Application Note

Drägersafety

Sewage Plant

Introduction

Water which has been used to flush and transport human and liquid wastes of residences, businesses and industries is defined as wastewater. The sewage system also transports the run-off surface water and storm water. Any wastewater that is potentially dangerous to humans or the environment because of its toxicity, flammability, corrosivity, chemical reactivity, etc. requires treatment before it is released back to the water system. Wastewater Treatment Plants (WWTP) are facilities designed to prevent pollution and disease by treating wastewater before released to the environment.

Market Segment

- Municipal and industry wastewater treatment plants

Description of the Challenge

Typical gases to be monitored at a wastewater plant are: combustible gases (primarily Methane, CH_4), Hydrogen sulfide (H_2S), Chlorine (Cl_2) and Oxygen (O_2). In addition, some plants also require Sulfur Dioxide (SO_2), Ammonia (NH_3), Ozone (O_3), Chlorine Dioxide (ClO2) and Hydrogen Peroxide (H_2O_2) gas detection.

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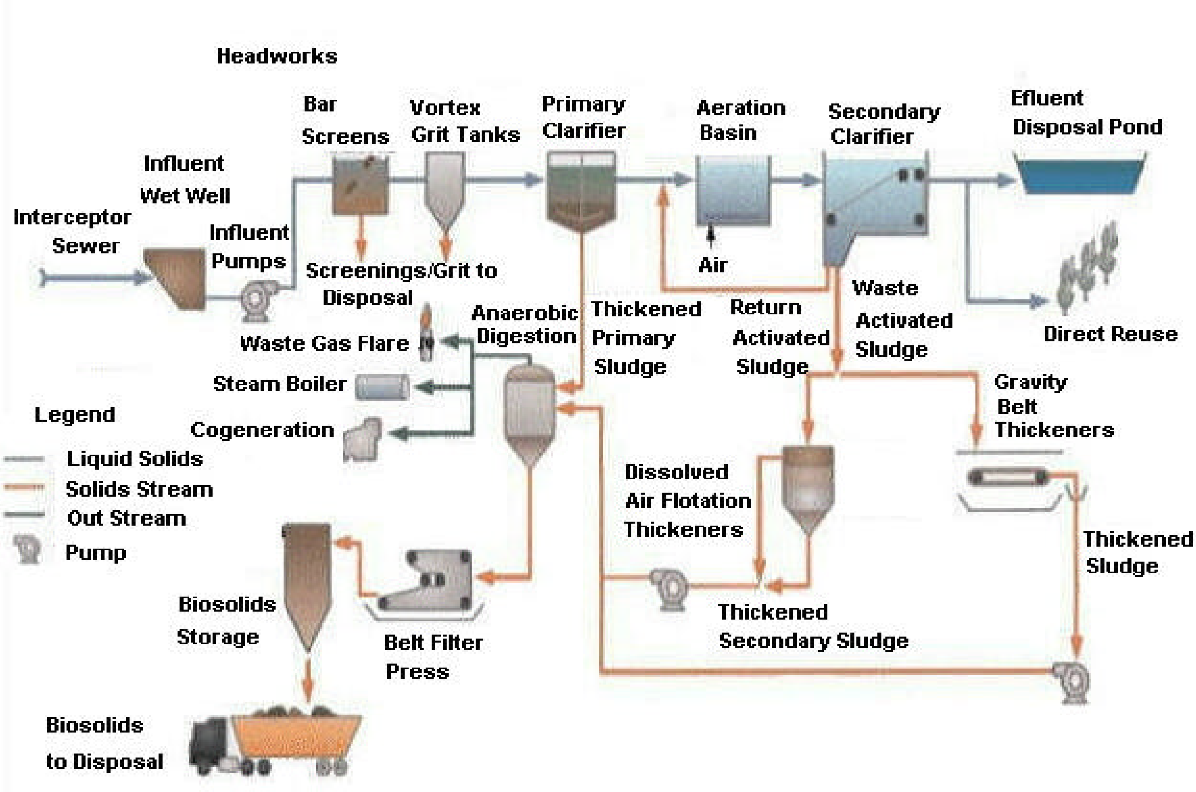


The terrain of the treatment plant site and the influent sanitary sewer depth govern the need for and location of in-plant pumping facilities. In-plant pump stations are facilities that consist of pumps and service equipment designed to pump flows from lower to higher elevations to allow continuous and cost-effective treatment through unit processes within the plant.

> Gas detection for combustible gases and vapors may be required where surface and storm water might carry fuel oil, gasoline, or flammable solvent spills. If those pumping stations, lift stations, dry wells or wet wells are in an enclosed building or structure, additional to Methane (CH_4) monitoring, Hydrogen Sulfide (H_2S) and Oxygen (O_2) detectors might be needed.

