

Description

The invention relates to a process for the drying of a substance such as sewage sludge, fish flour, sludge from starch, soap and paper factories as well as biomasses such as wood shavings, grass, chopped sugarbeet, using a drying drum.

Such substances can markedly pollute the environment with smells and dust, and this is particularly unpleasant if the apparatus, for example a sewage sludge apparatus, is located near a residential area. The process is therefore designed for low-emission drying.

Apparatus for the drying of sewage sludge is described in DE-A-2 302 836 (Koppers). The drying drum is heated by means of the flue gases from the combustion process and not by a closed circuit with indirect heat transfer. A so-called chemical washing process is proposed for the after-treatment of the flue gases.

GB-B-2 015 419 (Thames) describes apparatus for the processing of sewage sludge operating by the passing machine or spaghetti machine principle, in which several strands of the dried or doughy sludge are pressed through a sieve and cut up at the outlet.

US-A-3 936 951 (Haueise) describes a process for heating an air stream in a painting plant for the car industry. This design is not proposed for the processing or drying of sludge.

An object of the invention is to provide a process for the drying of a substance in which virtually no environmental pollution by smells or dust is caused.

According to the invention, this object is achieved by the features in the first claim.

A partial stream of the steam/air mixture is continuously separated and supplied to a condenser, the resultant condensate being supplied to a further heating application, for example a heat exchanger.

The flue gases pass through the combustion chamber and then through a gas/gas heat exchanger in which they give up the majority of their heat content to the steam and air mixture from the drying circuit.

Owing to a combination of filter arrangement, condenser and after-combustion in the combustion chamber, the separated air or the flue gases from the combustion chamber can be discharged into the atmosphere in a virtually odourless and dust-free manner ($<2\text{mg/Nm}^3$) and without visible streaks of vapour.

A significant proportion of the heat used for drying is preferably used - owing to the dew point ($80-90^\circ\text{C}$) which is exceptionally high for a drying drum owing to the closed drying air circuit - for the heating of the building, preheating of the product or other heat carriers, after condensation, the heat being used in several stages.

The vapour can also be supplied to a heat consumer for the pre-concentration of products or for air heating in a gas heat exchanger.

The air is preferably aspirated from all conveyor elements and silos in order to keep the apparatus free from smells and dust and supplied to the combustion chamber.

Fossil energy is preferably used as drying energy.

An embodiment of the subject of the invention is described in detail hereinafter with reference to the drawing which shows a flow diagram of an apparatus for the processing of sewage sludge to granules.

Dewatered sludge 2 is supplied by means of a conveying screw 1 to a double shaft mixer 3 to which dry material 5 is also supplied by a second conveying screw 7 from a silo 6 fed via a scraper chain conveyor 7. The dry product 4 preferably consists of a dried end product of the same type of sludge as the product to be processed. The granules are split into three fractions in a vibrating sieve 17, the bottom and top granule size being added to the sludge. The middle fraction, on the other hand, is packed into bags and may be used as fertilizer. The quantity which is not to be deposited as fertilizer may also be incinerated and has a calorific value corresponding roughly to that of lignite.

From the double shaft mixer 3, the flowable mixture 8 is supplied via conveying screws 9 and 10 to a drying drum 11 in which the dry granules are supplied to the outlet by whirling, whereas the wet particles advance more slowly and fall to the ground several times until they are sufficiently dry and flow to the outlet.

After the drum 11, the dried sewage sludge in the form of granules is separated from the air and steam mixture by a cyclone separator 12 with an integrated bag filter 13, and the granules pass via an outlet sluice 14, an oblique screw 15 and an elevator 16 to the vibrating sieve 17 which sorts them into the three granule sizes. Cooling of the end product takes place in the counter-flow with ambient air and prevents condensate formation in the storage silos or after bagging up.

The granulate has a particle size of about 2 to 4 mm, is dust-free and is hygienically perfect and may be supplied selectively after cooling silos 18 and 19 to various storage, loading or bagging installations.

The conveyor system for the return of granulate comprises the scraper chain conveyor 7, a crushing mill 20, the dry product return silo 6 and the metering screw 4.

