BIO-BLOK® INTELLIGENT FIXED FILM BIOLOGICAL FILTER MEDIA

2.5.1. Aeration Plant

1. The hydrological cycle

Water is one of the most widespread substances in the world. Water makes 70-80% of a human being and our nourishment, and it cannot be replaced by another matter.

Approx. 60% of the surface of the earth is covered by water, but less than 0.5% of this water volume is ground water, surface water, and water in the form of vapour.

Part of the total volume of water forms part of the so-called hydrological cycle. In the atmosphere, the aqueous vapours condense to clouds which by further cooling will result in precipitation. Part of the precipitation will evaporate again, either directly from the surface via evaporation or through the stomas of the plants via perspiration. The remaining part of the water flows to the sea, either through streams via the surface water or through the earth via the ground water.

The water that is being used in households and in the industry has to meet certain demands. As the water is being used as drinking water, for cooking etc., and it sometimes forms part of products made in the industry, the demands can be roughly worded as follows:

The temperature of the water should be between 5°C and 15°C. The water has to be clear (colourless) without taste (tasting fresh), odourless, free of toxins and radioactive substances. Bacteria are only allowed in small numbers and pathogenic bacteria are forbidden.

The content of oxygen should be 5 mg oxygen/l when the water leaves the waterworks. This demand ensures that the water has a fresh taste.

In order to ensure that above mentioned water qualities are present when the consumers receive the water, different types of treatment plants are being constructed to treat the water. Common to them all are that they are build on a sand filtration.

The following types are the most common:

- Slow sand filters which are normally constructed as open sand filters
- Rapid sand filters which are constructed as open and closed sand filters
- "Pre-filters" which are used in combination with slow sand filters and rapid sand filters when the raw water is heavily polluted

The most common matters that are being treated in above mentioned treatment plants are iron compounds and manganese compounds, CO2, hydrogen sulphide, and methane.

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2. Iron compounds (ferro-bicarbonate)
Ferro-bicarbonate is the iron compound that comes into existence by the action of carbon dioxide on the iron sulphide in the earth.

$FeS + 2\ H_2CO_3 \rightarrow Fe(HCO_3)_2 + H_2S$ (hydrogen sulphide)

Please note the formation of hydrogen sulphide.

If water containing $Fe(HCO_3)_2$ is aerated, the ferro-bicarbonate will be converted into an insoluble compound (iron hydroxide).

$4\ Fe(HCO_3)_2 + \mathbf{O_2} + H_2O \rightarrow 4\ Fe(OH)_3 + 8CO_2$

Therefore, if a sufficient treatment (aeration) is not made, a bigger content of $Fe(HCO_3)_2$ (ferro-bicarbonate) in the raw water can give cause for liberation of $Fe(OH_3)_3$ in pipes and tanks where an aeration can take place. A co-instantaneous growth of iron bacteria can - at worst - clog up the water conduits.

The water will become turbid and gets a distaste, furthermore, the content of iron can come off on laundry.

Normally the aeration process takes place on the treatment plants of the waterworks in form of special filters which can be made of BIO-BLOK® 80 HD G. The quantity of $Fe(OH)_3$ is liberated and removed in the following sand filters. A content of 1 mg Fe++/l water requires 0.1 mg O_2/l for a complete aeration.

3. Manganese compounds (manganese-bicarbonate)
Manganese-bicarbonate is the manganese compound that comes into existence following the same principle as ferro-bicarbonate. By aeration of the insoluble matter pyrolusite (MnO_2) is formed.

The disadvantages with this compound are the same as by the iron compounds, however, the content of manganese in the raw water is normally smaller than the content of iron.

Iron and manganese are often found in the ground water.

4. CO_2
Of gasses CO_2 has been mentioned previously as this gas comes into existence in connection with the aeration of the iron compounds. The quantity of free carbon dioxide that is in the water depends on the hardness of the water (content of lime). Free carbon dioxide "attacks" lime and is aggressive, and it will cause a corrosion of the concrete pipes. Also iron pipes will corrode when the water is aggressive.