In Primary Treatment, in which 40 - 50% of the solids are removed, sanitary (or separate) sewers carry wastewater from homes and businesses to the treatment plant. Bar screens let water pass through but filter out trash which is collected and disposed of. A grit chamber slows down the flow of water, allowing sand, grit, and other heavy solids to settle out. A primary sedimentation tank collects the smaller particles. Lighter-than-water liquids, primarily oil, float on top. These “floaters” and “sinkers” are removed.

> Gas detection for combustible gases and vapors may be required where surface and storm water might carry fuel oil, gasoline, or flammable solvent spills.

In Secondary Treatment, which removes 85 - 90% of the pollutants, an aeration tank supplies large amounts of air to a mixture of wastewater, bacteria, and microorganisms. Oxygen (aerobic process) speeds the growth of these helpful organisms which consume harmful organic matter. A secondary sedimentation tank (anaerobic breakdown) allows the microorganisms and solid waste to settle out.

> In the process of aerobic breakdown, when happening in enclosed buildings or structures, gas detection may be required for Carbon Dioxide (CO_2) and Oxygen (O_2; depletion). In the process of anaerobic breakdown gas detection for Methane (CH_4) and Hydrogen Sulfide (H_2S) may be required.

The sludge collected at the bottom of the clarifier is then recycled to the aeration tank to consume more organic material. The term "activated" sludge is used, because by the time the sludge is returned to the aeration tank, the microorganisms have been in an environment depleted of "food" for some time, and are in a "hungry", or activated condition, eager to get busy biodegrading some more wastes. Since the amount of microorganisms, or biomass, increases as a result of this process, some must be removed on a regular basis for further treatment and disposal, adding to the solids produced in primary treatment.

One commonly used method of sludge treatment is digestion. Since the material is loaded with bacteria and organic matter; why not let the bacteria eat the biodegradable material? Digestion can be either aerobic or anaerobic. Aerobic digestion requires supplying oxygen to the sludge; it is similar to the activated sludge process, except no external "food" is provided. In anaerobic digestion, the sludge is fed into an air-free vessel; the digestion produces a gas which is mostly a mixture of methane and carbon dioxide. The gas has a fuel value, and can be burned to provide heat to the digester tank and even to run electric generators. Digestion can reduce the amount of organic matter by about 30 to 70 percent, greatly decrease the number of pathogens, and produce a liquid with an inoffensive, "earthy" odor. This makes the sludge safer to dispose of on land.

> In the process of aerobic breakdown, when happening in enclosed buildings or structures, gas detection may be required for Carbon Dioxide (CO_2) and Oxygen (O_2; depletion). In the process of anaerobic breakdown gas detection for Methane (CH_4) and Hydrogen Sulfide (H_2S) may be required. The description herein is only meant for **monitoring of ambient air**.
>
> For any in-line biogas monitoring see separate application note since different measuring ranges and conditioning of the biogas is absolutely essential.

Chlorine is the most widely used disinfectant for municipal wastewater because it destroys target organisms by oxidizing cellular material. After the disinfection the Chlorine residual has to be reduced to a level that is not toxic. Some prosesses use Sulfur Dioxide (SO_2) for the de-chlorination of the water. Some alternative desinfectants include ozonation (O_3), Chlorine Dioxide (ClO2) or ultraviolet (UV) disinfection. The wastewater, now safe for the environment, flows as an effluent to a river, lake or the sea.

> Gas detection for Chlorine Cl_2 and Sulfur Dioxide (SO_2), or whatever other gas is used as disinfectant

Also:

Ammonia stripping is a simple desorption process used to lower the Ammonia (NH_3) content of a wastewater stream. In Ammonia stripping, lime or caustic is added to the wastewater which converts Ammonium Hydroxide ions to Ammonia gas.

In some areas of the wastewater collection system, odors and corrosion within the wastewater system are controlled by direct oxidation of Hydrogen Sulfide H_2S with Hydrogen Peroxide H_2O_2. Typically, this is upstream of sensitive pump stations or force main discharges.

Solution from Dräger

Example:

1. Detection of gasoline and solvents (from surface and storm water):

Polytron SE Ex and cross-calibration for solvent monitoring using 40 %LEL Propane. Adjust channel card to 92 %LEL as the applied span gas concentration (this implies the factor 2.3).

Polytron XP Ex and cross-calibration for solvent monitoring using 40 %LEL n-Butane. Select C_9H_20 (n-Nonane) in the gas configuration menu and chose 80 %LEL instead of 40 %LEL as the applied span gas concentration (this implies the factor 2.0).

Polytron IR Ex is suitable to detect a great number of flammable liquids when calibrated for Methane or Acetone. Since the linearity is of lesser interest, a typical „sensitivity adjustment to be on the safe side" for Polytron IR Ex would be:

- Category: Propane
- Measuring range: 0 to 50 %LEL
- Apply 2.0 % by Vol. Methane
- Adjust to 30 %LEL
- Reduce measuring range down to min. 20 %LEL, if required.

Polytron IR is suitable to detect a great number of flammable liquids when calibrated for Nonane (selectable in the gas-library). The biggest advantage is, that the transmitter can be calibrated with Methane (the gas which is produced in the processes of the WWTP) and changed to Nonane without the need of re-calibration.

