

Oct. 7, 1941.

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2,257,907

METHOD OF MAKING ACTIVATED CARBON

Filed Aug. 8, 1940

2 Sheets-Sheet 1

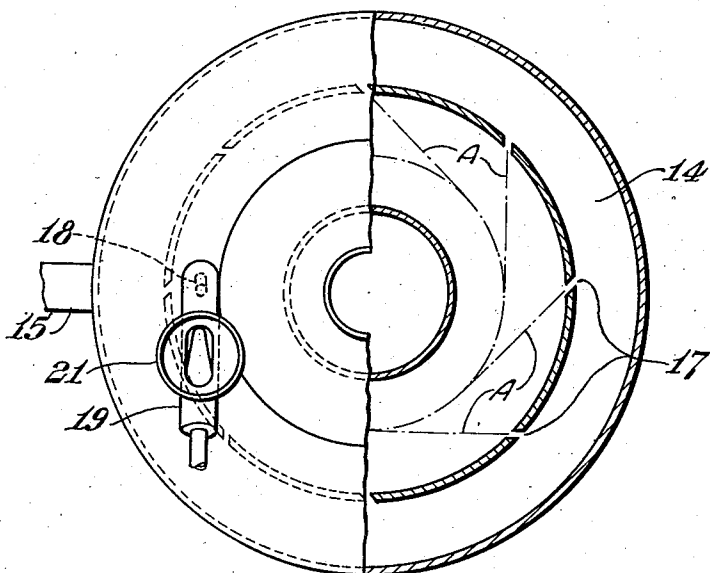


Fig. 2

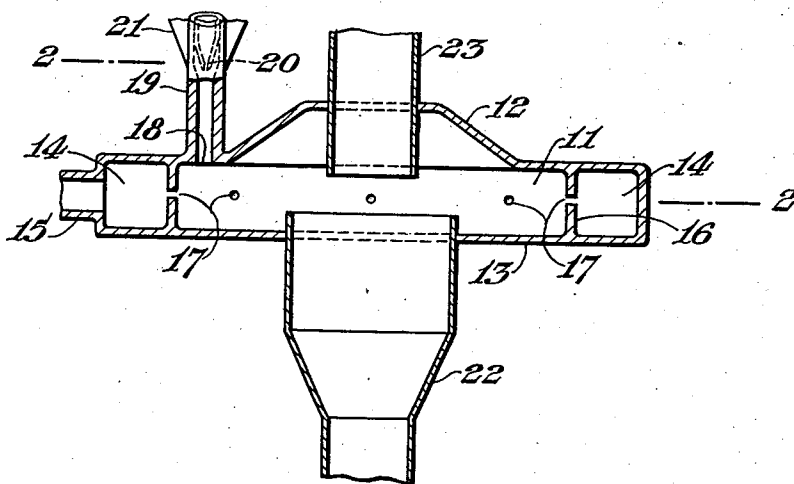


Fig. 1

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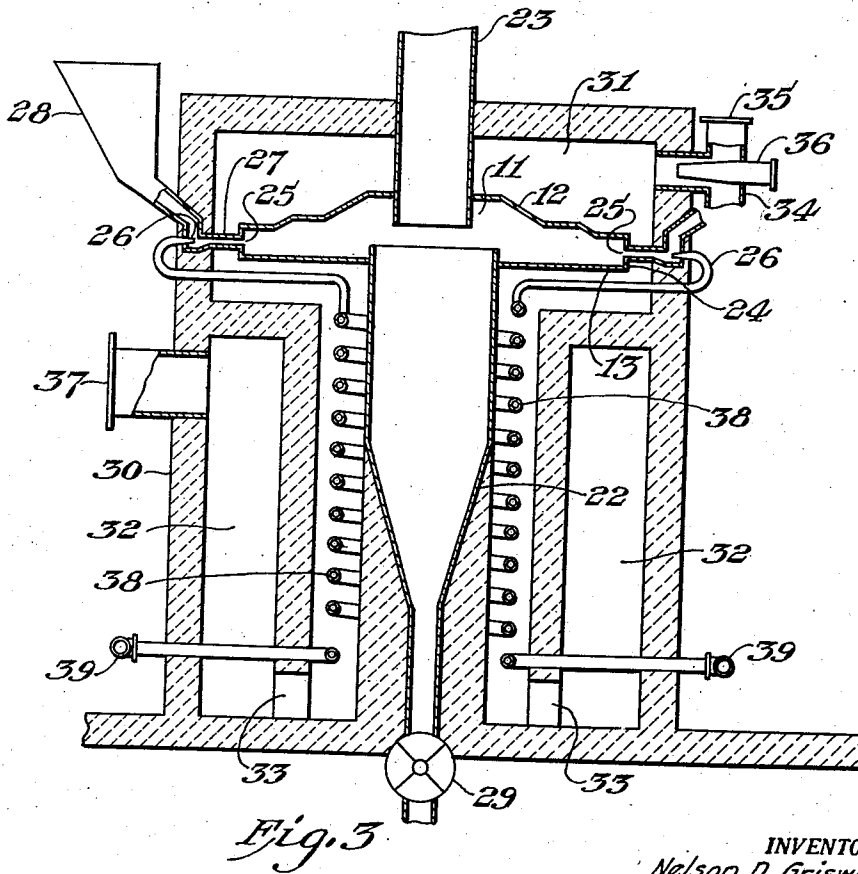
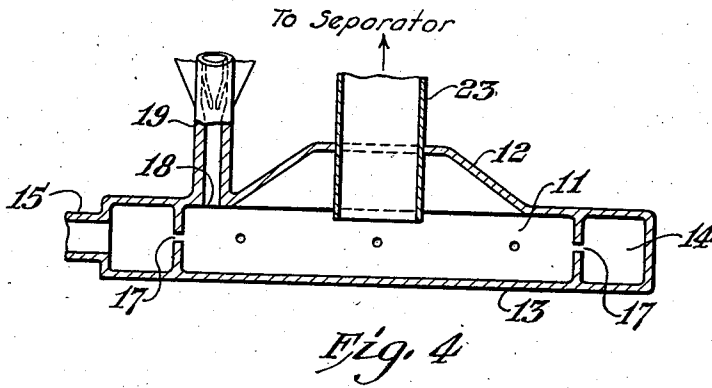
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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METHOD OF MAKING ACTIVATED CARBON

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8 Claims. (Cl. 252—291)

This invention relates to a process for the treatment of comminuted carbonaceous material to produce activated carbon.

In the manufacture of finely divided activated carbon, it is general commercial practice first to activate carbonaceous material in gross form, and then to grind the activated product to the desired fineness. The activation is accomplished by exposing the carbonaceous material, e. g. charcoal, in the form of lumps or coarse powder to the action of activating oxygenated gases, and the subsequent grinding is carried out in a ball mill, attrition mill, or the like. This method is disadvantageous in that it is difficult to prepare a uniform, highly active product. That is, the activation is accomplished by exposing relatively large particles of carbonaceous matter to the activating gas, and in consequence, in ordinary operation, the individual particles do not attain a uniform degree of activity throughout. Subsequent grinding of this activated material at best results only in a mixture of more and less active particles.

In an effort to overcome this difficulty, the art has suggested a number of processes in which the carbonaceous material is first ground and is then activated while in suspension in a gaseous current. These methods are of somewhat limited usefulness, however, because of their inherent inability to maintain uniform distribution of the activating gas in relation to the carbonaceous particles, to provide adequate temperature control, or to provide uniform heating of the mass being activated. Moreover, in these processes, the gaseous current used to suspend the particles also tends to carry the particles out of the activating zone. As a result, low gas velocities must be employed, and even then the treatment must be carried out in extremely bulky, expensive apparatus.

An object of the present invention is to provide a process for activating carbonaceous material while in suspension in a gaseous current which avoids the difficulties just mentioned. Another object is to provide a method of making finely divided activated carbon having a uniformly high activity. Still another object is to provide a process which employs a high gas velocity and an extreme degree of agitation in the activating zone, but which may be carried out in simple, inexpensive apparatus of small size.

