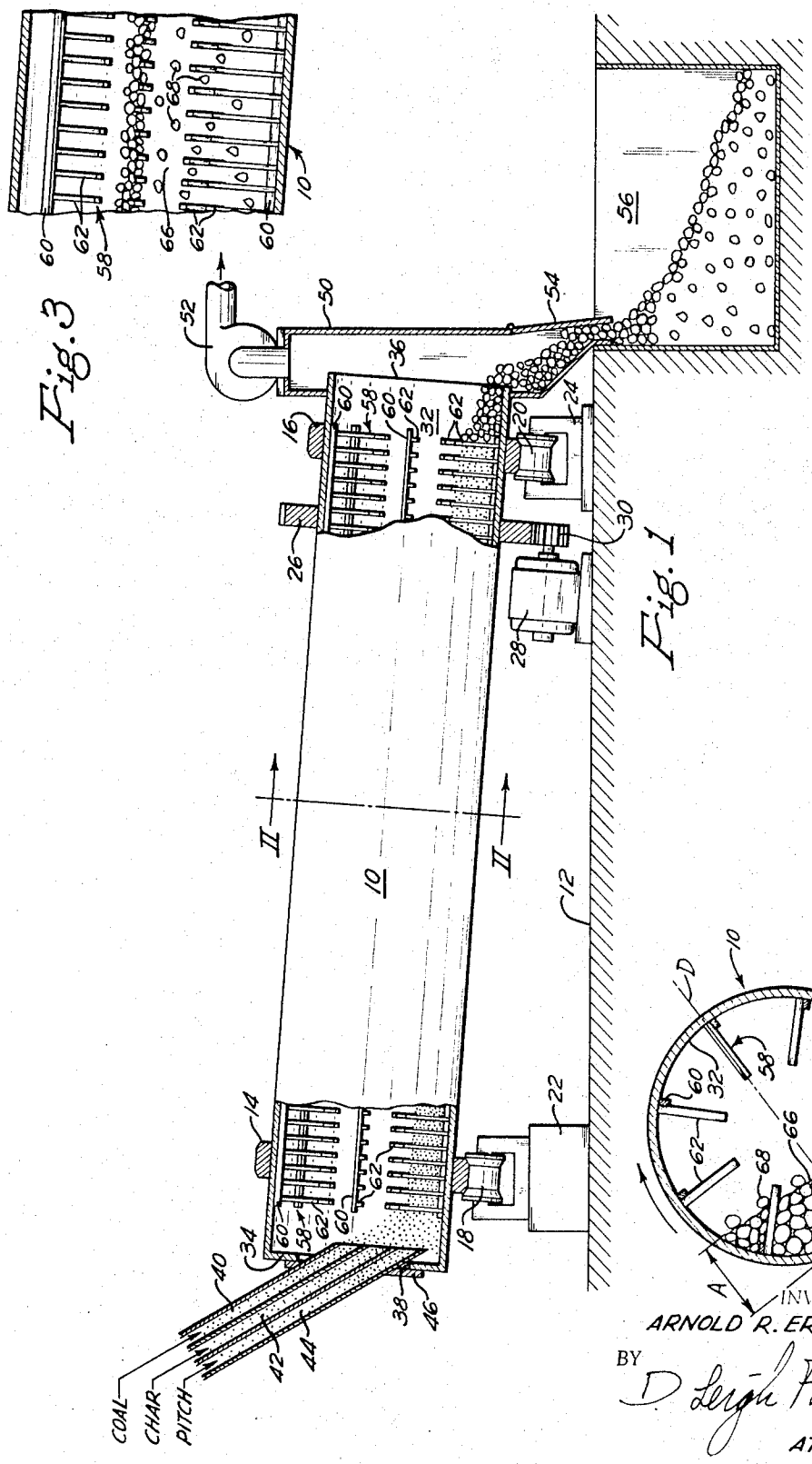
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PROCESS FOR AGGLOMERATING CARBONACEOUS MATERIALS

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PROCESS FOR AGGLOMERATING CARBONACEOUS MATERIALS

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This invention relates to a process for forming agglomerates of predetermined size from discrete carbonaceous particles in a rotating retort and more particularly to a process for agglomerating finely divided coal particles and finely divided particles of a carbonaceous residue in a rotating retort to form a carbonaceous agglomerate product having a predetermined size consist.

