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COMMUNUTED COAL FINES AND METHOD OF COMMUNUTING AGGLOMERATED COAL FINES

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This invention relates to the processing of agglomerated coal fines and, more particularly, to the treatment of agglomerated coal fines with spent sulfite liquor.

Silt is the final product resulting from the processing of coal, for example, anthracite silt comes from the preparation of run-of-mine anthracite. This run-of-mine coal is processed through a coal breaker in which it passes over a bull shaker. The bull shaker segregates the larger lumps of coal and sends them through crushing operations to a reduction in size. The crushed coal, together with the segregated run-of-mine coal, are then fed to a set of shaker screens which classify the lumps of coal according to size in the well known sizes of egg, stove, nut, pea, buckwheat, rice and barley. This screening produces buckwheat #4 which will pass through a screen having mesh openings of $\frac{3}{8}$ of an inch and will pass over a screen having mesh openings of $\frac{1}{4}$ of an inch. Further screening of the material that passes through mesh openings of $\frac{3}{8}$ of an inch produces buckwheat #5 which are pieces of coal that pass through a screen having openings of $\frac{3}{8}$ of an inch and over a screen having openings of $\frac{1}{2}$ of an inch. The remaining coal is known as anthracite silt. The anthracite silt contains particles in the following range of sizes:

- +20-mesh particles which pass over a 20-mesh screen
- +40-mesh particles which pass over a 40-mesh screen
- +80-mesh particles which pass over an 80-mesh screen
- +100-mesh particles which pass over a 100-mesh screen
- +150-mesh particles which pass over a 150-mesh screen
- +200-mesh particles which pass over a 200-mesh screen
- 200-mesh particles which pass through a 200-mesh screen

The anthracite silt is discarded from the classification procedures and piled up in the form of huge banks or dumped into abandoned stripping pits. In addition to the general accumulation of the various particle sizes of the silt during the normal classification process, a concentration of the -200-mesh silt occurs mostly at the end of a period of breaker operation, such as after a shift or a day's run. The -200-mesh particles are so fine in body that a normal breaker operation will tend to accumulate them in various settling tanks and traps provided for that purpose. At the end of the period of operation, this accumulation is removed by flushing the surfaces with a sluice of water through the breaker equipment. This sluice of water carries the -200-mesh particles into the culm bank in which the silt is accumulated. The fine coal of the -200-mesh particles is deposited in a layer, as a result of this flushing of the material. This layer of almost exclusively -200-mesh particles and the water which it retains at the end of the flushing reaction, is referred to as liver. The silt bank on which the silt is accumulated thus contains a range of co-particle sizes with interspersed concentrations of -200-mesh particles in layers. These layers of the concentrated -200-mesh particles contain a tenacious adhesiveness and stubbornly resist comminution. The variety of particle sizes in the

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silt is a product of factors in the operation of the classification, such as the stage of the operation during which the silt is deposited.

As indicated by the description of the deposition of the liver layers in the silt, the coal dust from the classification operation is carried to the silt bank by a liquid medium, such as water. This liquid medium carries the silt particles by floatation and most of the liquid drains off the silt bank leaving the coal particles as a deposition.

Some of the moisture of the floatation medium is retained in the silt bank after deposition. This retained moisture and other factors cause the coal fines of the silt to become agglomerated into a mass of material which does not exhibit the properties of free flowing comminuted particles. The -200-mesh particles are agglomerated by adhesion so badly after collection in a silt bank that the coal cannot be processed. It will not dump out of cars, it forms a solid coating over the mesh of shaker screens and it coats or packs in bins and in feed pipes. The +200-mesh particles and larger particles also exhibit these properties to some degree. The -200-mesh particles form a substance which is impossible to handle by ordinary means even when mixed with coal fines of a larger particle size. Accordingly, quantities of fines and particularly coal fines having particles of -200-mesh cannot be processed for combustion economically.

It is an object of this invention to provide comminuted coal fines of a particle size which will substantially pass a 200-mesh screen.

It is another object of this invention to provide comminuted coal fines from agglomerated silt which will handle in ordinary coal fines handling apparatus.

It is still another object of this invention to provide coal fines from agglomerated coal fines of a silt bank which will pass a screen of 200-mesh.

Another object of this invention is to provide a method of decreasing adhesiveness in agglomerated fine particles of coal.

A still further object of this invention is to provide a means and method for decreasing adhesiveness in agglomerated particles which have had an original size of passing through a $\frac{1}{32}$ -mesh screen.

It is still another object of this invention to provide a means and method for providing comminutable coal fines from agglomerated coal silt containing a substantial proportion of water, such as up to 30% water.