Recommendation:
Other than **Polytron IR**, none of the detectors should be submersed in water or wastewater because of possible damage. Only Polytron IR has IP 66 & IP 67 ingress protection, can be hosed off and is fully operational again.

2. Detection of Methane (produced during bacterial breakdown of organic material)

Polytron IR robust gas detector with SS 316 stainless steel housing, sophisticated double compensated optics which ensures less than 2 %LEL signal drift over 24 month, wide temperature range covering all climates (- 40 to + 65°C) and beam block warning before failure to schedule maintenance because of build-up of deposits on the optics.

Polytron Pulsar (outdoor) best used where the detector will be subjected to exposure to the elements, vibration, sunlight (and other bright light sources) and longer beam distances.

GDXL or GD2000 (indoor) ideal for applications in covered or enclosed areas where the need is for high sensitivity to flammable gas and relatively short operating distances, where there is little or no exposure to vibration, and complete protection from the elements.

Recommendation:
Open path detectors should be used when a large area should be monitored, e.g. across basins or along piping, **Polytron Pulsar**, or within buildings, **GDXL or GD2000**. **Polytron IR** is ideal as point detector where a possible leakage can happen only on one spot, e.g. flanches or valves..

3. Detection of toxic gases and oxygen (covering all gases found in a WWTP)

Polytron 2, Polytron 2 XP Tox a universal transmitter which accepts any DrägerSensor, downloads sensor-specific information from the embedded sensor EEPROM. The sensor has an embedded temperature element which allows to compensates the sensor signal in the range of - 40 to + 65 °C.

Advantages of the Dräger Solution

Catalytic bead detectors: - economical solution

IR detectors:
- lower measuring ranges along with higher sensitivities result in larger monitoring areas
- constant sensitivity over lifetime of the instrument
- can be submersed without damage (IP 66 & IP 67)

Open Path:
- monitoring of large areas
- low cost of ownership
- fast response time

DrägerSensor:
- bigger sensor means bigger electrodes and more electrolyte, hence faster response, higher accuracy, more stability and longer life
- embedded micro-chip and temperature element
- sensor recognition, numerous self-test functions, remote calibration and signal compensation over the whole temperature range of typically - 40 to + 65 oC

Restrictions

Catalytic bead detectors: - H_2S might be poisoning the sensor

References (internal, external)

Nigg STW	Aberdeen, England
Lowestoft STW	Suffolk, England
Torbay STW	Devon, England

STW = Sewage Treatment Works (UK expression for WWTP)

Drawings & Pictures

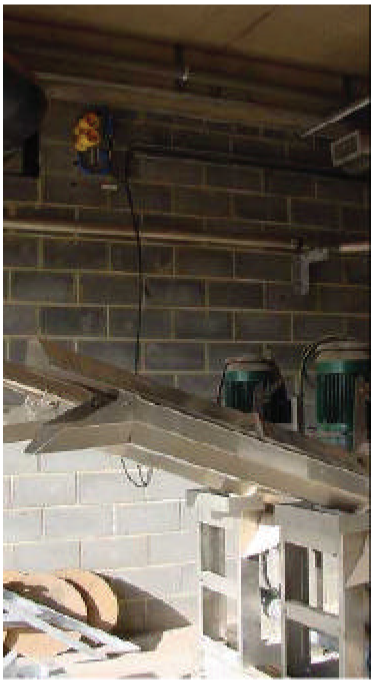
WWTP Devon, England

2	Control Cabinets c/w Regard HART & 4-20 mA channel cards	
36	Polytron 2	H_2S
36	Polytron 2	O_2
7	Polytron 2 IR	Methane
3	GD2000	Methane
4	GDXL	Methane

Inlet Works

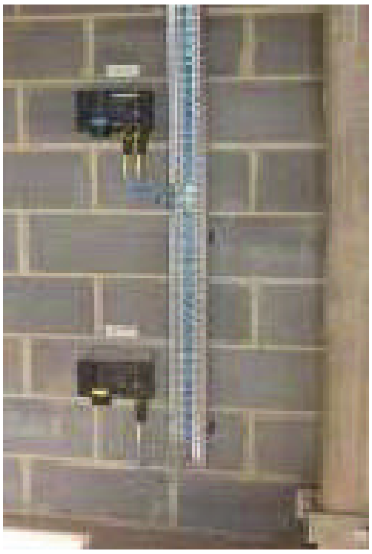
Sludge separation area

Screenings Handling Room



Locations: Screenings handling room, Centrifuge room, Grit & grease-low level, Sampling/ Densadeg® Corridor (clarifier), Biofor™ Pipe Gallery (biological aerated filtration), Biofors

Sensors are located in similar formats, ie: O_2 and H_2S heads paired up



Appendix

NFPA 820, especially table 2-4 'column G' shows whether a gas detector for combustible gases (CGD) is needed in a particular location (column A).

Responsible PM: Hr. Huber