BIOFILTERS OPERATION MANUAL

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Amendment List

Amendment No.	Date	Section Involved	Brief Description of Change	Inserted by
	July 2009	All	Created	M. PT
1.0	July 2015	All	*Equipment Maintenance* transferred into the *Maintenance Programme.* Bio Bed A1-4 added. Section 5.5 added.	M. PT
2.0	January 2017	All	Bio Bed No. 5 (A2-5) added. Trouble shooting amended. Title change from TEST PROGRAMME FOR ONSITE BIOFILTERS to BIOFILTERS OPERATION MANUAL	M. PT
3.0	November 2019	1.1	Added	M. PT

1. DESCRIPTION

A biofilter consists of a waterproof tank consisting of a lower air space to receive the odorous air above which is a mesh floor. This floor supports 1.5 – 2.5 meters of media which is wood chip. This media does not remove odour but rather provides surface area for bacteria to grow on. The biofilters work on the principal that microorganisms growing on the media break down any volatile organic and inorganic odours compounds being emitted from the factory and water treatment plant. For efficient air removal from the factory and reduction of odour emissions it is essential the biofilters are correctly supervised.

The odorous air is blown by variable speed fan's into the air space below the media. This air moves upwards through the media and the bacteria feed on the odorous gases within the air. The time the air takes to enter and exit the media is the residence time and is measured in seconds. This can be controlled by the fan speed and the depth of media. Residence time is the relationship between volume of air passing through the bed and the area and depth of the bed. Increasing the fan speed reduces the residence time and decreasing the fan speed increases the residence time.
Differential pressure is a measure between atmospheric pressure and the pressure in the air space under the biofilter floor. The air entering a biofilter contains odours. The odour concentration to be treated is the odours multiplied by the air volume. Increasing the air volume by increasing the fan speed reduces the odour concentration but also reduces the residence time. The odour concentration depends on the age and type of the raw material and fan speed.

Bacteria on the media prefer warm moist conditions, optimum pH and a constant food source (odour). The air entering a biofilter is warmer and moister than the ambient air (this is the air around us). The bed works best with a stable working temperature we achieve this by controlling the temperature and the moisture. The moisture can be controlled by the volume of water applied to the media.

The biofilters prefer a stable environment that promotes bacterial growth. The bacteria in the biofilters require:

1. A constant air flow with stable odour concentrations.

2. The moisture and temperature levels should be adequate for good bacterial growth.

The Farragh Proteins biofilters are subject to three quite different environments:

1. Processing conditions Monday afternoon to Saturday afternoon/Sunday.
2. Non-Processing conditions Saturday evening/ Sunday to Monday morning.
3. Seasonal temperatures & humidity.

1.1 Design and build specifications for biofilters

Biofilters are sized based on retention time and loading rate. Gas loading at no more than 125m3 air/m3 medium per hour in the bed. The gas residence time within the BB to be not less than 30 seconds. Air stream should be not less than 90% humidity. Summary of guidelines regarding Biofilter sizing:

1. The CWW BREF recommends the residence time for effective abatement of odour through the biofilter at a minimum of 30 – 45 seconds, with ranges of 25-60 seconds also commonly noted.

2. As per Odour Emissions Guidance Note (Air Guidance Note AG9) issued by Environmental Protection Agency in September 2019:

- Biofilters range in depth from 0.5m to 2.5m.
- Media required for a biofilter need a neutral pH (7-8), pore volumes of 80% or greater and organic carbon content of 55% or greater.
- The start-up of a biofilter typically requires about two weeks for the micro-organisms to become accustomed to the specific compounds in the exhaust stream.
- Typically, a Carbon/Nitrogen/Phosphorous ratio of 100:5:1 in the media is required to provide adequate conditions for micro-organism growth.

3. Best Available Techniques (BAT) Reference Document for Waste Treatment Final Draft (October 2017)

Appropriate medium height and surface area, associated with a suitable ventilation and air circulation system, are selected in order to ensure a uniform air distribution through the medium and a sufficient residence time of the waste gas inside the medium (e.g. empty bed residence time from 40 to 100 seconds).

A prior treatment of the waste gas with a water or acid scrubber may be needed in the case of high NH_3 content (e.g. 5–40 mg/Nm^3) in order to control the medium pH and to limit the formation of N_2O in the biofilter.

Some other odorous compounds (e.g. mercaptans, H_2S) can cause acidification of the biofilter medium, and using a water or alkaline scrubber in combination with the biofilter may also be needed in this case. The biofilter is operated by monitoring and controlling the medium moisture content and medium pH and by monitoring and controlling the temperature and humidity of the waste gas entering the biofilter.

The abatement efficiency of the biofilter is monitored via the comparison of the biofilter air inlet and outlet NH_3, H_2S and/or odour concentration.

