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FESTEL CAPITAL
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Jet-Zone-Reactor for (Waste) Water Treatment

Summary

The small and compact Jet-Zone-Reactor (JZR) is a high-performance bioreactor for the aerobic treatment of industrial and municipal waste water.

JZR technology yields excellent results in the following areas
- Sulphate reduction and heavy metal removal.
- Service water supply with drinking water quality.
- Biological degradation of hard-to-degrade compound.

Industrial partners and financial investors are sought for various possible commercialisation options.

Background

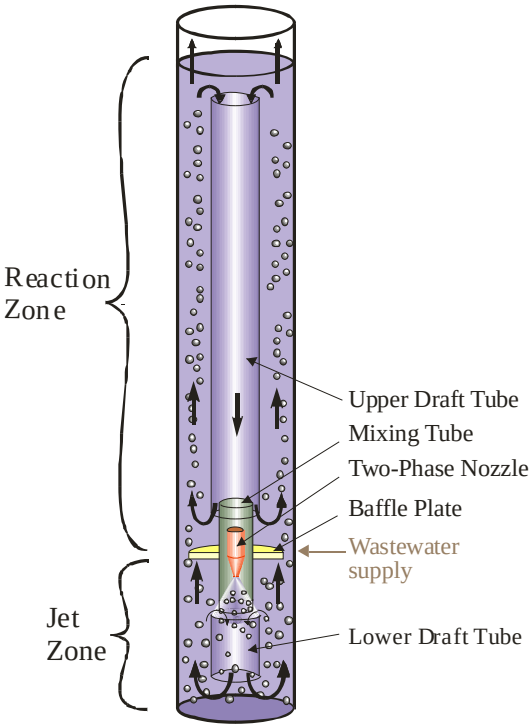
FESTEL CAPITAL is supporting a German university to commercialise an innovative high-performance reactor for waste water treatment.

Description

JZR

The JZR has a substance exchange zone with high materials flow density as well as an optimal substrates supply at the bottom of the reactor. The reaction zone arranged above has the required reaction conditions for the formation of a sufficient flocculation size and the decomposition of the organic substrates. Thus, in comparison to other high-performance reactors, the JZR shows a higher mass transfer as well as a higher degree of purification combined with a drastic reduction of energy consumption. For the biomass retention it is possible to use a membrane unit (micro- or ultra-filtration) instead of a sedimentation tank. The JZR can be used in a wide field of applications. This holds true even for high and suddenly occurring peak loads and toxic waste water substances.

The JZR consists of a cylindrical tube, in which two draft tubes (an upper and lower one) are placed. The jet zone and the reaction zone are separated by a baffle plate. The mixture of waste water and activated sludge is fed into the lower jet zone via a two-phase nozzle with inner oxygen aeration. The bacteria are intensively mixed with air and sewage substrates. The mixture flows to the reactor bottom, is deflected and flows back through the outer ring zone. A part of the mixture is again drawn into the two-phase jet resulting in an optimal loading of the biomass with substrates.



Part of the three-phase mixture flows passed the baffle plate into the upper part of the reactor (reaction zone), where the bacteria form flocculation agglomerates and react. In the reaction zone a loop is also formed, as an effect of the difference in gas content between the three-phase mixture in the ring zone and the draft tube.

JZR-UF Plant - High-Performance Biomembrane Reactor

The high-performance biomembrane reactor consists of a JZR combined with an ultra-filtration (UF) membrane instead of a settling tank. The application of the UF membrane technology not only allows the complete retention of the biomass, in order to reach a high concentration of mixed liquor suspended solids (MLSS) and a high sludge age, but also enables the adjustment of the substrate-specific residence times. This is particularly necessary, if the waste water contains a high amount of biologically hard-to-degrade ingredients.

In most cases, the current aerobic waste water treatment plants are not designed efficiently enough to change the degradation capability of the biocenosis. Normally, micro-organisms specialised in degrading persistent substances very often exhibit smaller growth and reaction rates than micro-organisms that remove biodegradable compounds. For process optimization both the biomass and the not easily degrad-

able compounds have to be retained completely in a suitable reactor system, so that a maximum reaction rate can be reached by accumulation. These properties can be achieved by an integrated membrane filtration section, the use of which is easy in combination with the application of JZR-technology.

To achieve a high performance of the bio system as well as the membrane section the following conditions have to be met.

- The membrane has to be chosen in such a way that no accumulation of such substances will occur which could inhibit the micro-organisms.
- By decoupling the substrate and the waste water retention times, combined with high concentrations of biomass within the bioreactor, an adapted biocoenosis and thus a high degree of degradation is reached.

