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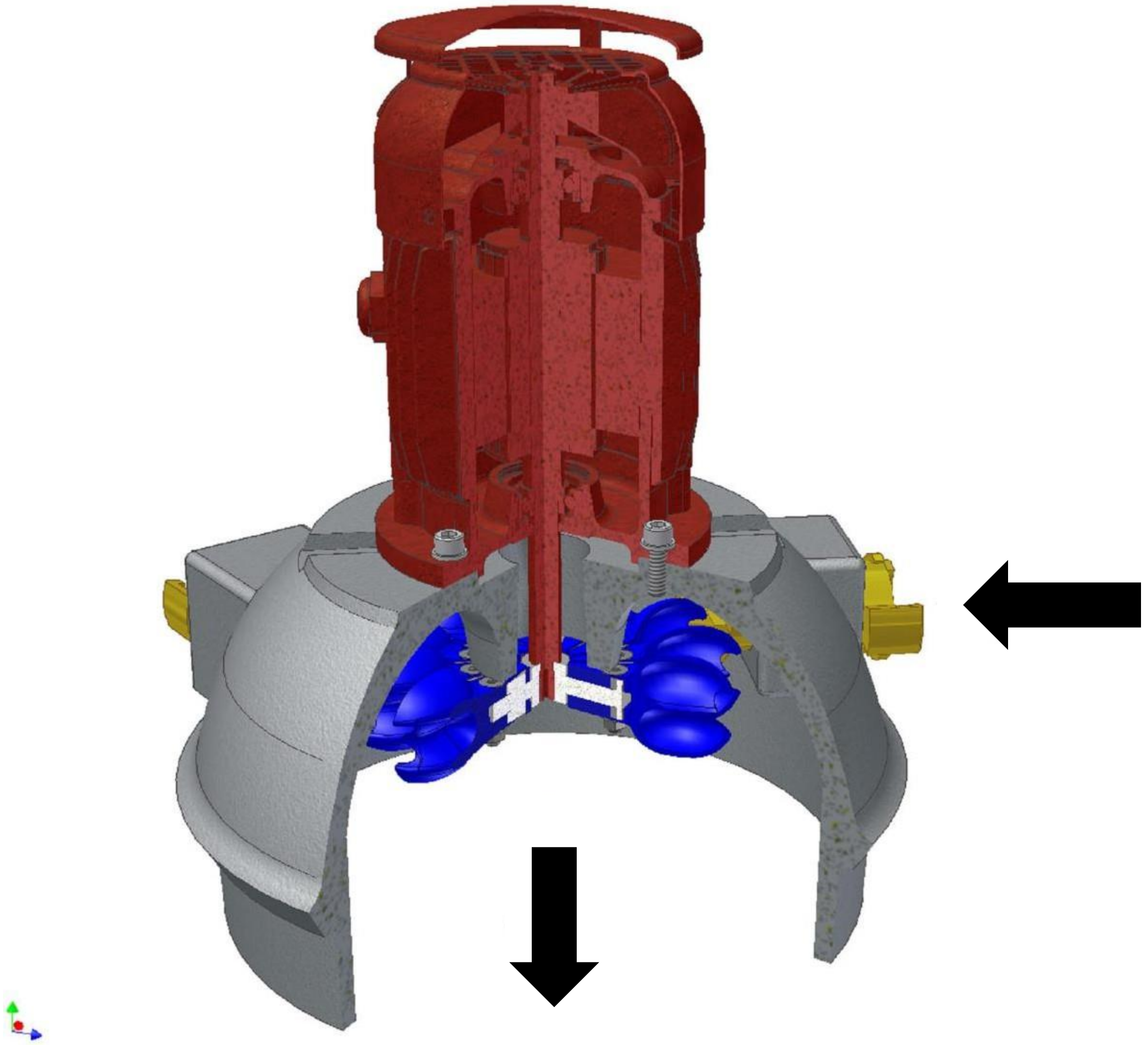
Technical documentation for portable water turbines

KT100/ KT340/ KT1000 (100-1000Watt)



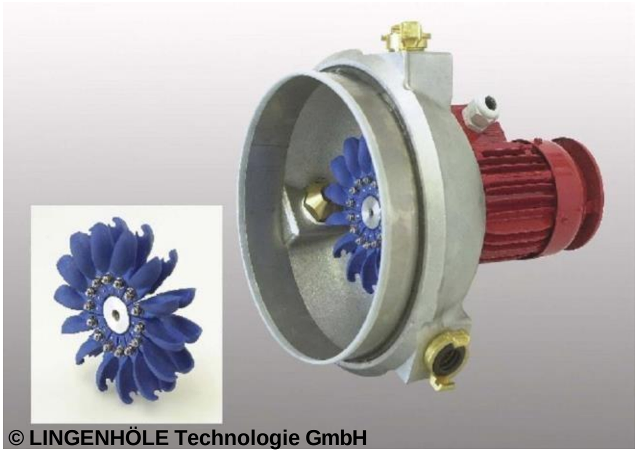
Decentralized, environmentally friendly energy generation