Biofilters can be divided into open biofilters and enclosed biofilters.

4. Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector 2016

The height of the filter material is between 0.5 m and 1.5 m, with a maximum of two to three layers. The specific load of the filter bed is between 100 and 500 Nm^3/h per m^2 of filter surface. In France, best practices show that the height of the filter material should be at least 1 m to obtain a residence time between 15 s and 60 s and the specific load is between 100 and 150 Nm^3/h per m^2 [227, CWW TWG 2009].

Parameters such as biofilter media pH, moisture content (relative gas moisture of about 95 % and more is required) and inlet gas temperatures affect odour removal capacity.

The moisture balance is regulated by a preconnected humidifier or gas scrubber, at times in combination with a moistening of the filter material. The moistening device needs protection against freezing in regions where temperatures are substantially below 0 °C. For application to warm waste gas streams (> 38ºC), cooling is necessary, either by mixing with outside air or introducing a gas scrubber or heat exchanger/ condenser. Wet scrubbing can be applied as a pretreatment with the aim of decreasing excessive particulate content, pollutant load and amount of pollutants not suitable for biofiltration.

The residence time to allow an effective abatement, e.g. of odour, depends on the pollutant concentration. As a rough guide, a minimum residence time of 30 s to 45 s should be aimed for.

The lifespan of the organic filtering material (e.g. root wood, tree bark, peat, compost, coco material and/or mixtures of these) is primarily determined by acidification (N, S and Cl), depletion and/or poisoning and pressure drop.

The typical surface pressure of a biofilter is around 50–500 Nm3/(m2×h), but it can drop to 5 or rise to 500 Nm3/(m2×h).

The filtering material should be replaced periodically (every 0.5–5 years), depending on the type of packing material and the composition of the gases.

The residence time of the gas in the filter should be at least 30–45 seconds in order to properly abate odorous compounds and solvents (e.g. toluene).

Table 3.178: Application limits and restrictions associated with biofiltration

Issue	Limits/restrictions
Gas flow (Nm^3/h)	100–200 000 (1, 2) 100–400 per m^2 of filter surface (3)
Temperature (°C)	15–38 (1) 50–60 (1), with thermophilic bacteria
Pressure	Atmospheric (1)
Pressure drop (mbar)	5–20 (1)
Oxygen content	Near ambient level (3)
Relative humidity (%)	> 95, nearly saturated with water (3)
Content of dust, grease and fat	Can cause clogging, hence pretreatment is necessary (4)
VOC concentration (mg/Nm^3)	200–2 000 (1)
Ammonia concentration (mg/Nm^3)	5–20 (1) Can decrease efficiency of degradation for hydrocarbons Can be degraded to N_2O
Odour concentration (ou_E/Nm^3)	20 000–200 000 (1)
Toluene concentration (mg/Nm^3)	20–100 (1)
Styrene concentration (mg/Nm^3)	50–500 (1)
Hydrogen sulphide (mg/Nm^3)	5–20 (1)
Compounds containing N, S or Cl (mg/Nm^3)	5–20 (for chlorous compounds) (1) Can acidify and deactivate the biofilter without buffer capacity, which brings about an increase in replacement frequency
Climatic conditions	Frost, rain and high ambient temperature affect the filter material and decrease efficiency
(1) [176, Schenk et al. 2009]. (2) [227, CWW TWG 2009]. (3) [9, BASF 1999]. (4) [250, Ullmann's 2011].	

Summary of Biofilters in Farragh Proteins:

	Area (m^2)	Flow rate (m^3/h)	Media depth (m)	Residence time (s)	Gas loading (m^3air/m^3medium/h)
BB 1	339.3	65000	1.7	31.9	112.70
BB 2	236.6	40000	1.6	34.1	105.65
BB 3	44.0	10000	2.2	34.8	103.31
BB 4	186.5	40000	1.8	30.2	119.15
BB 5	33.7	10000	2.5	30.3	118.84
Criteria			**0.5 - 2.5**	**minimum 30 - 45**	**maximum 125**

2. TEST PROGRAMME AND FREQUENCY

The biofilter sprinklers system, differential pressure, fan operation and olfactory assessment are checked daily. The inlet/outlet: humidity, temperature, gas loading and visual inspection of the bed are checked weekly. The emissions are tested in the biofilters weekly in the middle of the week when the factory is in full production and the maximum emissions can be monitored. Moisture, pH, ammonia and OFG content in bed material are checked quarterly by an independent laboratory as well as bacterial count which are carried out every 6 months. Biannually amines are checked by independent consultants.