The supply of coals particularly suitable for making metallurgical coke in conventional coke ovens is limited. A process has now been developed for making coke that is relatively independent of the restrictive specifications imposed upon the coals now employed in current coke plants. By this process an agglomerate, hereinafter called formcoke, is produced which has the desired properties of metallurgical coke. The formcoke produced has the desired strength to sustain the "burden" of a conventional blast furnace and is in many respects superior to metallurgical coke made in conventional coke ovens.

The process for making a suitable formcoke from a caking coal is described in U.S. Patent No. 3,073,751 entitled, "A Method of Making Formcoke," and assigned to the assignee of this invention. In this process particulate bituminous coal and finely divided char (the solid carbonaceous residue of coal which has been distilled between 800 and 1,400° F.) is introduced into a rotating, substantially horizontal retort. Pitch may also be added to the rotating retort with the coal and char. Where the coal used is a caking coal, the pitch increases the yield of formcoke by pitch recycle. An increase in the strength of the formcoke is also obtained where pitch is used with a caking coal. Where the coal used is a weakly caking coal, the pitch is essential as a fluid binder to provide the proper forming regime to produce strong formcoke. Formcoke of desired strength cannot be obtained from weakly caking coals without the addition of pitch or some other suitable binder.

Where a caking coal is used, suitable relative proportions of the coal, char and pitch introduced into the retort are: 35 to 60 parts by weight coal; 40 to 65 parts by weight char; 0 to 15 parts by weight pitch. The temperature within the retort is maintained in the range of between 750 and 825° F. The desired temperature of the mixture in the retort is maintained under essentially adiabatic conditions, that is, by preheating the raw materials before admittance to the retort to supply as sensible heat substantially all the heat required to achieve the desired temperature in the tumbling zone. The retort is rotated to effect tumbling and intimate mixing of the solids. As the mixture is tumbled in the retort, discrete agglomerates are formed while concurrently partial distillation of the coal occurs, thereby evolving tar, the pitch portion of which when recycled serves as an additional binder for the agglomerates when pitch is included in the formulation. The residence time of the carbonaceous solids in the retort is generally between 15 and 40 minutes. The hot agglomerates are recovered from the retort and thereafter calcined at an elevated temperature, e.g., between about 1,500 and 1,800° F. The calcined agglomerate is the product formcoke that has the density, strength and abrasion resistance of conventional blast furnace coke and, in fact, the strength is generally superior to that of conventional coke.

The density of the formcoke can be varied within limits by the amount of the agglomerates or product from the rotary retort that is recycled and again introduced into the rotary retort. It is believed that formcoke having a higher density than conventional blast furnace coke will be superior to conventional coke in a metallurgical furnace. Thus by controlling the operating conditions and the formulations introduced into the substantially horizontal rotary retort, it is now possible to make formcoke suitable for use in a metallurgical furnace from coals previously unsuitable for use alone in the making of metallurgical coke. The restrictions on the formulations of different types of coals for making suitable metallurgical coke are no longer applicable when the process described in U.S. Patent No. 3,073,751 is practiced and the source of raw materials for metallurgical coke is now expanded by the use of this process.

As has been disclosed in the process set forth in U.S. Patent No. 3,073,751, a relatively deep bed of the carbonaceous material in the rotary retort is desirable to obtain uniformly sized agglomerates under the conditions described in the process. It has now been discovered, where larger sized rotary retorts are used, that the formation of uniformly sized agglomerates is affected by the absolute depth of the bed. Absolute bed depth is intended to designate the true dimensional depth of the bed as distinguished from the volume of the rotary retort occupied by the carbonaceous material. The absolute bed depth is measured at the deepest point in the semi-cylindrical bed of carbonaceous material within the cylindrical rotary retort and is designated dimensionally. The absolute bed depth is measured radially from the axis of the retort and is the radial depth measured from the surface of the bed to the wall of the retort. For example, in a 5′ diameter retort a given quantity of carbonaceous solids will form a bed having an absolute depth of 7″. The same quantity of solids in a 3′ diameter retort would have an absolute bed depth much larger than that of the 5′ diameter retort.