The gases from processing and conveying means or the granulate cooler are heated to above 750°C in the combustion chamber 24 by means of fossil fuels. The heat content of these gases is discharged in a heat exchanger 25 to the steam and air mixture of the closed dryer circuit. The steam and air mixture is heated to about 500°C in the heat exchanger, dries the product in the drying drum, is cooled in the process and absorbs the evaporated water.

After the drying drum, the product is separated from the steam and air mixture in a cyclone 12 with an integrated dust filter 13. By means of a fan 29, the steam and air mixture is returned to the heat exchanger 25 for the heating process, a proportion of the steam and air mixture being continuously aspirated and supplied to the condenser 26 or as air for combustion to the combustion chamber 24.

The air content from the drying circuit may also be supplied, after condensation, via a droplet separator 27 and an exhaust air heat exchanger 28 to the combustion chamber 24 as air for combustion.

Owing to the high temperature level of 85 to 90°C, the heat separated by condensation affords ideal conditions for heat utilization in digestion tower treatment, sludge preheating and the like.

The air aspired from the conveyors and the cooling air from the dry product silos is purified in the bag filter 21 and is supplied, together with the air separated from the drying circuit, to the combustion chamber 24 as air for combustion. The fine fractions 23 present in the bag filter 21 are supplied via a discharge screw 22 also to the scraper chain conveyor 7 for return to the silo 6.

The apparatus is aspired for smell and dust clearance, and parts of the apparatus as well as conveyor elements are operated at a vacuum to prevent odorous air and steam condensation in the conveyor elements from escaping.

The air aspired from the conveyors and the cooling air from the dry product silos is purified in a bag filter and is supplied together with the air separated from the drying circuit to the combustion chamber 24 as air for combustion.

The performance and operating data of the apparatus described in the example and other circuit data are as follows:

The current consumption and operating data in an apparatus operated without sludge preheating or other waste heat utilization is described as variation 1.

The data of a similar construction during operation with sludge preheating and a dry substance which is therefore 2% greater are listed in variation 2.

The operating data during operation with sludge preheating and waste heat utilization for digestion tower heating of 420 kW are listed in variation 3.

1. Throughput and Water Evaporation

Variation	1	2	3	
Dry Substance	473.6	523.0	523.0	kgDS/h
DS before Dryer	28	30	30	% DS
DS after Dryer	95	95	95	% DS
Quantity DS before Dryer	1691.4	1743.5	1743.5	kg/h
Quantity DS after Dryer	498.5	550.6	550.6	kg/h
Water Evapor. per Line	1192.9	1192.9	1192.9	kgWE/h

2. Heat Requirement

Variation	1	2	3	
Temp. Loss Dryer On	450	450	450	°C
Dryer Off	125	126	126	°C
Heat Generator Power	1.171	1.108	1.108	MW
Fuel	Bio-Gas	Bio-Gas	Bio-Gas	
Calorific Value	5400	5400	5400	kcal/Nm ³
Fuel Consumption	186	176	176	Nm ³ /h

The power consumption for driving this apparatus (excluding dewatering) is about 60kw.

Specific Heat Requirement

Variation	1	2	3	
Per kg Evaporation	0.981	0.929	0.577	kWh/kg
Per kg Sludge 28(30)%DS	0.692	0.636	0.395	kWh/kg
Per kg Sludge 95%DS	2.348	2.013	1.250	kW/kg
Per kg DS	2.472	2.119	2.119	kW/kg

All parts of the apparatus, with the exception of the dry granulate silos, are made of stainless steel. The thermal data are listed in the foregoing table.

The apparatus may be monitored from a central control stand. No special maintenance work is required apart from periodic lubrication.

Table 1Sewage Emissions in the Apparatus described in the Example

pH		8.9	8.9	8.9	8.9
DS	%	0.04	0.04	0.04	0.04
CSB	mg/l	34.4	51.5	33.0	43.2
DOC	mgC/l	3.4	3.0	2.9	2.9
NH ₄	mgN/l	27.9	27.8	27.8	28.1
Kiehl'd.N	mgN/l	27.9	27.3	27.8	28.1
Ges.P	mgP/l	7.6	6.7	7.2	6.9
BSB5	mg/l	6	6	5	5

Table 2

Emission/Exhaust Gas Values of Flue gases from the Apparatus described in the Example.