Section No.	Frequency	Parameter	Equipment/Analysis Method
4.1.	Daily	**Pressure drop across the filter**	Differential pressure gauge
4.2.	Daily	**Fan operation**	Visual inspection
4.3.	Daily	**Olfactory assessment**	Subjective assessment
4.4.	Daily	**Sprinkler system**	Visual inspection
4.5.	Weekly	**Visual inspection** of the bed	Visual inspection
4.6.	Weekly	Relative **humidity** at inlet & outlet of biofilter	Humidity sensor
4.7.	Weekly	**Temperature** at inlet & outlet of biofilter	Temperature sensor
4.8.	Weekly	**Gas loading** at inlet & outlet of biofilter	Flow sensor
4.9.	Weekly	**Ammonia** at inlet & outlet to biofilter	Colorimetric indicator tube
	Weekly	**Mercaptans** at inlet & outlet to the biofilter	Colorimetric indicator tube
	Weekly	**Hydrogen sulphide** at inlet & outlet to the biofilter	Colorimetric indicator tube
	Quarterly	Bed material: **pH** at peak loadings	Standard Method
	Quarterly	Bed material: **moisture** at peak loadings	Standard Method

4.10.	Quarterly	Bed material: **ammonia** at peak loadings	Standard Method
	Quarterly	Bed material: **oils, fats & grease** at peak loadings	Standard Method
4.11.	Biannually	Bed material: **Total Viable Counts** at peak loadings	Standard Method
4.12.	Biannually	**Amines**	NIOSH Method 2010

Table 1. The test frequency of the biofilters

3. TROUBLE SHOOTING

The biofilters are very sensitive air treatment systems, partly because the method of air treatment is performed by microorganisms.

Problem	Cause	Action
pH- Rise or fall of pH <6.0 or >8.5 The pH is an important factor in the reproduction and work rate of the bacteria. Optimum pH for the bacteria **6.0-8.5**.	Contaminant biotransformations may cause acid or alkaline substances to be formed either rising or dropping the pH.	Rise in pH =Add acid. Fall in pH= Add caustic. The chemicals are pumped into the biofilter irrigation tank using a chemical connector to the in feed water pump. The biofilter which requires the chemical can be selected to constantly irrigate until the irrigation tank is empty.
Ineffective foul air treatment	Retention time too short.	Check the media for channelling and top up with woodchip if required. Adjust adequate irrigation and fan speed.
Rise or fall of media **moisture** content. Optimum in woodchip**: 60% – 85%.** Moisture content is essential for the proper conditions of the bacteria.	Too much or too little irrigation and air temperature changed. * If the air temperature drops and the irrigation rate remains the same, the moisture content will increase. * If the air temperature increases and the irrigation rate stays the same then the moisture content will decrease.	The sprinklers are on timers and are controlled by computer. • If the moisture content rises above optimum then the irrigation must be cut back and regulated. • If the moisture content drops then the irrigation rate must be increased.
Humidity: Optimum between 90-100% relative humidity.	Moisture content, inlet air temperature and irrigation water volume.	Monitor moisture and temperature of the bed to achieve optimum humidity. Adjust adequate irrigation and fan speed.
Temperature-Sudden changes in this factor	The inlet air temperature and the	The temperature can be controlled by introducing air to the biofilters

effects bacterial operation in the biofilters. Bacteria work most effectively at temperatures between 18-38ºC.	atmospheric temperature have implications on the media temperature.	slowly on start up to ensure that it doesn't receive vast amounts of cold air from the factory that's only starting production.
Differential pressure above 700 kPa - effecting the treatment of air flow through the biofilters. Excellent indication of the volume of air flowing through the biofilters.	If the media gets clogged with fat, dead bacterial cells, decayed media. The differential pressure will increase this results in less air been treated	The differential pressure should be monitored and kept as low as possible. If it gets too high the media will need to be replaced. Therefore the media needs to be kept as clean as possible. This involves irrigating the biofilter without effecting the other parameters.
TVC decreasing suddenly or drops below 1.0×10^3	Conditions of the bed material are not favourable for bacterial growth.	Investigate conditions of the bed material and inlet gases. Inoculate with bacteria from another bed if required.
Increasing **OFG** in bed material and exceeding 0.7%. Could cause blockage of material thus increasing pressure.	OFG getting into the bed material with foul air. Washer not working properly or fan speed too fast.	Consider washing or replacing bed material. Check operation of the biofilter washer and fan.
Increasing **Total Ammonia** in bed material and exceeding 1%.	Bed could be overloaded or bacteria in bad condition causing ammonia accumulation.	Decrease loading on the biofilter. Increase retention time. Consider washing or replacing bed material.

Table 2. Trouble shooting

4. CONTROL AND MONITORING; STANDARD OPERATION PROCEDURES

4.1. PRESSURE DROP ACROSS BIOFILTER

General

The differential pressure should be monitored and kept as low as possible. If it gets too high the media will need to be replaced. Therefore the media needs to be kept as clean as possible. This involves irrigating the biofilter as much as possible without affecting the other parameters.

Purpose

Differential pressure effects the treatment of air flow through the biofilters.

