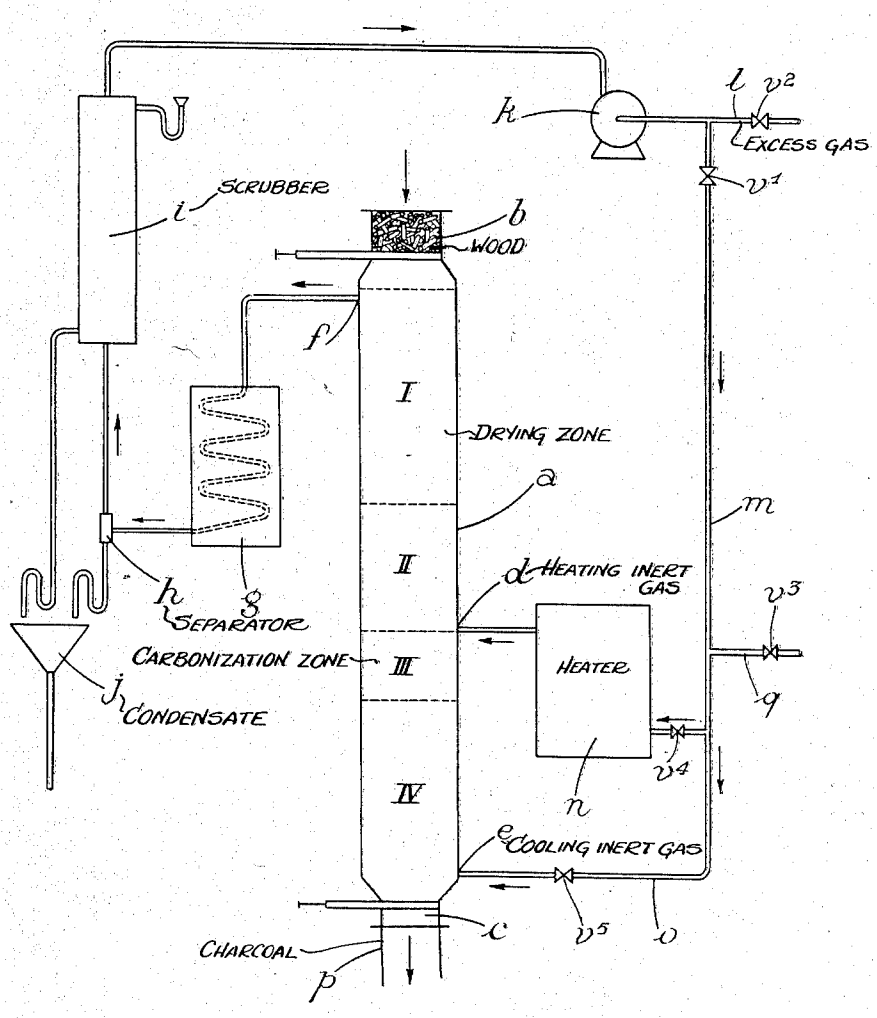
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PROCESS OF CONTINUOUS CARBONIZATION OF CELLULOSIC MATERIALS

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PROCESS OF CONTINUOUS CARBONIZATION OF CELLULOSIC MATERIALS

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The present invention relates to the destructive distillation of materials such as wood, peat, lignin and other cellulosic materials which, on being carbonized, give rise to an exothermic reaction.

The invention more particularly relates to a method of continuously carrying out distillation by treating wood or other material, preferably dried, in a chamber or retort with inert gases introduced into the retort through the cooling zone, i. e. the zone in which the carbonized material is cooled before it is discharged from the retort. Hitherto a disadvantage of this method was the slow progress of carbonization, which could not be remedied by increasing the rate of flow of the inert gases, as said gases require to be heated in the cooling zone, and any increase in their rate of flow would result in lowering their temperature and gradually stopping the reaction. Slow carbonization on the other hand lowers the efficiency of the process and causes the distillation products, e. g. methanol and acetic acid, to remain too long in the carbonizing zone at a high temperature which favors their decomposition, thereby decreasing the yield in valuable distillation products. Furthermore the gases issuing at a slow rate from the cooling zone are not evenly distributed through the material, and the discharged charcoal is incompletely carbonized.

It is an object of my invention to avoid these disadvantages and to provide a process in which carbonization is accelerated, while a high yield in distillation products is obtained.

In accordance with my invention the wood or other material to be carbonized is fed through a furnace or retort heated by a current of inert gases circulating through the retort in contracurrent to the wood, said gases being heated outside the retort and introduced into the retort at an intermediate point thereof, in immediate vicinity of the carbonizing zone. In addition, cold i. e. unheated gases are introduced at or near the outlet for the carbonized material. The rates of supply of the hot gases and of the cold gases are independently controllable so that it is possible both to obtain an efficient cooling of the charcoal and suitably to control the carbonizing zone.