These and other objects of this invention will become more apparent upon consideration of the following description.

In general, this invention provides treating agglomerated fines of a size that will pass a $\frac{1}{32}$ of an inch screen aperture and produce a comminutable product from said agglomerated fine coal silt which can be handled in normal coal silt handling equipment. The comminutibility is effected at least in part by a decrease of the adhesiveness of the -200-mesh particles. This comminution is achieved by mixing the agglomerated coal silt with a small percentage of spent sulfite.

Spent sulfite is a compound which is made up principally of calcium lignosulfonate. It also may contain sodium lignosulfonate in a substantial proportion, together with certain sugar degradation products. Stated otherwise, it may be considered for the purpose of this description that spent sulfite in general refers to the complex mixture of the salts of low molecular weight of lignosulfonic acids and the alkaline hydrolysis products of pentoses and hexoses which are extracted from coniferous woods in the sulfite pulping process. The spent sulfite liquor also contains tannin and ash in appreciable percentages.

The Journal of Technical Association of the Pulp and Paper Industry, at page 555, indicates that calcium

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lignorsulphonates comprise some 60% of spent sulfite solids, while the sugar products make up about 20% of the total spent sulfite solids. Also included in the spent sulfite may be calcium and magnesium oxides, sulfite as SO_4 and other substances which make up the remainder of the spent sulfite solids. The spent sulfite liquor is a solution of the spent sulfite solids in water. The liquor is about half water by weight. The specific spent sulfite compounds referred to herein are defined as to composition in greater detail below.

The spent sulfite liquor contains 2-4% free SO_2 , 2-7% SO_3^- , 2-5% SO_4^- , 80-90% solids and 12-16% ash with calcium compounds, carbohydrates and lignone sulfonate. Spent sulfite is commercially available in liquid and powdered form in the products of several companies. The following Table I sets forth the products available as identified by their trademark names and associated with the supplying companies.

TABLE I

Company	Name liquid sugar retained	Name solid sugar retained	Name liquid desugared	Name solid desugared	Lbs. per gallon
International Paper Company.....	Bindarene.....	Bindarene Flour (Marasperse C. Marasperse N. Maracarb NC. Marabond.....)			10.04
Marathon Corp.....	Norlig.....				10.08
Lake States Yeast Corp.....			Toranil A.....	Toranil B.....	10.05
Robeson Process Co.....	Glutrin.....				10.08
American Gum Products Company.....		Goulac.....			

All of these compounds contain the waste spent sulfite.

The following are the analyses of the chemical compositions and characteristics of the spent sulfite compounds, set forth in Table I, as identified by the trademark names listed therein:

Characteristics of bindarene liquid

Brown viscous liquid
Completely miscible in water
50% water solution
Specific gravity 1.26 (30° Baumé)
pH 5.5
Viscosity, 175 centipoises 20° C. (60 R. P. M. Brookfield)
Boiling point, 212° F.
Freezing point, 17° F.
Heat value, 3900 B. t. u.'s
Sugar content, 20% of solids
Calcium lignosulfonate, 70% of solids
Inorganic material, 10% of solids

Typical chemical analysis of bindarene liquid

Solids basis:	Average, percent
Volatile acids	3.9
Total sulfur	4.1
Free sulfur dioxide	0.2
Sulfur trioxide	0.8
Sulfone SO_2	6.6
Calcium oxide	4.3
Iron	0.02
Magnesium oxide	1.9
Sodium oxide	0.3

Characteristics of bindarene flour

Light yellow powder
Particle size, 95% thru 100 mesh screen
Completely soluble in water
Moisture content, 5%
pH 5.5
Organic material, 90%
Inorganic material, 10%
Sugars 20% (mannose, glucose, xylose, etc.)
Calcium lignosulfonate, 70%
Heat value, 7800 B. t. u.'s

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Typical chemical analysis of bindarene flour

Solids basis:	Average, percent
Volatile acids	3.9
Total sulfur	4.1
Free sulfur dioxide	0.2
Sulfur trioxide	0.9
Sulfone SO_2	5.5
Calcium oxide	4.9
Iron	0.02
Magnesium oxide	1.5
Sodium oxide	0.3

Characteristics of Toranil A

15 Coffee colored viscous liquid
Specific gravity (60° F./60° F.), 1.24
Baumé, 28.5°

Viscosity (cps.):

70° C.—45
50° C.—130
30° C.—420
pH (50% water solution), 4.5 to 4.6
Boiling range, 107° C. to 108° C.
Freezing range, -4° C. to -6° C.
40 Surface tension (dynes/cm.) (10% water solution), 48

Characteristics of Toranil B

Free flowing light tan powder
Apparent bulking value¹ (#/ft.³):
Loose 25-29
Tamped 35-39
Equilibrium moisture² 7.7
pH (50% water solution) 4.6 to 4.7
Surface tension (dynes/cm.) (10% water solution) .. 48
50 Charring temp.:
In air (30 min.) °C. 475
(Approx. 1 min.) °C. 600
In nitrogen (30 min.) °C. 500
(Approx. 1 min.) °C. 630

¹ Modification of ASTM C29-42.