It has been found where the bed of carbonaceous material has an absolute depth of 7″ or less, the agglomerates formed all have a size smaller than 4″ and about 40 percent by weight of the agglomerate product has a size between ¾″ x 2″. Where, in the same diameter retort, the absolute depth is increased to 15″, the agglomerate product formed has between 10 to 20 percent by weight of agglomerates having a size greater than 4″ and the yield of the desirable sized agglomerates with a size between ¾″ x 2″ is decreased to between about 25 and 37 percent by weight. From an economic standpoint, and especially in a continuous process, it is desirable to use larger sized rotary retorts and to maintain as large a volume of carbonaceous material as possible in the rotating retort to thereby obtain a maximum output from the process. It is, therefore, highly desirable to maintain as large an absolute bed depth as possible in the rotary retort and yet obtain uniformly sized agglomerates of the preferred size spectrum.

This invention is primarily concerned with narrowing the size spectrum of the agglomerates formed in a rotating retort having an absolute bed depth in excess of 7″ and increasing the yield of agglomerates having the desired narrow size spectrum. The invention is directed to a method and apparatus for agglomerating carbonaceous material that includes a binder either supplied with the carbonaceous material to the rotating retort or autogenously evolved within the retort from one of the carbonaceous constituents. The invention includes auxiliary apparatus positioned within the rotating retort to relieve the compaction pressures exerted on the bed of carbonaceous material where the absolute bed depth exceeds 7″.

A discussion of how it is believed the auxiliary apparatus functions to provide uniformly sized agglomerates will be better understood by first setting forth the mechanism for agglomerate formation within the rotating rotary retort.

The initial stage of agglomerate formation is the development of a loosely coherent plastic mass within the retort by mixing the hot char with the particulate coal and the pitch binder. This initial mixing is accomplished by the rotation of the retort. Where the bed depth is less than a predetermined absolute depth the agglomerates are formed by the rotation of the retort and the tumbling of the carbonaceous mass therein in the following stages. The initial plastic mass breaks up during tumbling into relatively fine plastic particles. The plastic particles grow by a snowballing type of mechanism as the particles roll down the inclined top surface of the bed. Repeated tumbling of the carbonaceous mass within the retort causes continued growth of the small plastic agglomerates feeding on each other as they tumble on the inclined top surface of the bed. The agglomerates continue to grow until the binder loses its plasticity as a result of the pyrolysis that takes place under the operating conditions within the retort. After the binder loses its plasticity, the agglomerates rigidify and substantially no growth or size reduction takes place and the uniformly sized agglomerates are removed from the retort. In a continuous process the initial stage of the agglomeration takes place at the feed end of the rotary retort and the agglomerate growth takes place as the agglomerates progress toward the discharge end of the rotary retort.

Where the bed depth exceeds the predetermined absolute depth, undesirable oversized agglomerates and an undesirable wide range of different sized agglomerates is obtained. It is believed the primary cause of the undesirable product is the higher compaction pressure caused by the relatively deep bed interfering with the desired tumbling action. The large agglomerates are not efficiently lifted by the rotary action of the retort and tend to grow by a compaction of one agglomerate against another. The agglomeration by compaction mechanism is an undesirable mechanism for agglomerate growth and results in the formation of oversized agglomerates in the product. The problem is further increased in continuously fed rotary retorts in that the larger agglomerates move more slowly through the rotary retort and cause additional problems in the control of the size consist.

It has been discovered by including auxiliary apparatus, namely a plurality of longitudinally extending rows of rakes or lifters, in the rotary retort the difficulties described above are eliminated and deep beds exceeding the predetermined absolute bed depth can be used and an increased percentage of the agglomerates formed have the desired size consist. The rows of longitudinally extending rakes are secured to the walls of the rotary retort and have a plurality of tines extending radially inwardly toward the center of the retort. The tines are spaced from each other preferably at a uniform distance and assist in the formation of agglomerates having the desired size consist. The rakes prevent the undesirable agglomeration by compaction previously described and cause the plastic particles to agglomerate by rolling down the top inclined surface of the bed. The rakes tend to relieve the bed of the compaction forces present due to the weight of the bed and agitate the bed so that agglomeration within the bed due to compaction pressures is minimized. The smooth tumbling action obtained with the rakes also eliminates the undesirable size classification within the bed and the growth of oversized agglomerates so that large sized rotary retorts can be used in a continuous process.