Application areas

Sulphate reduction and heavy metal removal

- Problem: Industrial waste water highly loaded with organic carbon, sulphates and heavy metals, e.g. demulsification waste waters from metalworking industry.
- Solution: Specific reaction control of biological processes allowing the use of aerobic and anaerobic micro-organisms in a single step due to special JZR engineering; combination of biodegradation of organic contaminants and sulphate, precipitation of heavy metals under oxygen-limited conditions.
- Result: Excellent simultaneous reduction of sulphate and elimination of heavy metals.

Supply of service water with drinking water quality

- Problem: Increasing demands on the hygiene and quality of service water with drinking water quality as well as safe compliance with threshold values.
- Solution: Pilot operation with a high-efficiency JZR, ultra filtration, reverse osmosis and optional disinfection.
- Result: Stable operating safety of the JZR, even at high inflows and activated-sludge concentrations; reliable barrier for micro-organisms during continuous operation; almost total degradation and retention of chemical parameters (COD, DOC, nitrogen, and phosphorus) in the whole system (86 - 98%).

Biological degradation of hard-to-degrade compounds

- Problem: A high toxic potential of waste water mixtures, mainly defined by substances, which in practice, very often show a very low concentration; most of the available biological-chemical degradation potential cannot be exploited by present reactor technologies (see growth kinetics); a very small amount of waste water ingredients causes high waste water treatment investments.
- Solution: Selective separation and accumulation of the biologically hard-to-degrade substances in the reaction chamber; adjustment of substrate-specific residence times; combined application of membrane filtration and a bioreactor.
- Result: A production-integrated process with significantly reduced plant size due to selective degradation of toxic substances; simple degradation of remaining substances in high-performance reactors without accumulation of bio-sludge; complete system of low plant volume for closing of cycles.

Advantages

JZR

Technical advantages:

- Increased mass transfer due to an intensive mixing of air, waste water and biomass.
- Huge amount of active biomass, resulting in a high reaction rate.
- Efficient waste water treatment of biologically hard-to-degrade substances and/or toxic substances.
- Small and compact plant designs due to a very high and adjustable purification performance (5-30 times higher purification performance than in conventional activated-sludge plants).
- A compact design, allowing a production-integrated application in even a most limited space.
- Minimum of excess sludge production due to the increased metabolic activities of the micro-organism (ca. 0.05 - 0.3 kg TS/(kg$COD_{elim.}$)).
- Good settling properties of the biomass (SVI = 50-100mL/gTS) allows the use of smaller sedimentation tanks.

- The housing of the plant prevents aerosol and noise emissions.
- An additional exhaust air filter can easily be installed.

Economic advantages:

- Low investment costs due to its compact design as well as its low floor space requirements.
- Low energy costs = 0.2 - 0.5 kWh/(kg$COD_{elim.}$) depending on the degree and type of pollution.
- Low sludge disposal costs due to the low excess sludge production.
- Low personnel and maintenance costs due to fully automatic operation.

JZUR-UF Plant

- The JZR-UF-Plant not only offers the adjustment of very high biomass contents, it also maintains their optimal oxygen supply by its special hydrodynamics.
- The decoupling of the substrates and the waste water retention time leads to an increased COD-reduction and simultaneously a decreased reaction volume. This enables the elimination of complex and often biologically hard to degrade organic substances.
- A compact design, allowing a production-integrated application even in a most limited space.
- No large-volume sedimentation tanks for the biomass retention are necessary.
- The complete biomass retention brings a high sludge age, even if the settling behaviour of the biomass is poor as well as the accumulation of specialists with low growth rate (e.g. nitrifying bacteria).
- No problems with bulking sludge or the flushing out of biomass by rainwater.
- Efficient disinfection of the purified waste water as a result of the retention of bacteria and viruses is reached.
- Purification of the waste water up to process water quality is possible (closing of cycles).
- The reactor technology offers a flexible modular system. The technology can be used in areas of disaster or cases of emergency.

Investment Opportunity

The aim of FESTEL CAPITAL is to commercialize this innovative (waste) water treatment technology. In the search for industrial partners and financial investors different commercialization options, such as founding a dedicated start-up company, out-licencing or a sale of all relevant intellectual property and know-how, are possible. Detailed information can be provided after the signing of a confidentiality agreement.

About FESTEL CAPITAL

FESTEL CAPITAL is an advisory and investment firm focusing on the commercialisation of technologies in the areas of energy, environment, health, materials and nutrition.

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