² Percent increase in weight when oven dry material is exposed at 70° F. and 50% R. H.

Typical chemical analysis of Toranil dry solids non-summativ

	Percent
Calcium lignosulfonate.....	96.0
Total carbohydrates.....	4.0
65 Reducing sugars (as glucose).....	1.2
Methoxyl	8.8
Tannin	49.4
Ash	17.3
Calcium and magnesium as oxide.....	7.50
70 Sulfate (as SO_4).....	8.70
Silica (as SiO_2).....	0.60
Iron and aluminum:	
As oxide.....	0.27
As phosphate.....	0.03
75 Insolubles	0.17

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Typical chemical analysis of Goulac

Water	percent	1.29
Ash	do	11.89
Iron	do	.022
Calcium oxide	do	4.59
Magnesium oxide	do	2.75
Solids	do	98.71
pH		6.73

Typical chemical analysis of Glutrin

[Baumé 31.00 @ 60°.]

Water	percent	48.75
Ash	do	5.82
Iron	do	.011
Calcium oxide	do	2.52
Magnesium oxide	do	1.35
Solids	do	51.25
pH		6.90

Typical chemical analysis of Marabond

	Percent
CaSO ₄ ·½H ₂ O	0.68
CaSO ₃ ·H ₂ O	2.63
Fe ₂ O ₃	0.05
Al ₂ O ₃	0.16
SiO ₂	0.28
Sulfonic SO ₃	10.25
Sulfonic Ca	2.56
CaCO ₃	2.41
CaO over	7.58
MgO	0.26
Inorganics	26.86
Organics	73.14
Calcium lignosulfonate	77.98

Typical chemical analysis of Marasperse C

Moisture	7.00% maximum.
pH—3% solution	6.7–7.3.
Total sulfur (as S)	4.97% on moisture free basis.
Sulfate sulfur (as S)	0.25% on moisture free basis.
Sulfite sulfur (as S)	None.
CaO	3.83% on moisture free basis.
MgO	0.39% on moisture free basis.
Na ₂ O ₃	3.50% on moisture free basis.
Fe ₂ O ₃	0.17% on moisture free basis.
Reducing sugars	None.
OCH ₃	9.74% on moisture free basis.

Composition (on moisture free basis)

Calcium lignosulfonate, percent:	
Lignin	67.4
SO ₃	11.8
Ca, Na, Mg	2.8
	82.0
Organics, nonligneous, percent	14.2
Inorganics, percent:	
CaSO ₄ ·½H ₂ O	1.13
Fe	0.11
Na over sulfonic	2.60
	3.8
	100.0

Typical chemical analysis of Marasperse N

Moisture	6.00% maximum.
pH—3% solution	7.0–7.5.
Total sulfur (as S)	6.10% on moisture free basis.
Sulfate sulfur (as S)	1.62% on moisture free basis.
Sulfite sulfur (as S)	0.03% on moisture free basis.
CaO	0.50% on moisture free basis.
MgO	0.46% on moisture free basis.
Na ₂ O	9.32% on moisture free basis.

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Fe ₂ O ₃	0.06% on moisture free basis.
Reducing sugars	None.
OCH ₃	9.25% on moisture free basis.

Composition (on moisture free basis)

	Percent
Na lignosulfonate	78.12
Nonreducing carbohydrates	11.55
Organic combined Na not as sulfonic	3.11
CaSO ₄ ·½H ₂ O	1.28
MgSO ₄ ·H ₂ O	1.58
Na ₂ SO ₄	4.26
R ₂ O ₃	.10
	100.00

15 All of the products set forth in the above Table I may be employed in the process of this invention and produce the comminutable fines product in varying degrees of comminution or free flowing properties. Spent sulfite liquor obtained from the pulping of wood contains sulphur oxides, calcium compounds and carbohydrates, as indicated above. Some of the spent sulfite compounds have been desugared to reduce the percentage of sugars in the spent sulfite liquor. Toranil A and Toranil B, set forth in Table I, are desugared compounds having a low carbohydrate content. The spent sulfite liquor is made up of about 51% solids and 49% water. As indicated in Table I, the spent sulfite liquor is also available in powdered solid form, with or without its sugar content. An analysis of the lignon complex groups of some spent sulfite liquors is indicated by the following chemical composition:

