Monitoring of Polluted Waters in Vietnam's Industrial Zones

The continued strong economic growth in Vietnam increases the demand on appropriate sites for industrial parks. Currently, there are more than 200 industrial zones (IZ) registered, of which the majority do not have a sustainable waste water treatment solution. The consequences are highly polluted and toxic waters. In the context of the flagship project 'AKIZ' , sponsored by the German Federal Ministry of Education and Research, a reliable water monitoring system for the analysis of toxic pollutions has been installed.

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In addition to the construction of a central sewage treatment plant in the industrial zone, this German-Vietnamese joint project also develops an exemplary integrated waste water concept for industrial zones for Tra Noc Industrial Zone in Can Tho City, located in the Mekong-Delta. The joint project is planned to be finished by 2014. It is devided into several sub-projects of which one is the development, installation, and operation of a containerised laboratory with the aim to monitor diverse waste water parameters – among them toxicity.

Figure 1: Mekong-Delta at Can Tho (IEEM, AKIZ-Project, sponsored by "Federal Ministry of Education and Research)

The Institute of Environmental Engineering and Management at the University of Witten/ Herdecke GmbH (IEEM), the Vietnam Institute of Industrial Chemistry (VIIC) and LAR Process Analysers AG are partners of this 5th sub-project in order to develop a monitoring concept. Using containerised pilot installations, high technology solutions are being tested for the decentralised waste water pre-treatment as well as for their capability to be adapted to specific local circumstances. A database of polluted waste waters by toxins will be worked out in order to be used for a monitoring programme. Additionally, not only the local conditions but also the tropical climate must be considered for a proper operation of the laboratory and monitoring stations.

LAR AG is the leading manufacturer of water analysers in Germany and in charge of the installation and operation of the project's laboratory. Among others, LAR AG equipped the laboratory with analysers for the determination of toxicity as well as biological and chemical oxygen demand (BOD and COD). These measuring systems are maintained by the manufacturer together with trained personnel from the project partners.

The Challenge

The precarious situation of the open waste water pipes leads to grave environmental pollutions. The danger to people and nature grows steadily. Hence, in order to detect toxic contamination and any inhibitors that may affect the biological treatment processes of a waste water treatment plant, the laboratory's first main focus is on the identification of relevant measuring points and parameters. Since the majority of the population lives at rivers and lakes another focus is on surface water monitoring, as waters that are polluted by toxins endanger human health and the environment.

What is toxicity? Toxicity means the direct harmful effect of substances to organisms. It can already occur at small concentrations of these substances. It is a sum parameter that does not describe specific substances but the effect of such. There are a few test methods on the market that test whether the water sample triggers toxic effects on certain organisms such as fish, daphnia, algae or luminescence bacteria. However, many of these organisms are hard to obtain or to cultivate. Daphnia for example can only be cultivated under laboratory conditions and their suitability for toxicity tests is limited to a certain stage of development. Furthermore, many of these above-mentioned organisms are not sensitive enough or only sensitive against a certain group of toxins. In the case toxicity occurs, often the complete measuring system will be affected and the test organisms need to be replaced completely. Hence, the measuring methods are not well suited for online measurements in general as well as for the use as de-centralised monitoring in particular.

Figure 2: Open sewage pipe in Tra Noc Industrial Zone (IEEM, AKIZ-Project, sponsored by Federal Ministry of Education and Research)

Federal Ministry of Education and Research

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Thus, based on their weaknesses regarding response time, reproducibility as well as availability for single measurements, these methods did not meet the requirements of the project.

For the efficient, economic and ecological monitoring, analyser systems were required that are characterised by low operational costs, environmentally friendly methods, and reliable results. Due to the de-central installation sites in the tropical country, the analysers need to work autonomously, e. g. the need of service and maintenance has to be minimal. In addition, the toximeter in use should not only work in online mode but also be equipped with the single measurement feature.

The Pre-warning System

Figure 3: Toxicity analyser ToxAlarm at containerised laboratory

Being a project partner LAR AG supplied its toximeter ToxAlarm which is equipped for the online installation as well as the operation in a laboratory. It contains a permanently available, highly sensitive bacteria culture within a well designed fermenter. These bacteria produce independently and constantly new biomass. Additionally, the fermenter is separated from the measuring cell in order to prevent any impairments of the biomass by toxicity of a sample. To ensure sufficient provision of fresh biomass, for each measurement only a small portion is used. This measurement method stands out through its high reproducibility as the measuring cell is flushed with a cleaning solution after each measurement. Any cross contamination or memory effects of previous measuring processes are avoided. With the ToxAlarm the operator can set up three individual warning levels on the touch screen. This feature makes the system adjustable to the specific requirements of any application. In less than 15 minutes the watery samples are checked for toxicity, giving an alarm in the case toxicity is detected and providing the operator with enough time to take counter measures.

