

SPECIFICATION

Process for the Preparation of Coal-containing Sludge Pellets Valuable as Fertilizer and Fuel

This invention relates to a process for converting a coal-containing sludge concentrate formed at the sewage or sludge treatment using fine dust coal to a coal-containing sludge pellet having a low water content, which is valuable as fertilizer and fuel.

Excretions, animal excretions discharged from stock farms, waste waters from slaughterhouses, waste waters from marine product processing plants, waste-waters from food processing plants, waste waters from paper making plants, kitchen waste waters, waste waters from leather processing plants, city sewages, other industrial waste waters and sludges formed in the treatment of these waste waters contain considerable amounts of energy resources and valuable resources. In conventional treatments, valuable components contained in waste waters or sludges are let to putrify and decompose during the treatment process, because it is very difficult to recover these components sufficiently and effectively for re-utilization and the treatment expenses become tremendous if such recovery is conducted. Accordingly, in the conventional sludge or waste water treatment processes, another environmental pollution is caused by the putrefaction and decomposition of these valuable components.

I previously proposed a process comprising incorporating into sewage or sludge size-adjusted fine dust coal having a low degree of carbonization, which has such a particle size distribution that 30 to 70% by weight of the whole particles have a size of 9 to 150 mesh (sieve opening 2 mm to 104 microns) and 70 to 30% by weight of the whole particles have a size of 150 to 500 mesh (sieve opening 104 to 33 microns) to coagulate and sediment solids in the sewage or sludge with the fine dust coal and separate purified water (supernatant liquor) from a carbon-containing sludge concentrate, and introducing the coal-containing sludge concentrate onto a filter, whereby coarse particles of the fine dust coal are first deposited on the filter to form a precoat layer, the coagulate of the solids and fine particles of the fine coal dust is then sucked and deposited on this precoat layer and removal of water by filtration can be performed very effectively (see the specification of British Patent No. 1,380,592).

This process is advantageous over the conventional sludge concentrating treatment method in that a sludge cake having a considerably low water content can be obtained. However, the water content of this cake is not so low that it can be used directly as fuel or fertilizer, and this process is still insufficient because this cake should be dried so as to use it as fuel or fertilizer and additional energy expenses are necessary for this drying treatment.

It is therefore a primary object of the present invention to provide a process for converting a coal-containing sludge concentrate formed at a sewage or sludge treatment using fine dust coal to a coal-containing sludge pellet having a low water content and being valuable as fertilizer and fuel.

Another object of the present invention is to provide a composite process for the treatment of sewage or sludge in which effective resources contained in sewage or sludge can be effectively caught and recovered in the form that can be used directly as fertilizer and fuel and the treatment cost can be remarkably reduced.

Still another object of the present invention is to provide a sewage or sludge treatment process in which organic components contained in sewage or sludge are formed into substantially odorless, coal-containing sludge pellets which can be used directly as fuel and fertilizer.

In accordance with the present invention, these objects can be attained by a process for the preparation of coal-containing sludge pellets valuable as fertilizer and fuel, which comprises incorporating in sewage or sludge size-adjusted fine dust coal, which has such a particle size distribution that 30 to 70% by weight of the whole particles have a particle size of 9 to 150 mesh (Tyler Standard) (sieve opening 2 mm to 104 microns) and 70 to 30% by weight of the whole particles have a particle size of 150 to 500 mesh (Tyler Standard) (sieve opening 104 to 33 microns), thereby to separate the mixture into purified water and a coal-containing sludge concentrate, removing water from this coal-containing sludge concentrate according to the self-precoat filtering method, continuously dehydrating the resulting cake under a reduced pressure or in vacuum while imparting vibrations to the cake layer in the direction of the thickness thereof, and extruding the resulting dehydrated cake having a water content lower than 50% by weight under compression and shear to form coal-containing sludge pellets having a water content lower than 30% by weight.