Accordingly, the principal object of this invention is to provide a process for forming agglomerates of preselected size from carbonaceous material in a large sized rotating retort that has a bed depth of carbonaceous material therein exceeding a predetermined absolute bed depth.

Another object of this invention is to provide a process for preventing the formation of oversized agglomerates of carbonaceous material in a large sized rotating retort that has a bed depth of carbonaceous material exceeding a predetermined absolute bed depth.

Another object of this invention is to provide a process for increasing the production of carbonaceous agglomerates from discrete carbonaceous material in a large size rotary retort.

These and other objects and advantages of this invention will be more completely disclosed and described in the following specification, the accompanying drawings and the appended claims.

In the drawings:

FIGURE 1 is a view in side elevation partially in section illustrating the improved rotary retort of this invention and the process for making carbonaceous agglomerates of a preselected size.

FIGURE 2 is a view in section taken along the line 2—2 in FIGURE 1 illustrating the arrangement of the tines and the manner in which the tines pass through the bed of carbonaceous material and illustrating the absolute depth of the bed of carbonaceous material.

FIGURE 3 is a fragmentary view of the rotary retort in section and in side elevation illustrating the agglomerates rolling down the top surface of the bed and the tines being lifted from the bed.

Referring to the drawings and particularly to FIGURE 1, there is illustrated a rotary retort or kiln generally designated by the numeral **10** that is generally cylindrical in shape and rotatably supported in an inclined plane relative to the floor **12**. The external wall of the retort **10** has a pair of annular bearing rings **14** and **16** secured thereto for rotatably supporting the retort **10** on bearings **18** and **20** that are journaled in fixed supports **22** and **24**. An annular gear **26** encircles the retort **10** and is secured thereto for rotation therewith. A motor **28** has a gear **30** meshing with the annular gear **26** and is arranged through gear **26** to rotate the retort **10** at a preselected speed in a preselected direction. For example, as viewed in FIGURE 2, the motor **28** rotates the retort **10** through gears **30** and **26** in a clockwise direction.

The retort **10** has an internal cylindrical surface or wall **32**, an inlet portion **34**, and an outlet portion **36**. The inlet portion **34** has an aperture **38** through which inlet conduits **40**, **42** and **44** extend into the inner portion of retort **10**. A suitable seal, diagrammatically illustrated at **46**, extends around the conduits **40**, **42** and **44** and provides a seal for the inlet opening **38** to effectively seal the inner portion of retort **10** from the surrounding atmosphere. Coal, char and pitch are supplied respectively through conduits **40**, **42** and **44** to the inner portion of retort **10**. Suitable check means are provided in the conduits **40**, **42** and **44** to effectively seal the conduits from the surrounding atmosphere to maintain a nonoxidizing atmosphere in the retort **10**. It should be understood that the manner of introducing the carbonaceous constituents to the rotary retort **10** is illustrated semidiagrammatically in FIGURE 1 and other suitable means may be provided without departing from the scope of the invention herein described. It is desirable, however, to agglomerate the carbonaceous material in the rotary retort under nonoxidative conditions so that suitable seal means should be provided at the inlet portion of the rotary retort and for the respective conduits that supply the carbonaceous constituents to the retort **10**.

The rotary retort discharge end portion **36** has a shroud or housing **50** therearound which also effectively seals the inner portion of the retort **10** from the surrounding atmosphere. Positioned on the upper portion of the shroud **50** is a blower **52** or other suitable aspirating means that conducts the volatile carbonaceous gases given off during the agglomeration of the carbonaceous material in the retort **10** to suitable tar condensation apparatus where the tar may be separated from the more

volatile constituents. The blower **52** may also be positioned after the tar condenser to minimize the fouling of the blower by the condensation of tar thereon. The tar is distilled to provide pitch which is then recycled to the rotary retort **10** through conduit **44**. The housing **50** has a gate **54** adjacent its lower portion which permits the agglomerates discharged from the retort **10** through outlet **36** to flow into a receiver generally designated by the numeral **56** for further processing.

In FIGURE 2 the diameter of the retort **10** is indicated by the line designated by the letter D. The absolute bed depth of the carbonaceous material in the retort **10** is measured radially along the diameter of the kiln at the deepest point in the bed. The absolute bed depth is measured from the surface of the bed to the wall of the retort. In FIGURE 2, the absolute bed depth of the bed of carbonaceous material is indicated by the distance between the top surface of the bed to the wall of the retort and indicated dimensionally by the line A.

