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# Hydrostatic Load Influence on Water Oxygenation Process

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**Abstract**

The paper presents the influence of the water height layer on the dissolved oxygen concentration. The connection between the dissolved oxygen concentration in water, the water height layer and the oxygenation process efficiency are presented. The increase of dissolved oxygen concentration in water function of time, the efficiency and effectiveness of oxygenation process for different hydrostatic load, are theoretical determined. The computing results are compared with the values of experimentally measurements. The performance of the oxygenation plant increase with increased water layer height above the fine bubble generator.



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*Keywords:* fine bubbles generator, dissolved oxygen in water;

## 1. Introduction

Water oxygenation processes are aimed to increase or to maintain high or optimum level of dissolved oxygen in a water body which is to be used in many fields, including medicine, agriculture, fisheries etc.

Oxygenation devices used for air dispersion in water are: mechanical devices, pneumatic or mixed devices; it may disperse air, pure oxygen or ozone.

The most used are pneumatic devices, due to its effectiveness.

For an efficient water oxygenation, it is necessary to ensure a uniform dispersion of the air throughout the water body located in a container or in a tank [1]; air must be uniformly distributed so as to provide the necessary oxygen required for the process [2-3].

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A classification of oxygenation systems that use bubbles generators is made by the bubbles size [2]:

a) fine bubbles generators: less than one millimeter;

b) medium bubble generators: 1 ... 3 mm diameter;

c) large or coarse bubble generators: 3 ... 120 mm.

Bubble sizes depend on the air outlet nozzles diameter, the pressure and the air flow rate within the distribution network [4-7].

The size of the emerging bubbles is a function of the surface tension, the size of the orifices and the air flow rate through the FBG. In [8] the authors define the critical pressure as the pressure required for the formation of the first bubble through the FBG orifice. It depends on the FBG structure, its geometrical characteristics, the number and the diameter of the orifices and the water height.

In [9] is indicated that the influence of the hydrostatic pressure is negligible.

Several recent publications provide a summary of the performance of air injection systems with fine bubbles [10-13].

According to these authors, the main parameters influencing oxygenation performance are:

- The density of the diffusers;
- The air flow rate;
- The hydrostatic load;
- The horizontal velocity of the water.

In [14] the authors did not observe any significant variation of bubble size as a function of the water height (for a height of water varying from 1.55 m to 3 m) for the same measurement point (1.25 m above the diffuser).

A hydrostatic load in an oxygenation process is the load exerted by the existing water mass above the fine bubble generator, i.e., the height of the existing water layer above the GBF.

## 2. The connection between the dissolved oxygen concentration, the water layer height water and the oxygenation process efficiency

The main results published in the specialty literature on the influence of water layer height on the oxygenation process in clean water with constant air flow rate, present a variation of the oxygenation process efficiency based on the water depth [15].

Starting from the basic oxygen transfer mechanisms, the theoretical models which incorporate variations in the dissolved oxygen concentration in water and the water depth is in the form of the relations [16]:

- Using the exchange surface:

$$a = \frac{a_0}{\left[1 + z\left(H - h\right)\right]^{\frac{2}{3}}} \tag{1}$$

- Transfer coefficient:

$$k_L = k_{L_0} \exp(-0.0013(H - h)) \tag{2}$$

- The oxygen concentration at saturation:

$$C_s = C_{s_0}[1 + z(H - h)](1 - \eta_h) \tag{3}$$

where:

a - interfacial surface of mass transfer;

z -the variable height at which the bubble is located function of the FBG perforated plate surface of [m];

H -the water layer height [m];

h - the local height of the air bubble during the ascent to the water surface [m];