

Case study 5

Forecasting phosphorus trends

WHAT IS SOFT-SENSING?

Soft sensing entails using readily available online data to infer the value of something that is difficult to measure in real time. Here we inferred total phosphorus using ammonia and total solids data. There are a number of hardware analysers that can measure phosphorus online but they're expensive (ca. £8,000 to £10,000) and the measurements are delayed by around 5 to 10 minutes. Soft sensing here avoided the need for an expensive online analyser by using data the client already had.

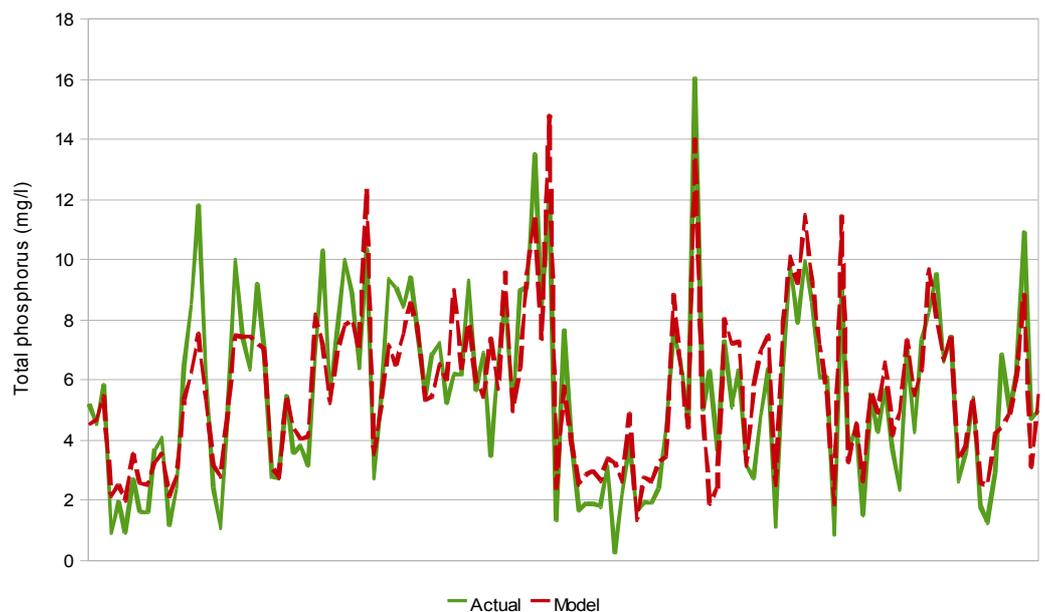
APPLICATIONS

Soft sensing can be used to estimate any quantity that is difficult to measure online or in real time. Examples include biochemical oxygen demand (BOD), chemical oxygen demand (COD), biological intermediates in pharmaceutical production and species concentrations in all types of chemical and petrochemical manufacture.

BENEFITS

Soft sensing offers a cheaper alternative (up to 50%+ saving) to hardware but with very comparable accuracy. Soft sensors are easy to recalibrate and do not require the maintenance that hardware analysers need.

Total phosphorus predictions



Our client was a large and well known UK water company. The wastewater treatment works (WwTW) the client operates are subject to effluent quality consents enforced by the EA and many of these consents specify limits for the concentration of total phosphorus in the treated effluent.

It is widely known that excessive amounts of total phosphorus in a watercourse can contribute to eutrophication. This occurs when large concentrations of nutrients cause the proliferation of algae and other simple forms of aquatic life, often resulting in depletion of oxygen in the water and the death of fish and amphibians.

The WwTW we looked at in this work has a total phosphorus consent. Coagulants are dosed in the crude sewage and these cause phosphorus to precipitate as a solid. Subsequent stages of treatment remove the phosphorus-bearing solids.

Coagulant doses at this site are set according to the flow of sewage it receives. The relationship between flow and total phosphorus is weak, however, and the client asked us to analyse data from the WwTW with the aim of finding a more accurate way of forecasting total phosphorus trends.

Using a data set covering seven years of crude sewage data we carried out a very comprehensive data analysis and modelling exercise. We discovered that accurate estimates of total phosphorus could be produced using only total suspended solids and ammonia data. This offers the client the possibility of using the model online and in real time as part of a feedforward predictive control system for coagulant dosing.