

SEWAGE TREATMENT PROCESS

The present invention relates to a waste-water treatment process, and more particularly to such a process for forming a solid fuel material from wastewater containing organic substances such as human wastes and effectively utilizing the solidified fuel material.

Wastewater including drainage water discharged from homes such as human wastes is generally treated by the standard activated sludge process since the wastewater contains organic substances. In the activated sludge process, the wastewater is passed through a coarse screen to allow sludge to be gravity-settled in a settling basin, and then is passed through a finer screen for further settling of the sludge, after which the wastewater flows through a preliminary aeration tank into a final settling basin in which sludge is settled. The treated water separated from the sludge is passed from the final settling basin through an aeration tank into a chlorination chamber from which the sterilized water is discharged. The collected sludge is thickened by being processed through a concentration tank and a sludge storage tank and delivering the sludge to a sludge mixing tank in which the sludge is concentrated uniformly. The concentrated sludge is then pumped from a supply tank to a filter press which separates a solid cake from the sludge. The solid cake is delivered by a belt conveyor, for example, and will be incinerated.

In the foregoing known treatment process, it takes a long time to settle the slurry containing organic substances since the organic substances have an a density very close to that of water and a high water content. The sludge thickening is also time-consuming as the dewatering process is complex. The incineration of the

solid cake requires a large amount of high-heat-capacity fuel such as coal.

The conventional sewage treatment process has therefore been disadvantageous in that it involves a number of steps since it is time-consuming for the organic substances to settle and a complex dewatering process is required for concentrating the sludge, resulting in a high cost of sewage treatment. For increasing the dewatering rate, it is usual to add a dewatering agent such as slaked lime or ferric chloride. However, the use of such a dewatering agent increases the amount of inorganic substances in the treated sludge which leads to secondary pollution, and requires an increased amount of water to be used in the process.

Recently pulverized coal has been added to sludge to utilise its adsorption ability with high molecular weight polymer flocculation agents for facilitating and accelerating the dewatering and thickening of the sludge. The product filter cake is used finally as a secondary fuel, utilizing the latent combustion heat of the pulverized coal. However, the sludge cannot easily be settled due to the floating property of the pulverized coal. Since the sludge has to be mixed during the process, ionic organic substances such as cations and anions are increased in amount, necessitating an additional secondary processing step. Therefore, the above known method cannot meet desired economical requirement although the time required for dewatering the sludge can be shortened and the cake has a reduced water content.

The recent trends in treating wastewater are not confined to the processing of drainage water only, but toward economical treatment processes which effectively utilize water and solid materials produced in the wastewater processing. Judging from this standpoint, the

conventional wastewater treatment process employing pulverized coal has proven unsatisfactory in that the pulverized coal is used only as a dewatering agent, and the high cost required of treating the wastewater cannot be recovered.

There has been an attempt to employ a pressure flotation method to meet the economical requirements. However, it is relatively complex to select a reagent for the flotation and a selected reagent has to be consumed in an extremely large quantity. Therefore, this method is also uneconomic.

A new process according to the invention comprises the steps of mixing water, pulverized coal, and wastewater into a slurry in a flotation cell;
stirring the slurry in the flotation cell to extract a floating floc therefrom;
discharging the floating floc from an upper portion of said flotation cell;
discharging a residual slurry from a lower portion of said floating cell;
stirring the residual slurry discharged from the flotation cell to extract a floating floc from the residual slurry in at least one other flotation cell;
collecting the floating flocs discharged from the flotation cells; and
dewatering the collected floating flocs to form a fuel bulk. In the new process wastewater containing organic substances and a flotation agent composed of pulverized coal are mixed in a flotation cell, and the mixture is stirred by a stirrer such as an impeller or a cyclone separator to produce a flotation floc composed of the organic substances adsorbed and floated by the pulverized coal. The floating floc may then overflow from the flotation cell, while any sedimented materials are discharged from a lower portion of the flotation cell.

The residual slurry is fed to a next flotation cell wherein the above process is repeated. The floating flocs discharged from the flotation cell are collected and dewatered to produce dried cakes which will be
5 combusted for instance in a heat power plant to generate electric power. The combustion energy of the pulverized coal and the organic substances in the cakes allows them to be combusted sufficiently, and the odor which would be produced by the organic substances is eliminated when
10 they are combusted.

The flotation cells used in this process are conventional cells and may also be referred to as floating machines.