Scope

Differential pressure is a measure between atmospheric pressure and the pressure in the air space under the biofilter floor. It is read on the differential pressure gauge located on the side wall of the biofilters.

Responsibility

Environmental Officer

Procedure

Differential pressure is read on the differential pressure gauge located on the concrete wall of the biofilters. This indicates the amount by which the air pressure increases as it passes through the filter bed. An increase of the pressure is normally due to increased watering or clogging of the filter media. A decrease of the pressure is normally due to a drying of the media or a lower airflow. Make sure that there are no dry spots on the filter media.

The reading is taken daily and recorded in Pa. Results are kept on site for inspection.

4.2. FAN OPERATION – VISUAL INSPECTION

General

Proper fan operation is a foundation in biofilter functioning.

Purpose

This test is designed to see that the fans are operating properly.

Scope

All fans used in biofilters.

Responsibility

Environmental Officer

Procedure

The procedure is to inspect the fans in operation; if they work properly.
Inspect for unusual noise, motor overheating and vibration.

The test is carried out daily. Results are kept on site for inspection.

Weekly the fans speeds are checked. The speeds are set on the inverter i.e. minimum, maximum and medium. And the Speeds are checked with the SCADA system to ensure that the speed set on the SCADA system is the actual speed of the inverter driving the fan.

4.3. BIOFILTER – SUBJECTIVE ASSESSMENT

General

Due to the fact that odour is identified by one or more physiological or psychological responses to an often complex grouping of airborne compounds, no instrument has yet been devised that can better identify and measure the intensity of odour than the nose.

Only a few odorous compounds such as Hydrogen Sulphide (H_2S) or Sulphur Dioxide (SO_2), can be measured mechanically for monitoring purposes.

Purpose

The measurement of odour in and around the biofilters would allow for the determination of the largest sources of odours and the possible methods to control them.

Scope

All sources of odour from the biofilters.

Responsibility

Environmental Officer

Consultants

Procedure

The most important assessment is the odour rating in the biofilter. The odour is rated from 0-4 (4 being extremely bad and 0 being excellent or no odour detected). The odour is the best and quickest indication if the biofilter is working properly. A bad odour in the biofilter may be a result of some of the necessary factors not being correct (see 3. Troubleshooting)

The olfactory assessment is carried out on the biofilter system to check that it is working properly. The procedure is to check the entire biofilter system for any odours that would indicate that the system is not functioning properly.

Try to find words that describe your immediate impression of the odour. Alternative you can collect some outlet air in a bag, close it tight and take it to an office etc. Here you prick a small hole in the bag and smell the air. It will be easier to judge the odour here than out at the filter outlet, as there is no disturbing odours.

The check is carried out daily. Results are kept on site for inspection.

4.4. SPRINKLER SYSTEM – VISUAL INSPECTION

General

Moisture content is essential for the proper conditions of the bacteria. To help maintenance it make sure the sprinkler system works properly.

Purpose

The moisture can be controlled by the irrigation sprinklers in each biofilter. To make sure that the Sprinkler System is working properly and there is no channelling or drying out of the bed material.

Scope

It is essential to check single sprinklers in entire biofilter while operating.

Responsibility

Environmental Officer

Procedure

This test is carried out daily and it is designed to inspect the Sprinkler System in operation. Check if the sprinklers are not blocked and moving without any disturbance. Check the bed material. If dry areas are found, the water intensity has to be increased until the filter media is sufficiently humidified. If it needs to be dampened, the sprinkler system is switched on. This happens on a very rare occasion, as the water used on the biofilters is of good quality and the sprinklers are checked daily so the bed does not get time to dry out. Results are kept on site for inspection.

4.5. VISUAL INSPECTION OF THE BED

General

Media moisture is maintained because high air speeds have a drying effect. Dry areas must be humidified immediately, because here the air will be able to pass uncleaned through the filter media and this will result in a poor cleaning efficiency. Media remains moist but not wet as wet media can give rise to a compost odour.

Purpose

The biofilters need to be examined on a regular basis to ensure that no channelling or drying out of the bed material is evident.

Scope

The biofilters need to be visually examined on a daily basis.

Responsibility

Environmental Officer

Procedure

The test is carried out daily. The procedure is to visually inspect the bed material:

- If dry areas are found, the water intensity has to be increased until the filter media is sufficiently humidified. If it needs to be dampened, the sprinkler system is switched on. If dry areas are observed, take out some extra samples to examine the degree of dryness.
- Media remains moist but not wet as wet media can give rise to an earthy odour. If too wet areas are found decrease the irrigation time.

Turning, restructuring and dampening of the bed material or bed material replacement is carried out as required, subject to the bed performance.

The check is carried out weekly. Results are kept on site for inspection.