In the process of the present invention, mixing of sewage or sludge with size-adjusted fine dust coal to separate the mixture into purified water and a coal-containing sludge concentrate and self-precoat filtration of the coal-containing sludge concentrate can be performed according to my previously proposed method disclosed in the specifications of British Patents No. 1,380,591 and No. 1,380,592. The important feature of the present invention is that the dehydration cake obtained according to this method is continuously dehydrated under a reduced pressure or in vacuum while imparting vibrations in the direction of the thickness of the cake layer and the obtained dehydrated cake having a water content lower than 50% by weight is extruded under compression and shear to form pellets having a water content lower than 30% by weight, especially lower than 20% by weight.

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The dehydrated cake of coal-containing sludge obtained according to the above-mentioned self-precoat filtering method (hereinafter referred to as "primary dehydrate cake") comprises coarse particles including coarse particles of fine dust coal as nuclei, which are coated with agglomerates of fine particles of fine coal dust and solids of sludge. Water layers closely affined with these coarse particles are present among these coarse particles. Accordingly, the water content of the cake obtained according to this filtration method is still high and in some cake, the water content is about 60% by weight according to properties of sludge, and even if dehydration is carried out in high vacuum, it is difficult to further reduce the water content. In contrast, if the primary hydrated cake is dehydrated under a reduced pressure or in vacuum while imparting vibrations according to the present invention, the above-mentioned affined water layers present among the coarse particles can be removed, and in the coarse particles thus separated from the affined water layers are extruded under compression and shear, by effective destruction of the above-mentioned nucleus-coating micro-structure and friction heat, water can be evaporated and removed from sludge solids. Therefore, coal-containing sludge pellets having a low water content and a high strength can be obtained very easily without performing the drying operation.

The present invention will now be described in detail by reference to the accompanying drawing, which is a flow sheet illustrating the steps of the process of the present invention.

Low carbonization degree, size-adjusted fine dust coal MFC is thrown in water of a suspending tank 1 to form a suspension B having a coal concentration of 1/10 to 1/15. In a mixing tank 2, the suspension B is mixed with sewage or sludge A to be treated. According to need, an assistant C such as a polymeric coagulant is supplied to the mixing tank 2 from a store tank 3 to form coagulation flocs. The mixture is supplied to a high-speed solid-liquid separation tank 4 and is separated in purified water D and sedimented sludge concentrate E.

The coal-containing sludge concentrate E is supplied to a liquid reservoir zone 7 of a self-precoat filtering machine 6 from the bottom of the separation tank 4 through a rotary valve 5. In this filtering machine 6, an endless filter cloth member 8 is disposed so that the upper portion of the filter cloth member 8 is inclined, and the filter cloth member 8 is continuously driven by a driving drum 9. The coarse particles of the fine dust coal or agglomerates thereof with the sludge are first deposited on the filter cloth 8 from the coal-containing sludge concentrate E to form a precoat layer, and agglomerates of fine particles of the fine dust coal with the sludge are then deposited on the so formed precoat layer. In this state, dehydration is carried out. Dehydration may be performed by natural dehydration; reduced pressure dehydration or combination thereof.

The coal-containing primary cake F formed by dehydration by the self-precoat filtering machine 6 is then continuously dehydrated under a reduced pressure or in vacuum by a vibrating reduced pressure filtering machine 10 while vibrations are being given in the direction of the thickness of the cake layer. This filtering machine 10 comprises a lower frame member 11 and an upper frame member 12, which are supported so that the height can be adjusted by supporting legs 13 and 14, each being provided with a position-adjusting screw. A pair of rollers 16 and 17 driven by a motor 15 are mounted on the lower frame member 11, and an endless filter cloth 18 is supported by the rollers 16 and 17. A great number of receiving rollers 19 having a small diameter are arranged at small intervals on the upper running passage of the endless filter cloth 18, and these receiving rollers are rotatably attached to a common supporting frame 20. This supporting frame 20 may be vibrated by a vibration generator 21. A vacuum box 21' is disposed along the upper passage portion of the endless filter cloth 18 and is connected to a vacuum pump or pressure-reducing blower 22 so that a sucking force is imposed on the filter cloth 18 by the receiving rollers 19. A pair of rollers 23 and 24 are mounted on the upper frame member 12, and an endless belt 25 is supported by the rollers 23 and 24. A great number of pressing rollers 26 having a small diameter are disposed at small intervals in the lower running passage of the pressing endless belt 25.