Portable water turbines (Pelton turbines)

Micro hydro turbines are used to generate electricity in regions without a public supply grid (island application).
These small hydropower plants operate preferably via battery buffers, so that even small amounts of energy accumulate over time. This operating mode allows the short-term withdrawal of power that is several times the continuous output of the hydropower plant. These micro-turbines are preferably used with a battery voltage of 24 volts.
This keeps the losses in the cables to a minimum. However, a battery system with 12 volts can also be used. In this case, however, the maximum permissible charging current must not be exceeded. This is only recommended for lower outputs, as otherwise large cable cross-sections are required. Conversion to 230 volt alternating current takes place via an inverter. For small systems with only a few watts of useful power, the lighting should be operated directly from the battery so that the idle consumption of the inverter does not destroy a considerable part of the energy generated in advance.
For minimum hydraulic requirements, see performance diagram.

Areas of application

- Energy supply for the Alps
- Mountain huts and hunting lodges
- Weekend houses, vacation homes
- Data measuring stations
- Elevated tank
- Developing countries
- Regions without a public supply network



Type overview

KT 100	Performance: 15 to max. 100 Watt
KT 340	Performance: 100 to max. 340 Watt
KT 1000	Performance: 150 to max. 1000 Watt (also larger service areas on request)

Advantages

- Power generation at any time of day, 24h
- Simply, robust design
- Low maintenance
- Suitable for drinking water
- Easily customizable
- Can be combined very well with photovoltaics
- Low weight
- Inexpensive

Structure

The portable small water turbines are characterized by a particularly simple design. Essentially, the turbine consists of a brushless synchronous generator with permanent excitation and three-phase winding.
The generator is driven by a Pelton impeller mounted on the same shaft.
The impeller consists of an aluminum hub and abrasion-resistant plastic blades (polyamide with 30% glass fiber content).
The synchronous generator has permanent excitation, is brushless and has lifetime-lubricated bearings. This makes the generator very low-maintenance and highly efficient.
The aluminum housing is equipped with a centering collar so that it can be placed on a plastic sleeve or a concrete pipe without additional fastening.

The flexible number of nozzles (1-3 pieces) makes it possible to adapt to different water volumes. A manual nozzle needle adjustment (optional) can be used to limit the water volume when the water supply is low.

A charge controller with "maximum power point function" enables the turbine to be set to the optimum operating point. This ensures the ideal speed of the generator in relation to the net head.

These turbines cover a wide range by adapting to the different heads and water volumes (for more information, see the turbine type data sheet).

The much larger field of application is decentralized energy supplies for the Alps, mountain huts, hunting lodges, weekend homes and data measuring stations as well as developing countries.
The turbine delivers outputs of several watts at a drop height of just 3 meters.

Project planning

Pressure pipeline

When planning the system, the pipe cross-section should be dimensioned accordingly when laying new pressure pipes that a maximum pressure loss of 10% occurs at the maximum water volume.

It is important that the water is allowed to flow without turbulence within the pipe. Narrow radii and constricted cross-sections should be avoided.

To avoid damaging the cable, it should be laid in the floor. The use of materials with the smoothest possible surface is also recommended
(e.g. plastic pipes) so that the friction on the walls causes as few losses as possible.

The flow velocity in the pressure pipe should be slow in order to keep friction losses to a minimum (approx.. 1m/s as a guide).

Calculation of friction loss:

e.g. Q=2l/s v=1m/s =10dm/s

Q=v*A → A= square root [(2/10)*4/Pi] =0,5dm → <u>Inner diameter at least 50mm</u>

We will be happy to help you with cable dimensioning! We need the following parameters for this:

Maximum water volume, pipe length, material of the pressure pipe.

Please note that the pressure pipe is designed for a least 1.5 times the pressure.
Pressure-resistant plastic pipes ware available up to pressure rating PN16/PN25, e.g. PE80 or PE100.
These pipes are available in rolls for smaller dimensions, which considerably simplifies pipe laying.

