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Modeling of the On Site Gravel Contact Oxidation Process

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Under the current climate of limited domestic water resource, the clean water becomes very precious resources. In order to achieve the prospect of sustainable water resource management, not only we have to protect the upstream waters, but also we need to treat the domestic wastewater from polluting the downstream rivers. For rural area without public sewer service, generally the domestic wastewater is discharged directly into receiving water bodies, thus causing water pollution problems and affecting the beneficial uses of the water resources. In order to mitigate the waste loading into the water bodies, the on site gravel contact oxidation package (also referred as biofilter) has been developed and deployed in Taiwan. In that way, sustainable development can be achieved from bottom to top and extend. A smart eco-community can be recognized as the whole system and the on site gravel contact oxidation process is the system component. As this process adapts concept of natural purification mechanisms of organics biodegradation (the so called self-purification), this made the component appropriate to be applied in smart eco-communities to increase mobility, reduce environmental pollutants and comply sustainability.
The on site gravel contact oxidation package primary is capable of removing some extent of waste organics in terms of biochemical demand and transforming ammonia into nitrate. Although there are some packages currently in service, very few studies have been conducted on modeling the biodegradation reaction and process mechanisms of the gravel contact oxidation system. This study intends to develop model to describe the reactions and mechanisms of the reaction process. The model considers the water advection and the fate and transport of carbon and nitrogen. BOD removal kinetics and other relating parameters are obtained mainly from first order reaction equations. Nitrification occurred on gravel surface is simulated to describe ammonia removal in the biofilter system. The oxygen needed for the BOD and ammonia removal is determined by the amount of oxygen consumed during the bio-process. The data used for model calibration and verification steps are acquired from six gravel contact oxidation package systems constructed in the past five years in Taiwan. The model will be used for simulating the reaction process in the biofilter and will be useful to optimize the process design. In addition, the energy required for aeration in the biofilter and costs of the units are also considered and will be discussed in this study.