These pressing rollers 26 may be attached to the upper frame member 12 through a coil or plate pressing spring, so that a compressive vibrating force is applied to the belt 25. In the pressing rollers 26 and receiving rollers 19, their positions and sizes are arranged so that they are engaged with one another. In order to maintain good engagement between the pressing rollers 26 and the receiving rollers 19 through the endless filter cloth 18 and endless belt 25, weights 27 may be mounted on the upper frame member 12, and furthermore, the engagement gap between the pressing rollers 26 and the receiving rollers 19 may be adjusted by the above-mentioned position-adjusting screws 13 and 14.

For the reason set forth above, the primary dehydrated cake F obtained by the filtering machine 6 still contains a considerable amount of water, and it is very difficult to pelletize such cake without drying. According to the present invention, by subjecting this primary dehydrated cake F to the dehydration operation under reduced pressure and vibration by the vibrating reduced pressure filtering machine 10, there can be obtained a dehydrated cake having a water content lower than 50% by weight, which can be pelletized irrespectively of properties of the starting sludge.

More specifically, the primary dehydrated cake F from the self-precoat filtering machine 6 is placed on the endless filter cloth 18, and while it is gripped between the endless filter cloth 18 and the pressing belt 25, it is forcibly introduced into a gap between the receiving rollers 19 and pressing rollers 26 engaged in a zigzag manner. Accordingly, the coal-containing sludge cake on the filter cloth

18 is compressed in the direction of the cake layer thickness by the rollers 19 and 26, and as soon as this compressive force is released, the cake undergoes a vacuum or reduced pressure sucking force by the vacuum box 21'. These two actions are repeated alternately on the coal-containing sludge cake. By the vibrations given in the direction of the cake layer thickness, coarse particles of the fine dust coal which are contained as the nuclei in the coal-containing sludge cake, are caused to jump and shake, and therefore, water contained in the layers interposed among the coarse particles of the coal-containing sludge and water left in the sludge in the state of sol are oozed out from the cake as free water and the dehydration operation can be performed very effectively.

The secondary dehydrated cake G from the vibrating reduced pressure filtering machine 10 is then fed to a pelletizer 28 and extruded as pellets H under compression and shear. More specifically, the secondary dehydrated cake G is fed to a cylinder zone 31 by a spiral feeder 30 and is extruded forward under compression by an extruding screw 33. Baffle plates 34A, 34B and 34C are arranged on the top end of the cylinder, and cutter knives 36A, 36B, 36C and 36D corresponding these baffle plates are fixed to a shaft 35 of the screw extending through these baffle plates. The coal-containing sludge cake fed to the cylinder zone 31 is compressed and kneaded by the screw 33 and simultaneously sheared by the baffle plates and cutter knives, whereby the above-mentioned nucleus-coating microstructure of coarse particles of the coal-containing sludge is destroyed and residual water is evaporated and removed effectively by frictional heat. Thus, pellets having a much reduced water content and a high strength can be formed.

Any of fine dust coals may be optionally used as the size-adjusted fine dust coal, so far as it has the above-mentioned particle size distribution. In the present invention, however, fine dust coal of a low grade is preferably employed. When coal-containing sludge pellets are used as fuel, ordinary coal having a calorific value higher than 6400 Kcal/Kg may be used, but since the water content in the coal-containing sludge pellets is reduced below 30% by weight, substandard coal having a calorific value not higher than 5000 Kcal/Kg, especially 4500 to 5000 Kcal/Kg, is effectively used. If such substandard coal is used, good results can be obtained not only from the economical viewpoint but also the effect of coagulating solids of sludge. When the coal-containing sludge pellets are used as fertilizer, fine dust coal having a high humic acid content, such as brown coal or lignite powder, especially one having a calorific value of 2800 to 4000 Kcal/Kg, is preferably employed. High grade coal in which the degree of carbonization is advanced hardly contains humic acid, but coal having a low degree of carbonization contains humic acid at a high content. For example, as a result of the elementary analysis of brown coal or lignite, it is confirmed that the humic acid content is in the range of from 10 to 98% by weight.

