NEEDS AND USES OF CONTINUOUS MONITORING EQUIPMENT FOR WASTE WATER TREATMENT. STANDARDIZATION Y/N ?

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1. Abstract

Users and producers of continuous monitoring equipment (on line, in line or in situ) have expressed the need for standards describing the specifications, performance tests, procedures of use including maintenance and finally certification. But what are the real needs of this standardization, mainly for the treatment plants of waste water. From the European directive 91-211, and the application law in each country in Europe, users, owners of plants or their operators have needed to control the effluent coming into the natural water.

Consequently, there is an urgent need for improvement of comparability, reability and quality of measurements obtained for continuous monitoring equipment used to determine the chemical composition of waste water in order to support the protection of environment.

At the moment the main objective is to dispose of parameters for the control of processes and the measurement of the water quality to apply the regulation.

In term of technical point of view for the all application fields, the problems are approximately the same.

In the future, the users claim to have a regulation application including the indirect and global parameters. An important R and D study is to standardize the principle and the application methods for these parameters.

In conclusion, a standardisation of equipment for continuous measurement and also a standardisation for the procedures to apply them is necessary.

2. Introduction

For a long time, the operators of waste water treatment plants have been looking for a continuous measurements to improve the control of process. Many parameters are able to measure : basically parameter as flow, temperature, pH, Redox, turbidity, ... but also chemical parameters as nutrients : nitrate, ammonium, orthophosphate, ...
Due to the very heterogeneous medium and complex procedure of use the equipment : sensors, analyzers are poorly used with success.

Users and producers of continuous monitoring equipment (on line, in line or in situ) have expressed the need for standards describing the specifications, performance tests, procedures of use including maintenance and finally certification. But what are the real needs of this standardization, mainly for the treatment plants of waste water. From the European directive 91-211,(1) , and the application law in each country in Europe, users, owners of plants or their operators have needed to control the outlet coming into the natural water. Four needs are involved,(2) :

- obligations from regulation
- contract between the " actors " : users, operators, suppliers
- technical solutions : R and D of new equipment
- economical contents : cost of investment and use.

Consequently, there is an urgent need for improvement of comparability, reability and quality of measurements obtained for continuous monitoring equipment used to determine the chemical composition of waste water in order to support the protection of environment.

At the moment the main objective is to dispose of parameters for two fields,(3) :

- control of process
- measurement of quality to apply the regulation.

In term of technical point of view for the all application fields, the problems and solutions are approximately the same. Finally, there are three types of parameters :

- parameters in application of need for process or regulation, named direct parameters
- parameters in substitution, with the direct parameters, there is a perfect correlation between them, named indirect parameters
- parameters as indicators, without correlation with the previous parameters they give an information of variation, the main subtype is named global parameters.

In the future, the users claim to have a regulation application including the indirect and global parameters. An important R and D study is to standardize the principle and the application methods for these parameters.

The main difficult is at the moment to measure with a relatively good efficacy the parameters fixed by the technical application of regulation. In France, the European Directive 91/271 has been translated by the low on January 1992, named " Low for water ". Three parameters in general application are : BOD_5, COD, SS (solids in suspension), for the sensitive eutrophisation areas two other parameters must be measured : TNK (Total Nitrogen Kejdahl) and TP (Total Phosphorus).

Unfortunately, there is any easy method to measure continuously these five parameters. The usual procedure consist in a sampling and a determination in laboratory by standardized methods. The batch measurements by daily samples give buffered information, the result is a mean of actual values, as shown in figure 1. For this first reason solutions are reached to have an information from a continuous measurement, named continuous monitoring.

This term includes all measures obtained in line, on line or in situ, in real time or with a minimal delay (few seconds or minutes) . The procedure is other a true continuous measure or a sequential one.
The true continuous measures are physical phisico-chemical parameters : pressure, temperature, conductivity, pH, Redox, certain selective electro chemical sensor, or optical sensors. The sequential measures are obtained by analyzers consisting in an equipment reproducing in continuous procedures the laboratory methods, there are mainly absorptiometric principles : nitrate, ammonium, orthophosphate, toxic compounds as cyanide, heavy metals. The delay attains 20 to 30 minutes for example for orthophosphate.

