

## **AQUAKULTUR ALS EIN ÖKOSYSTEM – AQUAPONIK MIT MEMBRANBIOREAKTOR**

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## **AQUACULTURE AS AN ECOSYSTEM - AQUAPONICS WITH MEMBRANEBIO REACTOR**

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*Together with the Ben Gurion University (Israel) and the company Busse GmbH (Leipzig), the Solar Initiative Mecklenburg-Vorpommern e.V. has developed a new system for sustainable aqua and hydroponics (aquaponics with biomembrane reactor). The developed aquaponic facility makes it possible to breed fish and plants independently of other resources. Wherever people live, they also produce wastewater. This water can serve as the basis for the production of food (fish and plants).*

### **1. State of knowledge - aquaculture**

Fish plays a special role in a healthy diet, especially because of its components: fats, omega-3 fatty acids (at least two fish meals per week), fish protein (amino acids), proteins (human needs at least 0.8 g / kg body weight), minerals. Compared to whole grains and vegetables in terms of

ingredients, fish ranks first or second in many areas. The increasing demand for fish as a food has led to the installation of aquaculture worldwide as catch quotas have been declining for many years. The deficit between demand and catch can only be covered by aquaculture facilities.

These aquacultures are characterized by:

- Breeding under controlled conditions

Examples of such systems are commercially operated trout or carp ponds. The fish produce feces, which are rich in nutrients for plants.

- If they are not disposed of, but instead fed into adjacent bodies of water, this can lead to eutrophication: the high supply of nutrients leads to a massive increase in algae, bacteria and plankton. The equilibrium of the water is out of joint.

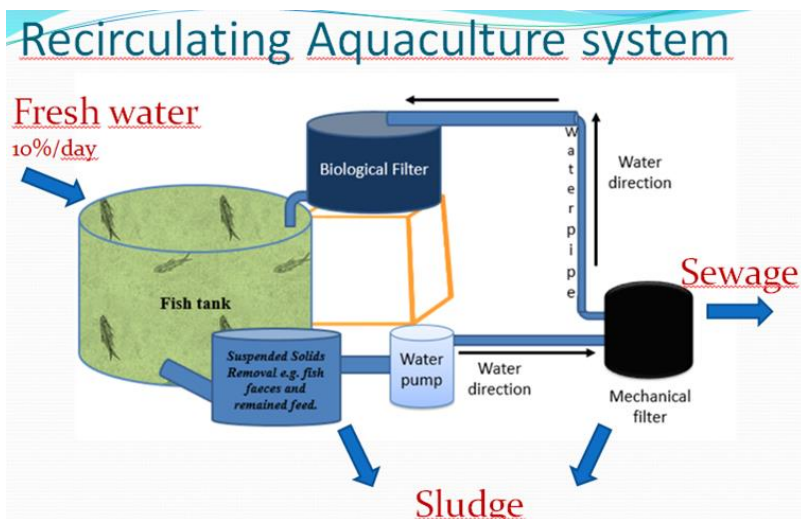
- In the worst case, the body of water can "tip over", which leads to the death of all its inhabitants who are dependent on oxygen.

For controlled fish farming in aquaculture facilities, the factors of feed utilization and water demand are important. Here the fish comes first.

Sustainability		Milk	Fish (Aquaculture)	Eggs	Chicken	Pigs	Cattle
Feed conversion	kg feed/kg	0,7	1,5	3,8	2,3	5,9	12,7
Protein contained	%	3,5	18	13	20	14	15
water demand	l/kg	1000	300	3300	3900	4800	15500

Pond management has been practiced for centuries and, despite modern technology, still has risks and disadvantages. In order to ensure a sufficient oxygen content in the water of the ponds, large areas, considerable water exchange rates or lower stocking quantities are necessary. Far more important here is

the risk of disease. Even with constant monitoring, infections can occur, which can lead to damage or loss of the population. The stocks in extensive pond farms also grow quite unevenly due to the uneven distribution of feed. Weather influences such as heat, cold, flooding, drought and storms can contribute to slower growth, lead to the loss of parts of the stock or kill all fish.



Modern circulation technology tries to solve the problems of normal aquaculture in the open air through the use of pumps, mechanical and biological filters, oxygen supply as well as alarm and control systems. Antibiotics are very often used due to the high population density and the risk of disease. The fresh water use of up to 20% of the tank volume, which is also required in aquaculture systems, and the disposal of the waste water and sludge (residual feed, excrement) are additional problems. In particular, reheating the fresh water can lead to considerable additional costs.

In aquaponics one goes one step further and tries to copy the natural cycle by breeding fish and plants in parallel.