Within the retort **10** there are a plurality of longitudinally extending rakes generally designated by the numeral **58**. The rakes each include a longitudinally extending strap or support member **60** that is suitably secured to the retort inner wall **32** as by welding or the like. The support members **60** are rectangular in cross section and preferably have a narrow edge portion secured to the retort inner wall and extend radially inwardly therefrom, as is illustrated in FIGURES 2 and 3. Extending radially inwardly from the retort wall **32** and secured to the retort wall **32** and the respective support member **60** are a plurality of tines **62**. The tines have a rectangular shape in cross section and are welded or otherwise secured to both the support members **60** and to the retort inner walls **32**. The tines **62** have a length preferably between one-fourth and one-third the inner diameter of the retort **10**. Tines of a length of between 15" and 20" have been found suitable in a retort having an internal diameter of about 60". The tines **62** may be spaced from each other a distance substantially equal to the desired size of the agglomerates. For example, where it is desired to obtain an agglomerate of a size between ¾" x 2" the tines are spaced on 3" centers where the tines are formed from ⅜" x 1½" stock. Thus the clearance between adjacent tines is 2⅝". The tine spacing can be increased, however, with only a slight increase in the range of sizes of the agglomerates. Tine spacing of up to 4⅝" has been used and suitably sized agglomerates were obtained. In the embodiment illustrated, the rakes **58** are equidistantly spaced along the retort inner wall **32** and have an annular relationship therebetween of approximately 45°. In the embodiment illustrated, the rakes extend lengthwise from a position substantially adjacent the retort inlet portion **34** to the retort outlet portion **36**. It should be understood, however, depending upon the relative intermixing of the carbonaceous materials as they are introduced into the retort at the inlet end **34**, the rakes **58** may begin at a position spaced from the inlet portion **34**. Where the agglomeration of the carbonaceous material is substantially complete at a location spaced from the retort outlet portion **36**, the rakes **58** may not extend all the way to the retort outlet portion **36** and may terminate at a location spaced inwardly therefrom. The tines **62** on each of the rakes **58** extend radially inwardly toward the center of the retort **10** and are aligned in the same transverse radial planes. The bed of carbonaceous material is generally designated by the numeral **64** and has an inclined top surface **66**. The agglomerates rolling down the top surface **66** are indicated generally at **68** in FIGURE 2. FIGURE 3 illustrates the agglomerates rolling or snowballing down the top surface **66**, as previously described and discussed. FIGURES 2 and 3 illustrate how the tines **62** move through the bed of carbonaceous material **64** and relieve the compaction pressures exerted by the depth of the bed of carbonaceous material.

The agglomerates are formed in the rotary retort **10** by feeding finely divided coal particles and finely divided particles of char with a preselected amount of pitch as a binder through the conduits **40**, **42** and **44** to the inner portion of retort **10**. The char is heated to a temperature of approximately 1000° F. to supply the heat for the agglomeration of the fine coal particles and the fine char particles. A bed height or absolute depth of 15" in a 60" diameter retort is maintained and the retort is rotated at a preselected velocity. The rotation of the retort **10** by the motor **28** admixes the preheated char, the finely divided coal particles and pitch until agglomerates are formed from the constituents. For use as metallurgical coke it is desirable that the product be no greater than 3" in size and preferably between ¾" and 2" in size. The narrowest possible range of sizes is preferred but a size range between ¾" x 2" size is satisfactory. Agglomerates having a size smaller than ¾" are recycled to the feed end of the rotary retort **10** with or without preheating to be again admixed with additional coal and char. It is, however, highly desirable to have a maximum percent of the agglomerate product of a size between ¾" x 2".

EXAMPLE

To illustrate the unobvious improvements in the process by the apparatus previously described, six separate runs were performed in a 5' diameter rotary retort under substantially the same operating conditions and with substantially the same constituents. Runs #1, #2 and #3 were made in a rotary retort that did not include the rakes described in this invention. Runs #4, #5 and #6 included the rakes. In runs #4 and #5 the tines were spaced 4⅞" from each other. In run #6 the tines were spaced 2⅝" from each other.