According to the invention, carbonaceous or readily carbonizable material is activated in an activating zone while in suspension in an oxygenated gas under conditions of high gas velocity and extreme agitation, centrifugal force being utilized to maintain the material within the zone in contact with the activating gas for a time sufficient to insure activation.

In the invention, the material to be activated

is exposed to the gaseous activating agent in a shallow cylindrical activating zone, the heated activating gas being injected into the zone at high velocity in such direction as to form therein a gaseous vortex spiralling inwardly toward the center of the zone. The material being treated is introduced continuously into the vortex and is rapidly activated by the action of the whirling gas, is carried inwardly to the center of the vortex, and is there discharged.

In order to establish the vortex, gas is injected at high velocity into the activating zone at a plurality of positions spaced around the periphery thereof in such direction as to have one component of motion which is forward in the direction of vortical rotation and another much smaller component which is transverse to said direction, both components being in the plane of the vortex. In this way a vortex having a velocity of rotation very high in comparison to its velocity of inward motion may be maintained. The particles of material introduced into the gaseous vortex are whirled about with great speed, mixing intimately with the hot activating gas forming the vortex, and colliding violently with other particles and with the sides of the activating chamber. As a result of the continual collisions taking place between particles, there is a certain abrasive or pulverizing action which tends continually to expose fresh surfaces of the particles being activated, and simultaneously to reduce the size of the larger particles. In consequence of the high gas velocity, extreme agitation, and continual exposure of fresh particle surfaces which is taking place in the vortex, activation of the material occurs rapidly and with unusual efficiency.

During operation, the particles of material tend to be carried to the center of the vortex by the inwardly spiralling gas. However, as the center is approached, centrifugal force due to rotation of the vortex becomes very great, and most of the particles are thrown back toward the periphery; only a relatively few particles keep reaching the center of the vortex and are discharged. That is, because of the centrifugal action, the average particle of carbonaceous material is exposed to the activating gas for a considerable time before it escapes from the activating zone; relatively complete activation is achieved.

The process of the invention is adapted to activating carbonaceous and readily carbonizable materials of any degree of fineness, relatively coarse comminuted material being ordinarily used. Thus the process may be carried out to produce activated carbon having a particle size finer than 100 mesh from an extremely coarse feed, say one-eighth inch lumps or larger.

The process of the invention may be employed

to activate carbonaceous materials, such as charcoal, and readily carbonizable materials, especially ligno-cellulose materials such as sawdust, ground waste wood, nut hulls, and the like, which are commonly employed in making active carbon. In the process, these latter materials are both carbonized and activated in a single step. The material to be treated is preferably, though not necessarily, dried thoroughly before treatment.

In practice, the invention may be carried out using any of the activating oxygenated gases commonly used for activating carbonaceous material, e. g. steam, air, carbon dioxide, flue gases, generator gas, etc., or mixtures thereof. The activating gas and carbonaceous or carbonizable material are supplied to the activating zone preferably in the proportion of at least one-half part by weight of gas per part of carbonaceous material (i. e. less than 2 parts of solid per part of gas), and much higher proportions, e. g. 10 or more parts of gas per part of solid, may be employed.

The rates of injection into the vortex of the activating gas and of the material being activated are, of course, adjusted so that the material remains in the zone for a period of time sufficient to attain relatively complete activation, and may also be controlled so that only pulverized materials having a particle size finer than a desired value, say 100 mesh, reach the center of the zone and are there discharged.

In practicing the invention, the heat necessary to maintain the activating zone at activating temperatures, viz., 450°-1200 C., and the heat required for activation may be supplied by any suitable means. Thus the activating zone may be heated externally by hot gases or by induction. Again, when air is the activating gas, a portion of the material being activated may be burned within the activating zone and thus furnish the necessary heat. Alternatively, the steam or combustion gases used for activating the material may be super-heated to an extent sufficient to supply the heat of activation. Combinations of these methods may be employed. This wide variety of heating means applicable to the present process is a distinct advantage over prior art processes, most of which are limited to a single method of heating.

The process constituting the invention may be better understood with reference to the accompanying drawings in which:

Fig. 1 is a vertical sectional view of one form of apparatus in which the process of the invention may be carried out;

Fig. 2 is a plan view partly in horizontal section along the line 2-2 in Fig. 1; and

Figs. 3 and 4 are vertical sectional views showing other forms of apparatus.