4.6. RELATIVE HUMIDITY

General

Media moisture is maintained because high air speeds have a drying effect. Dry areas must be humidified immediately, because the air will be able to pass untreated through the filter media and this will result in a poor efficiency.

Purpose

To ensure that all air emissions are quantified and recorded on a regular basis. The biofilter is examined to ensure that no channelling or drying out of the bed material is evident.

Scope

Analysis of gases is carried out weekly at the inlet and outlet of the biofilter at peak loadings.

Responsibility

Environmental Officer

Procedure

Humidity sensor is employed in this procedure. Before a reliable measurement can be made, the measuring probe and the medium to be measured must be in a state of temperature and humidity equilibrium. The adaptation time can take up to 30 minutes. The instrument is ready to use after a start-up time of approx. 2 seconds. Monitor the temperature and only measure the humidity when the temperature is stable.

Analysis for humidity is carried out weekly at the inlet and outlet to the biofilter at peak loadings.

- For outlet air: the metal hood is left on the surface of the bed for at least 10 minutes before the measure is taken. The probe must be fully insert into a metal hood covering an area of 0.5-2.0 square meters with an outlet of 50-100 mm for sample collection.

- Polluted air is taken from the inlet pipe in the 8 mm hole before the biofilter. The probe must be fully insert into the inlet pipe. Care must be taken in an air flow that dust and dirt do not contaminate the probe.

The test is carried out weekly. Results are kept on site for inspection.

4.7. TEMPERATURE READING IN BIOFILTER

General

Sudden changes in temperature effects the bacterial operation in the biofilters. Environmental bacteria work most effectively at temperatures between 18-45^{o}C.

Purpose

The stable media temperature helps to maintenance good condition of bacteria population. The inlet air temperature and the atmospheric temperature have implications on the media temperature.

Scope

Temperature readings of gases are carried out weekly at the inlet and outlet of the biofilter at peak loadings.

Responsibility

Environmental Officer

Procedure

Temperature readings of gases are carried out weekly at the inlet and outlet of the biofilter. To read the polluted air temperature the sensor is placed into the 8 mm hole in the inlet pipe. Take the reading when the temperature indicator is stable. Care must be taken in an air flow that dust and dirt do not contaminate the probe.

For outlet air fully insert the temperature sensor into the outlet hole in the metal hood left on the surface of the bed for at least 10 minutes before the measure is taken.

Readings are taken on a weekly basis. Results are kept on site for inspection.

4.8. GAS LOADING

General

Gas loading is calculated by multiplying air velocity (measured by a flow sensor) by the cross section area of a duct.

Purpose

To ensure that all air emissions are quantified and recorded on a regular basis.

Scope

Analysis of gas loading is carried out weekly at the inlet duct of the biofilter at peak loadings.

Responsibility

Environmental Officer

Procedure

Flow sensor is used in this procedure. The instrument is ready to use after a start-up time of approx. 2 seconds. The probe must be fully inserted into the 8 mm hole in the inlet pipe. The two openings in the probe tip must be parallel to air flow for best accuracy. A convenient way to assure proper alignment is to note the orientation relative to the handle before insertion. When extending or collapsing the probe tip, be sure the connecting cable moves freely through the opening at the base of the handle. Care must be taken in an air flow that dust and dirt do not contaminate the probe.

- Take the reading; velocity is expressed in meters per seconds (MPS).
- Determine the air volume by multiplying air velocity by the cross section area of a duct (the factors). The following factors are used to determine the gas loaded in 1 second:
  1. Bio Bed No 1 (A2-1) → **1.238 m^2**
  2. Bio Bed No 2 (A2-2) → **0.815 m^2**
  3. Bio Bed No 3 (A2-3) → **0.180 m^2**
  4. Bio Bed No 4 (A2-4) → **1.150 m^2**
  5. Bio Bed No 5 (A2-5) → **0.0735 m^2**

To convert m^3/sec to m^3/h multiply received results by 3600.

The test is carried out weekly. Results are kept on site for inspection.

4.9. PROCEDURE TO MONITOR AIR EMISSIONS

General

On a weekly basis the air emissions from the Biofilters are monitored and records kept for: Ammonia, Mercaptans and Hydrogen Sulphide. Colorimetric indicator tubes are used in the procedure.

Analysis for the above parameters is carried out at the inlet and outlet to the biofilter. Outlet samples from the biofilter are collected in a metal hood covering an area of 0.5-2.0 square meters with an outlet of 50-100 mm for sample collection. The hood is left on the surface of the bed for at least 10 minutes before sampling. Samples are collected with the hood in various positions on the surface to ensure the sample is representative.

Polluted air is taken from the inlet pipe in the 8 mm hole before the biofilter.

Purpose

To ensure that all air emissions are quantified and recorded on a regular basis.