Carbon	percent	50.22 to 56.27
Hydrogen	do	5.22 to 5.87
Sulfur	do	5.52 to 8.80

40 This invention provides for a processing of silt which changes the silt from a tenaciously adhering agglomeration of the particles into a material which is either in comminuted form, or is comminutable having decreased adhesiveness. The original agglomerated silt is in a physical condition which prevents it from passing through normal classifying shaker or vibrator screens. It also is a material which will cling to the walls and surfaces of a retaining receptacle and resist or defy removal. Such properties of silt render it prohibitively difficult to handle. According to this invention, these properties of the agglomerated silt may be counteracted by a mixing of spent sulfite in the agglomerated material. This mixing or other incorporation of the spent sulfite in the agglomerated material removes the objectionable properties and allows the silt to become a substance which can be processed for further use, such as combustion.

45 It has been found that the amount of spent sulfite compound, which must be mixed or otherwise incorporated with the agglomerated silt, is related to the percentage of moisture in the silt. The percentage of spent sulfite is also dependent upon the average fineness of the silt and the procedure used in the separation of the silt from the other coal.

50 The flotation process of separating the coal particles may use instead of water such liquids as fuel oil, pine oil, alcohol or kerosene in separating sizes below buckwheat #4 and #5. The use of such flotation media influences the amount of spent sulfite necessary to bring about a comminution of the silt resulting from said previous separation by flotation. Similarly, the average fineness of the particles in the silt is determinative of the amount of spent sulfite necessary in bringing about satisfactory comminutibility in that as a rule the finer the particles in the silt, the greater the amount of spent sulfite necessary to produce comminutibility.

55 The liquid content of the silt material is closely correlated to the relative amount of spent sulfite needed. It has been determined, when the comminuting material

is made up of -200-mesh particles in agglomerated condition, that spent sulfite liquor in a range of from .02% to 20% of the water content of the silt will produce the comminuting effect of this invention. A silt containing a substantial proportion of -200-mesh particles and not less than 10% by weight of water when treated with from .002% to 2% of spent sulfite liquor will lose its property of clinging to surfaces of coal handling equipment.

This process may be used for treating silt containing up to 30% by weight of water. With 30% by weight of water, the percent of spent sulfite liquor ranges from .006% to 6% by weight of the silt treated. The silt containing these percentages of water, when treated with the respective percentages of spent sulfite liquor will result in a product which forms easily breakable lumps and has lost the objectionable adhesiveness, so as to not stick to metal surfaces. Larger percentages of the spent sulfite liquor will result in a product which is sloppy and which contains an excess of moisture. The product will not be comminuted particles, having a relatively dry nature, but will be more in the nature of a liquid slurry of coal particles.

The comminution of the silt, by mixture with these percentages of spent sulfite liquor permits the treated silt to move as coal fines through chutes and screens of handling apparatus without objectionable hold-up or coating or adhesion of the coal fines in the apparatus. The following examples are illustrative of the processing of silt with the spent sulfite and are not limitative.

EXAMPLE I

Coal fines or silt, containing 15% by weight of water, are mixed with 3% by weight of bindarene liquid at room temperature. The mixing takes place in a cement mixer hopper in which the mixture is tossed on itself by a rotary motion of the hopper. The mixing formed a number of small balls but did not form a heavy rubbery mass.

A mixture of an equivalent amount of bindarene liquid in silt, containing 30% by weight of water, formed a soggy mass which would not stick to metal and could be broken up by mechanical action. This example indicates that 3% by weight of spent sulfite liquor produces a satisfactory comminution of agglomerated coal dust containing 30% by weight of water.

EXAMPLE II

Two and one-half percent bindarene flour is mixed with silt containing 15% by weight of water to form small soft balls which break up readily under mechanical action. To this was added another 15% of water, bringing the silt to a water content of 30%. This produced, by a tumbling action, small, irregular chunks of material which are not gummy and which remain dry so as not to stick to metal. The products of this example are good for handling in ordinary silt handling apparatus and are satisfactory for the purposes of the product of this invention.

EXAMPLE III

Toranil B is mixed in a quantity of 2½% by weight of silt containing 15% by weight of water to form a very soft product by tumble mixing. The product contains a few balls and is dryer in its physical properties than the product of Example II with a 15% by weight of water silt. 15% of water with no Toranil B was added to the mixture thus bringing it up to 30% by weight of water by tumble mixing action. The mixing forms a dry mass of coal fines with small easily breakable lumps of coal fines.

