United States Patent Office 3,012,826 Patented Dec. 12, 1961

3,012,826

HYDRAULIC CONVEYING METHOD

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No Drawing. Filed Apr. 28, 1960, Ser. No. 25,250
5 Claims. (Cl. 302—66)

The present invention relates to a method of hydraulically conveying goods. It is known to convey in pipe lines minerals as, for instance, coal and ores mixed with a carrier liquid such as water. To this end, the minerals, after having been sifted to a certain medium granular size or grain size band, and after corresponding crushing of the coarser components to the same medium grain size or the same grain size band, are intermixed with corresponding quantities of a carrier liquid and are then pressed by pumps through a pipe line. Inasmuch as pressure losses and energy consumption increase with increasing grain size, the grain size of the mineral to be conveyed is kept as small as possible. However, practical experience has proved that with decreasing grain size, the difficulty of later separating the mineral from the conveying liquid increases considerably.

It is, therefore, an object of the present invention to provide an improved method of hydraulically conveying goods of the above-mentioned character, which will overcome the difficulties outlined above.

It is another object of this invention to provide an improved method of hydraulically conveying goods such as coal and minerals, which will make it possible to transport the specifically lighter and softer particles of the goods to be conveyed with a particularly coarser grain size than was heretofore permissible.

It is still another object of this invention to provide a method set forth in the preceding paragraphs, which will reduce the labor heretofore required for crushing the goods to be conveyed.

These and other objects and advantages will appear more clearly from the following specification.

The present invention is based on the fact that usually the minerals to be transported do not consist of homogeneous solid materials but consist of mixtures of solid particles of different specific weight and hardness. Thus, when coal is involved, the material comprises coal proper, coal intermixed with mine waste, and mine waste, whereas with minerals, the material to be transported contains the mineral proper, minerals intermixed with gangue, and gangue. It will be apprecated that the respective quantities of these components and their respective granular size, specific weight or hardness, will have a decisive influence on the transport conditions.

According to the present invention, such mixture of solid particles to be transported hydraulically is, prior to its transport, if desired, after a pre-crushing has been effected, split up into at least two components. One of these components contains, to a greater extent, the specifically lighter and usually softer ingredients, and also contains, to a less extent, the specifically heavier and usually harder ingredients. The other component comprises the specifically heavier and usually harder ingredients. The splitting up or separation may be effected in conformity with standard preparatory measures such as dressing on pneumatic tables, dressing in pneumatic separators, jigging in plunger jigs or air jigs, washing in troughs, heavy liquid washing, or the like. In connection herewith, endeavors are made primarily to transport one of the two components, viz. the more valuable one, whereas the other component is transported only to such an extent as it cannot be avoided, or is dictated by necessities.

Each of the two components of the material to be transported as they are obtained during the dressing operation, is, in conformity with the present invention, crushed to a different extent. More specifically, the specifically lighter and usually softer component is crushed to a less extent, whereas the specifically heavier and usually harder component is crushed to a greater extent while avoiding any material quantity of very fine granulars. The ratio of the medium grain size of the coarser, specifically lighter ingredients to the medium size of the finer, specifically heavier ingredients is so selected that the medium sink velocity of the finer, specifically heavier ingredients is equal to or less than the sink velocity of the coarser ingredients. This step is carried out in such a manner that the two components of the material to be transported and obtained by the preceding dressing operation are crushed in two different crushing operations adapted to be selected and adjusted in conformity with the respective crushing step. These two different crushing operations may be carried out successively in one and the same crushing device by adjusting the same differently. These two crushing operations may, however, also be carried out parallel to each other in one and the same crushing device by introducing the two components at different points of the crushing path and by discharging both components together in form of a mixture. Preferably, however, the components are crushed in two equal or two different crushing devices. In this way, there will be obtained the possibility, by respectively adjusting the crushing device, respectively to crush the said two components to a different extent so that the quantities of finest grain of said components will be different and the formation of material quantities of very fine granulars may be prevented. It will be appreciated that major quantities of very fine granulars considerably handicap or interfere with the separation of the transported goods and the carrier liquid from each other after the transport has been completed.

The differently crushed components will then be intermixed, and the thus obtained mixture will then be intermixed with a carrier liquid for hydraulically transporting the goods.

When hydraulically transporting goods of the above-mentioned character, experience has shown it advantageous to employ a carrier fluid which will at least partially protect the pipe lines against the combined influence of corrosion and erosion during the transport of the goods. Such means when employed (for instance in the form of chromates or phosphates) affect the inner surface of the pipe lines in such a way that they bring about the formation of a non-corrosive fixed protective layer, or, when employed for instance in the form of higher amines soluble in water under difficulties only, they settle in a preferred manner on the inner surface of the pipe line between the pipe wall and carrier liquid. As far as such layers are damaged by erosion, a continuous slight addition of such protective means during the transport brings about the formation of a new protective layer, thereby preventing to a greater extent the wear of the conveying pipes.