The wood continuously charged into the retort thus can be brought by the hot gases exactly to the temperature which is necessary in order to induce the exothermic carbonization reaction, while the cold gases introduced separately absorb the heat developed by the exothermic reaction, thereby avoiding overheating of the distillation products in contact with the material being carbonized. In this way carbonization can be carried out rapidly, as is necessary for successful continuous operation. Owing to the possibility of controlling the gas currents independently of each other, carbonization can be regulated in proportion to the input and vice versa, the extent of the carbonizing zone can be regulated as desired.

In the accompanying drawing illustrating diagrammatically, by way of example, a plant for carrying out the present invention, *a* is the carbonizing furnace or retort having at the top an inlet chamber *b* for the pieces of wood to be carbonized and at the bottom a discharge outlet *c* for the charcoal. In operation hot inert gases are introduced into the retort at an intermediate point *d* thereof, whereas cold inert gases are introduced at *e* near the bottom, and the gaseous products of distillation are withdrawn from the top at *f*.

In one method of carrying out my improved process, the inert gases are circulated in a closed circuit. Issuing from the outlet *f* in admixture with the products of distillation they are led through a cooler *g*, a separator *h* and a scrubber *i*, whence the condensed products are collected at *j*. A fan *k* sends the residual inert gases past a tapping pipe *l* for discharging excess gas, through a pipe *m* whence a portion of the gases passes through a heater *n* to the hot gas inlet *d*, while another portion flows through a pipe *o* to the cold gas inlet *e*. It will be understood that valve v^1 then is fully open, valve v^2 is partly open to regulate the outward flow of excess gas; valve v^3 is closed while valves v^4 and v^5 are partly open to regulate the supply of gases at *d* and at *e* respectively.

In operation, the rate of progress of the wood through the retort and the rates of flow of the hot gases fed at *d* and of the cold gases fed at *e* are so regulated that, when reaching point *d*, the downwardly travelling wood has reached the temperature at which exothermic carbonization is initiated. Thus, the wood passes gradually and successively through a drying zone I and a torrefaction zone II while travelling in contracurrent to the upward flow of hot gases introduced at *d* and of the cooler gases introduced at *e* and heated in the lower portion of the retort. Carbonization being initiated at or near the level *d* continues throughout the zone indicated at III and is followed by cooling in zone IV in which

the charcoal travels in contra-current to the upward flow of cold inert gases introduced at *e*.

It has been found that, as shown, the carbonization reaction extends beyond the inlet of the hot gases, in the direction of travel of the wood. Owing to the fact that cold gases are continuously introduced at the bottom of the retort, the volatile distillation products which are evolved in the carbonizing zone III, i. e. beyond the point *d* of introduction of the hot inert gases, remain only for a short time in contact with charcoal at high temperature, and I have ascertained the surprising fact that said volatile products are not decomposed to an appreciable extent, even though they pass through material in the course of carbonizing at high temperature.

The gaseous distillation products are withdrawn with the inert gases at *f*. When the valuable products, such as methanol, acetic acid etc. are condensed, a certain percentage of said products remain in the circulating gases. It is an advantage of my process that the greater part of the products remaining in the circulating gases are not decomposed since, when they are again passed through the retort, only the gases introduced at *e* pass through carbonized material liable to favor their decomposition.

The temperature and the quantity of inert gases to be introduced depend on the amount of wood charged, the size of the pieces of wood and the degree of moisture of the wood. As stated, the rate of input of the wood at *b* and the rate of flow of both the hot gases introduced at *d* and the cool gases introduced at *e* are such that a well defined carbonization zone is created in the vicinity of point *d*, between two zones of gradually decreasing temperatures.

In practice, the temperature of the hot inert gases at *d* is about 300 to 600° C., while the temperature of the cold gases at *e* is under 40° C. The gases and vapors escaping from the retort at *f* should preferably be at a temperature high enough to ensure that no condensation of the distilled products will take place in the cool upper portion of the retort. Such is normally the case when the exit gases have a temperature of at least 100° C. For carbonizing 1 cubic meter of wood, there is usually required a total amount of about 800 to 2000 cubic meters of inert gases of which 150 to 200 cubic meters are used as cold gases.

I have found that I have full control of the carbonization when the rate of travel of the wood and the rate of flow of the hot gases are so adjusted that the zone of carbonization forms beyond the inlet of the hot gases, the said zone then being swept only by the cooling gases. Under these conditions, by merely varying the rate of flow of the cooling gases I am enabled to control the evolution of heat. The location of the exothermic reaction zone can easily be ascertained by temperature tests; thus if the exothermic zone were situated above the hot gas inlet, the temperature in the retort would rise above the temperature of the inert gases introduced at *d*.

