penergetic

Water – the blood of the Earth

The basics of water remediation

Content

1. Water Basics

1.1 Water

1.1.1 The blood of the earth

There are an estimated 1.348 billion km³ of water on earth. Out of this immense amount 97.39 % is sea water and a further 2 % is frozen. Only 0.6 % of the water reserves are freshwater passing through the constant cycle of evaporation, precipitation and outflow.

If we took the amount of existing freshwater as 100 %, 0.35 % is in lakes and 0.003% is in rivers. We can therefore see that, compared to the total amount of water, this is only a minute fraction.

This comparison illustrates how small the amount of water is that is available to us as drinking water. Are we aware of our enormous responsibility towards the preservation of “water“, our most important foodstuff?

1.1.2 What is water?

Chemist: H_2O, a molecule made up of 2 Hydrogen atoms and 1 Oxygen atom.

Schauberger: “ ... that water is not just some thing, that we can treat carelessly - as if it were *dead*! Water is not just H_2O but a *living* **organism** with its own inherent laws, that have to be respected by humans.“

1.2 Bodies of water – standing waters (natural ponds, man-made ponds and lakes)

Ponds, man-made ponds and lakes are all standing waters, for which the environmental factor of a “current“ plays hardly any role. This enables not only fish but also microorganisms which float and which avoid slowly sinking to the bottom, e.g. using flagella, to use water as their habitat. This world of suspended organisms is usually referred to as plankton, regardless of whether these organisms are unicellular or multicellular animals, plants or bacteria. By comparison, the active swimmers (e.g. fish) are called nekton.

1.2.1 Differences between lakes, natural ponds and man-made ponds

- **Lakes:**
  Lakes are so deep that light usually does not reach the entire bottom, therefore no plant growth is possible in its deepest parts.

- **Ponds:**
  “A pond is a lake without depth“ (Forel, founder of limnology). It is usually not deeper than 2m, rarely up to 5m deep. Sunlight can reach the entire bottom if the water is not too murky. This enables plant growth on the entire bottom of the pond. A pond has the highest biodiversity of the waters in our part of the world. The living conditions for plankton organisms are good because of the relative richness in nutrients.

  Frequently, ponds are silted-up lakes. Lake Neusiedl for example is not a lake in the true sense of the word, but a pond, because it is very shallow.

- **Man-made ponds:**
  Usually identical to natural ponds but man-made. Can be emptied by opening a sluice at any time.

1.2.2 Structure of waterbodies

1.2.2.1 Pelagic zone (open water zone):

Habitat for plankton (phytoplankton and zooplankton) and fish.

1.2.2.2 Benthic zone (bottom zone):

The benthic zone is sub-divided into the littoral and the profundal zones.

- **Littoral (shore zone):**
  The zone with most life! Plants and microorganisms, but also algae and nutrients. Higher water temperature and light transparency have a growth promoting effect (photosynthesis).

- **Profundal zone (deep zone):**
  Refers to depths of 2m and deeper. Fewer lifeforms exist because there is hardly any incidence of light (photosynthesis). During the summer, there is often very little oxygen which promotes chemical processes and reactions. Silt deposits and remains of dead plants produce sludge.

1.3 Heat regulation and water movement in water bodies

Heat exchange in water bodies only happens through movement of the water because water has a low thermal conductivity. This movement occurs when wind generates a current by creating friction on the water's surface. The current is then redirected in the opposite direction when it hits the shore.

We differentiate seasonally between stagnation (summer and winter) and circulation (spring and autumn).

During **summer stagnation,** three water layers are formed: the **epilimnion** (top, warm) the **hypolimnion** (bottom, cold) and in between the two the **metalimnion** (thermocline). The water in the hypolimnion keeps a relatively constant temperature of 4°C in deeper lakes.
Because of the stronger winds in spring and autumn when the water is no longer or not yet frozen, more movement is generated in the water. **Spring and autumn circulation** occurs.

During winter, the water only has two layers: a cold surface that could also freeze and below it deep water with a temperature of 4°C.

Because oxygen can be bound more easily by cold water than by warm water, the anomaly that water is at its highest density at 4°C enables animal lifeforms to survive under the ice during the winter as well as during periods of excessively high water temperatures in the summer. During very cold winters only very shallow waters can freeze through.

For the process of thorough mixing of the water during circulation we distinguish between:

- *dimictic*: circulation and stagnation alternate twice annually
- *monomictic*: circulation and stagnation only take place once a year (Lake Constance is a monomictic lake that only circulates during the winter months [autumn circulation])
- *holomictic*: thorough mixing down to the bottom
- *meromictic*: thorough mixing not to the bottom

1.4 Substances dissolved in water

Oxygen and carbon are direct indicators for the bioactivity in the metabolism of water bodies.

If the temperature increases, the oxygen content of the water decreases, but the oxygen demand of the animals increases. This is compensated partly by the water movement.