It is most preferred that size-adjusted fine dust coal be used in the suspended state in an amount substantially equal to the amount (on the dry basis) of suspended solids and BOD components contained in sewage or sludge. However, the amount of fine dust coal may be changed in the range of 0.1 to 5% by weight, especially 0.5 to 2% by weight, based on sewage or sludge. Incidentally, all "%" and "parts" in the instant specification are by weight unless otherwise indicated. When dilute waste water having a suspended solid content of 200 to 1000 ppm, such as sewage, is treated, it is preferred that the amount of fine dust coal be somewhat larger than the amount of the suspended solids.

In precipitating and sedimenting the coal-containing sludge concentrate, at least one member selected from coagulating assistants such as finely divided carbon preferably in an amount corresponding to 1/20 to 1/5 of the amount of fine coal dust, coagulants capable of forming aluminum hydroxide or aluminum oxide and iron hydroxide by hydrolysis preferably in an amount of 0 to 1% by weight based on the sewage or sludge, pH-adjusting neutralizing agents preferably in an amount of 0 to 0.5% by weight based on the sewage or sludge and polymeric coagulants preferably in an amount of 1 to 50 ppm based on the sewage or sludge may be incorporated in the coal-containing sludge.

Finely divided carbon, for example, excessive carbon formed as a by-product in the naphtha cracking process, has an average particle size of 70 to 100 m μ . In short, this finely divided carbon is active carbon composed of very fine particles. This finely divided carbon has a much higher surface adsorbing capacity than ordinary coarse active carbon and when this finely divided carbon is used, pollutants in sewage, particularly coloring components, can be adsorbed and removed more effectively with the use of a smaller amount than the amount necessary when ordinary active carbon is employed. Thus, when this finely divided carbon is used in combination with fine dust coal, there can be attained an advantage that agglomerates of the finely divided carbon and pollutants grow with fine particles of the fine dust coal being as nuclei and flocs can be formed very conveniently. The amount used of the finely divided carbon is appropriately selected within the range of 1/20 to 1/5 of the amount of the fine dust coal according to properties of sewage or sludge to be treated.

As the aluminum type or iron-aluminum type coagulant, there may be employed aluminum sulfate, aluminum sulfate-iron sulfate complexes, sodium aluminate, alum and sulfuric acid-treated red mud. A product obtained by treating environmental pollution-causing red mud discharged from the aluminum refining process with waste sulfuric acid or the like discharged from an iron manufacturing plant (see my Japanese Patent No. 814,837) is used effectively advantageously in the process of the present invention. The amount used of this coagulant is not particularly critical, but it may be used in an amount of 0 to 1%.

As the neutralizing agent, there may be employed at least one member selected from alkaline agents such as hydroxides, carbonates and inorganic weak acid and organic acid salts of alkali metals and alkaline earth metals. For example, there may be optionally used caustic soda, lime, magnesium hydroxide, lightly calcined magnesia and Coral Leaf (see my Japanese Patent No. 814,837). When the resulting coal-containing sludge dehydrated cake is used as fertilizer, it is preferred that rough adjustment be performed in advance with magnesium hydroxide or lightly calcined magnesia through its neutralizing effect is lower than that of caustic soda and then, fine adjustment be carried out with a small amount of caustic soda. Thus, the amount of caustic soda used as the finishing agent for fine adjustment can be remarkably reduced. It is preferred that the neutralizing agent be used in such an amount that the pH of sewage or sludge to be treated be 6.3 to 7.2.