For carrying out my improved process I may use retorts or furnaces of any suitable construction. Preferably I use a vertical retort as shown in the accompanying drawing in which the wood travels downwardly by gravity, the hot inert gases being introduced near or beneath the middle portion of the retort and the cool gases being introduced at the bottom near the discharge outlet for the charcoal. With the retort 5 meters high, having a diameter of 2 meters, it is possible to carbonize one ton of wood per hour, the wood being in logs of about 30 cm. length and about 8 cm. diameter, there being simultaneously introduced 900 cubic meters of inert gases at 600° C. at a point about one fifth of the height of the retort, and 150 cubic meters of inert gases at atmospheric temperature at the bottom of the retort, near the charcoal outlet. Under these conditions the carbonizing zone in the retort forms adjacent the level where the hot gases are introduced. At the upper end of the retort the gases laden with distillation products are drawn off at 100° C. whereas, at the bottom, 230 kilogs. per hour of charcoal with very high carbon content are discharged into a sealed receptacle *p*.

The yields in acetic acid and methanol are approximately 15 to 30% higher than those attainable with discontinuous carbonization processes.

As inert gases I may use any gases which are not adapted to react with the distillation products, i. e. gases which are free from oxygen. Advantageously use can be made of the distillation gases formed in the course of the carbonization process, in which case the gases may be circulated in a closed circuit as above described.

Alternately I may use, as inert gases, natural gas where available, or producer gas or the like, and the gases may flow in an open circuit. Fresh gas being supplied through pipe *q* and valve v^3, a regulated portion of said gas is sent to the retort through the heater *n* and another regulated portion through the pipe *o*, the operation being the same as above described. All the gases may be drawn off at *l*, the valve v^1 being closed, or the valve v^1 may be partly open, so that a portion of the inert gases is circulated through *m* and mixed with fresh gases from *q*.

Whatever be the manner of circulating the gases, the heating of the inert gases introduced at *d* may be effected in any suitable way, as by preheating or by combustion, i. e. the heater *n* may be a heat exchanger, or a furnace, or a gas producer, the heating in any case being such that when entering the carbonization retort, the gases are at a temperature of from 300 to 600° C. or even more, according to the amount of volatile products it is desired to allow to remain in the charcoal.

The separation of the distillation products from the circulating gases may be performed in the usual manner. Since, as stated before, the hot circulating gases do not, or do only partly, come into contact with the charcoal, it is possible to recirculate the hot distillation gases without having completely separated therefrom the distillation products. Thus said products will concentrate in the gases, and if desired they may be separated only in the branch circuit *o* leading the unheated gases to the bottom of the retort, or in the branch pipe *l* through which excess gas is tapped from the circuit.

I may also introduce the heated gases at different points and at different temperatures into the retort, for instance through separate circuits. In this case less highly heated gases may be introduced into zones of lower temperature, such as the drying zone, and such gases may contain relatively high amounts of volatile products.

The height of the temperature maximum within the retort depends essentially on the rate of flow and on the temperature of the hot gases. The zone of highest temperature may be enlarged

and its temperature lowered by suitably increasing the rate of flow of the hot gases.

I claim:

1. In a process of continuous carbonization of cellulosic materials in which heat is carefully regulated for the production of acetic acid and methanol, passing the material to be carbonized through a chamber, introducing inert gases heated to between about 300° C. and 600° C. from the outside directly into said chamber at an intermediate point thereof to cause a carbonizing zone to form in said chamber in the vicinity of said point, introducing inert gases at a temperature under about 40° C. into said chamber near the discharge end thereof, causing said hot and said cold inert gases to travel through said chamber in contra-current to said material, controlling the rate of travel of said material and the rates of flow of said hot inert gases and said cold inert gases to produce a carbonizing zone in said retort located beyond and having its beginning immediately beyond the point of introduction of said hot inert gases in the direction of travel of said material, withdrawing said inert gases from said chamber together with the acetic acid and methanol at a temperature of at least 100° C., and separating said acetic acid and methanol from said inert gases.

2. In a process of continuous carbonization of cellulosic materials in which heat is carefully regulated for the production of acetic acid and methanol, passing the material to be carbonized through a chamber, introducing inert gases heated to between about 300° C. and 600° C. from the outside directly into said chamber at an intermediate point thereof to cause a carbonizing zone to form in said chamber in the vicinity of said point, introducing inert gases at a temperature under about 40° C. into said chamber near the discharge end thereof, causing said hot and said cold inert gases to travel through said chamber in contra-current to said material, controlling the rate of travel of said material and the rates of flow of said hot inert gases and said cold inert gases to produce a carbonizing zone in said retort located beyond and having its beginning immediately beyond the point of introduction of said hot inert gases in the direction of travel of said material, withdrawing said inert gases from said chamber together with the acetic acid and methanol at a temperature of at least 100° C., separating said acetic acid and methanol from said inert gases, heating to between about 300° C. and 600° C. a portion of the separated inert gases and leading them to said chamber as inert hot gases, and leading another portion of the separated inert gases at a temperature under about 40° C. to said chamber as inert cold gases.

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