Introduction

Effluent is defined as the outflowing of water or gas from either a natural body of water or a man-made structure. In industrial terms it is used to describe the water or wastewater discharged from a plant that is either treated or untreated and returned into either the river or sea from where it originated.

Effluent discharge monitoring is the act of recording how much of a substance is discharged back into the environment, in order to conform to legal requirements such as the amount allowed per day and the permissible limits of temperature and chemicals contained within. Failure to adhere to these limits can result in heavy financial penalties.

This document focuses on using ABB’s Recording & Control equipment in effluent discharge monitoring applications. It explains what must be monitored and controlled and details how the instrumentation is suitable to meet those requirements, including detailing features which are specifically applicable to this type of application.

Industrial water use

Water is an essential component in most industrial processes. It has a number of qualities that make it both a universal raw material and essential process component. For example, because of its ability to dissolve more substances than any other liquid, it is known as the universal solvent and is used widely in processes where dissolution or dilution is required; it also has a high specific heat capacity, which means the amount of heat it can absorb before the overall temperature increases by a degree is quite high and makes it perfect for use as part of a process coolant system. Common industrial processes include:

- electric power generation
- cooling
- heating (retorts, pasteurization, sterilization)
- pulp/paper manufacture
- mining

Using RVG200 paperless recorders in effluent discharge monitoring applications

Measurement made easy
Industry accounts for around a quarter of all global fresh water demands, unlike agriculture (which accounts for the highest percentage of freshwater withdrawals) where the majority is used for irrigation of crops returning very little of it to the supply. Industrial processes tend to consume very little of the water that is withdrawn and therefore it can be returned to the water supply and reused. However, the water coming from an industrial process is usually much lower in quality than the water that went into it. It is estimated that industry produces somewhere in the region of 300 to 500 million tons of toxic heavy metals, solvents and other waste much of which could find its way into the freshwater supply.

As such clean water legislation in developed countries has been introduced in order to control the quality of water dumped back into the public supply by industry.

Regulatory bodies such as the Environment agency in the UK are responsible for the creation and enforcement of legislation detailing the quality of water within the supply. From the expected standards of water supplied for drinking, to the quality of the water and amount an industrial process can expel and return to the water supply, for general purpose usage, strict guidelines must be followed otherwise strict punishments can be enforced. In order to adhere to this legislation businesses will have an onsite effluent plant, where waste water is treated and monitored to ensure it meets the legislative requirements before being returned to the water source from where it came.

Of the previously listed common processes, the type of legislation that must be adhered to changes depending on the processes used. Food & Beverage plants for example, will use smaller overall volumes of water for heating and cooling processes, which will have less direct contact with the product, therefore it can be reused much easier with much less treatment being required as its contamination levels will be at a minimum. Whereas, water used within the cleaning process will require a greater level of treatment to remove potentially harmful chemicals and waste which can cause harm to the environment/animal health if returned to the general water supply untreated.

A power generation plant however, will use larger volumes of water within the cooling system. Owing to the volumes required the plant will be geographically located alongside a large body of water typically a large river or by the ocean from which the required water is taken and returned to directly, rather than the normal mains water supply (see below):
In a steam generation power plant, a fossil fuel such as coal or gas is burnt in order to heat water taken from the local source (in this case a river). This water becomes steam and is used to drive a turbine inside a generator which is what produces the electricity.

As the steam cools and turns back into water, it would then be returned back to the supply from where it came. It is at this point that the legislation kicks in, the level of chemicals, metals and other substances in the water must be monitored and the water treated to ensure it meets the legal requirements before it can be returned to the source.

Pulp and Paper manufacture is another industry where close geographical proximity to a readily available source of water is essential. The first stage of making any paper is pulping. This process is not always carried out on the same site as the actual paper is made. The process itself involves taking the raw material such as wood or cotton and separating out the useful fibres (cellulose from wood or cotton for example).

This process can be achieved a number of ways, the most common way being mechanical pulp, where the raw material is ground up under pressure to separate the cellulose fibres. There are a number of variations on this whereby the raw material can be steamed or treated with chemicals prior to undergoing the mechanical process. This means the required mechanical process can be less vigorous and use less energy as well as decreasing the amount of damage done to the fibres during the process.