Scope

Analysis for: Ammonia, Mercaptans and Hydrogen Sulphide are carried out at the inlet and outlet to the biofilter on weekly basis.

Responsibility

Environmental Officer

Procedure

<u>Inspecting the Gastec Pump before measurement (air leak check)</u>

1. Confirm that the inlet clamping nut is firmly tightened

2. After confirming that the pump handle is fully in, insert a fresh unbroken detector tube into the rubber inlet of the pump
3. Align the guide mark (red line) on the back plate and the guide mark (▼100) on the handle
4. Pull out the handle fully along the red guide line on the pump shaft to the lock position and wait 1 minute
5. Unlock the handle by turning it more than ¼ turn and guide it back gradually by applying a little resistance (otherwise the handle will spring back due to the vacuum in the pump cylinder and possibly damage internal parts)
6. Confirm the handle returns to the initial position and the guide line on the pump shaft is not seen.

<u>Use the Gastec – tubes</u>

1. The required equipment for the Gastec – Measurement: Gastec-Multi Stroke Gas Sampling Pump and relevant Gastec-Tubes.
2. Break tips off a fresh detector tube by bending each tube end in the tip breaker of the pump.
3. Insert the tube securely into the rubber inlet of the pump with the arrow on the tube pointing towards the pump.
4. Make certain that the pump handle is all the way in. Align the guide marks on the shaft and pump body.
5. Pull the handle all the way out until it locks on 1 pump stroke. Wait until staining stops (approx. 30 seconds).
6. Read concentration at the interface of the stained – to – unstained reagent.
7. If the discoloration is before the first calibration mark, use additionally one pump stroke without removing the tube. Obtain true concentration by multiplying with the correction factor (2). In case of still No stains, use a tube with a lower range.
8. If the stain exceeds the highest calibration mark, use ½ pump stroke. Obtain true concentration by multiplying with the correction factor (½). If stains still exceed the highest calibration mark, use tubes with a higher range.

The test is carried out weekly. Results are kept on site for inspection.

4.10. pH, MOISTURE, AMMONIA AND OILS/FATS/GREASES ANALYSIS

General

The bacteria on the media prefer warm moist conditions, optimum pH and a constant food source. The pH and moisture are important factor in the reproduction and work rate of the bacteria in the biofilter. Optimum pH for the bacteria is: 6.0-8.5.

Analysis of OFG and ammonia in the bed material indicate the bed conditions and help to follow the performance in the biofilters.

Purpose

For efficient air removal from the factory and reduction of odour emissions it is essential the biofilters are correctly supervised.

Scope

Twice a year samples of the filter media at peak loading must be taken and sent to an independent lab to have it checked for: pH, moisture, ammonia and OFG.

Responsibility

Environmental Officer is responsible for preparing the samples and putting the order for the analysis on the samples.

Procedure

Four times a year samples of the filter media at peak loading must be taken for further analyses. A recognised lab carries out the analyses of the filter samples. The lab will measure the pH value, the moisture content of the media and the content of ammonia and oils/fats/grease.

The test is carried out quarterly. Results are kept on site for inspection.

4.11. MICROBIAL ANALYSIS – TOTAL VIABLE COUNTS

General

The biofilters work on the principal that microorganisms growing on the media break down any volatile organic and inorganic odours compounds being emitted from the factory and water treatment plant.

Purpose

For efficient air removal from the factory and reduction of odour emissions it is essential the biofilters are correctly supervised.

Scope

Twice a year samples of the filter media at peak loading must be taken and send to independent lab to have it checked for total viable counts.

Responsibility

Environmental Officer is responsible for preparing the samples and putting the order for the analysis on the samples.

Procedure

Twice a year samples of the filter media at peak loading must be taken for further analyses. A recognised lab carries out the analyses of the total viable counts on the filter samples.

The test is carried out biannually. Results are kept on site for inspection.

4.12. AMINES ANALYSIS

General

Analysis for amines (NIOSH Method 2010) is carried out at the outlet to the biofilter. Outlet samples from the biofilter are collected in a metal hood covering an area of 0.5-2.0 square meters with an outlet of 50-100 mm for sample collection. The hood is left on the surface of the bed for at least 10 minutes before sampling. Samples are collected with the hood in various positions on the surface to ensure the sample is representative.

Purpose

To ensure that all air emissions are quantified and recorded on a regular basis.

Scope

Twice a year samples from the outlet to the biofilter at peak loading must be taken and checked for amines.

Responsibility

Plant Manager is responsible for arranging the analysis.
Consultants

Procedure

Twice a year samples of the outlet air at peak loading must be taken for further analyses. Recognised consultants carry out the analyses.

The test is carried out biannually. Results are kept on site for inspection.

