The On-line Prevention
of Water Contamination in a Chemical Manufacturing Plant

By P.Aldrovandi - A Formenti - CIBA Spa- Additive Divisioni Pontecchio Marconi (BOLOGNA) - ITALY

INTRODUCTION

For the detection of water contamination in chemical industry processing and prevention of environmental contamination, it is necessary to ensure that adequate prevention measures are in place for the identification of and reaction to possible spillage.

Education of production personnel on environmental issues, while extremely important, cannot guarantee that accidental spillage of pollutants, which can compromise the plant efficiency, will be eliminated.

Similarly, careful management of the biological process in itself may not necessarily achieve the quality of effluent required for legal compliance.

Two kinds of risks have been identified, both strictly related; accidental leakage upstream of the plant and non conforming effluent.

It can be assumed that the use of on-line equipment for effluent monitoring, integrated with an automatic means of diversion will achieve a high level of prevention by storing polluted water and eventually mixing it with low load process waters.

This approach would translate into a significant investment in instrumentation, construction and/or modification of containment structures.

Nevertheless, in this case economic return and corporate image have been viewed to be of greater value than the expense, particularly considering the position of the chemical industry with regard to its environmental impact as perceived by the regulatory authorities and community alike.

GENERAL BACKGROUND

Since 1979 CIBA has owned the Additives Division plant which is located in Pontecchio Marconi near the Appentino Bolognese and the city of Bologna.

The Company is continually expanding, especially in the areas of production and personnel (CIBA currently employs 400 people). At present, about 90% of plant output is additives for plastic while the remaining 10% consists of active principles for insecticides.

With regards to environmental protection, the plant has an undercooling system for the recovery of solvents, an incinerator for gas emissions treatment, and an activated sludge biological plant for water treatment.

In December 1995 CIBA was awarded environmental certification by CertiEco in compliance with BS7750 (certificate n° 475).

WASTE WATER PLANT

The plant was built between 1985 and 1986 and purifies the contents of the mixed drainage system which collects low load industrial waters, waste waters and rain.

Process waters which contain the highest organic load, are added during a homogenization phase.

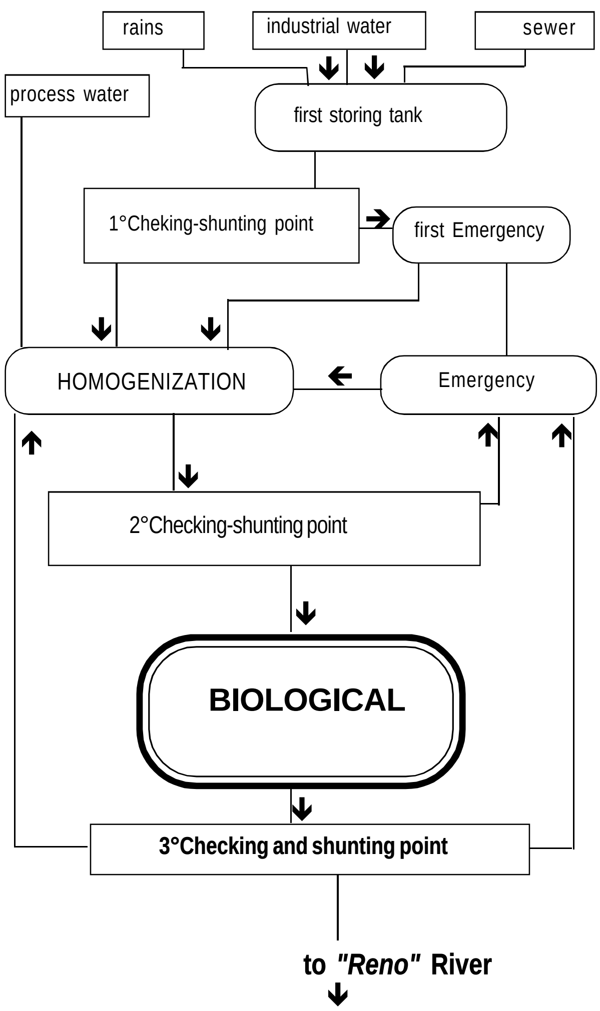
Final treatment takes place in a two stage treatment plant with activated sludge, a nitrification and a denitrification phase, followed by filtration with a two stage sand filter after secondary sedimentation.

