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Fresh Water at Your Fingertips

A revolutionary invention from Nanoseen, a nanotechnology startup headquartered in Poland, is likely to soon help solve the widespread problem of access to clean, fresh water

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The water-supply crisis is affecting more and more countries around the world, as the problem of drinking water shortages continues to grow. The root cause is climate change – largely caused by increasing greenhouse gas emissions released into the atmosphere year after year. This is leading to record heat waves, droughts, and fires on thousands of hectares of grasslands and farmland. It is estimated that by 2025, half of humanity will live in regions suffering from severe problems with access to drinking water and water needed to grow crops. The Earth is known as the "Blue Planet" because as much as 71 percent of its surface is covered by water. The largest share of the planet's water, at 97.5%, is saltwater in the seas and oceans. The remaining 2.5% is fresh water, of which only 0.1% is suitable for human consumption.

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The scale of the problem with potable water can be illustrated by the figures for average annual amounts of freshwater per capita. In Europe, this value stands at around 4,500 cubic meters, while Poland has about 1,600 cubic meters per capita, which puts our country in one of the last places in Europe in terms of freshwater resources. These figures are proof that the water-supply crisis is no longer just a problem for African or Asian countries, but is also starting to affect European countries.

Without water, there can be no life. The water-supply crisis can be expected to trigger increasing migrations of people and problems with labor, crop cultivation, food production, and hygiene (the spread of numerous diseases). Industries will face difficulties in manufacturing many products, including clothing, medicines, and cosmetics. Climate migration is already a reality, and the issue of water in agriculture is affecting many countries today, such as China, the United States, and southern European countries. Unfortunately, the water-supply crisis is truly becoming real and tangible, and it is only set to escalate. In Poland, on average, 100 liters of water is consumed per person per day. But note that only 13% of this amount is used by households, whereas a staggering 72% is used by industry, accounting for the largest share of water usage. Although Poland is a country where we still do enjoy good access to drinking water, according to increasingly warnings from hydrologists, the quantity of available and – most importantly – clean fresh water will be declining.

One of the methods for increasing the resources of drinking water worldwide involves treating unpotable water, e.g. by chlorination or ozonation. However, this is associated with high costs and often results in inadequate removal of impurities. Another method is the desalination of seawater, which may for instance proceed via the reverse osmosis or distillation processes. Unfortunately, the efficiency of these processes is very low, hence the costs of desalination are very high.

Nanomaterials

Our team at Nanoseen, an innovative nanotechnology startup based in Gdynia, Poland, has developed a state-of-the-art method for purifying and desalinating water of varying levels of contamination. Nanotechnology is the science of developing and applying various types of nanomaterials – chemical compounds and materials on the scale of individual atoms and molecules, ranging in size from 1 to 100 nanometers. Nanomaterials may take the form of zero-dimensional quantum dots, one-dimensional tubes, two-dimensional layers, or three-dimensional nanocrystals. Due to their increased specific surface area, nanomaterials may exhibit quite different properties as compared to the very same materials on larger scales. It is also possible to modify the structure of nanomaterials,

The Generation 1 NanoseenX mobile device

such as by functionalizing them with chemical elements, to improve their physicochemical properties or impart completely new ones. Such measures make it possible to tailor nanomaterials to a specific reaction, process, semi-finished product, or final product. The nanomaterials obtained by Nanoseen – which include graphene, carbon nanofibers or microfibers, metal–organic frameworks (MOFs), and many others – are characterized by nearly 100% purity, high homogeneity, and unique physicochemical properties, including extremely high efficiency of synthesis reactions.

NanoseenX is a groundbreaking solution based on nanomembrane technology, which allows water to be purified and desalinated using only the power of gravity, without the need for additional energy pressure in the filtration process. Thanks to nanomembranes, water suitable for drinking can be obtained in as little as two minutes. The solution is designed to create independent mobile installations. During the development of this innovation, we are bearing the issues of cost and cost-effectiveness firmly in mind: if producing such a product on a laboratory scale proved to be too expensive, it would not be possible to scale the product up for industrial use. Additionally, these membranes are biodegradable, environmentally friendly, and – given the lack of energy consumption during their application – carbon dioxide emissions are avoided.

Nanoseen technology

Nanoseen's labs have developed 20 different types of nanomaterials, used to create mixed matrix solutions, which are the main component of NanoseenX nanomembranes. Currently, 30 different types of nanomembranes have been developed, differing primarily in terms of the type of nanomaterials used to make them. This makes it possible to select specific nanomembranes in order to remove a particular type of contaminant present in the intake water. NanoseenX technology consists of three sections:

- separation of solid contaminants, i.e. suspended solids or colloids,
- a system for purifying water from macromolecules, detergents, dyes, microplastics and heavy metals,
- a system for desalinating water from group I and II metal cations and also removing nanoplastics.