The products of this example are highly satisfactory, both with the 15% and 30% by weight of water samples of silt.

EXAMPLE IV

Two and one-half percent of Marabond spent sulfite is

mixed with silt containing 15% by weight of water in a tumble mixing action to form a fluffy product containing lumps which crush easily. This material has no binding properties at all and can be easily stirred indicating a highly comminuted physical state. Additional water was added without changing the Marabond percentage, bringing the silt up to 30% by weight of water to produce a product which does not form permanent chunks or balls. The resultant products of this example are highly satisfactory for the purposes of this invention.

EXAMPLE V

Marasperse N solid is mixed in a quantity of 2½% by weight with silt containing 15% by weight of water to form a product by tumble mixing of loose material of approximately the original particle size of the coal fines. The product contains very few small pieces of agglomerated coal fines. There is no formation of substantial pieces of material in the product. Additional water is added to bring the mixture up to 30% by weight but no Marasperse N is added. This produces a comminutable product by tumble mixing which is slightly more adhesive than treated coal fines with 15% by weight of water. The resultant product has a putty-like appearance. The products of this example may be handled in coal handling apparatus.

EXAMPLE VI

Two and one-half percent of Marasperse C is mixed with coal fines containing 15% by weight of water to form a powdered product containing a few scattered lumps of agglomerated material. This product is satisfactory for the purposes of this invention.

EXAMPLE VII

Two and one-half percent by weight of Maracarb NC is mixed with coal fines containing 15% by weight of water by a tumbling action to produce a dry product of comminuted coal particles containing little balls. The small balls are formed by the tumbling action of the mixing motion. The balls break up easily. To the above was added sufficient water to make a 30% mixture without adding Maracarb NC. This mixture formed a comminuted coal fines product having dry small balls which break up easily under mechanical action to form a completely comminuted product. The products of this example are satisfactorily dry and comminuted for handling in a coal handling apparatus.

EXAMPLE VIII

Two and one-half percent of Goulac is tumble mixed with coal fines containing 15% by weight of water to produce a comminuted coal fines product containing small lumps of rubber-like balls and some material which sticks to a metal container. Additional water is added to this mixture to bring it up to 30% by weight of water. It forms a dough-like material as a product which will stick slightly to a metal surface but can be broken into small lumps. The products of this example are relatively satisfactory for the purpose of this invention. It is to be noted that Goulac is a non-desugared spent sulfite compound.

EXAMPLE IX

Two and one-half percent of Toranil A liquid is mixed with coal fines containing 15% by weight of water to produce a very fluffy and light product which does not produce small balls even with tumble mixing and which will not stick to metal.

EXAMPLE X

Two and one-half percent by weight of Norlig is mixed with coal fines containing 15% by weight of water to form a comminuted non-sticky product after thorough stirring and mixing. Small lumps are formed but may be readily broken up. The coal fines particles of the coal silt in the above examples all have an original particle

size, the great majority of which will pass a 200-mesh screen.

The desugared spent sulfite produces a comminuted product which is less subject to hygroscopic action than the comminuted coal fines produced with non-desugared spent sulfite. This non-hygroscopic property of the comminuted coal sent through the pelletizer produces a fluffy product of the comminuted coal fines and is not subject to atmospheric moisture. The products made from Marabond, Marabond N and Marasperse C are less hygroscopic than the products made by treatment with Goulac and Marasperse NC.

In Examples I through X, the mixing of the spent sulfite in the silt material is accomplished by the rotating of the substances in a cement mixer. To some extent, this type of mixing produced balls of silt material which mixed with the spent sulfite mainly through a covering on the outside of the balls which did not penetrate. Accordingly, the mixing is not as efficient as can be obtained with other forms of mixing apparatus.

EXAMPLE XI

Fifty gallons of bindarene are mixed with 100 tons of agglomerated coal silt containing about 15% by weight of water and a substantial proportion of -200-mesh coal particles in cohesive layers. The substances are mixed in a mixer containing a series of paddles rotating on a horizontal axis within and counter to the action of a drum. The substances enter the drum below the tumbling mass and are thrown back on themselves. The resultant product contains comminutable lumps of coal fines.

EXAMPLE XII

Three hundred and thirty pounds of bindarene liquid is mixed with 10 tons of agglomerated silt containing about 15% by weight of water and containing -200-mesh particles of coal in cohesive layers. The substances were mixed in the apparatus described in Example XI to produce a comminutable coal fines product.

The following examples are presented as illustrating the efficiency and advantage provided this invention by processing the silt in a pelletizer and spraying the spent sulfite on the silt under pressure through a nozzle. It will be understood that these examples of the means of processing according to this invention are not limitative on its scope.