Furthermore, experience has shown that the addition of substances, which have to be employed after the transport for affecting the surface of the transported goods or individual ingredients thereof, is advantageously effected already prior to the transport of the goods. This is due to the fact that the thus added substances will be able, already during the frequently long conveying path and conveying times, very evenly to distribute themselves over the surfaces to be affected. Thus, in this way, considerable savings in the substances to be added can be obtained, and the frequently considerable amount of en-

rgy for mixing and evenly distributing the said substances with the materials after the transport can be educed. Such substances adapted to affect the surface f the material to be transported are for instance wetting neans, flotation additions and the like which are added or instance to aid in the dressing of the transported mateial or to split it up by flotation into certain components.

There will now be described by way of example the mployment of the method according to the invention for ransporting a mixture of specifically lighter and softer oal with specifically heavier and harder mine waste.

According to the invention, the material to be transorted, if desired, after a pre-crushing, is split up into t least two components which contain the preferred nore valuable ingredients to a greater and minor extent espectively. One component contains the specific lighter nd softer coal with no or only a very small percentage f less valuable coal ingredients and mine waste, whereas ne other component contains the possibly major portion f the specific heavier and harder medium quality ingreients and mine waste. If the material to be conveyed to be taken from a dressing device already in existence, n additional separating cut is effected in said device in ne following manner. If in the dressing device a separation is effected in "coal" and "mine waste," a threefold ivision will be effected in "coal," "medium quality oods" and "mine waste." If the dressing installation arries out a threefold division for instance into "coal," medium quality goods," and "mine waste," the additional separating cut will result in four products namely oal with a minor quantity of medium goods, coal with onsiderable medium quality goods, medium quality oods, and mine waste. The location of this additional eparating cut will be selected in such a way that the arder or heavier ingredients will be obtained in an operation favoring concentration in order that as far as possible only the respective necessary proportion of the goods ill be subjected to increased crushing.

The two components which contain the preferred materal to be transported in a major and nearly major quanty are, in conformity with the present invention, respecvely crushed to a different degree. More specifically, ne lighter and softer proportion of coal will be subjected less crushing, whereas the specifically heavier and arder proportion of coal which contains the major porion of medium quantity goods and possibly mine waste ill be subjected to a greater crushing. The degree of ushing, or the medium granular size of the coal ingreents are selected or adjusted in a manner known per se conformity with the conditions of operation of the ansporting pipe and in conformity with the available parating devices for separating the carrier liquid and e goods to be transported. Thereupon, the degree of ushing of the medium quality ingredients is so selected at the formation of major quantities of very fine granars will be avoided and medium sized granulars will be ntained the sink velocity of which is equal to or less an the sink velocity of the selected medium granular ze of the coal. The different crushed ingredients of al and medium quality product are united and are emoyed together with a carrier liquid for the hydraulic ansport of the goods.

Experience has shown that the total of the above steps ings about considerable technical advantages for the draulic transport involved herein.

The fine crushed specifically heavier and harder comment of the material to be transported appears to act the carrier liquid so to speak as heavy pulp or slime thout being comparable thereto. In contrast to the retofore necessary granular sizes required for certain pe conditions, the specifically lighter and softer compoents of the goods to be transported can be transported th a considerably coarser granular size. This results various advantages. The total required energy for the ushing operation will be considerably reduced over that

heretofore required. Due to the required less crushing of the specifically lighter and softer ingredients, and the thereby greater quantity of these ingredients, for instance with coal, the formation of very fine grained masses will be reduced to a surprising minimum. Furthermore, the crushing of the specific heavier and harder ingredients may be selected and adjusted in such a manner that also in this instance the formation of very fine granular material will be reduced to a minimum.

In this way, the separation of carrier liquid from the goods to be transported following the completed transport will be considerably and frequently even decisively facilitated. If losses occur, these will be at the expense of the specifically heavier ingredients such as mine waste. In view of the increased crushing of the specifically heavier harder ingredients, further advantages with regard to the wear of the pipe lines will be obtained, said wear being due primarily by the specifically heavier ingredients knocking against and grinding the pipe lines. Such losses are also due in part to the loss in pressure brought about by such heavier particles hitting and grinding the pipe line. It will be appreciated that such losses have a considerable influence upon the energy consumption and the life of the pipe lines. If the crushing would be effected without dressing and at random, it will be obvious that prior to the harder ingredients reaching the appropriate granular size, the softer ingredients would be crushed far too much, and at the same time too much finest granular material would be obtained. Although in this way heretofore the specific pressure losses were reduced in the feeding lines, no advantage could be derived therefrom because the increased costs and losses during the separation of the transported goods and the carrier liquid far exceed the advantages obtained by a reduction in the specific pressure losses.