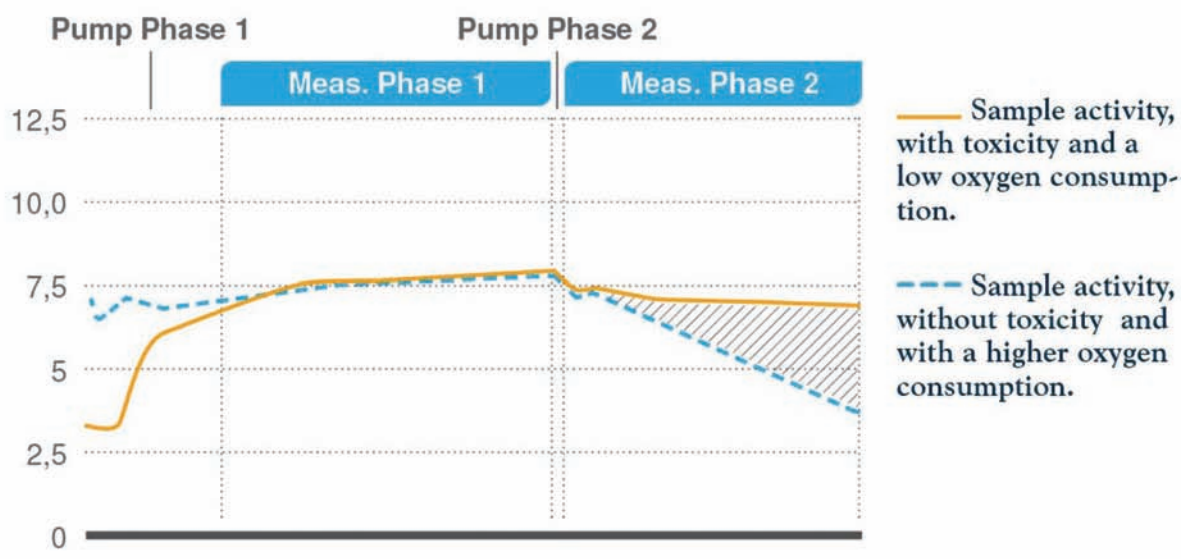

Figure 4: Pump phase and toxic event

The Measurement Principle

The biomass consists of very sensitive nitrifying bacteria that consume oxygen in order to convert ammonium to nitrate. This is a natural process and an important part of the biological degradation used in waste water treatment plants. The LAR online toximeter measures this oxygen consumption. Toxic ingredients of the sample will cause an inhibition of the respiration of the biomass. As a result the oxygen consumption will decrease or even stop. Thus, on monitoring the oxygen consumption, well-found conclusions can be made on the toxicity of the sample.

In the first phase of the measurement the sample is pumped into the measuring cell. Any water contains micro-organisms that may have an own oxygen consumption without being affected by toxic substances. Hence, this consumption rate must be considered for the correct result for the sample's effect on the biomass. In the second phase the real measurement takes place. A small portion of the nitrifying bacteria is dosed into the measuring cell which still contains the sample measured in phase 1. Again the oxygen consumption is being determined. The result shows the direct oxygen consumption of the nitrifiers.

When the sample does not contain toxic substances, the curve of the consumption rate shown on the display will sink significantly. This means that the biomass is active and consumes oxygen. On the contrary, a flat curve will indicate that the bacteria do not use oxygen. They must be inhibited by harmful substances. Within only a few minutes a reliable result is given. Moreover, since the analyser is ready at any time, its measurements allow not only to detect the occurrence of toxic events but also to see when the toxicity concentration decreases again.

Using these toximeter reliable databases from diverse waste water analyses can be set up and are of great importance for the technical and economic planning of the project. The accurate and reproducible results then may be used as basis for the creation of a monitoring programme for industrial zones throughout the country. Since this online toximeter requires minimal service and maintenance compared to other toximeters on the market, it is especially suitable for the de-centralised installation in the south Asian tiger state. The measuring system is able to determine toxicity autonomously as it is ready at any time. By the use of highly sensitive nitrifiers as test organisms, the analyser shows how toxic substances affect the nitrification part of a waste water treatment plant, which is an important biological process, as well as the effects of toxicity on the biology of rivers and lakes.