EXAMPLE XIII

One hundred pounds of coal silt containing a substantial proportion of -200-mesh coal particles and 25% moisture is tumbled in a pelletizer barrel for 2 minutes and 10 seconds. During the time of tumbling the silt in the pelletizer is sprayed with 5½ ounces of spent sulfite liquor in a period of 1 minute to provide 34% by weight of the silt and 1.3% by weight of the moisture. The product of this example is not satisfactory for normal handling.

The following Table II of examples shows the procedure of Example XIII repeated with varying quantities of spent sulfite liquor in varying periods of time. The rate of application of spent sulfite liquor is maintained at 5½ ounces per minute.

TABLE II

	Time of tumbling in pelletizer	Time of injecting Liquid	Percentage of Liquid	
			of Silt	of Moisture
Example XIV.....	2 min. 15 seconds.	1 min. 15 seconds.	.43	1.7
Example XV.....	2 min. 30 seconds.	1 min. 30 seconds.	.82	3.3
Example XVI.....	2 min. 30 seconds.	1 min. 15 seconds.	.43	1.7

A summary of the results is as follows:

Example XIV—Silt sticks to barrel of pelletizer, lumps smaller, mixture not perfect.

Example XV—Silt sticks to barrel less, mixture more satisfactory and uniform.

Example XVI—Silt sticks to barrel for the most part only slightly and has a loose formation.

A satisfactory comminutable product may be obtained by treating silt, including agglomerated layers of -200-mesh particles, with spent sulfite liquor in the proportion of 1 part by weight of spent sulfite liquor to 5 parts by weight of moisture in the silt. In other words, when using spent sulfite liquor, it has been found preferable to use the spent sulfite liquor proportions up to 20% by weight of the moisture in the silt. As little as .02% by weight of the spent sulfite liquor to the quantity of moisture in the silt has been found capable of providing the comminutable product of this invention from silt which includes agglomerated layers of -200-mesh particles.

The silt, deposited as refuse from coal screening in the classification of coal sizes, contains a substantial proportion of coal fines of -200-mesh particles together with 10% by weight of water. In many cases, such silt is made up of a major proportion of coal fines of -200-mesh containing 10% by weight of water. The processing of such silt, according to this invention, with spent sulfite produces a product which will not cling to coal apparatus surfaces. It has been found that the agglomeration of the -200-mesh particles with the 10% by weight of water can be destroyed by the use of spent sulfite, according to this invention.

As pointed out above, the specific amount of spent sulfite liquor or dry powder necessary to remove the agglomeration of the agglomerated silt varies according to the silt being treated. The factors entering into the quantity of spent sulfite necessary are indicated above. Accordingly, in the operation of this invention, the percent of spent sulfite incorporated in the silt, particularly in the agglomerated -200-mesh particles varies within the defined range, according to the presence of said above-mentioned factors.

The treated silt preferably does not contain a percentage of water that will make it soft in handling for shipment. If the silt contains excessive water, it becomes too sloppy to be used as a fuel and must be dehydrated. Accordingly, it is preferred that the treated silt contain not more than 15% water. However, this invention is applicable to treated silt containing up to 30% by weight of water. As the silt before treatment generally contains in the neighborhood of 15% by weight of water, the addition of up to 3% spent sulfite liquor does not seriously effect the consistency of the treated silt. Although larger amounts of water in this treated silt produce some of the above-noted undesirable properties, silt containing as much as 40% by weight of water provides a usable but less desirable product when treated according to this invention. Such silt, when treated with up to 3% by weight of spent sulfite liquor, forms larger chunks of material than is obtained in the processing of silt containing lesser amounts of water. As will be explained in greater detail below, this product is not one that is sought by this invention.

Water or moisture of the coal or silt as used herein refers to the moisture of the coal which is measured by the loss in weight obtained by drying the coal at a temperature between 104° and 110° C. under standard conditions.

It will be seen that if it is assumed the normal percentage of moisture in the untreated silt is approximately 15% by weight, that 3% by weight of the spent sulfite liquor provides the 5:1 ratio between silt moisture and the spent sulfite liquor, which is indicated as being a maximum preferred ratio. The critical limitation on the amount of spent sulfite is found to be in the minimum

amount. The spent sulfite liquor must be at least .02% by weight of the silt moisture.