1.4.1 Oxygen

Oxygen supply for water bodies takes place through:

- atmosphere
- photosynthesis
- possibly transported in by tributaries

Oxygen demand arises due to:

- breathing
- degradation and mineralisation of organic substances
- loss to the atmosphere

Because of the oxygen production that takes place during photosynthesis, the oxygen consuming processes of animals and micro organisms and the oxygen producing processes of plants usually balance out.

When phytoplankton production is too high there might even be an oxygen surplus during the day and an oxygen deficit by night.

1.4.2 Carbon dioxide

- Carbon dioxide enters the water from the air through precipitation

- and by metabolic processes of the organisms in the water (during the aerobic degradation of organic matter carbon is converted to CO_2; during anaerobic degradation only 50% of carbon is converted to CO_2 and 50% to methane).

- Furthermore, plants absorb more CO_2 during the day than they emit during the night. This results in an accumulation of aggressive CO_2. Attempts are often made to counteract this by adding lime to the water, because CO_2 can be partly bound as $CaCO_3$.

1.4.3 Nitrogen

Nitrogen occurs in the water in anorganic forms as nitrate, nitrite and ammonium, in organic forms as intermediate substances of microbial protein digestion, as excretion products of animals (e.g. duck and fish faeces, washed out liquid manure) and in free compounds.
Nitrate and ammonium are the nitrogen suppliers to water plants and algae.

- **Ammonium**
  Aerobic nitrifiers oxidise the ammonium that is set free during protein digestion to nitrite. Nitrate bacteria oxidise nitrite to nitrate. Nitrification is a strictly aerobic process. In water bodies that are polluted with organically degradable substances, ammonium occurs in significant concentrations, especially at some distance below large wastewater inflows.

- **Nitrite**
  Nitrite is mainly produced by the oxidation of ammonium. It usually only occurs in small concentrations because of its quick utilisation. Nitrite is highly toxic to fish and gives strong cause to concern because of its role as a starting material for carcinogenic nitrogen compounds.

- **Nitrate**
  Nitrate is the fully oxidised form of nitrogen and, in water bodies, is only problematic as a plant nutrient in high concentrations (excessive growth of algae).

1.4.4 Phosphorus

The total phosphorus content of a water body is made up of:

- orthophosphate (anorganically dissolved phosphate)
- organically dissolved phosphate
- organically particulate phosphate

Phosphorus is a plant nutrient that has a strong fertilising effect, even in small concentrations. In nature, phosphorus only occurs in minute quantities. Usually all other substances that are necessary for plant growth are present and phosphorus constitutes the “limiting factor“. Even small amounts of phosphorus that enter the water lead to an accelerated growth of algae and other plants. Phosphorus can get into the water by being washed out from minerally fertilised fields. However, the amount of phosphorus that stems from uneaten bread fed to ducks must also be considered.

1.4.5 Re-dissolving of nutrients

The lush vegetation of a pond leads to an accumulation of dead organic matter on the bottom. As a result of the high temperatures at the bottom of the pond during the summer (up to 20°C), it degrades two or three times faster than in the 4°C cold water at the bottom of deep lakes. The final compounds of plant decomposition are absorbed by the colloid-rich (particles do not settle but remain dissolved) sludge at the bottom. They do not remain there for long but instead can be mixed into the entire body of water again after a short period of time.

In a lake the difference of temperature between surface and bottom is approximately 20°C, whereas this is reduced to a maximum of 10°C in a pond because of the much higher temperatures at the bottom. Therefore the pond chills through to the bottom on every clear starry night, but especially when the weather changes from sunny to dull and rainy. The cooled down upper layer sinks to the bottom, the warmer layer raises to the top. With that the entire water mass is rearranged and a partial or a full circulation takes place from time to time. The shallower the pond the deeper they reach.

In this way nutrients that have settled at the bottom of the pond can be distributed throughout the entire body of water after a few hours. These processes frequently enable sudden bursts of mass growth of plant plankton and eventually lead to the well-known water bloom that at times changes the colour of a pond to green overnight. Because of the strong plant growth in a pond, these dissolved nutrients are quickly absorbed and returned to the sludge after the plants die. Therefore strong fluctuations of the nutrient content are normal and common.

Oxygen depletion reaches its highest levels of the year due to degradation processes of plant remains during autumn.

Anaerobic decomposition processes create ammonia. Ammonia is more toxic for fish than ammonium. If ammonia is distributed evenly throughout the entire body of water by the powerful circulation of the water (autumn circulation) and if this coincides with a reduced oxygen content, the toxic effects of ammonia and reduced oxygen add up. Then, in very rare instances, a total loss of oxygen might occur which is deadly for most animal life forms.

1.5 Water quality and eutrophication

“Eutrophication“ is the continuous increase of plant nutrients in waterbodies. Eutrophication causes the decline of waterbodies through excessive plant growth (siltation) and its consequences for the concerned waterbodies. Classification is best done by looking at the primary production. During the primary (initial) production the photosynthetic or chemosynthetic creation of organic substance from anorganic substances occurs. In a body of water, phytoplankton relates to the primary production.

The intensity of the creation of organic substance by photosynthesis in a waterbody is known as its “trophic state“. It changes with the release of anorganic, plant growth promoting compounds and can also be influenced directly, for example by mineral fertiliser from agricultural activity being washed in.

