Wastewater Monitoring Systems

Introduction:

Webster's dictionary defines monitoring as **(1)** to check and sometimes to adjust for quality or fidelity, **(2)** to watch, observe or check, especially for a special purpose, **(3)** to keep track of, regulate or control (as a process for the operation of a machine). Note that both (1) and (3) involve adjustment, regulation, or control, which fit well with the various types of monitoring information. A distiction can be made between different monitoring activities:

- **Survey:** short term observation(s) on water quality (in present context) to fulfill definite objective(s);
- **Surveillance:** a continued programme of surveys systematically undertaken to provide a series of observations in definite time period;
- **Monitoring:** continuous surveillance undertaken to fulfil set of objectives.

Monitoring of wastewater is needed and serves as management tool for not only regulators and operators; but also for policy makers. Monitoring of wastewater can be done by conventional sampling and analysis techniques, as well as though real-time monitoring of important parameters.

With rapid industrialization, it is becoming a need and necessity to regulate and minimise inspection of industries on routine basis. Therefore, efforts need to be made to bring self-discipline in the industries to exercise self-monitoring & compliance and transmit data of effluent and emission to SPCBs/PCCs and to CPCB on continuous basis. For strengthening the monitoring and compliance through self-regulatory mechanism, online emission and effluent monitoring systems need to be installed and operated by the developers and the industries on, 'Polluter Pays Principle'.

Central Pollution Control Board vide its letter No. B-29016/04/06PCI-1/5401 dated 05.02.2014 issued directions under section 18(1)b of the Water and Air Acts to the State Pollution Control Boards and Pollution Control Committees for directing the 17 categories of highly polluting industries such as Pulp & Paper, Distillery, Sugar, Tanneries, Power Plants, Cement, Oil Refineries, Fertilizer, Chloral Alkali Plants, Dye & Dye Intermediate Units, Pesticides and Pharma Sector, Common Effluent Treatment Plants (CETP) and STPs, Common Bio Medical

Wastewater Monitoring Systems

Waste and Common Hazardous Waste Incinerators for installation of real-time wastewater quality and common emission monitoring systems to help track the discharges of pollutants from these units.

Components/ Techniques involved in Wastewater Monitoring Systems:

The Real time continuous analyzers are mainly of two types:

- Online Analyzers
- Inline Analyzers

Brief Description of each component /Technique:

- **Online Analyzers**
  - Generally based on automated laboratory based measurement techniques.
  - Sample is usually injected using rotation valves or peristaltic pumps to the instrument using flow injection analyses (FIA) or sequential flow injection techniques (SFI), via a separate analytical line which is connected to the main process stream.
  - The sample is then extracted, pre-treated if required and presented to the analytical instruments for the analysis required
- **Inline Analyzers**
  - Inline analyzers are simpler in design and can measure directly in the process line, using a probe that is chemically insensitive.
  - They are more susceptible to physical and chemical interference from the sample matrix as measurement backgrounds are more changeable
  - Usually require ex-situ calibration.

Additionally, these analyzers can be further divided into following categories considering the techniques employed by them for measurement of parameters:

- **Photometric sensors :**
  - Colorimetric
  - UV Absorption and
  - UV Visible absorption
- **Ion Selective Electrodes :**

Pros and Cons of real-time wastewater monitoring systems:

- **Pros:**
  - Very quick analysis of parameters as compared to conventional offline sampling and analysis.
  - Convenient for regulators, stakeholders to monitor performance of treatment plant and their discharges in to severs.
  - Operator can predict the situation very early and fine tune treatment process accordingly.
- **Cons:**
  - High cost for installation
  - High operation and maintenance cost.
  - Require frequent calibration
  - Require skilled manpower for operation.

SUITABILITY OF TECHNOLOGIES FOR DIFFERENT MATRICES

Available Technologies	Parameters Measured	Applications	Limitations
UV Spectrophotometry (Single /two/four wavelengths)	COD, BOD	Fresh Water analysis with constant matrix	Suitable for fresh water and not for waste water analysis. Interference of colour & high turbidity. Suitable for stable matrix. Single bond organic compounds are not measured.
UV-Vis Spectrophotometry 40 wavelength	COD, BOD, TSS	Fresh Water & Waste Water analysis with constant matrix	Many organic compounds are unattended due to lesser scanning of UV spectra. Suitable for stable matrix. Any matrix change would require revalidation of factor. Sample pumping limitation.
UV-Visible Spectrophotometry (Single Beam)	COD, BOD, TSS	Fresh Water & Waste Water analysis.	Interference due to colour & high turbidity affects the analysis. Reference beam compensation not available.

			Suitable for stable matrix. Any matrix change would require revalidation of factor.
UV-Vis Spectrophotometry (Double beam with entire spectrum scanning)	COD, BOD, TSS	Fresh water to Waste water analysis.	Interference of colour & turbidity is compensated in visible spectrum. Any matrix change would require revalidation of factor.
Combines Combustion Catalytic Oxidation at 680°C and NDIR Method	TOC (Co-relation with BOD & COD)	Fresh Water and Waste Water analysis.	Carrier gases required Continuous High power requirement For Analyser: Infrastructure is required More than 10-15 minutes sampling frequency. Only TOC can be measured. Any matrix change requires fresh correlation to COD & BOD
UV Persulfate NDIR Detector	TOC (Co-relation with BOD & COD)	Fresh Water & Waste Water analysis.	Carrier gases required Continuous High power requirement Analyser: Infrastructure required. More than 10-15 minutes sampling frequency. Only TOC can be measured. Any matrix change requires fresh correlation to COD & BOD.
Persulfate Oxidation at 116- 130degC NDIR Detector	TOC (Co-relation with BOD & COD)	Fresh Water & Waste Water analysis.	Applicable for moderate polluted effluent. Carrier gases required. Analyser: Infrastructure required Any matrix change requires fresh correlation to COD & BOD
Measuring COD using Potassium dichromate($K_2Cr_2O_7$)	COD	Fresh Water & Waste Water analysis.	Discharge of hazardous chemicals.

+Calorimetric			
Electrode / Electrochemical method	pH	Fresh water & Waste Water analysis.	Electrode life
Scattered Light Method (IR)	TSS	Fresh water & Waste Water analysis.	---
Nephelometry Method	TSS	Fresh Water & Less turbid water	Fresh Water analysis with Low turbidity
Colorimetric (645-655nm)	NH3	Fresh Water & Waste Water analysis.	Turbidity interference is there which can be overcome. 3-15 min cycle time
Ion Selective Electrode method With temp correction	NH3	Fresh Water & Waste Water analysis.	Interference from Potassium. Requires additional measurement of potassium for compensation.
UV Absorbance or Multiple Wavelength UV Absorbance Spectrophotometers (200-450nm)	NH3	Fresh Water & Waste Water analysis.	Turbidity interference is there which can be overcome.
Colorimetric method Reaction of Cr-VI with diphenyl carbazide in acid solution	Chromium	Fresh Water & Waste Water analysis.	Experience in Indian condition is not available.
Voltammetry (Anodic Stripping Voltammetry)	Chromium	Fresh Water analysis.	Experience in Indian condition is not available
Dual Beam UV-Visible Spectrophotometry	Chromium Hexavalent and Trivalent in full spectrum	Fresh water & waste water analysis.	Experience in Indian condition is not available
Voltammetry (Anodic Stripping Voltammetry)	Arsenic	Fresh Water analysis.	Experience in Indian condition is not available

Source: Guidelines for Real-time Effluent Quality Monitoring System, CPCB, New Delhi