The spent sulfite may be introduced for incorporation with the agglomerated silt in any manner which will produced the desired modification of the agglomerating and adhesive characteristics of the silt particles and produce a relatively dry type of substance. The spent sulfite may be fed to the untreated silt by batch feeding into a simple rotary mixer, as indicated in Examples I through X, above. It is preferable, however, that the spent sulfite liquor or solids be introduced for incorporation by some atomizing or finely sub-dividing means, such as a spray nozzle. It has been determined that spraying spent sulfite liquor on untreated silt produces desired results with smaller amounts of spent sulfite material. Similarly, it has been determined that mechanically turning and breaking up the untreated silt material, prior to and during the incorporation of the spent sulfite material, provides superior results with lesser amounts of the spent sulfite compounds. It thus will be seen that the manner of incorporation of the spent sulfite compounds in the agglomerated silt acts as a factor in determining the amount of material necessary to achieve a satisfactory comminution of the agglomerated material.

It is a feature of this invention that by spraying the spent sulfite material onto the agglomerated silt material provides a means for adjusting the ratio between the materials. This ratio can then be adjusted to the requirements, as indicated by the moisture content of the agglomerated silt. Thus, by check testing the moisture of the agglomerated silt, the spray nozzle capacity may be adjusted to provide an economic but adequate quantity of spent sulfite material.

As indicated by the above description, the use of the term agglomeration is employed herein to describe the massing of the coal silt and particularly the -200-mesh particles, which massing or agglomeration is caused by the adhesion between the silt particles. This adhesion can be considered to cause a more or less unified body or substance in which the particles are cohering objects. Comminution is used to describe the action of the process in decreasing the adhesiveness between the particles. Thus, the particles after they have been treated are decreased in adhesiveness and are comminutable or may be comminuted. The first product of the invention is to form the formerly cohesive particles, which make up the agglomerated silt, into balls, slivers, flakes or flocs of coal in which the particles have a decreased adhesiveness and are, therefore, comminutable. These balls, slivers, flakes or flocs form a dry mass of loose material. They are easily breakable lumps and when broken, readily form small particles and can be reduced to the original particle size. Thus, the balls, slivers, flakes or flocs made from -200-mesh silt, such as liver, can be processed to form particles of -200-mesh. Such comminution is the full treatment of the process of this invention and produces the ultimate product. It will be understood, however, that this invention is not limited to this complete treatment and that it involves the incomplete treatment of the preparation of the first product as well.

As described above, the agglomerated silt, which is treated according to this invention, clings to metal surfaces so as not to be subject to the gravitational pull of its own weight. The balls, slivers, flakes or flocs will not cling to surfaces and will slide across a metal surface under a gravitational pull.

Various modifications of this invention are possible within its broad concept. First, it has been stated above that this invention applies to the processing of anthracite silt. The invention can also be applied to the processing of bituminous silt, for example, it can be used with buck dust which is otherwise valueless for burning purposes.

As described in the examples herein, the spent sulfite material is described as incorporated in silt containing aqueous moisture. This invention is equally applicable to the treatment of agglomerated silt containing other compositions of moisture. Also, two means for mechanically stirring or breaking up the agglomerated silt have been set forth. It will be understood that additional methods and apparatus may be employed to effectuate the process of this invention and to achieve the desired product. Such modifications may vary the amount of spent sulfite material required and its ratio to the silt moisture content. However, such variation from these modifications will not depart from the basic concept of this invention which relates to the treatment of agglomerated coal silt containing substantial quantities of -200-mesh particles and from which excess water has been drained off.

In the above description, reference has been made to spent sulfite compounds, as identified by trademark names and typical analyses of the spent sulfite compounds of these trade-marked compounds. It will be understood that other similar products may be employed in this invention.

As mentioned above, characteristics of the silt enter into the attainment of the desired comminution. These characteristics include the silt moisture content; the fineness of the silt particles, the source process from which the silt originates or the agent used in separating sizes below buckwheat #4 and #5. Another characteristic is the hardness of the anthracite from which the agglomerated silt is derived, which hardness is a product of the veins and locations from which the silt is derived. All of these characteristics combine to produce an untreated silt which is agglomerated and the treatment of this process reduces the adhesiveness of the silt particles.

The advantages of this invention can be seen in considering the silt as a fuel. The silt largely passes through a $\frac{1}{32}$ -mesh screen. It is formed into a silt bank which retains a large percentage of the processing water. The silt in the physical form that it assumes in the silt bank cannot be successfully used as a fuel at the present time because of the difficulty in handling the material. The base of the silt banks are fines, which, if below 200-mesh, cake heavily; it will not dump out of railroad cars; it will not loosen itself on shaker screens; it forms a solid coating over the mesh of shaker screens and thus vitiates the separating purpose of the shakers; and it packs in bins and in feed pipes. These difficulties are experienced even when coal particles, having an original size greater than 200-mesh, make up the silt due to the particular kind of flotation process which has been used.