1.5.1 Stages of eutrophication

When a waterbody is assessed, it is classified as being in one of the following stages from unpolluted to heavily polluted:

Term	Content of plant nutrients
oligotrophic	low
mesotrophic	medium (α- and β-mesotrophic)
eutrophic	high
polytrophic	very high
hypertrophic	excessively high

In an oligotrophic lake the primary production is lower than 0.2g carbon / m² water surface / day (70g x m^{-2} x $year^{-1}$), in a mesotrophic lake approximately 150g and in a eutrophic lake approximately 500g.

These numbers show that the eutrophication generally depends on organic load pollution (i.e strong algae and plant growth = high organic production).

Increased concentrations of phosporus and nitrogen compounds are accepted across the board to be the initial factors for all aspects of eutrophication.
We have to assume that **1g phosphate(V)** (orthophosphate) can enable the creation of **100g biomass**. After it has died off, this causes an oxygen depletion of approximately 150g of oxygen.

1.5.2 Eutrophication and silting up of lakes

Nowadays, lakes are considered to be open systems, where the turnover of matter is determined by the ratio between the supply and loss of matter as a result of a dynamic balance.

Every oligotrophic lake develops to a eutrophic lake even without human influence - it ages. However, in nature this only happens over geological periods. In recent years, human influence has become more and more noticeable. A lake in Sweden, for example, has been supplied with the same amount of phosphorus in the last 15 years as in the 9000 years previously. Things look quite similar for other bodies of water.

1.5.3 Consequences of eutrophication

Some of the consequences are:

- Reduction in depth visibility
- Change in water colour
- Emergence of oxygen imbalances as well as changes in the animal life of the shore and depth zones (littoral and profundal fauna).

With progressive eutrophication, catastophic changes and shifts may take place such as:

- The occurrence of water bloom
- Invasion of blue-green algae
- Oxygen depletion during the summer
- Occurrence of hydrogen sulphide and ammonium
- Accumulation of non-mineralised organic substances
- Formation of methane,
- Elimination of profundal fauna and game fish

The excessive growth of algae and weeds near the shore, the formation of water bloom (plankton clouds), changes in taste and the formation of unpleasant smells, and the allergies arising from these phenomena are of particular relevance for water bodies that are used for swimming and that are visited by tourists.

2 Water remediation with the Penergetic Technology

2.1 Future technology

With the forward-looking technology of the Penergetic technology, ecological restoration, and in particular water remediation, is possible.

The natural regeneration of water bodies can be stimulated and water can therefore be restored with the smallest technical effort and without any structural changes.

Increasing environmental costs and pollution should prompt us all to take part in the natural restoration of the environment and to promote its development. Many natural lakes and biotopes are no longer of use to us humans because they are too badly polluted. All the more reason, why we should aim to preserve and upkeep these biotopes, in order that we can leave behind a world for our children that is worth living in.

2.2 What the Penergetic Technology can offer

We were able to gain important insights from the evaluation of test results.

The following parameters can currently be treated successfully with the Penergetic technology:

- Visible depth
- Algae contamination
- Sludge
- Germs

From an analytical point of view, water quality is determined by several parameters.

2.2.1 Improvement of visible depth and reduction of algae

The Penergetic technology activates micro organisms that reduce carbon production and phytoplankton in a water body. These are, in part, organisms from the plankton itself that start the natural regeneration of the body of water. This lowers the primary productivity in a water body i.e. the water's own nutrient supply (internal cycle) is reduced. As a result, the total phosphate - concentration in the water is lowered. Thus the algae growth, in particular, is reduced and as a result the visible depth is improved.

2.2.2 Breakdown of sludge

A further result of this is that sludge eating and aerobic micro organisms become active and these can cause a mineralization of the sludge and sediment and their transformation into clay. The re-dissolving of nutrients is reduced which in turn also slows down algae growth.

Please note:

The activation of these micro organisms can result in a short-term increase in the re-dissolving of nutrients at the start of the treatment, which can lead to increased algae growth and murky water in particular.

Aerobic activity

The first noticeable characteristic in the transition from the anaerobic to the aerobic state is the reduction in water- and sludge-odour. This process enables the break-down of organic matter, which would usually only take place in colder months, to also take place in transition periods and, with longer treatment periods, also in warmer months.

By initiating the aerobic breakdown of the sediment, organic material undergoes a metabolic process, is mineralised and broken down. Deposited plant particles take on a peat or humus-like structure. It is therefore possible that the sludge thickness is only slightly reduced. However, this does not mean a reduction in the effectiveness of the Penergetic technology.

Please note:

The reduction of sludge is much more difficult, or in some cases even impossible, if a waterbody is excessively populated with fish and other aquatic animals (the production rate equals the breakdown rate).

2.2.3 Reduction of germs and bacteria

Germs and bacteria are very sensitive to light and UV rays. An improvement in visible depth will possibly reduce bacteria and germs.

2.3 Features of the Penergetic technology

The expression “energy level of a water body“ does not appear in limnology. However, we know from our experience to date with the Penergetic products that water bodies do, by all means, have an energy level.

