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PROCESS FOR CONVEYING CARBONACEOUS SOLIDS THROUGH CONDUITS

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The present invention relates to a process for conveying slurries of carbonaceous solids such as finely divided coals and bitumens and more particularly the invention concerns an improved process involving the use of coal acids in said slurries as viscosity-reducing agents.

Pipeline transportation of carbonaceous materials in the form of aqueous slurries is well known. See, for example, vol. 199, Electrical World, page 46, May 5, 1958 and vol. 56, The Oil and Gas Journal, page 127, June 16, 1959. In such operations, friction losses incurred as the slurry travels through a conduit or pipe account for much of the input energy required to maintain a desired flow rate.

It is an object of the present invention to provide an improved method for transporting aqueous slurries of carbonaceous solids through conduits. It is a particular object of the present invention to provide means for reducing the viscosity of aqueous slurries of finely divided carbonaceous solids thereby improving the pumpability and flowability of such slurries. Other objects will become apparent hereinafter as the invention is more fully described.

In fulfillment of these objects, it has been discovered that the viscosity of an aqueous slurry of finely divided carbonaceous solids can be substantially decreased by the incorporation therein of a minor proportion of coal acids.

The terminology "coal acids" as employed in this specification and the appended claims is to be considered as being inclusive of such materials or mixtures thereof as the free water-soluble coal acids, alkali metal and ammonium salts thereof and the alkali metal and ammonium salts of humic acids. Water-soluble coal acids, which are obtained as a mixture of predominantly polycarboxylic aromatic acids by the partial oxidation of coals and similar carbonaceous materials, have an average molecular weight of about 250 and an average equivalent weight of about 80. The average carboxyl group functionality of these acids is about 3 but depending upon the method of manufacture and raw materials employed therein, it may range from as little as 2.5 to about 5. Humic acids, like the water-soluble coal acids, are also obtained by the partial oxidation of coals and similar carbonaceous materials but due to their substantially greater molecular weight, they are not water soluble as free acids.

The coal acids that are employed in aqueous slurries of finely divided carbonaceous solids in accordance with the present invention can be obtained by any one of several known processes. Usually, these processes involve contacting a pulverized carbonaceous solid such as coal or other similar sources of complex aromatic nuclei with an oxidizing agent at an elevated temperature. Oxidizing agents that have been used for this purpose include nitric acid, permanganate in an alkaline solution and gaseous oxygen, which may be contained in air, in water or an alkaline solution. A frequently used method involving the use of gaseous oxygen in an alkaline slurry of a carbonaceous solid is more fully described by Charles W. Montgomery et al. in United States Letters Patent 2,516,640.

The product obtained by the method in Montgomery et al. contains a mixture comprising a salt form of water-soluble coal acids and a somewhat lesser but yet substantial proportion of salts of humic acids. Additional components of this reaction product such as unreacted coal, sodium carbonate and ash are generally of no consequence in the present invention. Thus, this crude reaction product can be employed directly in the slurry that is to be thinned. However, if it is desired for reasons such as the incompatibility of excess caustic or sodium carbonate that may be in the crude coal acid product, further conventional separatory procedures can be utilized to provide a water-soluble coal acid product of either or both of the water-soluble coal acids and the humic acids.

One such method involves acidifying the filtered reaction product. This causes precipitation of the acid-insoluble humic acids which are then recovered by filtration and converted to a water-soluble alkali metal or ammonium salt form by the addition of an appropriate reagent. The filtrate from this process is then extracted with methyl ethyl ketone in accordance with the method in Montgomery et al. to separate the water-soluble coal acids. Upon evaporation of the methyl ethyl ketone, the water-soluble coal acids remain as an amorphous residue which can be employed in the present invention in its then existing free acid form or be converted to an alkali metal or ammonium salt for use in the invention.

The process for conveying or transporting finely divided carbonaceous solids such as, for example, coal or gilsonite, through conduits involves the essential steps of preparing an aqueous slurry of the carbonaceous solid which has been reduced in size from dust to particles not greater than about ½ inch in their major dimension. It is preferred in most operations that the particles be not larger than No. 8 mesh screenings. The average particle size that is permitted is largely dependent upon flow rates within the conduit or pipeline since this factor determines the particle settling rate and thus the potential clogging of the pipeline. The slurries that are employed can contain up to 50 percent solids for effective operation but generally, depending upon such variables as average particle size, pipeline diameter and pumping head requirements, the optimum slurry concentration is found to be in the range from about 30 to 40 percent solids. Having prepared the slurry, it is then pumped into a conduit wherein it is forced along at a flow rate sufficient to insure little or no settling of the particles while not unduly increasing pumping power requirements needed to maintain the specified flow rate. At the receiving end of a conduit, which is utilized solely for transportation purposes, the slurry is filtered or otherwise processed by conventional means to recover the carbonaceous solids at their destination.