More specifically, wastewater discharged, for
15 example, from a wastewater treatment facility or homes is charged into the flotation cell which is supplied, optionally after sterilisation and/or pH adjustment, with the pulverized coal having particle size of about 2 mm or in the range of from 180 to 230 meshes, and usually also
20 with a prescribed amount of air. The mixture is stirred in the flotation cell by the stirrer such as the impeller or vortex flow produced by the cyclone separator. As a result, the slurry and air bubbles are caused to impinge upon each other to allow the pulverized coal to adsorb
25 the organic substances and float them to produce the floating floc. During this process, the air bubbles are scattered around by the stirring forces of the impeller or the intensive vortex flow pattern to keep the slurry free from violently varying in surface level and to cause
30 the air bubbles to impinge upon pulps containing the organic substances with a sufficiently large amount of energy. The floating floc is discharged as an overflow from the flotation cell, whereas the sedimented materials such as earth and sand and ores are discharged from the
35 lower portion of the flotation cell. The remaining

slurry is supplied to the next flotation cell in which it is subjected to the foregoing process. The floating flocs discharged from the flotation cell are collected. The residual slurry is finally turned into water that is preferably sterilized and adjusted in pH, after which the water is discharged. The collected flocs are dewatered, such as by a filter press, to produce a bulk or solid cake composed of pulverized coal and organic substances. The bulk may be used a fuel material combusted in the heat power plant. The pulverized coal and organic substances can be sufficiently combusted due to their latent combustion energy, and any substances liable to produce undesirable odor are also combusted at the same time. Therefore, the ambient pollution in the air around the heat power plant is minimised. The cost of the sewage treatment can be recovered by the fuel produced by the sewage treatment process for use in the heat power plant.

Thus, the organic substances contained in the wastewater can be reused as a source of energy, without producing additional wastewater, by floating them as a floc with the pulverized coal and processing the floc into a fuel cake suitable for use in a heat power plant.

The pulverized coal is used not only as a dewatering agent to assist the slurry in getting dewatered or as an auxiliary fuel for incinerating the slurry, but as a fuel to be combusted with the organic substances to produce energy for electric power generation. Therefore, the value of the pulverized coal can effectively and completely be utilized

Since the solid slurry component in the wastewater can be used as a fuel, any substances contained therein for producing odor can also be combusted completely. As a result, malodor problems around the heat power plant are minimised.

In the preferred system, a plurality of flotation cells are connected in series and the floating flocs are discharged and collected so that the residual slurry from the flotation cells can finally be turned into water which is sterilized and adjusted in pH before it is discharged into a river. Therefore, the sewage treatment process of the invention produces no secondary pollution.

The sewage treatment system for carrying out the process of the invention is simple and inexpensive to construct. By reusing the flocs as a source of energy, the cost of sewage treatment can be lowered. Consequently, the sewage treatment process can meet desired economical requirements.

The ratio at which the pulverized coal is to be mixed with the slurry which will be reused as an energy source depends on the composition of the sewage slurry and the coal and may be determined by experiment.

In conventional sewage treatment systems, the cost of pulverized coal has been added only as part of the treatment cost, and has not been recovered. The sewage treatment process of the invention is cost-effective since the pulverized coal is used not only as a flotation agent but also as a fuel itself.

The series-connected flotation cells allow the floating flocs to be dewatered efficiently, and hence the filter press for dewatering the collected flocs operates highly efficiently to produce solid cakes. The cost of electric power consumed by the filter press is therefore lowered.

The sewage treatment process for the invention is therefore capable of reusing resources which can be recycled as energy sources. The steps of floating and dewatering the floc are effected highly efficiently in short periods of time. Therefore, the cost of sewage treatment system is low and can easily be controlled.

The following description when taken in conjunction with the accompanying drawings in which a preferred embodiment of the present invention is shown to illustrate the invention.

5 The sole figure is a flow diagram explanatory of a sewage treatment process according to the present invention.

As shown in the sole figure, a coal processing plant 1 which is preferably located in a suburban area includes
10 a grinding plant 2 for grinding low-quality coal having a high ore content to select coarse coals. The selected coarse coals are then crushed by a crusher 3 comprising a mill or a cone crusher into fine particles having uniform sizes ranging from 180 to 230 meshes. The pulverized
15 coal particles are then charged as a flotation agent into a first flotation cell 4 which is connected to an array of series-connected flotation cells 4.

A sewage treatment facility 5 which is also located in a suburban area includes a processing device 6, for
20 sterilisation and pH control. Wastewater containing a large quantity of organic substances processed by the processing device 6 is charged through a known conditioning tank mixer 7 into the first flotation cell 4. At the same time, water is also charged from a pump 8
25 in the sewage treatment facility 5 through the conditioning tank mixer 7 into the first flotation cell 4. The relative amounts of the wastewater and water supplied from the processing device 6 and the pump 8, respectively, are determined by the conditioning tank
30 mixer 7.

Small air bubbles having sizes in the range of 1.5 to 2.5 mm are produced in each of the flotation cell 4. More specifically, each flotation cell 4 has a stirrer 9 which may comprise a mechanical impeller or a cyclone
35 separator. Where the mechanical impeller is employed, it

rotates to shear self-supplied air or air supplied under pressure into small air bubbles. Where the cyclone separator is employed, air supplied under pressure and the solid-liquid mixture or slurry supplied under pressure cause violent cavitation to be formed by air vortexes and the slurry for dividing air into fine air bubbles. The flow of the slurry-air mixture is caused upon a baffle plate so as to form fine air bubbles sizes ranging from 1.5 to 2.5 mm.