Typically mechanical pulp is used for products which require a lower physical strength such as newspaper. And also chemical pulp, which is where the raw material is placed into large vessels known as digesters where chemicals are added to the material and heat applied to break down the bonds which hold the cellulose fibres together. Because this process does no physical damage to the fibres themselves it is used to produce paper that requires stronger physical characteristics.

Once the pulp has been made, it is at this point it can then be bleached to create white paper. It is then dried and transported to the paper mill. At this point in the process there is water left which has been contaminated with a mixture of natural residue, chemical residue and bleach. All of which must be neutralized before any water can be returned to the supply.

The process of creating the paper itself uses far more water. Water is added to the pulp to create a suspension, this mixture is then passed through a screen to produce a mat of interwoven fibres. It is then pressed to remove the excess water. The waste water here is again contaminated with residual bleach and chemicals from the pulp making process. Once all the water has been removed the paper is then dried, rolled and is ready to be sent to be made into the end product.
...Industrial water use

Mining is another process which uses a large amount of water that can become heavily contaminated. Water is used heavily in the mining industry, from mineral extraction to gas and quarrying it has a variety of uses and is required in large quantities, but subject to heavy contamination as part of the process. The mining industry generally supplies itself with water, taking it from local sources and then returning it after decontamination back to where it came. This also unlike other industries is able to often return more than it took due to the process of dewatering mines, this is where old or deeper mines can often be below the natural water table and as a result will begin to fill up with ground water. As this happens they need to be cleared, this water is contaminated with dust and chemicals and so needs to be treated before it can be reused or returned to the water supply, which is critical as the local water table will decrease as the water is pumped from the mine.

There are of course the standard operational activities that the mining process requires water for:

- transportation of ore and waste slurries and suspensions
- separation of minerals through chemicals processes
- cooling systems around local power generation systems
- suppression of dust
- washing equipment

All of which result in heavy contamination of the water used. Currently there is a lot is discussion in the news about the gas mining process of ‘fracking’ which involves a highly pressurized water mixture being pumped into the ground to release gas trapped in the earth’s crust. This of course has a tremendous environmental impact due to the amount of contamination that would be in the water and also what that would do to the existing ground water in that area. Extracted water is either treated as effluent before being discharged back into the environment or disposed of in evaporation ponds, this is where water is stored in artificially created pond with a large surface area to allow the natural sunlight to evaporate the water away from any harmful substances or the substance that was mined and be returned to the environment without contamination.

Legal requirements

Where any water is taken from and discharged back into the environment by industry there will be legislation surrounding that which must be followed. Typically this legislation would cover the following:

- the amount per day which can be withdrawn from the source
- the amount per day that can be returned to the source
- the temperature of the returned water
- the pH of the returned water
- the level of other chemicals in the returned water

All of this is designed to keep the impact on the local environment to a minimum without prohibiting the use of that resource by industries who rely heavily upon it. Consent to discharge trade effluent is applied for by a company to its local water authority. Permission to then do so will be considered and granted on a business by business case. The levels and limits imposed are then unique to each business. Failure to adhere to the imposed restrictions can result in prosecution.

The following can also result in prosecution and revocation of a license if not reported to the local water authority:

- any proposed changes to the nature or constituents of the trade effluent
- any proposed changes to the rate of discharge or daily volume discharged
- a proposed change of ownership of the trade premises
- any proposed change to the name of the company or partnership

Discharge of trade effluent is taken very seriously. As such Companies such as paper mills and power plants who take and discharge a large amount of water on a daily basis will usually have a site based effluent plant, which is used to monitor the daily intake of water, treat the water once used, and then monitor the quality of and amount of water being returned. Records are then kept for an extended period of time for legislation reporting purposes and also for legal protection in the event of an accident taking place.
Effluent plants

An effluent plant would normally be made up of a number of different sections, each designed for a different stage of the treatment process, before it can be discharged. Those sections will also change slightly based on the content of the effluent to be discharge because as a result the treatments will be slightly different. But the basic principle will be the same throughout any water treatment system. The first stage of any effluent plant is the equalization tank. This is essentially a holding tank where the effluent is pumped into in order to equalize the flow through the effluent treatment plant, as obviously there will be times when the process demands more and less water and so a direct flow would make treatment of such differing volumes very difficult. Sometimes pre-treatment is also performed at this stage.

