Wastewater quality estimation through led spectrophotometry by means of Statistical models

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Abstract Regulatory developments emanating from the European Union (EU) in the last decade in the environmental field have placed emphasis on halting water degradation and combating illegal discharges. Continuous, real-time, reliable information about the pollutants in the input sewage is key to fulfil EU environmental policies. The current methods of analysis make difficult to carry out a real time analysis, since they are based on punctual samples, which are subjected to diverse treatments and require chemical substances in laboratory. This research work has been focused on the development of a cost-effective equipment for the calculation of several variables such as COD, BOD_5, TSS, P, TN, and NO_3-N, from spectrophotometry data (380-700 nm). Measurements are carried out in real time and without the need of chemical or pre-treatment, with the aid of different statistical models all through a new spectrophotometer based on LED technology that does not require the use of optical elements to work.

Keywords: Chemical Oxygen Demand (COD), statistical models, real time monitoring.

Methods

In order to obtain calculation models for the estimation of the pollution load of waste water from spectrophotometric data, a measurement campaign has been carried out with the following characteristics:

- Analysis in Cabezo Beaza wastewater treatment plant, Murcia (Spain).
- Measurement campaign: June 2019 - April 2020.
- More than 200 samples analyzed and characterized in the laboratory
- Analysis between 380-700nm. 81 wavelengths studied, measuring both transmittance and absorbance values.

A cost-effective equipment has been designed for the real-time characterization of the contaminant load in the sewage networks (Figure 1).

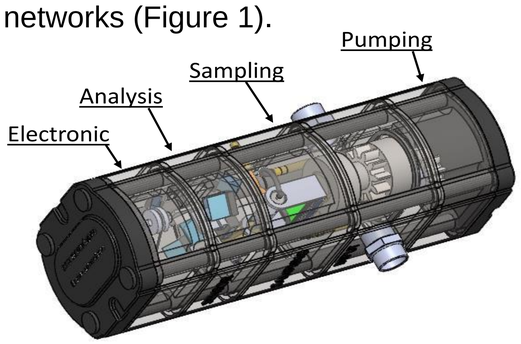

Figure 1: Equipment designed to characterize waste water automatically.

Results

Calculation models generated by genetic algorithms to estimates the following pollutants:

- Chemical Oxygen Demand (COD)
- Biological Oxygen Demand after 5 days (BOD_5),
- Total Suspended Solids (TSS)
- Phosphorus (P)
- Total Nitrogen (TN)
- Nitrogen Nitrate (NO_3-N):

Models valid for both raw water (treatment plant input water) and treated water (output water), with an estimation error of less than 4%, as shown in Figure 2.

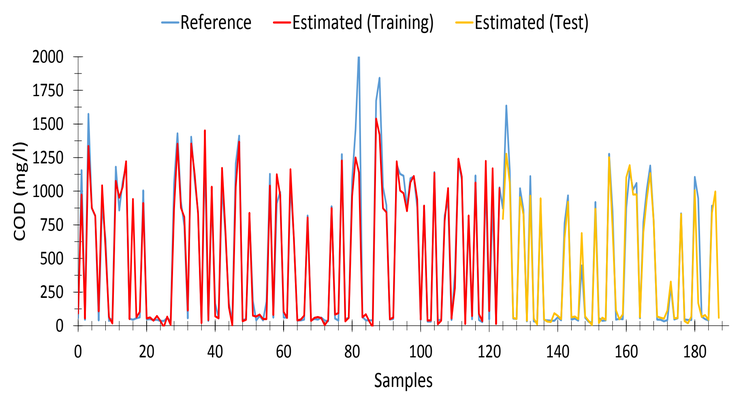

Figure 2: Comparison between COD values measured by the wastewater treatment plant laboratory and the values calculated from spectrophotometric data.

Conclusions

The equipment is an advance on current water quality analysis systems, providing real-time information on the state of the sewage network with a simple, economic and easy-to-operate system.

Furthermore, no pre-treatment of the samples or the use of chemicals for the characterization of the samples is required.

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