Each flotation cell 4 causes the slurry to be aerated as a secondary effect of the flotation process. Since the fine air bubbles in the flotation cell 4 have a large entire surface area and are well scattered around, the organic substances in the slurry can be brought into contact with the air bubbles much more effectively than would be possible with the conventional pressure flotation process. The air bubbles as they are scattered in the flow pattern thereof in the flotation cell 4 are effective in aerating the slurry while they attract the solid particles and cause them to float.

In each of the flotation cells 4, the pulverized coal, the wastewater, and the water charged therein are stirred by the stirrer 9. At the same time, the organic substances contained in the wastewater are aerated at the interfaces of the air bubbles. The air bubbles are highly scattered so that the slurry can be floated and separated without allowing settled organic particles including minute particles to coagulate. The surface of the liquid in each flotation cell 4 is controlled to guard against variations in liquid level and hence breakage of floated and separated materials. Further, the stirrer 9 is controlled to cause the air bubbles and pulp components in the wastewater to impinge upon each other with as high energy as possible.

Where the cyclone separator is employed, it is required to supply a large quantity of air at a rate in the range of from 800 liters/min. to 1200 liters/min. so that the surface tension of the air bubbles is high and
5 th air bubbles are scattered around to a high extent for floating and separating the organic substances highly efficiently.

Since the air bubbles produced are small in size and large in number, they have a large specific surface area
10 for contact with the slurry for an increased aerating efficiency.

In each of the flotation cells 4, the organic substances in the stirred slurry are strongly attracted to the pulverized coal particles by the adsorption
15 ability of the coal particles, and caused to float on the upper surface of the liquid in the flotation cell 4 by the flotation action of the pulverized coal particles. The organic substances are also caused to float under strong flotation forces of the air bubbles, and then
20 delivered from the flotation cells 4 through a collection line 10 to a filter press 11 which separates a solid cake form a liquid.

Sedimented materials such as earth, sand and ores other than the coal are discharged from each of the
25 flotation cell 4 through a discharge line 12 to a waste processing plant 13.

The flotation cells 4 are interconnected in series by feed lines 14 so that the residual slurry can successively supplied downstream to the flotation cells
30 4. The residual slurry successively supplied to the flotation cells 4 is stirred by the stirrers 9 therein to enable to solid organic substances to be adsorbed on and floated by the flotation agent. The floating organic substances overflow from the flotation cells 4 and are

supplied via the collection line 10 to the filter press 11.

The separated floc discharged from each of the flotation cells 4 is thickened to a high concentration 5 while it is supplied through the collection line 10 to the filter press 11. Therefore, the floc has a small water content immediately before it is supplied to the filter press 11.

The residual slurry flowing along the feed lines 14 10 through the flotation cells 4 is finally turned into water which is sterilized and discharged via a pH adjuster 15 into a river.

The highly concentrated floc supplied to the filter press 11 is separated to give water and a solid cake 15 which is compacted at a high concentration rate. The water from the filter press 11 is sterilized and discharged through a pH adjuster 15' into the river. The solid cake is delivered to a drier 16 which dries it naturally or forcibly, after which the cake is supplied 20 to a heat power plant 17. In the heat power plant 17, the cake and general coals are combusted in a boiler furnace for generating electric power. The pulverized coal and the organic substances contained in the cake, i.e., the floc, are completely combusted as they have 25 latent combustion energy. At the same time, substances which produce odor are also combusted in the boiler furnace, so that no malodor problem is caused around the heat power plant 17.

The cost of the fuel consumed by the heat power 30 plant 17 can be reduced, and the cost reduction results in a corresponding profit made by the sewage treatment plant. Therefore, the sewage treatment process of the present invention is cost-effective.

The sewage treatment process of the present 35 invention is applicable not only to the treatment of

wastewater discharged from the wastewater treatment facilities, but also to the direct treatment of drainage water discharged from homes or any wastewater containing organic substances which may be utilised as fuel.

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CLAIMS

1. A process of treating wastewater comprising the steps of:
mixing water, pulverized coal, and wastewater into a
5 slurry in a flotation cell;
stirring the slurry in the flotation cell to extract a floating floc therefrom;
discharging the floating floc from an upper portion of said flotation cell;
10 discharging a residual slurry from a lower portion of said flotation cell;
stirring the residual slurry discharged from the flotation cell to extract a floating floc from the residual slurry in at least one other flotation cell;
15 collecting the floating flocs discharged from the flotation cells; and
dewatering the collected floating flocs to form a fuel bulk.
2. A process according to claim 1, wherein the
20 wastewater is discharged from a wastewater treatment facility.
3. A process according to claim 1 or claim 2, wherein said fuel bulk is combusted in a heat power plant for generating electric power.
- 25 4. A process according to any preceding claim, including the step of aerating said slurry and residual slurry in said flotation cells.
5. A process according to any preceding claim, including the step of forcibly drying the cake comprising
30 the dewatered flocs.
6. A process according to any preceding claim, including the step of sterilizing the water from which the floating flocs have been removed.



7. A process according to any preceding claim, including the step of adjusting the pH of water from which the floating flocs have been removed.

8. A process according to any preceding claim, including the step of sterilizing the wastewater before it is mixed with the water and the pulverized coal.

9. A process according to any preceding claim carried out as herein before described with reference to the drawing.

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