As the polymeric coagulant, there can be used known anionic and cationic organic polymers such as polyacrylic acid, polymethacrylic acid, carboxymethyl cellulose, sodium alginate, starch, soaps, gelatin and albumin. These coagulants may be used singly or in the form of a mixture of two or more of them. However, in view of the object of converting sewage or sludge to a fertilizer, it is preferred that an anionic organic polymer as a secondary coagulant not causing a secondary reaction be used in a very small amount, for example, 1 to 10 ppm.

As will be apparent from the foregoing illustration made with reference to the accompanying drawing, in order to perform coagulation and sedimentation of components of sludge effectively, it is preferred fine dust coal optionally with finely divided carbon be contacted with sewage or sludge in the form of an aqueous suspension in which the respective particles are well-affined with water. In order to attain this feature, it is preferred that by using a blade agitator rotated at a rotation number exceeding 300 rpm, fine dust carbon optionally with finely divided carbon be agitated under friction in water for more than 10 minutes to expel gas present in spaces among particles and form a water film on the surface of each particle. It is preferred that the concentration of the so-formed suspension be 5 to 30%, especially 10 to 15%.

The operation of contacting the above-mentioned components with sewage or sludge is performed for 5 to 30 minutes, and separation of purified water from the coal-containing sludge concentrate is promptly advanced in 2 to 30 minutes. Therefore, according to the present invention, even in a tank having a relatively small capacity, the separation and sedimentation operation can be conducted continuously at a high efficiency.

The sludge taken out from the bottom of the coagulating and sedimenting tank is fed to the above-mentioned self-precoat continuous dehydrating machine and is converted to a primary dehydrated cake having a water content of about 60% in a yield of 99.8%.

In the case where the fertilizer component content in the final dehydrated cake obtained in the process of the present invention is lower than the standard level for fertilizers, at the step of feeding the sludge to the self-precoat continuous dehydrating machine, other sludge containing organic fertilizer components in large quantities and feces of domestic animals such as chicken feces are incorporated in the sludge in appropriate amounts, and the mixture is subjected to the dehydration treatment. In this case, the deodorizing effect can be simultaneously attained by MFC. Furthermore, when foul-smelling fibrous discharges such as primary dehydrated cakes of cow feces and raw sewages are mixed and subjected to the dehydration treatment according to the above-mentioned method, the dehydration efficiency as well as the deodorizing effect can be enhanced (see the comprehensive sewage treatment proposed by me in Japanese Patent Application Laid-Open Specification No. 152546/75).

In the present invention, when other fertilizer components are added to the coal-containing sludge, if the water content in such fertilizer component material is about 60%, it is added to the coal-containing sludge at a place where it is fed to the secondary dehydration apparatus, and if the water content in the fertilizer component material is lower than 50%, it is added to the coal-containing sludge at a place where it is fed to the extruding pelletizer. The amount added of such fertilizer component material is determined according to the desired fertilizer component content. However, since it has been broadly confirmed that the coal-containing dehydrated sludge cake obtained by treating ordinary sewage or sludge free of poisonous components according to the basic process of the present invention has a sufficient fertilizing effect, additional fertilizer components need not be particularly added except especial cases.

Materials having a fertilizer component content higher than the standard level, which cannot be used as fertilizers because of bad smell or tendency or reputrefaction, can be converted to effective fertilizers not causing environmental pollution, if they are added to coal-containing sludge and treated according to the present invention.

The primary dehydrated cake from the self-precoat continuous dehydrating machine is converted to a secondary dehydrated cake having a water content lower than 50%, which can be pelletized, by the vibrating reduced pressure dehydrating machine. The gap between the pressing belt 25 and the filter cloth 18 may be gradually narrowed toward the discharge side from the introduction side.

