range from 100 to 1000 Watts, the maximum total efficiency is 65 %, taking into consideration the efficiencies of the turbine and the generator.
The efficiency can fall to about 35 % in case of an unfavourable ratio of water quantity and net head, e.g. Q = 0,3 l/s at Hn = 50m. Due to the low net head and the small water quantity, the jet circle diameter will be very small causing an unfavourable effect of the geometry of the buckets. Further loss caused by charge controller, rectifier, battery, transmission, and inverter has also to be taken into consideration. Therefore we recommend preparing an energy balance for each project!
Compared with a power output of e.g. 100 Watt the efficiency is still attractive.

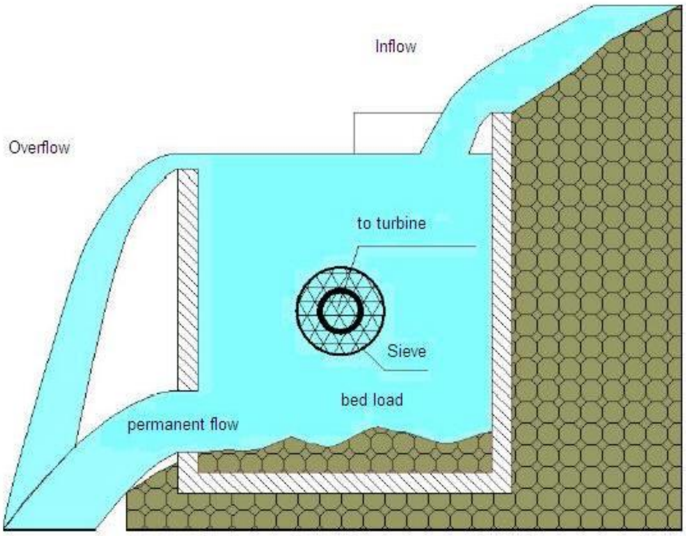
Micro hydro power plants with a higher power output of e.g. 100 kW achieve an efficiency of about 83 %.

Water Intake

In many cases the Pelton turbine is used with spring water. In certain cases the penstock is already available and there is no need to take a residual amount of water into consideration.
IMPORTANT: The penstock has to be checked for pressure resistance and correct diameter.

When taking water from public creeks and rivers a residual amount of water has to be guaranteed. This constant water quantity is also called permanent flow.
It is also important to stop larger particles (sand, etc.) that can be found in the penstock entering the turbine. The following construction is proposed:

The water of the creek flows into a settling tank (forebay) having in his lower part a notch as outlet. The size of the notch and the difference in height between notch and overflow determine the residual water quantity.



The size A of the notch could be calculated as follows:

$$A = 1000 * \frac{Q}{\sqrt{2 * g * h}}$$

Where:
A is the size of the notch in mm²
Q is the volume flow in l/s
h is the difference in height between overflow and notch in m
g is the acceleration due to gravity (9.81 m/s²)

The formula has only to be understood as guideline showing the relations between the parameters. Use this formula with great care, because at a low difference in height the current may also have an important influence.

The main reason for the notch is the discharge of bed load (sand, gravel, etc.). Therefore the outlet to the turbine has to be located at a higher level than the notch.

In case of debris lager than the notch the intake should be protected by a metal rack. The distance between the metal bars has to be smaller than the diameter of the notch.

You have also to choose the inclination of the metal bars in that way that debris can move over the rack. Underneath the rack there must be enough space for the debris. We also recommend the installation of a removable rack in order to clean the inside of the tank if necessary.

The outlet to the turbine has to be located at a higher level than the notch, but it has to be under the water level in order to avoid that floating particles (wood, waste, etc.) will not clog the sieve. The floating particles will then leave the tank through the overflow. The mesh size of the sieve depends on the jet of the turbine. The mesh size must be small enough to stop particles big enough to clog the nozzle of the jet.
The diameter of the discharge is determined by the diameter of the pressure pipe. The water intake or forebay can be a concrete pipe (bottom closed) or plastic container depending on the local circumstances. Complete sets for these purposes, which can be installed very easy, are already available from other suppliers.

Valves

Valves must be installed that the turbine can be switched off. These valves should not create whirls or friction loss. Most suitable for this purpose are ball valves. It is recommended to install a valve for each jet.
An electric ball valve with spring return may be installed. This device will switch off the turbine as soon as the battery is completely charged. Once the battery has to be charged again it will start up the turbine.

Water outlet

The Pelton turbine is an impulse type turbine. This means that the water will is discharged without pressure.
For an optimal performance the impeller must not be submerged in the water. This requires a minimum distance between impeller and highest water level. The water outlet has to be ventilated. The diameter of the discharge pipe has to be big enough that it will not be filled completely at the maximum water quantity.

Operation and Safety Instructions

The manual for operation and safety instructions have to be followed strictly. Please read before installation of the system!

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