Addition of the viscosity decreasing coal acids can be accomplished at the point of slurry preparation and, of course, subsequently at any point in the pipeline. Generally, since pumping efficiencies can be increased, it is desirable to add the coal acids to the slurry before it enters the pump. At the receiving end of the conduit or pipeline, the coal acids remain with the filtrate since they are water soluble. In this form, they can be concentrated and recycled, if desired.

Substantial reductions in the viscosity of aqueous slurries of carbonaceous solids can be achieved when a quantity of coal acids from about 0.05 to as much as 2 percent or more based on the weight of the slurry is incorporated into the slurry.

The following examples are illustrative of the present invention but should not be construed as limiting.

EXAMPLE 1

A series of aqueous slurries were prepared containing 50 percent solids in the form of finely divided coal particles (200 mesh) and additional quantities, as specified

in Table I, of additives from the group consisting of free water-soluble coal acids, sodium salts of water-soluble coal acids and a mixture comprising the sodium salt forms of water-soluble coal acids and humic acids. Control slurries were also prepared containing 40 and 45.5 percent coal solids. Viscosities of the above slurries were determined by means of a Stormer viscosimeter. Forces applied were those necessary to drive the stirring device of the viscosimeter at 600 r.p.m. Data obtained from the control slurries was plotted and an extrapolation thereof was used to estimate the viscosity of a concentrated 50 percent coal slurry which was too viscous for direct measurement in the Stormer viscosimeter. The results obtained for four viscosity-reducing additives and the control slurries are reported in the following table:

Table I

Sample No.	Additive	Weight Percent Additive	Force, Grams	Viscosity, cps.	Percent Reduction of Viscosity Based on Control
1	A[1]	.05	Too thick		
2	A	.10	240	85	72
3	A	.25	190	62	80
4	B[2]	.05	480	195	36
5	B	.10	330	126	59
6	B	.25	190	62	80
7	C[3]	.05	476	193	37
8	C	.10	235	83	73
9	C	.25	115	27	91
10	D[4]	.05	Too thick		
11	D	.10	700	295	3
12	D	.25	550	227	26
13	Control 40 Percent Coal Slurry.		222	77	
14	Control 45.5 Percent Coal Slurry.		408	162	
15	Control 50.0 Percent Coal Slurry.		(By extrapolation)	305	

(1) A = Water-soluble coal acids.
(2) B = Sodium salt form of the water-soluble coal acids.
(3) C = A crude partial oxidation product of coal of which a representative sample contained 16.9 percent of the sodium salts of water-soluble coal acids, 13.1 percent of the sodium salts of humic acids, 55.7 percent sodium carbonate and 14.3 percent insolubles.
(4) D = Sodium hexametaphosphate, a commonly used slurry thinner.

A comparison of the reduction in viscosity obtained by the use of coal acids over that obtained for sodium hexametaphosphate shows a substantial improvement for the additives of the invention.

EXAMPLE 2

A coal slurry was prepared containing 6 percent of a low volatile bituminous coal (200 mesh) and 20 percent caustic. This slurry was pumped into a high pressure system by means of a positive displacement pump possessing a theoretical maximum pumping rate (corrected by an efficiency factor of 0.89) of 2.66 pounds of the slurry per minute. During operation of the pump, it was found that due to resistance to fluid flow in the pump inlet line that the actual pumping rate was substantially less than the theoretical potential. Various quantities of a coal acids mixture hereinafter designated "F" were then added to the above slurry. The coal acids mixture "F" contained an average of about 25 percent of the sodium salts of the coal acids which consisted of about 4 parts by weight of the water-soluble coal acid salts for each part by weight of the humic acid salts and a balance of essentially sodium carbonate. The resulting improvements in pumpability as a result of decreases in the slurry viscosity are reported in the following table:

Table II

Lbs. "F" per 100 lbs. of Slurry	Pumping Rate Avg.,[1] Lbs. Slurry/Minute
0	1.32
0.044	1.75
0.35	2.00
1.41	2.34

[1] The reported pumping rates are averages of values obtained for at least two runs of 15 minutes each.

In a manner similar to that of the foregoing examples, the viscosity of aqueous slurries of such carbonaceous solids as coal and gilsonite can be reduced to provide corresponding improvements in pumpability and flowability of said slurry, by substituting the potassium, lithium and ammonium salts of the water-soluble coal acids for the sodium salts of the same in the foregoing examples and by substituting the potassium, lithium and ammonium salts of the humic acids for the sodium salts of the water-soluble coal acids in Example 1.

I claim:

1. In a process for transporting finely divided carbonaceous solids by forcing an aqueous slurry thereof through a conduit, the improvement which consists in incorporating a minor proportion of coal acids into said slurry.

2. A process as in claim 1 wherein the minor proportion of coal acids is at least about 0.05 percent by weight of the total slurry.

3. A process as in claim 1 wherein the coal acids are of the group of water-soluble coal acids and alkali metal and ammonium salts thereof.

4. A process as in claim 1 wherein the coal acids are of the group of alkali metal and ammonium salts of humic acids.

References Cited in the file of this patent

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