Moreover, the cake dehydrating ratio can be further improved by gradually increasing the compression strength of the springs supporting the rollers toward the discharge side from the introduction side. Also in this vibrating reduced pressure dehydration, fine dust coal contained in the cake acts as the filter

assistant and adsorbing agent and exerts functions of promoting the dehydration and preventing the

sludge solids from migrating in filtered water in the colloidal state. Thus, according to the present invention, excessive sludge or concentrated sludge having a high fat content, filtering dehydration of which is most difficult, for example, one generated at the treatment of waste water from a slaughterhouse, can be dehydrated, and the suspended solid content in the filtrate from the sludge concentrate of such excessive sludge or concentrated sludge and MFC does not exceed 300 ppm throughout the primary dehydration and secondary dehydration and the sludge catch ratio can be elevated to a level much higher than the sludge catch ratios attainable by other various dehydrating machines.

The secondary dehydrated cake from the reduced pressure dehydrating machine is formed into coal-containing sludge pellets having a water content lower than 30% by the extruding pelletizer. The rotation number of the screw may be freely adjusted within the range of from 50 to 200 rpm. The diameter of through holes formed on the baffle plate may be adjusted within the range of 3 to 10 mm appropriately depending on the desired size of pellets. In the present invention, when the coal-containing sludge cake undergoes compression and shear or friction in the pelletizer, the temperature is ordinarily elevated to 110 to 140°C. and water left in the coal-containing sludge cake is promptly removed in the form of steam. In order to utilize this heat effectively, a heat-insulating coating layer may be formed on the cylinder. Moreover, a heating mechanism such as a heating jacket or ribbon heater may be positively disposed outside the cylinder so as to supply a part of the heat necessary for removal of water.

It has been found that other various advantages can be attained in the present invention by imposing the compressive shearing force on the coal-containing sludge cake through the pelletizer and applying the frictional pulverizing force by fine dust coal to the cake. For example, seeds of weeds contained in waste waters from stock farms or slaughterhouses are annihilated by exposure to high temperatures exceeding their growth temperatures or to frictional pulverization by fine dust coal, and germination of these seeds after application of resulting pellets as fertilizer can be effectively prevented. Moreover, various microorganisms left in the cake are controlled or annihilated by such high temperatures. Furthermore, when foul-smelling dehydrated cakes of secondarily putrefied sludges from other waste water treatments are incorporated in the coal-containing sludge cake and the mixtures are treated by the extruding pelletizer in the above-mentioned manner, harmless and odorless valuable fertilizers can be obtained. Still further, coarse particles of fine dust coal are finely pulverized in the pelletizer and they are readily weathered and decomposed in the soil after the resulting pellets have been applied as fertilizer.

In the present invention, the coal-containing cake can be formed into pellets having a water content lower than 30%. These pellets are very advantageous also as fuel. In Table 1, the calorific value of sewerage sludge and the calorific value of a mixture formed by incorporating fine dust coal into this sludge in an amount equal to the amount of suspended solids in the sludge are shown.

From the data shown in Table 1, it is seen that in case of the coal-containing sludge cake according to the present invention, the calorific value reaches the self-burning level when the water content is 60% and when the water content is reduced below 30% as intended in the present invention, the calorific value is as high as 4000 Kcal/Kg and the resulting pellets are comparable or superior to firewood and charcoal. On the other hand, the water content of the dehydrated sludge cake according to the customary method is ordinarily 80 to 85%, and the calorific value is below the self-burning level even if the water content is reduced.

Incidentally, in Table 1, "water-containing sludge" means a sludge cake obtained by dehydrating sewerage sludge with a conventional coagulant and "coal-containing sludge" means a sludge cake obtained by dehydrating sewerage sludge with size-adjusted fine dust coal (MFC) according to the present invention.

Table 1
Relation Between Water Content and Calorific Value

Water Content (%)	Solid Content (%)	Calorific Value (Kcal/Kg of water-containing sludge)	Calorific Value (Kcal/Kg of suspended solids)	Remarks
Water-containing Sludge				
100	0	-935	—	
90	10	-543	-5430	
80	20	-148	-740	
75	25	48	192	
70	30	245	816	
60	40	495	1237	
50	50	1032	2064	
40	60	1426	2376	
30	70	1812	2588	
20	80	2213	2766	
10	90	2606	2895	
0	100	3000	3000	

Table 1 (cont).