Referring to Figs. 1 and 2, the vortex of activating gas is maintained in the circular activating chamber 11 which is formed by an upper wall 12 and a lower wall 13, and is surrounded by a header 14 into which heated gas under pressure may be introduced through a pipe 15. The inner wall 16 of the header is provided with a plurality of equally spaced small jets 17 drilled obliquely, so that the activating gas is injected from the header 14 into the chamber 11 at high velocity in a direction having a component of motion which is forward in the direction of rotation of the vortex and another smaller component which is transverse to this direction, as indicated by lines A. Comminuted material to be activated is fed continuously into the vortex

chamber 11 through a supply opening 18 by a feeding means 19 comprising a gas nozzle 20, which acts to drive material from a hopper 21 through the supply opening 18 into the chamber 11. The material fed into the vortex chamber 11 is rapidly activated by action of the whirling hot gases as hereinbefore described, and the activated particles are gradually carried to the center of the vortex chamber. These particles tend to settle out in a collection chamber 22 which may be closed at its lower end with a suitable receptacle. Gases substantially freed of entrained particles escape through a conduit 23. The entire apparatus is preferably covered with insulating material to prevent heat loss.

In another form of the invention as illustrated in Fig. 3, an apparatus similar to that shown in Figs. 1 and 2 may be inclosed in a furnace. The gaseous vortex is maintained in a chamber 11, which is formed by an upper wall 12, a lower wall 13, and a peripheral wall 24. This outer wall 24 is provided with a series of equally spaced openings 25 through which heated compressed gas supplied by way of nozzles 26 enters the chamber 11 through jets 27. These jets 27 are so disposed that the gas enters the chamber at high velocity in a direction having a component of motion which is forward in the direction of rotation of the vortex, and another smaller component which is transverse to this direction. Material to be activated is fed into the vortex chamber from a hopper 28 through one of the openings 25 by feeding means comprising one of the same nozzles 26 and jets 27, which also are used to inject heated gas into the chamber. Activation of the material takes place in the chamber 11 by action of the spiralling hot gases. The activated material is carried to the center of the vortex chamber, and gathers in a collection chamber 22 from which it may be withdrawn from time to time through a valve 29. Gases substantially free of carbonaceous particles are vented through a pipe 23. The entire apparatus, except for the hopper 28 and valve 29, is inclosed in a brick furnace 30 consisting of a combustion chamber 31 and an outer annular chamber 32 which are in communication through openings 33. The furnace is heated by the flame from a burner 34 consisting of an air inlet 35 and a nozzle 36 for admission of gaseous or liquid fuel. The hot products of combustion pass down the chamber 31 through the openings 33 into the outer chamber 32 and are exhausted through an outlet 37.

A pipe coil 38 provided at one end with an inlet 39 and connected at the other end with the pulverizer inlet nozzles 26 is disposed around the outside of the combustion chamber 31. This coil serves as a preheater or super-heater for the activating gas injected into the pulverizing chamber 11 through the nozzle 26.

In the process as carried out in the apparatus illustrated in Figs. 1 to 3, activation of the carbonaceous or carbonizable material and separation of activated product from the exit gases are carried out in a single piece of apparatus, activated product and effluent gases being discharged separately from the activating zone. While this practice represents the preferred process, it will be understood that separate discharge of product and gases is not essential in the broadest concept of the invention.

Fig. 4 illustrates one form of apparatus adapted to carrying out the process in which product and gases are discharged together from the activating zone and are subsequently sep-

arated. The vortex of activating gas is maintained in the circular chamber 11, which is formed by an upper wall 12 and a lower wall 13 and is surrounded by a header 14. Hot activating gas introduced into the header 14 through a pipe 15 is injected obliquely at high velocity into the chamber 11 through jets 17, forming the spiralling gaseous vortex. Material to be activated is fed continuously into the chamber 11 through a supply opening 18 by feeding means 19, and is rapidly activated by action of the whirling gases, the activated particles being carried to the center of the chamber. Activated particles and effluent gases escape together through a conduit 23, and may subsequently be separated by means not shown, e. g. a centrifugal separator.