2.3.1 Energy level

The more polluted and contaminated a water body is, the lower its energy level is. The lower the energy level, the lower the ability of the water to mobilise its own regenerative powers. For this reason, it is more susceptible to environmental influences. The composition of plant and animal species is also dependent on their energy level. Depending on their energy level, some life forms thrive more than others; some do not thrive at all. If we change this energy level, plants and other organisms have no basis for life and can no longer exist, or they will be replaced by other life forms.

Considerations when using the Penergetic Technology

In most cases, this energy level first of all has to be raised through using the Penergetic technology. In some cases this can take several years. When it is balanced, a visible reaction can be triggered.

PLEASE NOTE:
When the Penergetic technology is used in a water body the “effect“ sets in **i m m e d i a t e l y**.
A visible “reaction“ only occurs once the energy level is balanced.

2.3.2 Water reactions

Reactions to the use of the system may differ. A body of water might clear up shortly after the first application. However, it is also possible that it could take years, depending on the energy level.

Reactions evoked by the Penergetic technology can be divided into 5 stages:

Stage 1:

The water takes on a greenish colour because of micro algae. These are responsible for the breakdown of nutrients in the water. In a water body, this process can also set in naturally, in spring or after heavy re-dissolving of nutrients.

To speed up the reaction of the water, it is possible to innoculate it with a bucket of water from a healthy pond.

Stage 2:

When enough nutrients are broken down, the green colouration of the water will fade out. Crustaceans will then become active – these will give the water a brownish colour. These micro organisms are responsible for the mineralisation of organic material (e.g. sludge) and the regulation of algae. In this case (the brown discolouration of the water) the surplus micro algae undergo a metabolic process and the final product enters the cycle.

It is possible that this process will increase the amount of dissolved nutrients. This might trigger renewed algae growth. Furthermore, the effects of stage 3 and 4 might already show at this stage because too many nutrients from breakdown processes might come free from the sludge. This also results in an increased algae growth.

Stage 3:

Usually the crustaceans’ activity would slow down as the state of the water changes towards aerobic. The number of crustaceans decreases. Aerobic breakdown processes commence at the bottom (e.g. fungal growth, composting). Because of the increase in light, the water is better able to give a basis of life to water-filtering micro organisms (e.g. vorticellae or enzymes).

An enzymatic activity (protein breakdown) begins which manifests itself in the formation of foam. This foam does not appear rainbow coloured in sunlight. From now on the water becomes increasingly clearer.

Water might revert to its “old“ state (algae growth, brown discolouration) during these breakdown processes time and time again because of environmental influences, e.g. strong rainfall.

Stage 4:

The higher transparency of the water improves the water quality dramatically (e.g. germ and bacteria reduction). However, an increased bulking-sludge activity is also possible (black-brown floats of sludge on the surface). This is the reaction to breakdown processes of sludge-degrading bacteria.

These lumps of sludge are driven to the surface by gas (methane or CO_2), where they disintegrate under the influence of the sun or daylight.

Stage 5:

When these processes are completed, the water has usually regained its full self-cleaning powers. The dosage, e.g. of treated powder, as well as the frequency of treatment can be reduced. At this stage it will suffice to occasionally re-treat the water e.g. after strong rainfall or extended heatwaves.

<u>Please note:</u>
Two different types of bulking-sludge formation or activity occur naturally.

On the one hand we have the anaerobic processes, which mainly occur in sewage works and hypertrophic waters. Putrefaction processes drive bacteria to the surface with gases like methane and hydrogen sulphide. The sludge can then be skimmed off the surface.

On the other hand we have the more rare aerobic activity, which, it would seem, is initiated by the Penergetic technology. In our experience the two types can be distinguished according to odour and properties.

2.3.2.1 Distinguishing features of the sludge

The **anaerobic sludge** emits a strong smell of hydrogen sulphide and biogas, e.g. methane. A piece of that sludge feels **rubber-like** to the touch and does not disintegrate. It can be picked up.

The **aerobic sludge** does not emit any odour (more soil-like) and **disintegrates** on the surface (mineralisation) under the influence of light (fogging). It probably comes to the surface during aerobic breakdown processes with the final product carbon dioxide (CO_2), which is breathed out by organisms. It disintegrates and dissolves when touched.

2.3.2.2 Changes in nature

It is impossible to reach a constant state with living organisms. Just as humans are subject to ongoing changes, so is nature. Therefore a definitive "recipe" with regard to e.g. dosage, application or expected effects cannot be given. We can only try to understand nature and to learn from her.

Examples of reasons that can cause a water body to "suffer a relapse":

A body of water has become stable after two years of treatment. For inexplicable reasons a strong algae growth suddenly occurs. What has happened?

a) Nutrients got into the water.
This is possible for the following reasons:

- Flushed-out fertiliser as a result of rain.
- Foliage fell into the water in autumn and caused an increase in nutrients in spring.
- Aquatic animals (faeces)
- Re-dissolving of nutrients

If in doubt, an analysis can be carried out in order to closer examine and interpret the cause.

b) A heavy cloudburst has disturbed the pH-structure of the water.