The essence of our solution lies in both the nanomembranes and the materials from which they are made, as well as the cascade sequence in which these nanomembranes are arranged within the particular water filtration device.

Our nanotechnology is fully scalable. Different sizes, thicknesses, and shapes of nanomembranes can be obtained, tailored to the needs of the end users. This versatility allows NanoseenX to be used in industry as well as standalone mobile devices at home. Our first customers are countries grappling with a water crisis, both in Africa and Asia (such as India, the Philippines, or Singapore). The cost of the entire mobile unit is lower compared to the desalination devices currently available on the market. Costs are calculated to ensure the device is affordable for all social groups worldwide. Importantly, low production costs are achieved through the use of our own proprietary methods of synthesizing nanomaterials and nanomembranes.

The company is currently working on adapting the aforementioned nanomembranes and filter sets to handle a wider spectrum of organic and inorganic contaminants and to a higher degree of water salinity. Gravity/flow filters are currently being implemented on an industrial scale in Poland. Although their capacity is now about 6 m cubic meters per hour, the goal is to achieve a capacity of 6 m cubic meters per minute, which is already very satisfactory on an industrial scale.

Responding to crisis

In response to the crisis, our mission is to create technology capable of purifying all types of water from seas, rivers, or lakes, to provide people worldwide with access to clean drinking water. In the future, we also want to use our technology to purify other

liquid industrial fractions to minimize the emission of post-manufacturing pollutants into the natural environment. We want to create both industrial-scale installations and mobile devices (mini water desalination plants), providing people with drinking water in villages and cities. The design of the water purification and desalination installation looks slightly different in each of these cases because it must be properly tailored to the customer's needs. More specifically, each project must be individually adjusted to the physicochemical parameters of the treated water or parameters of industrial processes, including salinity, type of pollutants, quantity of flow, type and duration of the process, regeneration time, etc. For example, one country in Africa may need a solution mainly for purifying rivers and other water reservoirs, while other African or Asian countries may focus on desalination installations in smaller villages and on an industrial scale.

The insulation and casing of our mobile devices with NanoseenX technology protect the nanomembranes and purified water from variable weather conditions, so they can be used anywhere in the world, irrespective of climatic zone, including in households, on farms, or even on the beach. They take the place of the large and expensive water desalination installations currently available on the market, which many countries simply cannot afford. The current cost of building a water desalination plant averages around $1 billion USD. Unfortunately, the figure is often higher because the cost depends on the size of the plant. Due to its low price, our product can provide people worldwide with unlimited access to drinking water. At present, 55% of the global water desalination market is uses reverse osmosis (RO) technology, which is now the most popular method. The cost of the entire desalination process is calculated in dollars or euros per liter. Our technology is on average eight times cheaper than reverse osmosis technology and is currently the cheapest water desalination technology in the world. This is with all costs taken into account, including the price of the device, membranes, and their replacement costs, etc. The exact price of the filtration set depends, of course, on the type of water to be filtered, the level of contamination and/or salinity.

Without a doubt, a significant advantage of our NanoseenX nanomembranes and filtering systems is that they can also cleanse water of micro- and nanoplastics, as well as bacteria and viruses. Our technology also allows the retention of impurities and ions of light and heavy metals inside the membranes, making it possible to release, regenerate, and reuse ions of particular interest – such as lithium, magnesium, or copper. This is an extremely valuable property of our nanomembranes, especially in times when specific metals essential for battery production or widely used in the chemical and pharmaceutical industries are in short supply. The use of our product will thus reduce the costs of raw materials acquisition and make it possible to establish a closed loop in the industrial process.

The Generation 2 NanoseenX mobile device

In the context of the current crisis on Poland's eastern borders and the rising climate disasters, such as fires of forests and agricultural fields caused by droughts and water shortages, our mobile devices for water purification and desalination could significantly improve the quality of life for people affected by war or climate migration. The ability to selectively configure the replaceable filter segments will make the product universal and effective in all conditions. Thus, we will be able to provide people with the resource that is most precious, but which is often neglected – clean, fresh water. ■

Nanoseen

is a team of enthusiastic nanotechnology scientists working to demonstrate the extraordinary properties of nanomaterials and to create products to help solve many problems related to climate change. Nanoseen is a pioneer in creating the next generation of cutting-edge nanotechnological solutions – combining breakthrough research with state-of-the-art technologies to apply nanotechnologies in a wide range of industries.