INTRODUCTION

The purification of water is one of the most important environmental tasks today. This includes the physical-chemical treatment of natural water for the supply of drinking water and the biological treatment of wastewater. The latest report from the World Health Organization (WHO) states that the number of people affected by disease due to polluted water has not decreased but rather increased. Most of the industrialized countries have very good access to wastewater treatment plants, which is not the case in many developing countries. In these countries, water and wastewater treatment plants are still under construction and development.

ABOUT MIXING

General

A review of the mixing systems available for wastewater treatment reveals an enormous number of different processes. Reviews on the hydrodynamics of mixing systems, in order to avoid deep dives into the definitions of the mixing tasks as they are used in the fields of chemical and process engineering. A distinction is made between the reactor behavior and the mixing tasks.

1. Primary Treatment: Mechanical treatment using gravity or aerodynamic separation to separate solid liquid.

2. Aerobic Treatment: All processes except the aerobic treatment are used in its BOD- and COD-degrading capacity. The known aerobic treatment plants are the activated sludge process, the sequencing batch reactor (SBR), the cycle activated sludge process (CAS), the cylindrical activated sludge process (CA) and the anoxic intermittent cycle extended aeration system (ICEAS) which are covered in detail in the literature. Among the most important observations are:

- The critical point for oxygen uptake is 0.1 mmol/L.
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3. Tertiary Treatment: Includes the biological reduction of tertiary nutrients and the removal of nitrates. In the case of phosphorus removal, the wastewater needs to be treated as a digestion sludge. In the case of nitrogen removal, the wastewater needs to be treated as a denitrification sludge. In the case of the tertiary treatment for full nutrient removal, nitrification is obligatory for the removal of ammonia nitrogen in many countries. Many plants still have a very good coverage in the literature. All these biological processes strongly depend on the correct design of the mixing system. In order to achieve the most even flow and mixing conditions, the reactors.

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The paper at hand discusses the basic demands on a mixing system. It presents the basic design rules for the design and layout of mixing systems for anaerobic and anoxic basins. Using the example of a large wastewater treatment plant it is shown that the mixing design can influence the reactor behavior positively and negatively. Therefore, the plant cannot perform properly otherwise.

The following basic mixing tasks are listed:

- Suspension: Whirling and suspending solid particles
- Dispersing: Suspension of emulsions, suspensions, and sols
- Mass transfer: Intensifying the heat transmission, heating, cooling

The flow patterns shown in Figure 2 in more detail in the following chapter. Mixing also plays a major role in the process steps in which BOD and COD plus full nutrient removal is obligatory for the removal of ammonia nitrogen in many countries. Most of the industrialized countries have very good coverage in the literature. All these biological processes strongly depend on the correct design of the mixing system.

About the Design of Mixing Systems for Anaerobic and Anoxic Basins for Large Wastewater Treatment Plants

Marcus Hoefken, Walter Steidl, and Peter Huber

In the field of wastewater treatment, efficient mixers are needed to suspend solids and to homogenize in large mixing and equalization tanks, and especially in anaerobic and anoxic tanks for full nutrient removal in the activated sludge process. The layout and design of such mixing systems has to take into account process and the reactor design.

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**Experimental Setup**

Example 1

The test reactor type was commonly used in the biological treatment of wastewater and the plug-flow reactor and continuous flow attractor reactor were compared. The numerical simulations were executed using hydrodynamic models of wastewater treatment plants. Such models can be used to determine the flow pattern needed to create a given velocity or power input in the basin. The velocity vectors show the magnitude of the velocity and the direction of the flow. The turbulence regime they are directly proportional to the tip speed of the impeller and can be used for design purposes.

The simulation results showed excellent agreement between model and real scale tanks. More than 5 years trouble-free operation experience of 24 HYPERCLASSIC® mixers shows the overall design and layout of these reactors.

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**Mechanical Characterisation**

The mechanical characterisation of the mixing elements consists of the following case studies:

1. Mechanical forces on the reactor element. E.g. propeller blades and reactor support for the reactor and the mechanical equipment may provoke the reactor design.
2. Mechanical forces on the shaft - especially the bearings and shaft materials.
3. Mechanical forces on the bridge - especially the support for the reactor.
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The mechanical forces on the reactor elements are caused by the fluid flow around the reactor. The mechanical force does not need to be split into a normal component and an tangential component. These two components are not relevant for the structional design of the reactor. Since this design is re-arranged dependent will be set forth in a following section.

The shaft design of the reactor element is very important. The shaft cannot bend the shaft and almost no hard forces acting on the bridge. This is the reason why HYPERCLASSIC® mixers are chosen for this project.

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**Conclusions**

The achievement of purification goals in wastewater treatment plants, enhanced and efficient mixing and aeration systems are highly relevant to be used because mixing and aeration is the major processes needed in the biological treatment of wastewater. Approximately 70% of the total energy demand is related to the biological processes (Müller et al., 1993).

A study of systems available on the market showed that numerous mixing and aeration systems can be considered for use. Some simple considerations are made to ensure that efficient mixing systems should be used without exceeding the limitations of the system.

The design of mixing systems also influences the overall reactor behaviour of a wastewater treatment plant. Therefore it is crucial to select the mixing system in compliance with the reactor design process.

For the mechanical design of mixers it is important to understand the mixing processes acting on a mixing system and the bridge. These are necessary differences between standard propeller mixers and modern mixing systems. However, the mixing process on the reactor and the bridge is still not well known in the case of the mixing system. Therefore the design of the mixing system should be further improved in the design and longer lifetime.

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