4.13. PROCEDURE FOR THE PROPER START UP OF THE BIOFILTERS

On process shutdown the biofilters are changed to weekend mode. The parameters of which vary depending on the time of year. As the biofilters are sensitive to any environmental changes the start up and shut down procedures are very important for the effective air treatment of the biofilters for the week.
Biofilters in the WWTP are never shut down at the weekends.

Start up

On commencing start up of the biofilters:

- The weekend setting for the process buildings biofilters is deselected and the fan setting is turned up on Monday morning (Production staff).
- The **irrigation** is **not applied** to the biofilters until the beds have warmed up.
- The **fans** are then **turned up gradually** after production start up to ensure they do not get shocked by the temperature change. The biobeds are closely monitored. (Environmental officer).
- The **irrigation** and **fan** speed settings can be **regulated** accordingly. However, they should still be kept constant and as regular as possible. If **changes** have to be made do them **slowly over a period of time** (Environmental officer).

4.14. PROCEDURE TO TAKE MEDIA SAMPLE FROM THE BIOFILTERS FOR ANALYSIS

Responsibility

Environmental Officer

Procedure

Dig down to a depth of 20 cm, take a sample of the media with a scoop and put the sample into a marked plastic bag. The mass of the sample must be approx. 300 g. Fill in the dug holes carefully ensuring the media is compacted down as it was.

4.15. PROCEDURE FOR pH REGULATION

General

Contaminant biotransformations may cause acid or alkaline substances to be formed either rising or dropping the pH.

The pH is an important factor in the reproduction and work rate of the bacteria in the biofilter. Optimum pH for the bacteria is 6.0 - 8.5. Make sure that the pH is correct in the media and regulate it if it is not.

Responsibility

Environmental Officer

Procedure

1. If the pH is determined to be too low then Sodium Hydroxide solution must be added to the irrigation water.
2. If the pH is too high then Hydrochloric Acid must be added to the irrigation water.
3. The chemicals are added to the irrigation water tank via a pump connection to the IBC.
4. The chemicals should be added as a 1:100 dilution this involves adding 1 litre for every 100 litres of irrigation water in the tank.
5. A sign should be placed on the entrance to the biofilter indicating that there is chemical irrigation being carried out on the biofilters.
6. A second sample should be taken to ensure that the pH has being regulated.

4.16. PROCEDURE TO INSPECT EQUIPMENT

Purpose

Regular inspection of equipment is the most important feature of a successful maintenance program. Only through identification of imminent equipment malfunction can a suspected part be removed for repair or replacement before actual breakdown. The person performing the inspection should pay close attention to wear surfaces, such as gears, chains, and belts. All bearings should also be checked for temperature, excessive noise, or vibration.

Scope

Covers all equipment in the area of the biofilters.

Responsibility

Production Manager

Environmental Officer

WWTP Operator

Maintenance Team

All fitters

Procedure

The Inspection of equipment should be carried out as part of the main inspections on the site. The inspection should entail checking if there are leaks in pumps, blockages in pipes, motor overheating, etc. This is an important part of the operator daily routine.

When carrying out maintenance the equipment must be locked out. To ensure that this equipment lockout has occurred, the lockout procedure should be performed only by the personnel who will be performing the work. The following general procedures provide a safe, logical lockout sequence to follow:

<u>STEP 1</u>

1. Notify your co-workers that a specific piece of equipment is being locked out.
2. If the equipment to be worked on is in service, have operations shut the equipment down.
3. Arrange for the equipment to be repaired.
4. Verify that an operation has entered the equipment's status in the daily log.

<u>STEP 2</u>

At Equipment Control Centre:

1. Locate the equipment circuit breaker.
2. Open (disconnect) the correct circuit breaker.
3. Attach an "OUT-OF-SERVICE" tag to the open circuit breaker. Fill in information on why and by whom the equipment was taken out of service.
4. Physically lock the circuit breaker open, if possible, to further ensure the safety of plant personnel.
5. Dissipate any residual energy that may be "stored" in the equipment
6. Check the previous steps; try to operate the equipment to verify that it will not work.

Removing Lockout

After the equipment has been repaired, the following general guidelines can be use as a correct sequence for removing equipment from lockout:

STEP 1

At Equipment Control Centre:

1. Notify co-workers that equipment repair is complete.
2. Remove all nonessential tools or parts from the immediate area of the equipment.
3. Ensure that all guards and safety devices have been reinstalled.
4. Make sure that all employees are completely clear of equipment.
5. Close the equipment circuit equipment.
6. Start and test the repaired equipment.
7. If testing of the repaired equipment is not immediately possible, note the equipment status in daily status log as "untested". Do not place repaired equipment back into regular service until testing has been completed.
8. If equipment does not operate properly, lockout the equipment again and arrange for further repairs, verify that an out-of-service tag is still in place.

STEP 2

1. If equipment operates properly, remove out-of-service tag.
2. Verify that operations have entered equipment status as repaired into the daily log.

