

## NOTES ON NANO BUBBLES

Following the experience gained in the realization of emulsifiers for water-fuels WiFNE (Water in Fuel Nano Emulsion) and in the field of bioremediation, we have created an industrial generator of nano bubbles of any gas or air in water, which, from analyzes performed with the culter, were found to have the following dimensions:

- Average particle size 400 nm
- Maximum size 900 nm
- Percentage of particles <1000 nm = 90% allowing flow rates of even a few tens of cubic meters / h, where 30% is gas.

Nano bubbles have some important peculiar properties:

- are negatively charged, keeping themselves separate, thus slowing down or canceling the rise to the surface (zeta potential);
- are subject to the Brownian Movements;
- have a very high internal pressure of about 30 bar;
- they have a very small surface compared to the volume of the contained gas;
- have a long stay in liquids, they open when the external environment
- is lacking in oxygen;
- have a great solubility of the gases contained, favored by the greater
- internal pressure which facilitates their dissolution in the receiving body, making them immediately available

Thanks to this it is possible to insert quantities of oxygen higher than the natural saturation, which dissolves in the receiving body, guaranteeing an environment suitable for the development and work of aerobic bacteria which are more active and odorless than the anaerobic ones.

The nano bubbles do not rise to the surface except in a minimal percentage and dissolve in the water only within the limits of the maximum saturation possible under the given conditions, remaining in the liquid for even a prolonged period, a few weeks. Obviously, in situations of strong bacterial activity, dissolved oxygen is used by progressively reducing the saturation which the nanobubbles reintegrate thanks to the high pressure and contact surface, restoring an optimal situation.

The advantages of the treatment with air nanobubbles, compared to traditional forced oxygenation, not only generate a lower cost, but also a greater effectiveness as oxygenation can be prolonged over time and space, affecting a greater volume of water. even distant from the point of release.

Obviously, in the process we also have the production of micro and milli-bubbles that slowly rise to the surface, and if required they can be eliminated by stripping using a nano-bubble concentrator.

## APPLICATIONS

The versatility of the system allows for an integrated system capable of achieving the required objectives, in a variable period of time depending on the state of contamination of the soils, aquifer and technologies used, which provides for the stimulation of the microbial flora.

The nano bubble generator is widely used:

- in Bioremediation:
  - of waters and sediments, marine and lacustrine
  - groundwater
- in fish farming
- various industrial applications
- in waste water treatment:
  - in the oxidation tanks
  - the abatement of the bacterial load leaving the plant, as with our cutter mix we are able to reduce any element to dimensions <1  $\mu$  thus killing the bacteria as well.

## BIOREMEDIATION OF MARINE AND INTERNAL WATER

Both marine and lake waters are complex ecosystems in which an increase in organic load and temperatures generates imbalances, triggering the onset of eutrophic phenomena, as well as putrefactive and reductive phenomena in organic sediments with the formation of foul-smelling gases and turbidity of the water.

Oxygenation with the NabReLife System is a natural, economical, fast and low-impact method of bioremediation even with the activities present.

The objectives are:

- oxygenation of water to counteract eutrophic phenomena

- the revitalization of the indigenous sediment matrix by favoring the increase of degrading microorganisms with consequent regression of pollutants and organic sediments.

The water is sucked up by means of a ground or submerged pump, and its release, loaded with nano bubbles, takes place at a variable depth.

Sediment treatment can also be combined with or implemented by applying natural calcium carbonate of fossil origin (Coccolite), finely ground with high porosity, **AV-BioStim**. This, scattered on the surface of the water, by sedimenting has an initial mechanical action, bringing with it the suspended solids and, once it reaches the sediment, it triggers a bioremediation action by stimulating the growth of indigenous degrading microorganisms, favoring biological rebalancing.

### GROUND WATER TREATMENT

This treatment can be implemented in consecutive phases depending on the state of contamination of the aquifer and soil by:

- Oxygenation
- Adding nutrients
- Balancing of the CNP ratio by adding Carbon
- Inoculation of autochthonous or allochthonous bacterial strains

The system is applied by capturing groundwater from one or more downstream wells and fed into one or more upstream wells, after having been enriched with Nano bubbles and anything else necessary.

This makes it possible to make available the oxygen present in the nano bubbles which will be released in the presence of the pollutants. The treatment continues even outside the limited area, ensuring its effectiveness over time.

### PISCICULTURE

The application of nano bubbles in land-based fish farming systems, both in the lagoon and in the tank, generates multiple advantages:

- Improvement of water quality by increasing dissolved oxygen
- Faster fish growth
- Reduction of treatment operating costs
- Reduction of costs for the purchase of oxygen, whether it is replaced by air or dissolved in water through the NAB ReLife System.

The treatment with air is indicated for adult species, as the nitrogen content would be harmful to the fry and fish in the intermediate stages of growth.

The system can be successfully used in the diffusion of gaseous oxygen in the tanks, as it cancels its dispersion in the air, generating savings of over 78%, significantly reducing the operating cost.

### WATER TREATMENT PLATS

Starting from the principle that the smaller the bubbles, the greater their oxidation power, it can be deduced that the nano bubbles find a natural field of application in the oxidation tanks of biological plants.

Currently, oxidation takes place through the direct introduction of air into membrane beds capable of releasing bubbles between 1 mm and 3 mm in size. The nano bubbles produced by AVKEM are 6 orders of magnitude smaller, that is a million times smaller than those currently used.

The same mixer, placed at the outlet of the system, allows you to cut and destroy the bacterial flora present, effectively reducing the battery charger with a reduction in the use of chlorine.

### FERTRRIGATION AND HYDROPONICS

In this case, multiple studies have shown greater effectiveness in the germination process and a significant increase in growth (around 25%) and a reduction in water demand between 5% and 10%

Below is the table that indicates the quantity of O2 transferred to the soil depending on the water flow rate

FLOW RATE		AIR		O2	
cm/h	%	cm/h	%	cm/h	Kg/h
<b>0,5</b>	12 %				
<b>1</b>	13 %				
<b>3</b>	15 %	0,90	19 %	0,171	0,23
<b>6</b>	18 %	1,80	19 %	0,342	0,45
<b>10</b>	22 %	3,30	19 %	0,627	0,83
<b>15</b>	25 %	7,50	19 %	1,425	1,90

## THE NANO BUBBLE GERATORS

Di seguito la tabella con le tipologie standard dei generatori di nano bolle prodotti e venduti.

Su richiesta è possibile realizzare macchine con portate diverse, anche superiori a 30 mc/h.

Le dimensioni della macchina si intendono senza quadro elettrico.

I motori elettrici sono asserviti ad Inverter.

FLOW RATE MC/h	MOTOR		DIMENSION cm	WEIGHT Kg	
	Kw	Consum .			
<b>0,5</b>	<b>1</b>	2,2	< 0,7	120 x 30 x 20	25
<b>1</b>	<b>3</b>	3	< 1,2	125 x 35 x 25	30
<b>6</b>					
<b>6</b>					
<b>6</b>	5,5	1,5	130 x 40 x 40	50	
<b>10</b>	5,5	2,4	150 x 50 x 30	80	
<b>15</b>	7,5	3,5	160 x 50 x 35	100	
<b>30</b>	18	6,8	180 x 80 x 70	150	