In waters with low acid-bonding capabilities (hardness under 12° on the German scale of hardness, total hardness) just a heavy shower of rain causes sensitive micro organisms to lose their equilibrium through a change in the pH-value. Some of these micro organisms first have to be built up again. This occurs in particular in bodies of water with primary rocks and low lime content, because the water's ability to buffer is too low. Even though it is commonly recommended to add lime to the water, this method is totally wrong because the pH increase will cause bonded nutrients to be dissolved, which in turn will cause increased algae growth.

c) An increased or excessive use of the body of water (swimming or fishing lake) has disturbed the ecosystem.

On hot summer days, swimming lakes are heavily used and come under additional strain. An additional factor is the pollution with suntan oil and other substances. Under these conditions the water's self-healing powers are no longer sufficient.

If in doubt an analysis can be carried out.

d) The energy level is lowered and in turn a habitat for organisms on a lower level has been created.

The reasons for this can vary (environmental influences like ozone, UV rays, an increase in radio waves, cosmic influences, geomagnetic influences, lines of energy, etc.).

Again the energy level has to be balanced, all causes have to remedied by re-applying energised rock powder.

PLEASE NOTE:
There is no interruption in the effectiveness. The energy is compensated in whole or in part. The lost energy level can be raised again through re-application.

2.4 Remediation

2.4.1 Criteria

Which prerequisites have to be in place in order to carry out a water remediation with the Penergetic technology?

- The water body should still contain some micro organisms.
- The existing sludge should not make up more than half of the water body's total volume.
- The animal stock or swimming activity in the lake has to be appropriate for its size.
- Strong external polluting influences such as inflow from sewage works, highly contaminated drainage ditches or streams from agricultural land have to be eliminated or also cleaned up.
- Nature needs time. A remediation can often take years.

PLEASE NOTE:
Duration of pollution = duration of restoration! Only bodies of water where we can clearly evaluate the chances for success should be treated.

2.4.2 Type of remediation

Which parameters decide if a treatment with Penergetic or the water module (pipes) should be carried out?

There is no real general rule as to when quartz dust, calcium carbonate or pipes should be used. A body of water can only be evaluated very roughly in order to categorise it according to its potential energy level.

In principle it can be said that bodies of water with relatively low levels of pollution up to a size of 2 hectares can be treated without the water unit.

Decisive factors for the type of restoration are: several analyses of the body of water, an overall impression of the state of the water from an on-site inspection.

Important parameters

As mentioned earlier, there are plenty of parameters for the evaluation of a body of water, which have to do with the various cycles.

When signing our contract, the client commits to have a complete analysis carried out by an independent laboratory. After that we will carry out an on-site inspection and examination to be absolutely sure.
The following parameters can roughly decide if a restoration is promising and by which means it should be carried out.

- **Total-P**
  This is the main parameter for the catagorisation of eutrophication and pollution. If this parameter is higher than 0.084mg / l P (hypertrophic), then the water unit will be used. For eutrophic waters (0.018 – 0.084mg / l P) this depends on further parameters and the overall impression.

- **Nitrate**
  This is the main indicator for algae growth. If this parameter is above 10mg / l the water unit **should be used**; from a concentration of 50mg / l the water unit **must be used**.

- **Nitrite**
  Pure, unpolluted water may only contain traces of nitrites up to max. 0.001mg / l. It is harmless for humans, but toxic for fish even in small doses. It is always an important indicator for pollution if water contains nitrite. If the value is above 0.2mg / l the water unit should be used.

- **Sludge thickness**
  This is an important parameter for us, because sludge leads to the silting-up of bodies of water. From the sludge, nutrients are dissolved back into the water. If it is in a process of putrefaction then this influences the quality of water and the micro organisms in the water.

  So if the sludge / water height ratio is 1:10 the water unit should or can be used; if the ratio is 1:1 we will not carry out a treatment.

- **pH-value**
  The pH-value should always be between 6.5 and 8.5. Most aquatic life forms can deal with fluctuations within these limits. The pH-value on the one hand depends on the general pollution and on the other hand on the criterion of aerobic vs. anaerobic conditions. In general it can be said that upwards of a pH-value of 9 the water unit should be used.

- **Waste water and germ pollution**
  If these can be detected in any form, the remediation should only take place with the inclusion of a treatment of the causes (remediation of surrounding area)!

- **Fish stock, duck stock and other aquatic animals**
  Every water body has a certain maximum of living things that it can cope with on the water and in the water. There are no figures or data available on this, only limited information such as:

  The average daily faecal mass produced by humans is about 150g and contains 13×10^6 faecal coliforms and 3×10^6 faecal streptococci per gram. A duck excretes 336g with 33×10^6 faecal coliforms and 54×10^6 per gram daily. Theoretically 550m³ of water could be contaminated to its limits with the faeces of a single duck if all faeces entered the water.

  The carp family rummage in the mud and accelerate the re-dissolving of nutrients from the sludge into the water. This prevents the water from ever becoming clear.