4.17. PROCEDURE TO CALIBRATE EQUIPMENT

Purpose

Regular calibration is required to ensure high performance of the equipment and to achieve correct results. It ensures that all equipment is operating correctly.

Scope

Covers all equipment in the area of the biofilters.

Responsibility

Environmental Officer
Environmental Operator
Maintenance Team

Procedure

Calibration of equipment should be carried out as outlined in the Maintenance Programme. Maintenance programme is based on the instructions issued by the manufacturer/supplier or installer of the equipment, manufacturer's suggested guidelines or specification and company's own experience.

4.18. PROCEDURE FOR PARTS REPLACEMENT

Purpose

Another key ingredient of any successful maintenance program involves knowing when to replace worn parts identified during the inspection. Replacing worn parts before failure is important because:

- Equipment failure is avoided when a worn part is replaced before breakdown.
- Replacement work can be performed during regular work hours, avoiding overtime expenditures.

- Repair work is safer when emergency conditions can be avoided by anticipatory replacement of predicted failure equipment.
- Early replacement can avoid a negative impact on the environmental and avoid loss in production if equipment failure directly affects treatment.

Scope

Covers all equipment in the area of the biofilters.

Responsibility

Production Manager

Environmental Officer

WWTP Operator

All fitters and contractors

Procedure

Three different methods are available to indicate that replacement of a part is necessary:

- The first method is by means of the planned inspection program. During inspection, a maintenance fitter should be able to identify where wear has become pronounced and diagnose a replacement or repair. Other indications, such as overheating, unusual noise or vibration, increase slack in belts, increase lubrication requirements, changes in performance efficiency, or changes in amperage draw can also tell the fitter that something is wrong with that piece of equipment.
    - The second method of identification equipment for replacement involves following the manufacturer's recommendations regarding the anticipated life expectancy of a particular component. Manufactures can provide you with the life expectancy of equipment and components parts in terms of total operating hours on request. Equipment may still fail early due to unusual operating conditions, but this type of predicative parts replacement can help avoid emergency situations.
    - A third approach to identifying equipment-needing replacement is known as predictive maintenance. Your facility can employ such techniques as vibration

testing, infrared photography, or spent oil analysis to predict potential equipment failure and thereby to allow replacement of parts before the failure occurs.

FAN / PUMP REPLACEMENT

If it is noted that a fan or pump needs replacement then the biofilter must be turned off (this involves turning off any pumps, fans and irrigation systems). Spare parts for the biofilters are kept in a store in College Proteins, Nobber, Co. Meath. The part can be brought down from this plant immediately.

4.19. LEAK INSPECTION PROCEDURE

A leak inspection is carried out weekly on all outdoor pipes, valves and flanges that are used to transport liquids or foul air.

Responsibility

Environmental Officer

Production Manager

WWTP Operator

Maintenance Team

Procedure:

1. Inspect each valve and flange for leaks
2. Clean and dry wet valves and flanges
3. Re- inspect each valve and flange after 30 minutes
4. If there are signs of leak ensure that corrective action is under taken
5. In relation to air valves and flanges feel along the joints if any air is escaping also if an odour can be detected it is a sure sign of a leak.

Record the results in the leak inspection sheets and corrective action that was undertaken.

5. EMERGENCY RESPONSE PROCEDURE

5.1. Thermal treatment unit breakdown

If a leading thermal treatment unit (boiler or oxidizer) for Non Condensable Gases (NCG) breaks down for short period, biofilters No 1 and No. 2 will receive the NCG. The valves are changed automatically. The biofilters will be given extra irrigation adjusted by the environmental officer after this period as the increased loading dries out the media.

5.2. Maintenance of biofilter fan

During routine maintenance in a biofilter or associated equipment the biofilter is shut down to prevent the risk of fires due to welding or grinding. The fan would assist the spread of fire if one was to occur.

5.3. Parts replacement

During part replacement in a biofilter or associated equipment the biofilter is shut down to prevent the risk of fires due to welding or grinding and fugitive emissions.

5.4. Power cut

The plant operates on a continuous basis. The likelihood of a prolonged power failure is unlikely as there are two incoming electrical power supplies. So no emissions are likely to occur in the event of power failure.

However, if a power failure was to occur all incoming raw material would be diverted elsewhere.

5.5. Media Replacement

When the differential pressure of a biofilter starts to raise it generally means either too much irrigation or the media is starting to clog with fat, dirt, bacterial cells etc. When the differential pressure reaches its thresh hold of 700 kPa then the media needs to be removed from the biofilter and replaced with new media. This involves notifying the Agency, turning off the biofilter and digging out the media with a mini digger. The media would need to be removed off site and disposed off in a licensed landfill or composting plant if media is biodegradable. The media is replaced with new woodchip and the inoculation process would need to start again (as described in the Test Programme and Frequency section above).