This invention by its process has produced a product which completely avoids and obviates the above disadvantages of the silt. The products of the above noted examples are derived from the moisture retaining silt and may be handled and processed in the normal manner of anhydrous or relatively dry coal having particle size of the order of coal fines, as identified above.

Another advantage of this invention is the production of a silt having dry properties without the use of heating or grinding. A product is formed which may be blown in powder form into the furnaces with available equipment by standard procedures after passing through a combined ball and heating mill for further reduction in sizes. The product is comminuted coal fines or has the properties of comminuted coal fines and the process produces this product from an agglomerated silt material which includes silt bank liver. The product of this invention does not form particles which are easily airborne and are not susceptible to movement by gusts of wind. This facilitates transportation and obviates the necessity of preventing blowing of the silt out of railroad cars during transit.

In the above description, illustrative embodiments have been set forth by way of explanation. It will be under-

stood that modifications of the specific procedures and percentages may be made in accordance with the spirit of the invention set forth herein. Accordingly, it is intended that this invention be limited only by the scope of the appended claims.

I claim:

1. A process of producing non-adherent disintegrated coal fines from coal silt containing adherent —200 mesh particles, which comprises treating an agglomerated compact adhesive coal silt containing a substantial proportion of —200 mesh particles and from 10% to 30% of water by weight of the silt, incorporating with said silt a composition selected from the group consisting of spent sulfite liquor and the powdered solid form of sulfite liquor, said composition containing solids of spent sulfite liquor in a proportion of about .1% to 3% by weight of the silt, and mixing the composition and the coal silt into a mixture containing less than 30% of water by weight of the silt and until the coal silt is breakable by mechanical action.

2. A process of producing non-adherent coal fines from waste coal silt containing adherent —200 mesh particles, which comprises treating agglomerated compact adhesive coal silt containing a substantial proportion of —200 mesh particles and from 10% to 30% of water by weight of the silt, incorporating with said silt from about .02% to 20% of spent sulfite liquor by weight of the water content of the silt, said spent sulfite liquor being a product from paper processing and containing not more than 50% water by weight and mixing the spent sulfite liquor and the coal silt into a mixture containing not more than 30% by weight of water and until the coal silt is breakable by mechanical action.

3. A process of producing non-adherent disintegrated coal fines from waste coal silt containing adherent —200 mesh particles, which comprises treating an agglomerated compact adhesive coal silt containing a substantial proportion of —200 mesh particles and from 10% to 30% of water by weight of the silt, incorporating with said silt from about .1% to 3% by weight of the silt of the powdered solid form of spent sulfite liquor from paper processing and mixing the powdered solid form of spent sulfite liquor and coal silt to a mixture containing not more than 30% of water by weight of the silt and until the coal silt is breakable by mechanical action.

4. A process of producing non-adherent disintegrated coal fines from waste coal silt containing adherent —200

mesh particles, which comprises treating an agglomerated compact adhesive coal silt containing a substantial proportion of —200 mesh particles and from 10% to 30% of water by weight of the silt, incorporating with said silt from about .2% to 6% of spent sulfite liquor by weight of the silt, said spent sulfite liquor being from paper processing and containing not more than 50% water by weight of the liquor, and mixing the spent sulfite liquor and the coal silt to a mixture containing not more than 30% of water by weight of the silt and until the coal silt has been disintegrated and rendered non-adhesive.

5. A method of forming a non-sticky, dry flowable coal dust having a substantial portion of particles of less than —200 mesh from sticky waste coal silt, which comprises treating an agglomerated compact adhesive waste coal silt containing a substantial portion of —200 mesh particles and from 10% to 30% of water by weight of the silt, incorporating with said silt a composition selected from the group consisting of spent sulfite liquor containing not more than 50% of water by weight of the liquor and the powdered solid form of spent sulfite liquor in a proportion of from 0.2% to 6% of said spent sulfite liquor by weight of the silt and from 0.1% to 3% of said powdered solid form by weight of the silt to provide friability and pulverulence to said agglomerated silt and mixing said spent sulfite composition in said silt to cause the disintegration of said silt.

6. Disintegrated non-adhesive waste coal silt comprising particles of silt ranging from 20 mesh particles to 400 mesh particles having from 10% to 30% of water by weight of the silt, said silt having spent sulfite liquor containing not more than 50% of water by weight of the liquor in the proportion of from about .2% to 6% by weight of said silt.

7. Disintegrated non-adhesive waste coal silt comprising particles of silt ranging from 20 mesh particles to 400 mesh particles having from 10% to 30% of water by weight of the silt, said silt having the solids of spent sulfite liquor in the proportion of from about .1% to 3% by weight of said silt.

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