PLEASE NOTE:
Our overall impression of the water body is important for treatment. If the water results are mainly negative; plenty of fish, duck, etc., we can always assume a treatment with the water unit.

A questionnaire for gathering data about a body of water can be found in the appendix.

2.4.3 Products for water remediation

We generally work with Penergetic-w for surface waters. However, other products from the w-series can be used with certain remediation projects.

Examples
Penergetic-w for wastewater can be used, for example, in order to stop bulking-sludge formation. This will cause the sludge at the bottom to be broken down quicker and more effectively by activating further sludge-eating micro organisms.

In this case Penergetic-w for wastewater, which has been mixed at an appropriate ratio with sand or similar, is scattered dry, thus reaching the bottom of the lake quicker. This method is recommended especially when fresh organic matter has entered the water (autumn, spring).

If germs or similar occur in a body of water, for example in a swimming lake, we can use Penergetic-w for groundwater.
The complete analysis of the water gives, in particular, an estimation of breakdown processes in the water and detects sources of pollution.

PLEASE NOTE:
Generally Penergetic-w for surface water is used for water remediation. Additional support for certain processes can be obtained from the information of groundwater and wastewater. Special information and other products are only applicable in exceptional cases.

2.5 Practical Use

2.5.1 Garden ponds

Tips for the treatment of water bodies

There is no easy solution for the treatment of surface waters. Experience is the best advisor in any case.

It is always essential to locate the cause of the dysfunction of the waterbody to be able to take measures accordingly.

Examples for this are:

- Influx of external nutrients from fields or tributaries
- Influx of chemicals through spraying agents, anti-algae products, chlorine etc.
- Influx of faecal matter from connected cesspools or even a sewage plant
- Overstocking with fish and their unnatural feeding
- Medicine or antibiotics from feeds
- etc.

Initial treatment:

Carried out according to season and problem:

The application should naturally be started in early spring before the algae bloom.
Generally the first dosage is given according to the brochure. If one wants to calculate the dosage for the initial application more exact, it can be done by using the formula:

Penergetic = [5-(log water surface)]x water surface.
The result is Penergetic-w for surface water in grams.

There is also a graph in the presentation folder that reflects this formula. From it we can read the optimal dosage for the initial application.

Contamination with algae

If a normal dosage does not succeed in reducing the algae, or if a contamination with algae was already in existence at the start of the treatment, an additional dose of Penergetic-w for wastewater can be used:

Mix Penergetic-w for wastewater with a maximum of 1g / m² of sand (at a ratio of 1:10) and sprinkle directly onto the algae.

Further treatment

14 days later apply Penergetic-w for surface water (1g / m²), prepared with water.

Repeat treatment as above after a further 14 days.

Then apply 1g / m² Penergetic-w for surface water monthly as outlined above.

During midsummer, the treatment should be carried out fortnightly if necessary. After heavy rainfalls it is advisable to repeat the treatment directly after the event.

Sludge deposits

During autumn (late October, early November) 2g of Penergetic-w for wastewater / square meter should be applied (when stocked with fish after fish harvesting), because even in natural waters the sludge is broken down at the lower temperatures of the winter. The accumulated biomass is therefore processed faster and the sludge is reduced.
Start with Penergetic-w for wastewater in spring (apply once), then re-treat every 2-4 weeks with Penergetic-w for surface water as required.

Caution with existing fish stock

Only the minimum dosage of 0.5g / m² Penergetic-w for wastewater should be applied. A higher dose can cause a lack of oxygen for the fish, especially if a heat wave should occur after the treatment, because of the stimulation of sludge breakdown.

2.6 Prerequisites for a successful treatment of water bodies:

- Good and constant customer care
- Sufficient specialised knowledge (especially relating to reactions triggered by the Penergetic technology)
- Selection of projects before start
- Inclusion of surroundings in remediation

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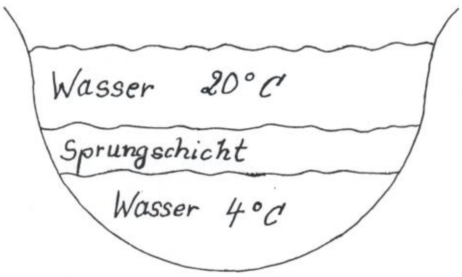
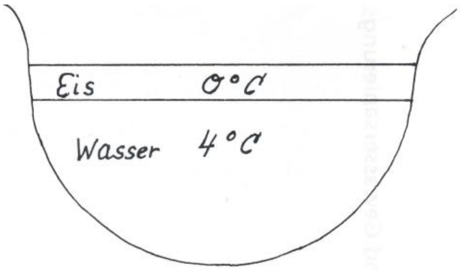
3 Illustrations for water remediation

The anomaly of water





water 20 °C
thermocline
water 4 °C

ice 0 °C

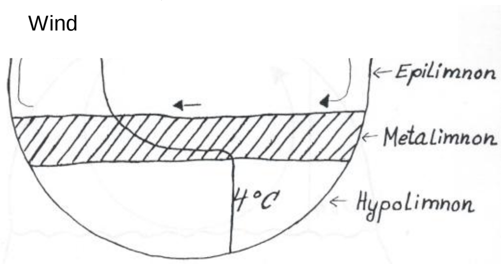
water 4 °C

Water is at its highest density at 4°C . This means that warm water as well as colder water and frozen water floats on the denser water.