Relation Between Water Content and Calorific Value

	Water Content (%)	Solid Content (%)	Calorific Value (Kcal/Kg of water-containing sludge)	Calorific Value (Kcal/Kg of suspended solids)	Remarks
Coal-containing Sludge					
	100	0	-935	-	
	90	10	-392	-3320	
	80	20	152	760	
	75	25	423	1692	
	70	30	695	2316	
	60	40	1167	2917	self-burning region
	50	50	1782	3563	"
	40	60	2326	3876	"
	30	70	2862	4088	"
	20	80	3433	4291	"
	10	90	5956	4395	"
	0	100	4500	4500	"

Note: sludge suspended solid/MFC=1/1

When the coal-containing sludge pellets of the present invention are used as fertilizer, various prominent advantages can be attained. As pointed out hereinbefore, low grade fine dust coal that is used in the present invention has a high humic acid content. It is known that organic nitrogen is converted in the soil to inorganic nitrogen compounds such as ammonia (NH_3) and nitric acid (HNO_3). As is well-known in the field of agricultural chemistry, humic acid, which is contained in size-adjusted fine dust coal that is used in the present invention, is linked with nitric acid to form nitrohumic acid (a compound containing a phenolic hydroxyl group and a carboxyl group) which has a durable effect as a catalyst or promotor assisting plants to absorb nutriment. Recently, enrichment of farmlands with chemical fertilizers has become a serious problem in various countries in the world, and the conventional compost fermentation techniques adopted for manufacture of natural fertilizers has been reconsidered and various investigations have been made on this old technique. In order to effect compost fermentation, however, it is indispensable that the organic substance component content should be higher than 40% on the dry basis, and it is also necessary that organic substances that can hardly be decomposed by aerobic microorganisms, such as cellulose and lignin, should be incorporated in appropriate amounts. Moreover, a large space and a long time of more than 20 days are necessary for compost fermentation. During this long period, generation of a bad smell or appearance of flies cannot be avoided. When size-adjusted fine dust coal having a low degree of carbonization is incorporated into sewage or sludge according to the present invention, during the purification process, smelling organic substances contained in the sewage or sludge, for example, aliphatic hydrocarbon mercaptans (RSH) and lower aliphatic amines (RNH_2), are oxidized and decomposed to substantially odorless substances by the activity of the constituent elements of fine dust coal having a low degree of carbonization. Accordingly, the coal-containing sludge concentrate formed by coagulation and sedimentation does not emit any foul smell at all during the dehydration step or in the state of the dehydrated cake, and even under high temperature and high humidity conditions in summer, secondary putrefaction is not caused at all. In other words, a dehydrated mixture of size-adjusted fine dust coal and sludge can be regarded as inorganic substance-incorporated organic aged fertilizer that can be formed in a short time and has a fertilizing effect comparable or superior to that of compost. Natural humic acid is a polybasic organic polymeric acid and its typical supply source is compost. The inorganic substance to be incorporated is an ash component contained in the size-adjusted fine dust coal in an amount of 20 to 40%, which may be regarded as an ion exchange member composed of silica (SiO_2), alumina (Al_2O_3), iron oxide (Fe_2O_3) and the like and is very valuable as a soil modifier.

Contents of effective fertilizing components in the coal-containing sludge pellets according to the present invention and other organic fertilizers are shown in Table 2. From the data shown in Table 2, it will readily be understood that the coal-containing sludge pellets according to the present invention are excellent and valuable as fertilizer.