To summarize, in the present process comminuted material is activated while in suspension in a gaseous current at high gas velocity and under conditions of extreme agitation. Despite the high gas velocity, the material being treated is kept in contact with the oxygenated gas for a time sufficient to accomplish activation by utilizing centrifugal force or other means to retain the material in the activating zone. As explained, the process tends to pulverize the material as well as to activate it, and may be controlled to produce an activated product finer than 100 mesh.

An essential feature of the process is that activation of the carbonaceous or carbonizable material takes place in a gaseous suspension at high gas velocities. Velocities from ten to several hundred times those heretofore deemed operable are commonly employed. As a result, the agitation of the particles being activated is extreme, being much greater than that attained in prior art processes for activating in gaseous suspension. Despite these extreme gas velocities, the loss of activated product in the exit gases leaving the activating zone is very small, rarely exceeding 5-10 per cent of the total activated material formed.

The following example will illustrate the invention, but is not to be construed as limiting its scope:

Example

Hardwood charcoal was activated in an apparatus such as shown in Fig. 3 in which the activating chamber was 20 inches in diameter and 2 inches in depth. Six jets having a diameter of about 0.25 inch were used in establishing the vortex. The gas burner in the furnace was operated to maintain a temperature of about 900° C. in the activator. Charcoal having an average size of about 10 mesh was fed into the apparatus at a rate of about 600 pounds per hour. Steam at 100 pounds pressure superheated to a temperature of 900° C. was injected at a rate of about 900 pounds per hour. The activated charcoal withdrawn from the process had an average particle size finer than 325 mesh and an activity characterized by an iodine number of about 75.

This application is a continuation-in-part of my patent application Serial No. 240,970, filed November 17, 1938.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the process herein disclosed, provided the step or steps stated by any of the following claims or

the equivalent of such stated step or steps be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A process for preparing finely divided activated carbon from a material selected from the class consisting of carbonaceous and readily carbonizable materials which comprises: injecting into a shallow cylindrical activating zone at a plurality of positions spaced around the periphery thereof streams of an activating oxygenated gas so directed as to form within the zone a substantially planar gaseous vortex; maintaining the said zone at an activating temperature; introducing the said material in relatively coarse comminuted form into the zone, wherein it is subjected to activation and pulverization by the action of the gaseous vortex, and the finer particles formed tend to be carried to the center of the zone but the coarse particles tend to be retained by centrifugal force near the periphery of the zone and are there subjected to additional pulverization and activation; and discharging the finer particles from the center of the zone.

2. A process for preparing finely divided activated carbon from a material selected from the class consisting of carbonaceous and readily carbonizable materials which comprises: injecting into a shallow cylindrical activating zone at a plurality of positions spaced around the periphery thereof streams of an activating oxygenated gas so directed as to form within the zone a substantially planar gaseous vortex; maintaining the said zone at an activating temperature; introducing the said material in relatively coarse comminuted form into the zone, wherein it is subjected to activation and pulverization by the action of the gaseous vortex, and the finer particles formed tend to be carried to the center of the zone but the coarse particles tend to be retained by centrifugal force near the periphery of the zone and are there subjected to additional pulverization and activation; controlling the rate of injection of the activating gas and of the said material into the vortex zone so that the material remains in the zone for a period of time sufficient to attain relatively complete activation and so that only pulverized material having a particle size finer than 100 mesh reaches the center of the zone; and discharging the activating gas and activated material finer than 100 mesh from the center of the zone.

3. A process according to claim 2 wherein the material being treated is charcoal.

4. A process according to claim 2 wherein the material being treated is sawdust.

5. A process according to claim 2 wherein the activated material finer than 100 mesh is separated from the activating gases by the centrifugal action of the vortex, and the gases and activated material thus separated are separately discharged from the center of the activating zone.

6. A process according to claim 2 in which the activating gas is steam.

7. A process according to claim 2 in which the vortex zone is maintained at an activating temperature by external heating.

8. A process according to claim 2 in which the activating gas before injection into the activating zone is super-heated to an extent to supply the heat required for activating the carbonaceous material.

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