Runs #1 and #2 show the effect of absolute bed depth under substantially the same operating conditions without rakes. Runs #3 and #5 illustrate the effect of rakes at the same peripheral speed of the rotary kiln. Runs #5 and #6 illustrate the effect of tine spacing on size consist control. Runs #2 and #4 illustrate another comparison of the effect of the rakes with relatively wide tine spacing under equivalent forming conditions.

Runs #4, #5 and #6 clearly illustrate how the rakes increase the weight percent of the product agglomerates that have a size between ¾" x 2" and eliminate the formation of agglomerates having a size greater than 3" in a bed having an absolute depth of 15". The other properties of the agglomerates were not adversely affected by the rakes.

In all of the runs a retort having a diameter of 60" was used to agglomerate an admixture of caking coal and char. Substantially equal amounts of finely divided char having a size of 8 mesh x 0 and finely divided coal having a size of 14 mesh x 0 were supplied to the rotary retort **10**. The char was preheated to a temperature of approximately 1,000° F. to supply the heat for agglomeration. In run #1 a bed height or absolute depth of 7.2" was maintained and the retort was rotated at a peripheral velocity of 190 ft./min. for a period of 40 minutes. After this period a total of 52.6 percent of the product had a size greater than ¾" and 41.3 percent of the product had the desired size of between ¾" x 2".

Run #2 was performed under substantially the same conditions and the bed height or absolute depth was increased to 15" as compared with 7.2" in run #1. The kiln was rotated at a peripheral velocity of 160 ft./min. for substantially the same period of time as run #1. The product of run #2 included 79.1 percent having a size greater than ¾". Note, however, 20.6 percent by weight of the product had a size greater than 4". The desired size consist of ¾" x 2" product was 37.8 percent. Thus the percentage of the desired size product in run #2 was less than the percentage of desired product in run #1, which clearly illustrates that an increase in the bed depth reduces the quantity of desired product obtained in the agglomeration process.

A third run, identified as run #3 in the table, was performed and substantially the same feed constituents were introduced into the same sized rotating retort that did not have the rakes installed therein. A bed height or absolute depth of 15" was maintained and the retort was rotated at a peripheral velocity of 283 ft./min. for a period of 40 minutes as compared with the 190 and 160 ft./min. of runs #1 and #2. 72.6 percent of the agglomerate product had a size greater than ¾"; of this quantity, however, 12.8 percent by weight of the product had a size greater than 4". 24.8 percent of the product in run #3 had the desired size of ¾" x 2" which was less than the amount obtained in runs #1 and #2. It is evident that without the rakes it was possible to obtain only 38 weight percent of the product in the desired size range having a size between ¾" x 2".

For runs #4, #5, and #6, eight rakes similar to the rakes designated by the numeral **58** were installed in the retort used in runs #1 and #2. The tines **62** were formed from bar stock ⅜" x 1½" and had a length of approximately 21". The rakes **58** extended throughout the length of the retort **10** and the tines were arranged on transverse radial planes. For runs #4 and #5 the tines had a clearance of 4⅞" therebetween. For run #6 the tines were arranged on 3" centers so that there was a 2⅝" clearance between adjacent tines. Substantially the same material was introduced into the retort **10** at substantially the same temperature for runs #4, #5 and #6. A bed height or absolute depth of 15" was maintained in the retort. In runs #5 and #6 the retort was rotated at a peripheral velocity of 283 ft./min. and a run #4 at a peripheral velocity of 160 ft./min. The material was tumbled for approximately 30 minutes. The yield of the desired sized product was increased substantially in runs #4, #5 and #6 with the rakes installed. The rakes improved the yield of desired sized product in a deep bed, i.e., 15" even when compared with the shallow bed of run #1. The rakes eliminated in the deep bed the growth of agglomerates to less than 4". Run #6 had 81.2 weight percent of the product with a size greater than ¾" and 78 weight percent of the product with a size between ¾" x 2". Run #6 clearly illustrates the improved production of the desired size agglomerates by the use of a rotating retort having the radially inwardly extending rakes previously described. Runs #4 and #5 also illustrate the improved size consist of the product obtainable by using rakes.

Set forth below in Table I are the tabulated results of runs #1, #2, #3, #4, #5 and #6. The product size is expressed in weight percent and the various sized fractions are set forth. The cumulative weight percent of the product having a size greater than ¾" is further tabulated. The median product size and the bulk density of the agglomerates is also set forth.