Power calculation

The net head and the water volume are required to calculate the achievable power. P=Hn*Q*η*10

Gross head .... Difference in height between headwater level and tailwater level
Net drop height..... Gross drop height- Friction loss- Free slope
Free slope .... Height of underwater level up to the nozzle inlet

g .... Gravitational acceleration 9,81 **[m/s]**
Q............... Volume flow **[l/s]**
Hn............. Net head **[m]**
η ....Total efficiency [without unit] e.g. 60%=0,6
v................ Jet velocity **[m/s]**
P .... Power **[Watt/kw]**

Estimate calculation:

Power [Watt]= net head [m] x volume flow [l/s] x efficiency factor x10

e.g.: Hn=20m Q=1l/s Total efficiency: 60%=0,6

P=20 x 1x 0,6 x 10=120Watt

Efficiency

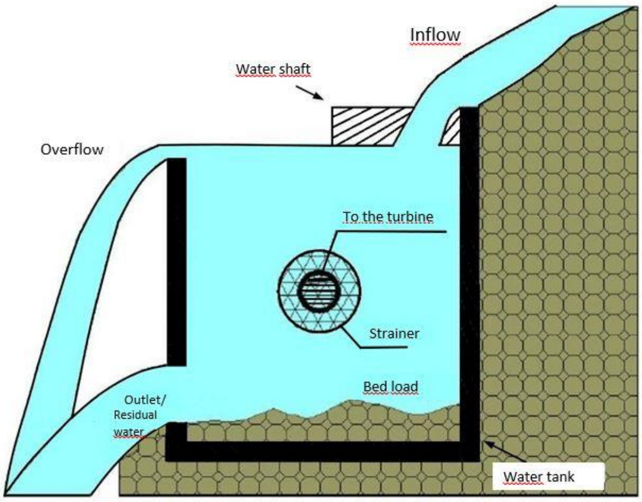
The overall efficiency of small hydropower plants (e.g. 100-1000 watts) is max. 65%. The losses up to the battery are taken into account here.
With unfavorable rations of water the volume to head e.g.. Q=0,3l/s at Hn=50m, the efficiency drops to approx. 35%.
Further losses due to inverters and cables may have to be taken into account. An energy balance is absolutely essential!

Water catchment

The Pelton turbine is often used with spring water. In some cases, the pipe to the future turbine may already have been drawn. In such a case, it is not necessary to pay attention to the residual water volume.
Important: The pressure line must be checked for pressure resistance and correct dimensioning.

When drawing water from an open body of water, the residual water volume must be ensured. This constant discharge of water is often referred to as dosing water. It is also necessary to prevent larger particles from entering the pipe. The author proposes the following design:

The water from the stream flows into a large container, which has a hole in the lower part for the drain. The cross-sectional area of this opening and the difference i height to the overflow determine the residual water volume.
The cross-sectional area A cpuld be calculated as follows:



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

A .... Cross-sectional area in [mm²]
Q .... Volume flow in [l/s]
h.................. Height difference between overflow and residual water hole in [m]
g.................. Gravitational acceleration (natural constant 9.81)

The formula is only intended as a guide and essentially shows the relationships. It should be used with caution, as the flow also has an influence that should not be underestimated when the difference in altitude is small.
The actual purpose of this opening is to discharge debris. Therefore, the discharge to the turbine must be higher than the doping water hole.
If bed load is to be expected, which also has larger bodies than the diameter of the doping water hole, the socket should be covered with a screen. The grid spacing must be smaller than the diameter of the doping water hole.
Furthermore, the slope of the bars must be selected so that the objects can roll/push over them. There must be sufficient space for the debris below the rake.
The screen should also be removable from the tank so that the debris inside the tank can also be removed if necessary.

As already mentioned, the drain pipe to the turbine must be positioned higher than the doping water hole. However, it should be below the water level line so that floating debris such as wood and garbage does not stick to the strainer but flows out via the overflow.
It is also advisable to install a screen over the drain. The mesh size of this screen depends on the nozzle in front of the turbine. The mesh must be narrow enough to prevent bodies from slipping through and clogging the nozzle.

The diameter of the drain depends on the diameter of the pressure pipe.
Depending on the size and conditions, a concrete pipe with a base or a modified plastic container can be used as a water collection tank. There are already spring collection shafts with overflow and outlet ponds that can be used for this purpose. These shafts can be buried in the ground and serve as small temporary storage tanks.

Shut-off devices

Shut-off valves should be provided so that the turbine can be switched off. These should allow a straight, vortex-free flow when open.
Ball valves are ideal for this purpose. If there are several nozzles, each individual nozzle should be able to be switches on and off. An electric ball valve with spring return in the supply line can also be implemented, this can switch off the turbine when the battery is full. If energy is required from the battery again, the ball valve opens the turbine supply line.

Discharge- underwater routing

The Pelton turbine is a free-jet turbine, i.e. the water leaves the turbine without pressure.
For optimum operation, it is important that the impeller is not submerged in water, i.e. there must be sufficient clearance between the impeller and the highest underwater level. In addition, the underwater area must be sufficiently ventilated. The drain should be generously dimensioned so that the waste water pipe is not completely filled at maximum water volume. This ensures that the underwater turbine chamber is ventilated.

Operating and safety instructions

The instructions in the operating and safety manual must be followed exactly. These must be read before installing the system!

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