In deeper zones water never cools down below 4°C which enables animal and plant life to survive and prevents waterbodies from freezing through from top to bottom.

Summer and winter stagnation

Wind

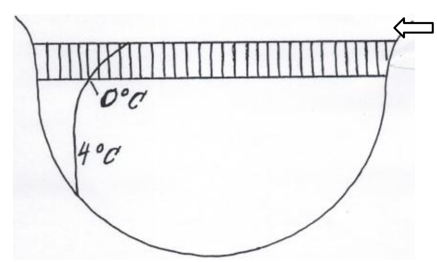


During summer stagnation, the water is divided into temperature layers. Only the warm top layer is set into circulation under the influence of wind. In the thermocline (metalimnion) the temperature declines rapidly. Below lies a rigid “stagnating“ layer with an even temperature.

wind

epilimnion
metalimnion
hypolimnion

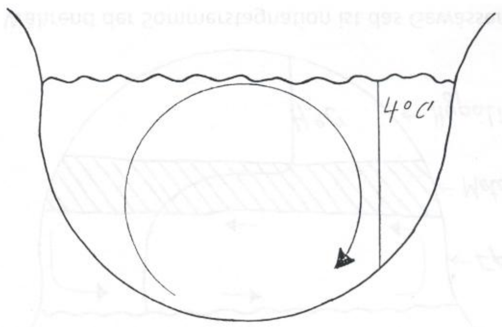
→→



ice

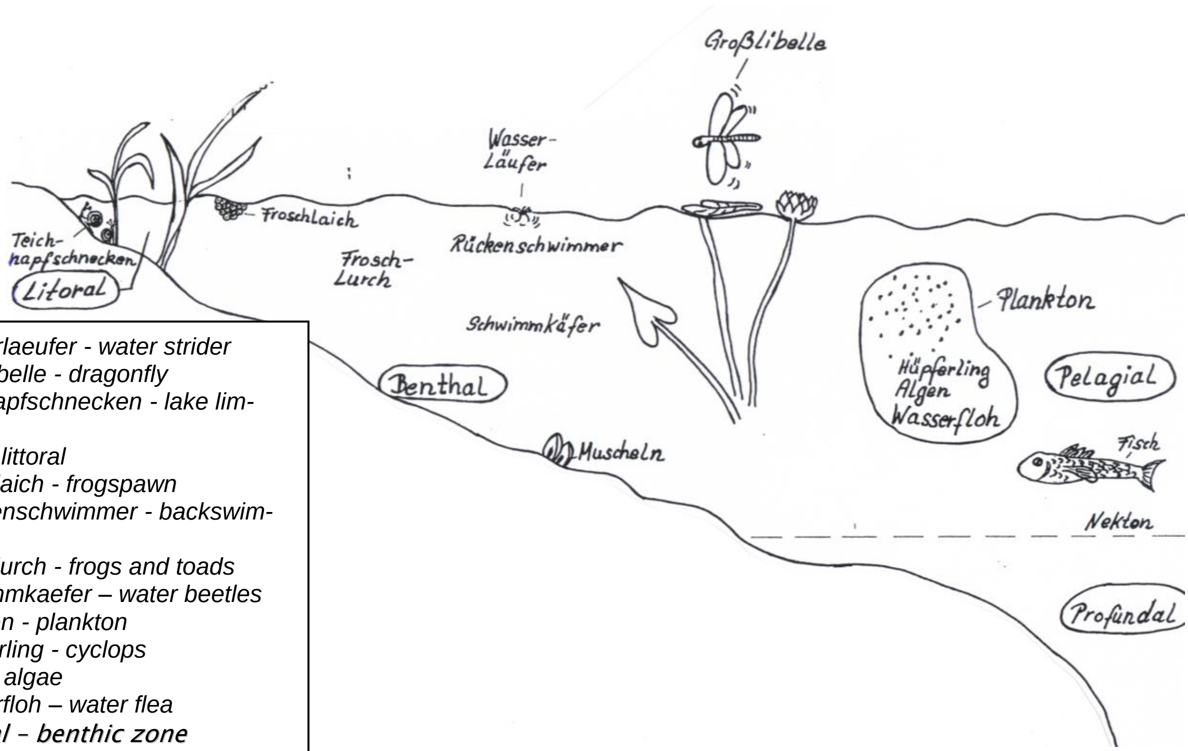
During winter stagnation, the water is in a state of rest. The colder water (ice) floats on the warmer water layer and isolates the deeper part of the water body. In this way, water life forms can survive. Problem: “oxygen consumption“.

Full autumn and spring circulation



During autumn and spring the temperature in a water body is even throughout. Because of the winds and gales during these times of the year the entire water body is circulated. This brings oxygen into the water and sludge that might have accumulated and nutrients are re-dissolved into the water.

