Application Note

AN06BA0411

Best Available Technique for Water Reuse in TextiLE SMEs: BATTLE

Introduction

This application note introduces an interesting application of XBASE Tool (see Application Note AN01XB0311): "BATTLE" an EU founded project (05 ENV/IT/000846). BATTLE (Best Available Technique for Water Reuse in Textile SMEs) is an Expert System to on-line control water quality is presented, coming from textile finishing discharges.
This project requires a formalization of the knowledge base around the recognition on-line/real-time discharges of wastewater.
To solve the problem concerning the monitoring On-Line/Real-Time of textile wastewater quality, we resort to measuring technology on-line multi-clustering index based on WPR (Water Pollution Index Rate).

Why?

The textile sector is highly water demanding and its biggest impact on the environment is related to primary water consumption (80-100 m3 / ton of finished textile) and wastewater discharge (115-175 kg of COD / ton of finished textile, large range of organic chemicals, low biodegradability, colour, salinity).
According to the IPPC directive, the textile BREF should be implemented by all big companies and by SMEs having a production capacity over the IPPC threshold of 10 tons/day. Also smaller companies are interested, since the BREF recommendations are used as a guideline for the overall sector.
The textile BREF contains several BATs for production processes, but only general advices on wastewater treatment and reuse. The closing of the water cycle is not a subject in the BREF and the document does not propose any available technique for the purpose. To give a contribution on this lacking point, the BATTLE project aims at configuring and applying on demonstrative scale a new BAT for low impact water management in textile industry.
The implementation of a BAT (Best Available Technique) for water reuse in textile finishing industries (in connection with environmental protection), requires to focalize a specific "Knowledge Base" around the on-line/real-time recognition of different "start of pipe" wastewater effluent patterns, to be segregated according to their suitability for treatment with membranes technology, belonging to the proposed BAT.
Textile wastewater is a mixture of many different chemical compounds and not all of these are recycled.
On-Line/Real-time monitoring of wastewater quality remains a scarcely resolved problem into the wastewater treatment industry.
A water quality assessment requires of more then fifty of specific chemical and physical parameters to be properly detected, all of them on samples by off-line laboratory instrumentation. Moreover, for water reuse scope (by using membranes technologies), on-line automatic controller and regulating flow valves require process real-time data-input.
A previous systematic characterization about quality and volume of the various process streams has been necessary, in order to identify those processes for which the substances contained in the various waste streams are still valuable and/or do not interfere with the quality of the product.
In spite of a deep changeability of textile segregated wastewater stream quality, there are only a few chances (instrumentation technologies) to on-line detect water quality parameters and, no one of them, it is directly correlated to a specific pollutant.

Features

To be able to solve the problem regarding on-line/real-time monitoring of textile wastewater quality, having only a few sustainable chances versus constraints satisfaction conditions, one suggests to resort to a multi-clustering on-line measurement technology (not multi-parameters only), based on WPR (Water Pollution Rate Index) indexes inferred to a appropriate Knowledge Base (network designed).
In fact, to better detect and learn, from the on-line measurements and process data-input, to decide if an effluent has to be sent to the reuse plant or to the WWTP (how much fresh water has to be mixed with the permeate and all operative actions for the maximisation of reuse, in respect of the limits at the final discharge), an appropriate

water pollution rate index has been defined and carried out, called WPR (see Application Note AN04WQ0411). This index has a mathematical normalized expression considering the main pollution driver patterns, apart from pH, previously balanced to a 6,5÷9 range value:

WPR = f(*dissolved salts; dissolved organic substance; total suspended solids*)$_{pH[6,5÷9]}$.

WPR will be able to on-line characterize the quality of wastewater streams and it will be "instructed" during the start-up phase (on the base of final effluent treatability evaluation and impact control, reclaimed water reusability, cost analysis, etc.) in order to be able to better control the selected streams. WPR is a value between 0 and 1, where WPR is close to 1, then the water is not good, but if WPR is close to 0, then the water is good.

To face up to the produced water outflow variability, from printing and washing departments in particular, as well a not-sustainable direct and on-line measurement of referred chemical-physic parameters (DOC, TSS, VSS, turbidity, etc.), it will be used a real-time process controlled by Expert Systems technology (XBASE Tool), by realizing a prototypal version in this project context.

XBASE Tool will be used as a shift about the traditional process control systems (like SCADA), since they are not able, at present, to detect and to infer the not-direct measurements that actually it is sustainable monitoring (pH, temperature, conductibility, colour). This is instead of not measurable direct target parameters, as well in cognitive processes of diagnosis and decision-supporting elaboration.

Advantages and Innovation

The implementation of a Best Available Techniques for water reuse in textile finishing industries (in connection with environmental protection), requires to focalize a specific "Knowledge Base".

The Knowledge base in BATTLE is formalized through functions that represent the relations existing between the inputs received from sensors (pH, temperature, conductivity, color) and quality (WPR).

These parameters produce a vector K. The learning algorithms are introduced in order to obtain the vectors of indices K that realize the Knowledge base, contained in the nodes of XBASE Tool.

The algorithm calculates vectors of optimal indices, so that the difference between the theoretical WPR and the detected WPR will be smallest.

The strategy of learning, chosen in BATTLE, takes advantage from Genetic Algorithms.

The Genetic Algorithm in BATTLE, as learning strategy, allows to obtain the optimal vector:

K = (K – PH, K – Cond, K – Temp, K – Color)

This vector influences the parameters PH, Conductivity, Temperature, Colour, and so WPR.

The Genetic Algorithm starts with the initial value of K - PH, K - Conductivity, K - Temp, K - Colour. Later, it tries to optimize the K-vector, in order that K calculates the WPR nearer to the votes of the operator: these new values minimize the difference between theoretical and detected WPR. Finally, the new K values will be visualized.

Another innovation in BATTLE is the high level of automation of the plant performed by the Expert System: the principal distinction between expert systems and traditional problem solving programs is the way in which the problem related expertise is coded. In traditional applications, problem expertise is encoded in both program and data structures. In the expert system approach all of the problem related expertise is encoded in data structures only; none is in programs. This organization has several benefits.

Conclusion

It has been realized "BATTLE", a real-time process controlled by Expert Systems technology, XBASE Tool.

Textile waste water is a mixture of many different chemical compounds and not all of these are recycled, so in order to assess the potential for reuse, the single process streams have to be carefully analysed and segregated according to their suitability for water treatment technology: XBASE Expert System is necessary for the on-line management of the plant to allow the maximisation of reuse and the respect of the limits at the discharge.

References

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