TABLE I

Run Number	1	2	3	4	5	6
Wt. Percent Coal	52.8	52.0	51.9	54.0	54.0	54.0
Bed Ht. (inches)	7.2	15.0	15.0	15.0	15.0	15.0
Ft. per min. Retort Peripheral Speed	190.0	160.0	283.0	160.0	283.0	283.0
Tumbling Time (min.)	40.0	40.0	40.0	30.0	30.0	30.0
Avg. Forming Temp., ° F	780.0	785.0	783.0	785.0	775.0	779.0
Tine Spacing (inches)	No rakes	----------	----------	4⅞	4⅞	2⅝
Product Size, Wt. Percent:						
+4"	0.0	20.6	12.8	0.0	0.0	0.0
3 x 4"	0.3	20.6	12.1	1.6	0.3	0.0
2 x 3"	11.0	20.7	22.9	14.4	15.0	3.0
1½ x 2"	13.5	14.9	11.1	21.2	26.3	16.0
1 x 1½"	17.9	15.2	9.7	27.8	34.6	41.2
¾ x 1"	9.9	7.7	4.0	12.2	13.2	21.0
½ x ¾"	11.3	7.7	3.3	10.7	7.9	13.9
−½"	36.1	13.2	24.1	12.1	2.7	4.9
Total+¾	52.6	79.1	72.6	77.2	89.4	81.2
¾ x 4"	52.6	----------	59.8	77.2	89.4	81.2
¾ x 3"	52.3	58.5	47.7	75.6	89.1	81.2
¾ x 2"	41.3	37.8	24.8	61.2	74.1	78.2
Median Size (inches)	0.82	1.73	1.87	1.27	1.39	1.11
Bulk Density +¾" Agglm. lbs. Per Cubic Foot	29.2	31.6	32.3	31.7	32.7	32.5

According to the provisions of the patent statutes the principle, preferred construction and mode of operation of the invention have been explained and what is considered to represent its best embodiment has been illustrated and described. However, it should be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A method of agglomerating finely divided carbonaceous material at an elevated temperature and forming a substantial quantity of agglomerates having a preselected spectrum of sizes consisting of:

feeding finely divided carbonaceous material at an elevated temperature into an inclined rotary retort having wall mounted tines, said wall mounted tines being symmetrically spaced and extending radially inwardly from said retort wall, and

rotating said retort at a preselected speed to thoroughly mix said finely divided carbonaceous material and a carbonaceous liquid binder and form agglomerates therefrom,

said tines each having an adjacent spacing of between about 5 and 2 inches to control the size of said formed agglomerates so that a major portion of said agglomerates have a size spectrum of between ¾ of an inch and 2 inches.

2. A method for agglomerating finely divided carbonaceous material as set forth in claim 1 in which:

the diameter of said rotary retort is more than 48 inches, and

the radial depth of the bed of finely divided carbonaceous material measured from the surface of the bed to the retort wall is more than 7 inches.

3. A method for agglomerating finely divided carbonaceous material as set forth in claim 1 in which:

said wall mounted tines each having an adjacent spacing of about 3 inches to control the size of said formed agglomerates so that a major portion of said agglomerates have a size spectrum between ¾ of an inch and 2 inches.

4. A method for agglomerating finely divided carbonaceous material at an elevated temperature and forming agglomerates therefrom, a major portion of which have a spectrum of sizes between ¾ of an inch and 2 inches consisting of:

feeding finely divided coal particles into an inclined rotary retort having wall mounted rakes, said wall mounted rakes each having a plurality of wall mounted symmetrically spaced tines thereon extending radially inwardly from said retort wall,

feeding particles of a carbonaceous non-caking residue of coal at an elevated temperature into said inclined rotary retort,

forming a bed of said particulate materials in said retort,

supplying a liquid binder to said bed of particulate carbonaceous materials in said retort, and

rotating said retort at a preselected speed to thoroughly mix said carbonaceous material and said liquid binder and form agglomerates therefrom,

said tines each having an adjacent spacing of about 3 inches to control the size of said formed agglomerates so that a major portion of said agglomerates have a size spectrum between ¾ of an inch and 2 inches.

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