Fuel: Digester Gas

The mean values of the measured variables determined during the day of measurement are compiled in the following table.

All values relate to a O₂ value of 3% and are mentioned for dry gas in the normal state (273°K, 1013 mbar).

Substance		Concentration	Limit Value LRV/KIGA
Oxygen O ₂	%	13.9+/-0.5	--
Carbondioxide CO ₂	%	5.3+/-0.5	--
Solids	mg/Nm ³	0.8+/-0.5	50
Heavy Metals (dust-free and filterable)			
Lead Pb	mg/Nm ³	0.23+/-0.5	5
Zinc Zn	mg/Nm ³	<0.05	--
Cadmium Cd	mg/Nm ³	0.004+/-0.002	0.2
Mercury Hg	mg/Nm ³	<0.004	0.2
Hydrogen Chloride HCl	mg/Nm ³	17+/-2	30
Hydrogen Fluoride HF	mg/Nm ³	<0.4	5
Sulphur Dioxide SO ₂	mg/Nm ³	39+/-4	500
Total Carbon as Cl	mg/Nm ³	39+/-4	50

The described drying drum apparatus has the following advantages over existing designs:

- very low emission level, in particular no odour emission and no streaks of vapour. All limit values are observed and usually fallen below considerably (see also measured values according to Table 2)
- high availability owing to the tried-and-tested drum drying concept
- dust-free homogeneous and bacteriologically perfect granulate as end product which may be stored without difficulty
- problem-free adaptability of the apparatus to various qualities of sludge and moisture contents (Table 1)
- high heat recovery potential from the condensate
- possibility for digester gas utilization, and
- simple in terms of operation and maintenance.

The properties of a drum drying apparatus with circulating air are:

- 100% recirculation air renewal rate with separation of leakage
- incorporation of an air-air heat exchanger
- combined cyclone/bag filter separator in the drying circuit,
- leakage and odorous air aspirated from the conveyor elements is used as air for combustion for hot gas production, and
- all moving seals and orifices are subjected to a vacuum.

Reference Numerals

- 1 Conveying Screw
- 2 Double Shaft Mixer
- 3 Conveying Screw

- 4 Dry Product
- 5 Dry Product Return Silo
- 6 Scraper Chain Conveyor
- 7 Flowable Mixture
- 8 Conveying Screw
- 9 Conveying Screw
- 10 Drying Drum
- 11 Cyclone Separator
- 12 Bag Filter
- 13 Discharge Sluice
- 14 Oblique Screw
- 15 Elevator
- 16 Vibrating Sieve
- 17 Cooling Silo
- 18 Cooling Silo
- 19 Metering Screw
- 20 Cyclone Separator
- 21 Bag Filter
- 22 Discharge Sluice
- 23 Oblique Screw
- 24 Combustion Chamber
- 25 Air Heater
- 26 Condenser
- 27 Droplet Separator
- 28 Exhaust Air Heat Exchanger
- 29 Fan

Claims

1. Process for drying a substance using a drying drum in a closed steam/air circuit, in which the pressure in the region of the product charge and of the seals at rotating parts is below the pressure of the surrounding air, wherein the steam/air mixture, after the dryer, is separated from the product in a cyclone with integrated dust filter and supplied to a heat exchanger, wherein water evaporating during the drying process as well as filter rinsing air and leaking air are separated from the circuit by transferring the water vapour to a condenser and the uncondensable gases as combustion air to a combustion chamber for heat generation in the circuit, and wherein the temperature in the combustion chamber is kept above 750°C.
2. Process according to claim 1, characterised in that the condensate produced in the condenser is supplied to a further heating application.
3. Process according to claim 1, characterised in that the separated steam is supplied to a heat consumer for preconcentration of products or for heating of air in a gas heat exchanger.
4. Process according to claim 1, characterised in that the steam/air circuit is operated at a dew point from 80 to 90°C.