Standing water bodies: pond, man-made pond and lake

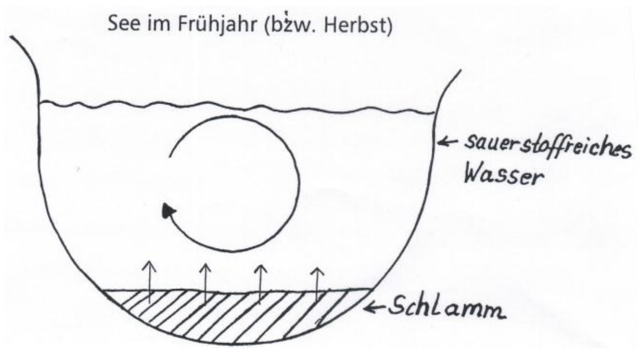


Wasserlaeufer - water strider
Grosslibelle - dragonfly
Teichnapfschnecken - lake limpets
Litoral- littoral
Froschlaich - frogspawn
Rueckenschwimmer - backswimmers
Froschlurch - frogs and toads
Schwimmkaefer – water beetles
Plankton - plankton
Huepferling - cyclops
Algen - algae
Wasserfloh – water flea
Benthal – benthic zone
Muscheln - mussels
Pelagial – pelagic zone
Fisch – fish
Nekton - nekton
Profundal – profundal zone

Natural and man-made ponds and lakes are standing bodies of water in which current plays very little role. Unlike in a stream, it is not only active swimmers such as fish that can exist in the free water (pelagic) zone, but also micro organisms that prevent themselves from slowly sinking to the bottom by flagellum-type movements. This world of suspended life is generally known as 'plankton' (multicellular animals, plants or bacteria). By comparison, active swimmers are referred to as nekton.

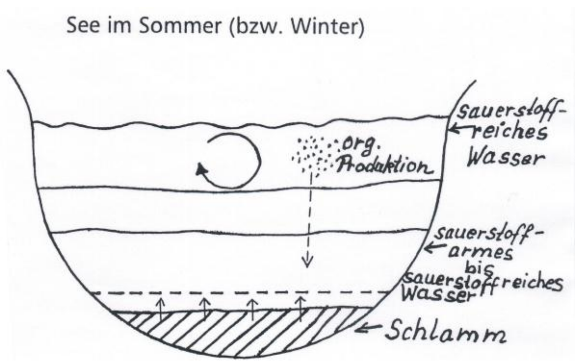
The bottom zone (benthic zone) of standing waters is structured in a characteristic way. It starts at the shore zone (littoral) which reaches from the dry edge that is still influenced by the water to the constantly flooded underwater meadows. Adjoining it might be a lightless depth (profundal) zone in which plant life is not possible.

Re-dissolving of nutrients in water bodies



The winds that prevail during these seasons cause an increased amount of nutrients to be re-dissolved from the sludge into the water and evenly distributed.

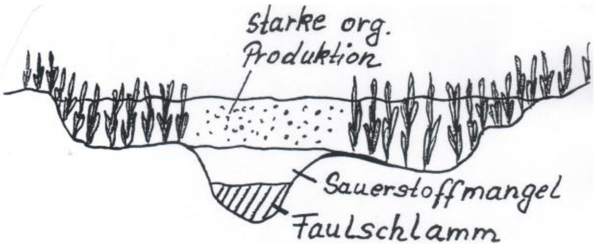
Lake during spring or autumn
oxygen-rich water
sludge



During the summer and winter stagnations, there is very little or no oxygen left at the bottom of the water body. Nutrients are accumulated at the bottom. An increased amount of organic matter is produced in the warmer upper layers which causes the sludge layer to grow. In a pond there is an additional problem with nutrients that are constantly, during the summer daily, re- dissolved because it is so shallow and does not have a temperature-layering.

Lake during summer or winter
oxygen-rich water
organic production
oxygen-low to oxygen –rich water
sludge

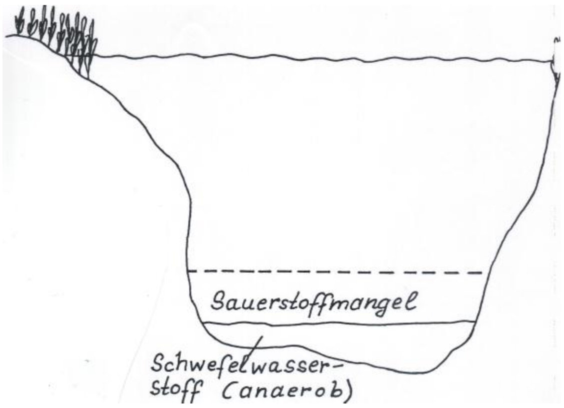
Basic properties of water bodies



intense organic production
lack of oxygen
sludge

Typical natural or man-made pond

Shallow stagnant water body with high organic production. Lack of oxygen sludge formation in deeper hollows.



lack of oxygen
hydrogen sulphide

Typical lake

Deep water with moderate organic production and resulting clouding. During the summer decreasing oxygen content with increasing depth because the accumulated organic mass is broken down in autumn or spring respectively.