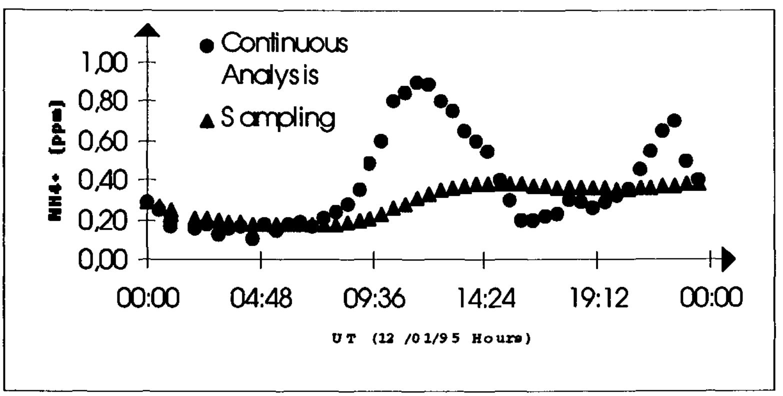
The accuracy and resolution of these procedures are very good, but the main problem is the maintenance in term of complexity and cost. In the other hand, the equipment are generally very expensive, the table 1 gives an idea of effective costs by uses.

The use of indirect and global parameters is cheaper in terms of investment and maintenance. It needs to know very well the system where it is used : volume and quality of effluents, risks of variation by rain water and industrial waste water.
This last point is very hard, to obtain an exhaustive knowledge of pollutants coming very industries and the evolution of their effects in waste water effluents.

3. Description

In order to support the protection of environment and to respect the obligations of the new regulation, there is an urgent need for improvement of comparability, reability and quality of measurement obtained from equipment for continuous measurement used to determine the chemical parameters and flow of water in
waste water treatment plants but also intakes of surface water for drinking water production plants, industries effluents. This need is expressed by users and producers, the authorities in charge of regulations application are waiting for an agreement to promulgate official use.

Figure 1 : Variation of NH_4^+ concentration for a final effluent of sewage plant



The objectives of this standardization will be :

- the description of technical specification of equipment
- the performance tests giving actual values to the technical specifications of equipment
- the operational procedures, checks, maintenance which will secure reliable results of equipment
- the definition of parameters type for specific application.

In fact, the usual approach consists to apply an equipment to obtain the equivalent result obtained by sample - laboratory analyses method, this is the main error, because it seems at the moment impossible to reach this procedure.

In resume, three groups of parameters are considered :

- in agreement with regulation BOD_5, COD, SS, TN, TP
- in substitution with parameters in agreement with regulation
- as indicators of pollution.

For the first group, there is any easy and simple equipment, 10 obtain correctly and rapidly values to be used either for regulation control or for process control. The investment and maintenance cost are very high. The use requires high technician person. In the second group, the parameters are obtained by simple equipment but the measures are correlated with results of usual procedure for previous parameters. There are a lot of example for this approach. But the correlation are not obtained in a controlled procedure. For example, the main cases are :

- TOC in substitution of COD
- Turbidity in substitution of SS
- UV absorption (254 mm) in substitution of COD.

Table 1 : Estimation of Costs for Continuous Measurements (from AGHTM's report to be published)