The final effluent is discharged into surface water and must therefore comply with the discharge allowed by table A of the Italian law for waste water (nr. 319/76).

The plant has a 1800 cubic meter emergency tank, which

CHECKING AND SHUNTING POINTS

Checking and shunting points of the plant may be shown in the following scheme:



is able to hold approximately two times the daily flow in two different partitions.

The smaller partition of the tank (250 cubic meters) is used to store highly polluted waters from flow diversion originating upstream of the plant (first check-diversion point).

The larger partition (1550 cubic meters) is used for containment of the final effluent in the event that discharge compliance cannot be met (this would be verified at the second and third check/diversion points). If the consumption of water inside the plant is restricted, this partition permits the retention of the waste water for approximately 70 hours.

THE SYSTEM

Instrument purchasing decisions were based on: dependability and robustness of the components, ease of maintenance, support capability of suppliers, and availability of parts and accessories.

The formalization of internal procedures for calibration and general maintenance was deemed very important to best guarantee the precision of the analytical data and efficiency of the entire system.

Another fundamental step decided upon is the progressive automation of the diversion system (figure 1).

Automation of the second and third check/diversion points is still in progress.

This gradual evolution from manual to semi-automated and finally to completely-automated, has contributed greatly to the better understanding by plant personnel of the importance of each upgrade as well as the system concept overall.

FIRST CHECK-DIVERSION POINT

The first check-diversion point is located downstream of the first tank and consists of a pH-meter and an Isco Model 3500 EZ-TOC analyzer.

Operating conditions for instruments in this area are very harsh for two reasons:

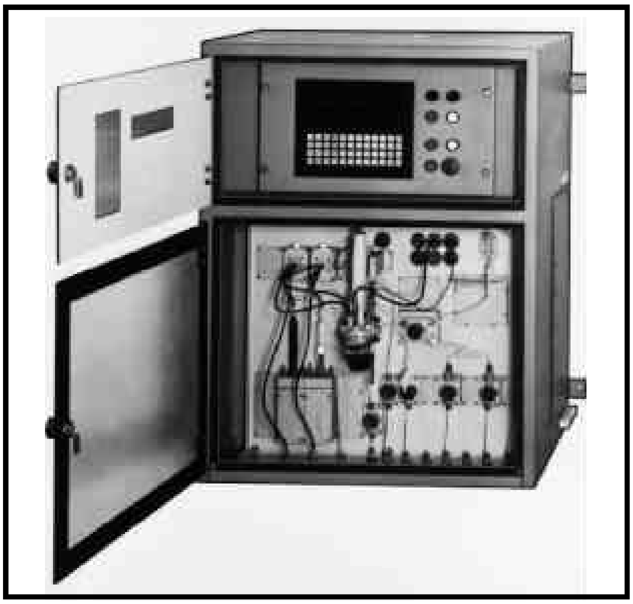
1. The liquid to be analyzed is the product of mixed drainage and may contain particles, acids, solvents, and product traces or scraps.
2. Distance from the plant is approximately 700 meters, making it difficult for plant personnel to perform frequent checks.

For the above reasons equipment must be used that can provide maximum efficiency with regards to hydraulic obstructions and corrosion, and, most importantly constant status reports.

Speed of response and precision are crucial to this check/diversion point.

The first alarm immediately alerts the plant personnel so that identification and isolation of the spill may begin.

Precision is essential to guarantee reliable outputs of the incoming load which can then at a later time be combined with process water. In addition, the equipment must report with reliability, the complete cycle of the "spill".



The sequence of events at the first check-diversion point is as follows:

- polluted water reaches the first collection tank
- at 200 ppm the first alarm is activated, alerting the production manager and assistants via beepers, so they may the begin to isolate the cause of the pollution.
- at 350 ppm the second alarm is activated, automatically diverting the polluted water to the first emergency tank via primary lifting pumps.
- within 12 minutes the TOC reaches 100% concentration value of the polluted water.
- when the TOC value falls below 350 ppm, the second alarm clears, diversion is halted, and the first alarm or "warning" state is restored.
- when the TOC value falls below 200 ppm the first alarm clears and normal operation resumes.

The polluted water is later mixed with process waters at other stages to ensure proper treatment.