The effluent is then moved through the plant to aeration tanks. This is where gas (normally oxygen) is mixed into the liquid in order to promote growth of microbes which begin to break down the contaminants in order to form solids which can be removed at a later stage.

The sedimentation tanks then allow the previously formed solids, or sludge to sink to the bottom of the tank and be separated from the liquid form. This sludge gathers in its own tank before being passed through a sludge thickening process which increases the solid content to allow further residual water to be removed from it. The newly sludge free effluent is then passed through the final stages of its treatment before being returned to the water supply as clean and treated water. It is at this stage that processes such dosing to control the pH would take place.

Example of the basic sections used in effluent plants
Instrumentation in effluent applications

In effluent treatment and monitoring applications there is a large requirement for instrumentation. The legislation dictates the level that a number of properties must be before it can be returned to the supply such as temperature, pH and the level of certain chemicals within it, it also very specifically dictates the amount of water that may be taken per day from the source for use in the process as well as returned per day to the source after treatment.

These levels must not only be measured and controlled closely but also recorded so that in the event of any kind of accident or environmental disaster there is a clear record of what has been expelled so that any penalties can issued correctly and according with the severity of the violation.

Each stage of the effluent treatment process will have instrumentation requirements depending on the required function of that individual section. All sections will undoubtedly contain flow, temperature and level measurement equipment to ensure uniform movement and correct treatment of the effluent through the system at all times.

Specialist sections such as the equalization tank (if pre-treatment is required) or the individual treatment tanks where dosing of chemicals takes place will also contain Control equipment in order to ensure the exact amount of chemicals are added to treat the product correctly (For more information on using the CM30 in pH dosing applications please refer to TD/RandC/014).

After treatment and before being returned to the source, the temperature and chemical composition (depending on process) are measured and recorded, and the flow back into the source also recorded for legislative requirements.

The RVG200 and effluent discharge monitoring

The RVG200 has a number of features available which make it perfectly suited for use in effluent monitoring applications.

Dual totalizers

- With 2 totalizers per channel the RVG200 offers the flexibility to record both a continuous and resettable total for a single flow signal. Both totalizers can be clearly displayed to the operator together with the instantaneous flow rate or assigned to a recording channel in its own right.

Totalizer log

- A convenient summary of all totalizer occurrences. Whenever a totalizer is started, stopped or reset it is logged together with the value of the totalizer at that occurrence. The totalizer log is archived securely along with process data and can be reviewed using the DataManager Pro software.

Automatic totalizer reset

- Totalizers can be configured to easily to reset automatically at specific intervals. A daily, weekly or monthly reset time can be programmed into the recorder to provide an automatic reset at which point the final totalizer value will be entered into the totalizer log. A digital signal generated either internally or externally can also be used to reset the totalizer.

Flow limit alarm monitoring

- The recorders alarms can be configured to indicate a limit is approaching or has been reached. This is ideal for effluent monitoring applications where strict flow limits are imposed, and can help to avoid unnecessary penalties.
Ethernet communications

- The comprehensive Ethernet communications available as standard on the RVG200 allow for remote access to the recorded process data. This means that even in the remotest of plants, data can be collected quickly and securely using the DataManager Pro FTS Pro software. Additionally, the recorders internal webserver can be viewed using a PC, Tablet or smart phone allowing remote start, stop, and reset of the totalizers. It also allows for complete remote operation of the unit. Modbus TCP is also included as standard as part of the Ethernet functionality and can be used to collect real time process information.

Comprehensive environmental protection

- The RVG200 has full IP66 and NEMA 4X front face protection providing suitability for installation in environments subject to high level of moisture and possible hose down. This allows the recorder to be installed within the plant.

DataManager Pro data review software

- ABB’s DataManager Pro data review software is free to download software that requires no additional purchases to use the basic functionality. A license can be purchased to gain access to the more advanced functionality such as the FTS file transfer function. Data can be easily recalled and reviewed via chart format with a comprehensive number of analysis tools to enable easy creation of charts for legislative purposes.

- Chart information can be displayed simultaneously in a tabular format and the licensed version allows for export to excel if required.

- The database can be stored on a network drive allowing multiple users access to review the data without interference and long term data storage. With an automatic database back up included.