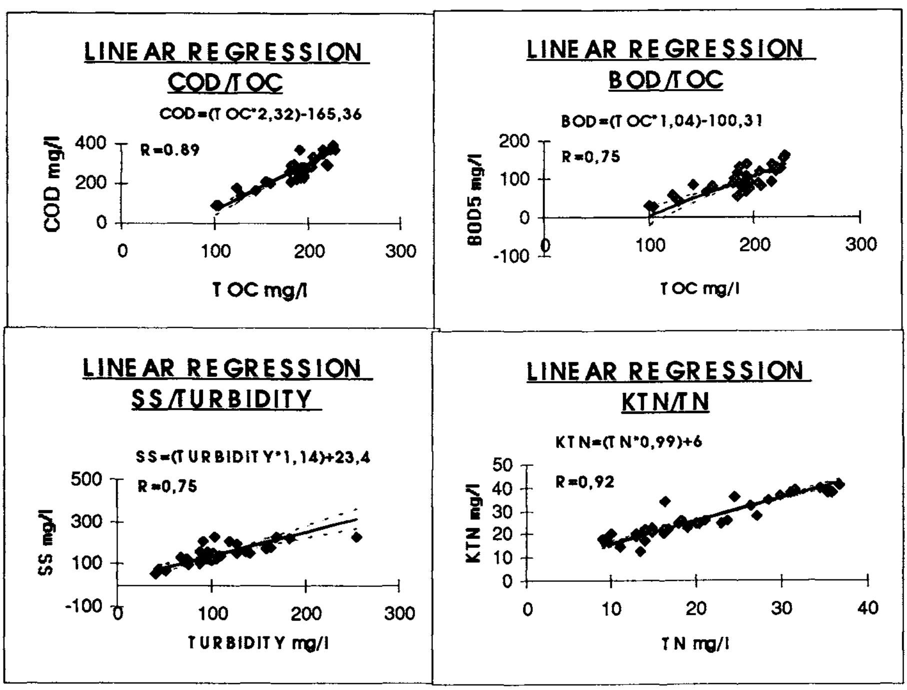
Parameters for regulation

	Units	DCO	COT	Ptot	Ntot
1- Investment					
Furniture Sensors :range of price	kF	180-250	100-160	100-180	100-160
Furniture Sensors : mean price	kF	200	130	150	130
Sampling, conditioning	kF	20	20	20	20
Installation	kF	25	25	25	25
Check in of chain of measure	kF	p.m.	p.m.	p.m.	p.m.
Duration of investment	year	7	7	7	7
Sub total of investment	kF/year	32	22	25	22
2- Cost of use and maintenance	Daily Cost for one man : 2 kF/day				
Duration of maintenance (one man)	j/year	27	24	24	24
Sub total Manpower	kF/year	54	48	48	48
Reagents + pieces in replacement	kF/year	30	20	20	20
Validation periodic of the chain	kF/year	p.m.	p.m.	p.m.	p.m.
Sub total for Use and Maintenance	kF/year	84	68	68	68
TOTAL.....	kF/year	116	90	93	90

Parameters in substitution

	Respir	Turbidity	Turbidity	PO4	NH4	NO3
1- Investment						
Furniture Sensors :range of price	250-400	40-80	20-40	80-120	70-120	60-110
Furniture Sensors : mean price	320	65	30	100	95	85
Sampling, conditioning	0	0	0	20	20	5
Installation	30	5	5	1	25	5
Check in of chain of measure	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
Duration of investment	7	7	7	7	7	7
Sub total of investment	50	10	5	14	17	13
2- Cost of use and maintenance						
Duration of maintenance (one man)	48	6	3	12	12	6
Sub total Manpower	96	12	6	24	24	12
Reagents + pieces in replacement	12	6	2	20	12	6
Validation periodic of the chain	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.
Sub total for Use and Maintenance	108	18	8	44	36	18
TOTAL.....	158	28	13	58	53	31

Figure 2 : Linear regression for parameters in substitution and parameters for regulation



In an homogeneous medium, with constant quality in terms of matter in suspension and dissolved, the correlation given by a linear relationship between a direct parameter and the parameter in substitution is good, fig.2. But in actual applications, these results are often no true. This approach requires a measurement of parameters in interference with the main parameter, consequently it needs to have a multiparameter measurement.

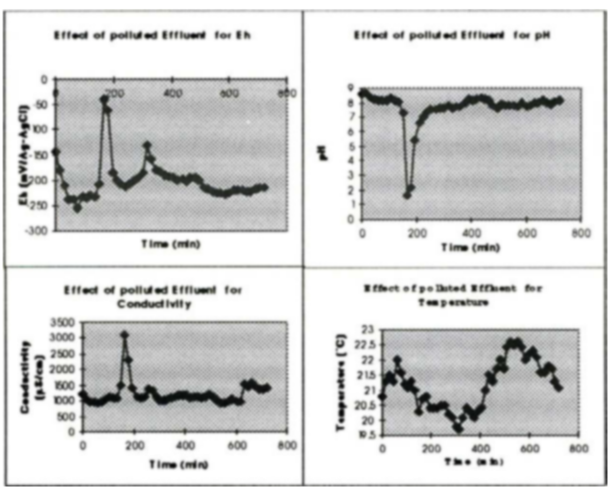
The parameters as indicators are obtained by very simple equipment, it is necessary to correlate result with the presence and the variation of regularly parameters and also with environmental parameter of measurement. This group of parameters includes global parameters :

- pH, Redox, Conductivity
- Solids in suspension
- Total Organic Load
- Biodegradable Organic Matter
- Toxicity
- Odors

The effective measurement are obtained by physico chemical parameters : electro chemical, optical, but also by respirometry or biological system, using bacteria, algae's, fishes,...