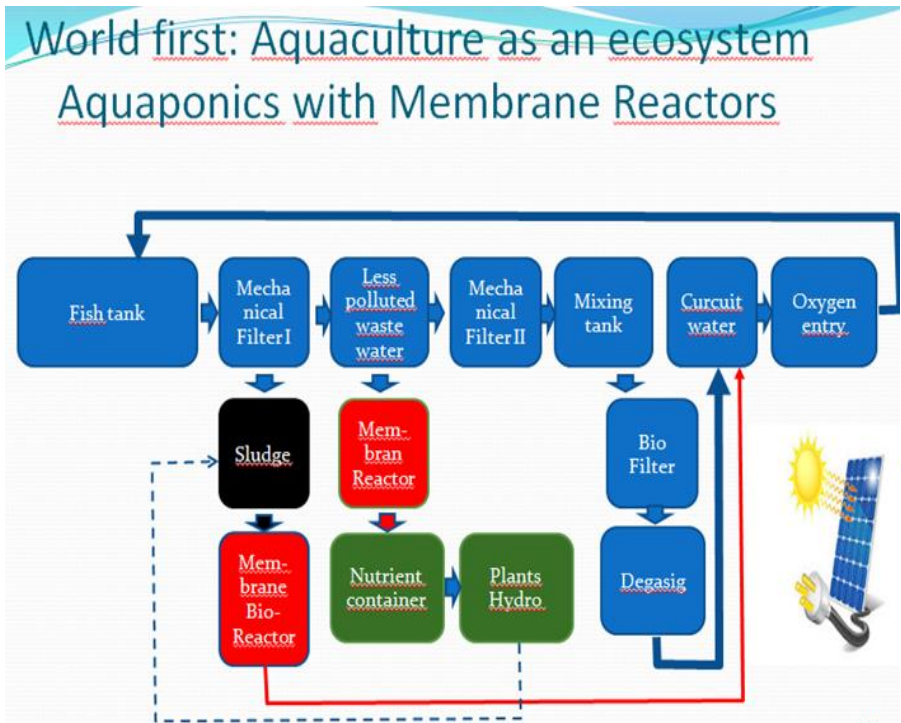
Aquaponics refers to a process that combines the techniques of rearing fish in aquaculture and the cultivation of useful plants in hydroponics. The fish and crops are grown in largely closed water and nutrient cycle systems. Automated management can be implemented. The basic idea of aquaponics is to use all waste materials from the aquaculture system, such as faeces and carbon dioxide from fish farming, as nutrients for vegetable production. Ideally, a closed system is created that works completely emission-free.

## **2. The new aquaponic unit with membrane bioreactor**

The experience of Ben Gurion University (the only desert university in the world) with aquaponic systems to reduce fresh water requirements by using brackish water in combination with aeroponics (substrate-free plant cultivation, in which the roots are constantly wetted by an aerosol of fertilizer made from water and nutrients produced with the aid of ultrasonic atomizers ) and the patented solutions of the company Busse GmbH (membrane bioreactors) for the purification of water in closed aquaculture systems form the prerequisites for a technological change for aquaponic systems. In the bioreactors, 100% of the purely biological hydrocarbon chains of the waste water (sludge) are absorbed, i.e. converted to carbon dioxide and water.

The results obtained in the field test show the advantage of membrane technology compared to the cleaning performance of previously used biofilters in standard aquaculture systems.

		Treatment efficiency (%)	MBR results		normal Biofilter		Efficiency
		MBR certificated	mg/l	mg/l	mg/l	mg/l	Biofilter
			Inlet	Outlet	Inlet	Outlet	%
COD	Chemical Oxygen Demand	96,8			43	6,00	86,05
BOD5	five-day biochemical oxygen demand	99,7	307	< 2	16	8,00	50,00
SS	suspended solids	99,5	389	2			
NH4	Ammonia	97,9	39	< 1	55,44	25,10	54,73
Ptot	total phosphorus	98,1			4,99	2,70	45,89
FC	faecalcoliforms	99,99			590	56,00	90,51



In the present pilot project, we are building a sustainable circular aquaculture system with decoupled hydroponics and operating it for information, demonstration and training. In addition to the functional components for innovative system components in aquaponic systems (bioreactor, fish water treatment with mixed water tank, industrial water treatment, drinking water module) and various hydroponic technologies, the quality assessment of the fish and plant products plays an important role.

Various types are available to demonstrate the variety of possibilities for effective hydroponics (partly based on NASA experience in the area of space shuttle programs in space). The hydroponics include the cultivation of vegetables, medicinal plants and useful plants. All currently known hydrotechnologies are used:

- Nutrient film technique
- Ebb and flow
- Aeronics (spray systems)
- Drip irrigation
- Airpot.

The decisive factors for the evaluation are the production quantities per unit of time (growth rates), product properties, energy use, light quality, feed quality and the quality of the end products. All of these factors are part of information and educational activities.

The project location is the Energy-Power-Greenhouse (EPG), a solar-powered multi-zone climate house (tundra, Africa, Europe). The EPG is characterized by:

- New type of film covering with 100% spectral light transmission (light spectrum inside = light spectrum outside)
- Creation of system-oriented approaches for the generation of electricity, heat, cold and optimized plant growth

through light separation (global radiation into direct and diffuse radiation

- efficient use of solar radiation to generate electricity, heat and cold with building-integrated long-term storage (Fresnel lenses with concentrator technology)
- Realization of three different regulated climate zones: Tundra, temperate Europe, tropics and the unregulated zone "greenhouse"
- Storage of winter cold and summer heat.

The energy supply (light, temperature, electrical energy) takes place via the building envelope of the EPG and via an additional 5 kWp photovoltaic system with a lithium iron phosphate storage system (12 kWh). The memory serves to maintain the essential basic function of the system in the event of a power failure.