Therefore, it is extremely important that this CO_2 has been aired before outlet into the conduits.

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5. Hydrogen sulphide
As it has been made clear in above processes with regard to aeration of iron compounds, water gets a content of hydrogen sulphide by the conversion of iron sulphide into bicarbonate. In bigger quantities this gas will make the water malodorous and bad tasting and - at worst - even poisonous. The hydrogen sulphide is only removed in wastewater treatment plants with a high content of oxygen.

6. Methane
In certain stratums of earth anaerobic bacteria can form methane, CH4 of hydrogen sulphide and carbon dioxide. The content of methane in the water gives different sorts of drawbacks. By the influence of certain bacteria, the following process will take place:

$$CH4 + \mathbf{O2} \rightarrow CO2 + 2\ H2O$$

As a content of 1 mg methane consumes 4 mg oxygen, it is seen that only 2 to 3 mg methane per litre raw water consume the volume of oxygen that is possible to supply to the raw water by the process in the aeration towers in the waterworks. Therefore, it is difficult to get the liberation of iron and manganese to take place.

This water deficient in oxygen will get a mouldy taste and at the same time the mentioned growth of bacteria will result in a clogging up of the filters of the waterworks.

Therefore, the content of methane, the content of hydrogen sulphide, and aggressive carbon dioxide, if any, have to be removed before the further treatment in the waterworks.

As described, it is important to the efficiency of the waterworks in the wastewater treatment plant that there is a high content of oxygen in the water.

Therefore, the first treatment that the raw water is subject to is an aeration that partly serve for giving the water a sufficiently big content of oxygen and partly serve for the iron and manganese bicarbonates being able to convert the heavy-soluble compounds iron hydroxide and pyrolusite and also cause a liberation of the mentioned gasses.

The aeration of the raw water can take place in different ways, and it is the content of the mentioned matters and gasses in connection with the degree of hardness that is decisive for how heavy the aeration should be.

Besides compressed air and chemical aeration, free fall and oxidation steps are being used for aeration of raw water.

A new method for aeration of raw water and following improvement of existing and new waterworks has now been developed.

The method is very simple as the raw water instead of the mentioned aeration is spread over net tubes that are welded together to blocks and placed horizontally. These together-welded net tubes are made of polyethylene and are called BIO-BLOK® 80 HD G.

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Tests have proved that if you let water flow down over a horizontally placed BIO-BLOK® 80 HD G, 10% to 50% more oxygen is supplied than what the water can absorb if falling freely from the same height.

At the same time the water is degassed heavily.

It has also been proved that the big surface of BIO-BLOK® 80 HD G has a catalytic effect on the precipitation of iron and manganese compounds. The speed of precipitation can thus increase by a factor 10 to 100.

These conditions are with great effect used for aeration and treatment of drinking water in waterworks in which aeration steps or similar aeration systems for raw water are installed. By installing BIO-BLOK® 80 HD G in existing and new aeration plants for raw water, the lift for raw water can be lowered or the aeration and treatment effect can increase heavily. In most cases, much money can be saved by a reduced consumption of energy.

EXPO-NET's BIO-BLOK® 80 HD G for aeration of tap water has the following qualities:

BIO-BLOK® 80 HD G

- Requires only a filter to disperse the water.
- High percentage of oxidation as the water is effectively broken.
- Smaller water lift as the air is lead through the horizontally placed net tubes and thus gets in touch with millions of water drops.
- Requires no expensive box constructions as the BIO-BLOK® products are constructed as self-supporting modules.
- Made from the imperishable and environmentally compatible material - polyethylene.
- Polyethylene has been approved for use within the food industry.
- Easy to handle.
- Easy to adjust to both existing and new plants.

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Technical Specifications	
Type of filter media	**BIO-BLOK® 80 HD G in smooth version**
Specific surface (m2/m3) (approx.)	80
Area of flow (approx.)	70%
Percentage of hollow space (approx.)	90%
Tube diameter	70mm
Standard module form	54x54x55cm

The surface measurements have been calculated by the producer. Alterations in process, material and structure may slightly change the figures above (by up to 10%)). Above filter media are available with densities of approx. 0.5 and 0.95.