Table 2

No.	Fertilizer	Place of Collection	Contents (%)							
			in the as-collected state			after drying				
			water	total nitrogen	P ₂ O ₅	K ₂ O	total nitrogen	P ₂ O ₅	K ₂ O	pH
1	raw excessive sludge	Stock Product Circula- tion Center, Kumamoto Prefecture, Japan	88.4	0.27	0.33	0.04	2.3	2.8	0.37	6.5
2	size-adjusted fine dust coal- incorporated sludge	ditto (in-situ test by EDEX Research Institute)	2.4	2.13	1.01	1.93	2.18	1.03	1.88	6.9
3	ditto	ditto (in-situ test by EDEX Research Institute)	6.6	1.40	0.82	1.74	1.49	0.88	1.87	7.2
4	ditto	ditto (in-situ test by EDEX Research Institute)	62.5	0.61	0.40	0.68	1.63	1.05	1.87	6.7
5	Fermented cow fecets (compost- fermented for 2 months)	Koyama Tojima, Kikuchi City, Kumamoto Prefec- ture, Japan	66.7	0.49	0.51	0.26	1.46	1.53	0.79	7.8
6	average values of natural composts	various places, Japan	75.1	0.39	0.19	0.7	1.56	0.76	2.8	—
7	stable compost	Ueki Town, Kumamoto Prefecture, Japan	57.0	0.64	0.8	0.75	1.49	2.06	1.75	7.7

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Claims

1. A process for the preparation of coal-containing sludge pellets, which comprises incorporating in sewage or sludge size-adjusted fine dust coal, which has such a particle size distribution that 30 to 70% by weight of the whole particles have a particle size of 9 to 150 mesh (Tyler Standard) (sieve opening 2 mm to 104 microns) and 70 to 30% by weight of the whole particles have a particle size of 150 to 500 mesh (Tyler Standard) (sieve opening 104 to 33 microns), thereby to separate the mixture into purified water and a coal-containing sludge concentrate, removing water from this coal-containing sludge concentrate according to the self-precoat filtering method, continuously dehydrating the resulting cake under a reduced pressure or in vacuum while imparting vibrations to the cake layer in the direction of the thickness thereof, and extruding the resulting dehydrated cake having a water content lower than 50% by weight under compression and shear to form coal-containing sludge pellets having a water content lower than 30% by weight.
2. A process according to claim 1 wherein the size-adjusted fine dust coal having a low degree of carbonization is incorporated in an amount substantially equal to the amount (on the dry basis) of suspended solids and BOD components contained in the sewage or sludge.
3. A process according to claim 1 or 2 wherein the coal-containing sludge pellets for use as fuel and the fine dust coal has a calorific value of 4500 to 5000 Kcal/Kg.
4. A process according to claim 1 or 2 wherein the coal-containing sludge pellets are pellets for use as fertilizers and the fine dust coal has a calorific value of 2800 to 4000 Kcal/Kg.
5. A process according to any one of claims 1 to 4 wherein (a) the size-adjusted fine dust coal in an amount of 0.1 to 5% by weight based on the sewage or sludge, (b) finely divided carbon having a particle size of 70 to 100 μ m in an amount corresponding to 1/20 to 1/5 of the amount of the fine dust coal, (c) an aluminum type or aluminum-iron type coagulant in an amount of 0 to 1% by weight based on the sewage or sludge, (d) a neutralizing agent in an amount of 0 to 0.5% by weight based on the sewage or sludge and (e) a polymeric coagulant in an amount of 1 to 50 ppm based on the sewage or sludge are incorporated in the sewage or sludge.
6. A process according to any one of the preceding claims wherein the dehydrated cake formed by the self-precoat filtering method is gripped and supported between an endless filter cloth and an endless belt and passed through a plurality of receiving rollers and pressing rollers arranged in a zigzag manner so that they are engaged with one another, and suction under reduced pressure is performed from the back of the filter cloth.
7. A process according to claim 6 wherein the gap between the receiving rollers and the pressing rollers is gradually narrowed toward the filter cloth and belt discharge side from the filter cloth and belt introduction side, so that the degree of dehydration of the cake is gradually increased with the advance of the filter cloth and belt.
8. A process according to any one of the preceding claims wherein at the step of extruding the dehydrated cake under compression and shear, the temperature of the coal-containing sludge cake is elevated to 110 to 140°C. by frictional heat and the coal-containing sludge cake is frictionally pulverized at this elevated temperature.
9. A process according to claim 1 substantially as described with reference to the accompanying drawing.