SECOND CHECK-DIVERSION POINT

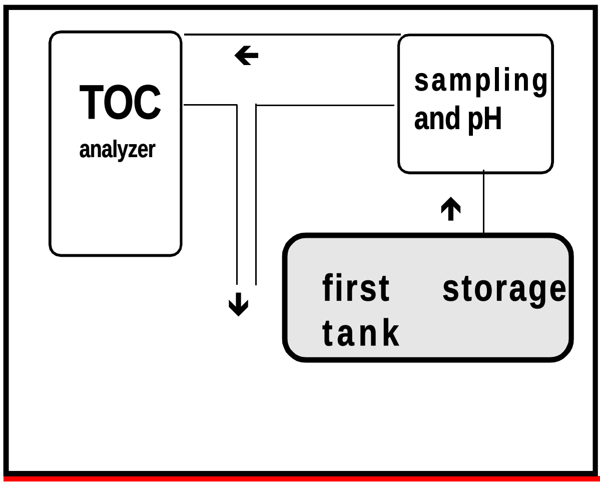
The second check-diversion point concerns flow from the homogenization tank which feeds the biologic tank.

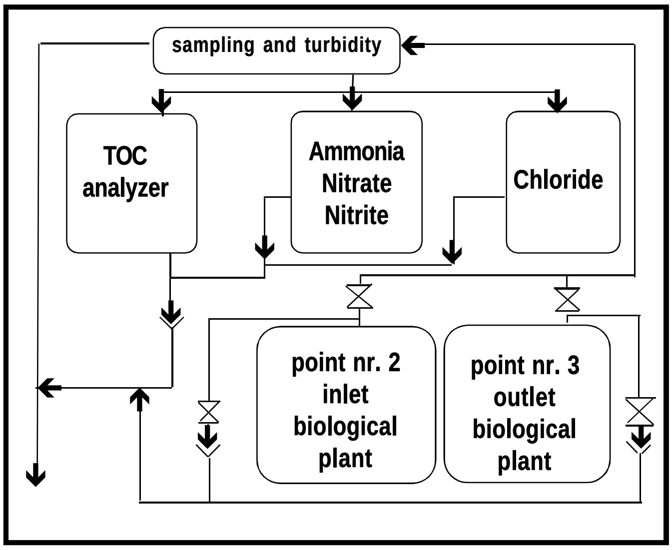
The equipment used, shared also by the third check/ diversion point (figure 3), encompasses a much broader range of parameters including: TOC, turbidity and the use of an Applikon Analyzer for controls of : ammonia, nitrate, nitrite, and chloride.

This checkpoint is crucial to the correct management of the biological process.

It gives plant personnel the ability to evaluate the effective organic load to be submitted to the plant and verifies the correct dosage of the contents of the first emergency tank to be added the process water.

Irregular situations such as excessive levels of nitrogen or chloride substances which are undetectable at the first check/diversion point can also be identified. In the event that irregularities occur at this checkpoint, corrective measures are taken which incorporate the partial transfer of volumes of water from the homogenization tank to the emergency holding tank.





The volume transferred is sufficient for the restoration of critical parameters to an acceptable level.

THIRD CHECK-DIVERSION POINT

The third check/diversion point is relevant to the final plant effluent.

As already mentioned, it shares the same equipment with second point. In both cases the sample is relatively simple to handle because it is low in pollutants and devoid of solids.

The importance of "on-line" monitoring in this phase is to allow for nearly instantaneous evaluation of overall plant efficiency and to ensure compliance with discharge limits permitted.Internal operation procedures have been devised which require adherence to levels lower than those actually permitted.

These "operating levels" are determined by plant management and serve to create a window of response time which enables plant personnel to react to spills and if necessary compensate for the analytical precision of the various methods involved.

When the internal limit is reached, flow is immediately interrupted and sent to the emergency holding tank.

At the end of the emergency, the stored water is gradually treated with process water dilution in proportion to the level of pollution measured.

CONCLUSIONS

The aforementioned prevention measures have be able to eliminate most pollution problems associated with the chemical plant in question. It is clear that the efficiency of the first two stages of prevention makes the third practically redundant. The third stage is retained, however, in the event of temporary mechanical failure in the plant.

The automated system in its entirety has proved to be highly reliable and as a result has given plant personnel more time to dedicate to the control of biological processing as well as internal treatment.