An example is given fig.3, the problem was to control influent of an industrial waste water coming from metallurgical plants using acid baths contaming heavy metals (Pb, Cu, Zn, Cr...). It was impossible to measure the precise concentration of these metals compounds, finally a multiparameter probe has been used including pH, T, Conductivity and Redox. The combination of parameters has given in line earlier and sensitively an indication of small quantity of pollutant influent. The system has included a sampler to make precise analysis in laboratory. In the future, the waste water effluent could be control to prevent the risks for process in sewage plants.

Figure 3 : Effect of polluants from industrial effluent on domestic waste water quality

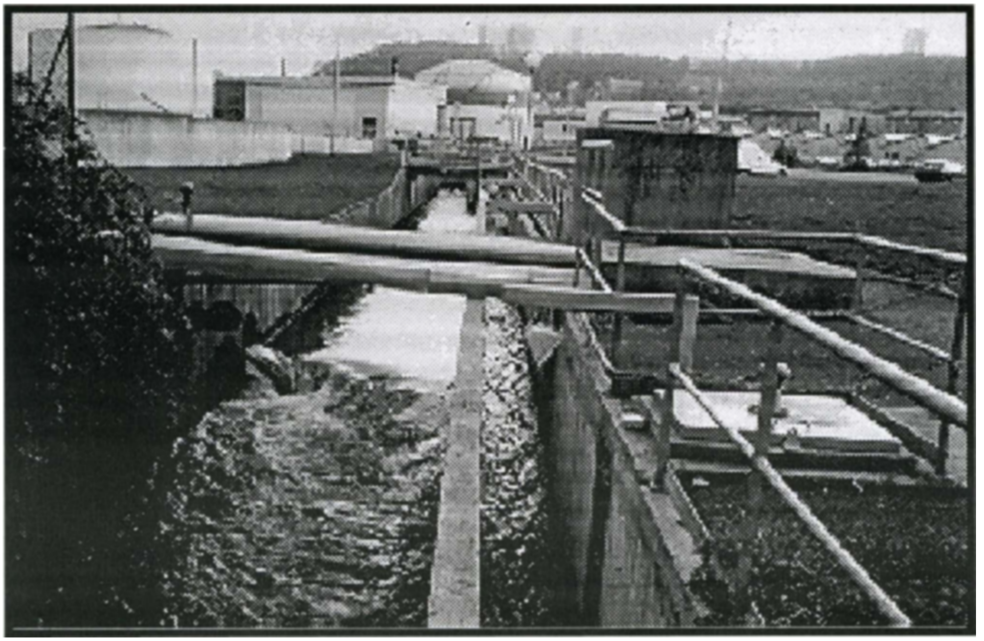


Many groups of research are working with this problems, for example in US there is an ASTM'S designation : Standard guide for continual on line, Monitoring Systems for water analysis. Recently Danish Standard Institute has proposed to create an ISO's working group named on line in situ sensors/analyzers for water. This approach is coming up from a research group ETACS, including Danish, French, English and Spanish researchers and suppliers. Specifications, performance tests and possible certification procedures.
Another group is working in CEN, CENELEC (BT WG 70-3) with European standards for process instruments, the leadership of this group is WRC in UK.
A group has been found in France at the beginning of 1997 to propose a French position. this group is an association of users, producers and authorities, users are owner of plants and operators.

In G.E.M.C.E.A., there are in development facilities as pilot plants to improve and apply procedures of evaluation :

- hydraulic channel for flow-meters, shown on the figure 4,
- rapid closed circuit for samplers and turbidimeters,
- pilot plant for sensors and analyzers of specific pollutants.

Figure 4 : Picture of hydraulic channel to test and to evaluate equipments in GEMCEA



4. Conclusion

Users and producers, but also authorities have expressed the need for standards of continuous monitoring equipment applied in water quality.

For this is necessary to define the parameters in good agreement with application, after that technical specifications are needed to be described. The performance tests are propose to confirm adaptation of equipment with uses. And finally all operational procedures must be perfectly given to reach good results for a better control.
In conclusion, YES, standardization of equipment for continuous measurement, but also standardization of procedures of use, is necessary :

- to control the quality of effluents in agreement with regulation,
- to control end improve the processes of treatement,
- to reference the specifications in contracts between for example users and suppliers.

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