BIO-BLOK® 80 HD G is available in heights (lengths of block tubes) from 45cm to 75cm.

7. Dimensioning of aeration plant with BIO-BLOK® 80 HD G

The dimensioning of an aeration plant depends on many factors. The most important are as follows:

* The content of oxygen in the raw water
* The content of iron and manganese in the raw water
* The content of CO2, hydrogen sulphide or methane in the raw water
* The content of toxins as e.g. choleric solvents in the raw water

Depending on above factors, we can as a minimum recommend that 1 m3 BIO-BLOK® 80 HD G is used per 10 to 30 litre raw water per second.

10 to 30 litre per second x 1 m3 BIO-BLOK® 80 HD G

The conditions of a good result with above mentioned minimum volume of BIO-BLOK® 80 HD G are simple as the best result is achieved by a good distribution of the water through the BIO-BLOK® products. In this way the water is "broken" most possible and the biggest possible contact to the oxygen of the air is achieved. At the same time the gasses in the raw water, if any, are effectively aired.

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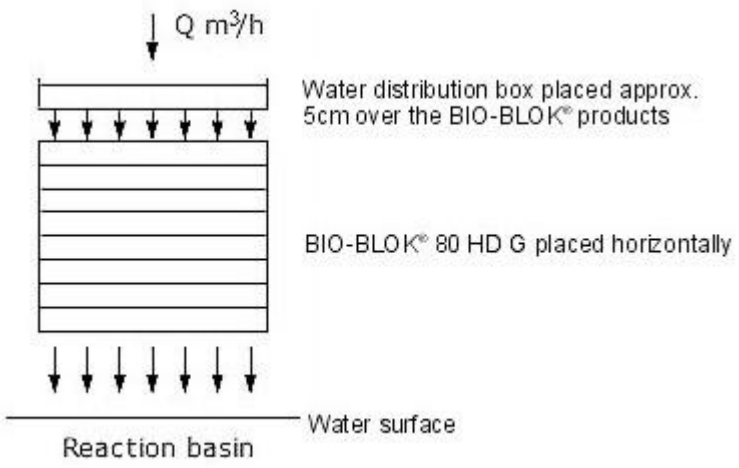
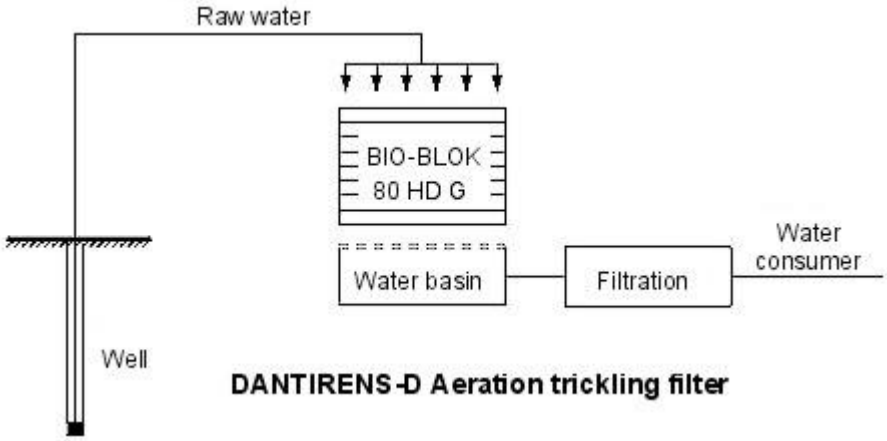
The raw water can be spread over the BIO-BLOK® products through e.g. a perforated box of stainless steel, plastic or the like. Depending on the volume of water, the holes should be 4mm to 8mm in diameter at intervals of approx. 5cm between the holes. The box has to be constructed in such a way that it is possible to clean the holes as they in time will clog up.

Instead of perforated plates, it is possible to use different types of dish spreaders or similar products.



Principle drawing of aeration/degassing of raw water



Process diagram

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