The invention will now be described in connection with some examples:

Example I

Pit coal with a granular size of from 0 to 10 millimeters with the specific weight $s=1.39$ and the medium grain diameter of $d=3.36$ millimeters corresponding to a sink velocity in water of $v=19.9$ centimeters per second is split up in a heavy media separation into two components A and B so that the component A will be obtained as two-thirds of the total quantity with the specific weight of $s=1.33$, whereas the component B will amount to the remaining one-third of the total quantity with the specific weight of $s=1.5$.

Component A will then in a roller mill be crushed to a grain size of from 0 to 3 millimeters, the medium grain diameter of this partial quantity amounting to 1 millimeter corresponding to a medium sink velocity of 10.0 centimeters per second. The component B is crushed in a disintegrator to a grain size of from 0 to 1.5 millimeters, the medium grain diameter of this component amounting to 0.66 millimeter corresponding to a medium sink velocity of likewise 10 centimeters per second.

The intermixed components A and B will then have a granular size of from 0 to 3 millimeters, a medium grain diameter of 0.89 millimeter and a medium sink velocity of 10 centimeters per second. The said components are then intermixed with a carrier liquid such as water for the hydraulic transport and introduced into a corresponding transport conduit.

If the starting coal were, contrary to the invention, i.e. without splitting the same up in the components A and B as outlined above, crushed to a granular size of from 0 to 3 millimeters corresponding to a medium grain size of 0.89, the medium sink velocity would amount to 10.9 centimeters per second, and the coarser granular size would represent the specifically heavier parts which settle most easily.

Example II

A pit coal of the granular size from 0 to 10 millimeters

with the specific weight of $s=1.39$ and the medium grain diameter of $d=3.36$ millimeters corresponding to a sink velocity in water of from $v=19.9$ centimeters per second is split up in a heavy media separation into two components A and B, component A amounting to two-thirds of the total quantity with a specific weight of $s=1.33$, and component B amounting to one-third of the total quantity with a specific weight of $s=1.5$.

Component A is then crushed in a roller mill to a grain size of from 0 to 3 millimeters, the medium grain diameter of this component amounting to 1 millimeter corresponding to a medium sink velocity of 10.0 centimeters per second.

Component B is crushed in a roller mill to a granular size of from 0 to 1 millimeter, the medium grain diameter of this component amounting to 0.4 millimeter corresponding to a medium sink velocity of 7.8 centimeters per second.

The combined components A and B will then have a granular size of from 0 to 3 millimeters, a medium grain diameter of 0.8 millimeter and a medium sink velocity of 9.3 centimeters per second. They are then introduced into a carrier liquid such as water for the hydraulic transport and conveyed through a corresponding pipe line.

If the starting coal were, contrary to the invention directly crushed to a granular size of from 0 to 3 millimeters corresponding to a medium granular size of 0.89 millimeter, the medium sink velocity would amount to 10.9 centimeters per second, and the coarse granular size would represent the specifically heavier parts which settle most easily.

Example III

A pit coal of the granular size of from 0 to 10 millimeters with the specific weight $s=1.39$ and the medium granular size of $d=3.36$ millimeters corresponding to a sink velocity in water of $v=19.9$ centimeters per second is split up in a heavy media separation into two components A and B, component A amounting to two-thirds of the total quantity with the specific weight of $s=1.33$, and component B amounting to one-third of the total quantity with the specific weight of $s=1.5$.

Component A is now crushed in a roller mill to a granular size of from 0 to 5 millimeters, the medium grain diameter of this component amounting to 1.5 millimeters corresponding to a medium sink velocity of 12.25 centimenters per second.

Component B is crushed in a disintegrator to a granular size of from 0 to 1 millimeter, the medium grain diameter of this component amounting to 0.4 millimeter corresponding to a medium sink velocity of 7.8 centimeters per second.

The combined components A and B will then have a granular size of from 0 to 5 millimeters, a medium grain diameter of 1.13 millimeters and a medium sink velocity of 10.8 centimeters per second. The components will then be intermixed with a carrier liquid such as water for the hydraulic transport and introduced into a conveying pipe.

If contrary to the invention the starting coal were directly crushed to a granular size of from 0 to 5 millimeters corresponding to a medium granular size of 1.5 millimeters, the medium sink velocity would amount to 13.3 centimeters per second, and the coarser granular size would represent the specific heavier parts which settle most easily.

It is, of course, to be understood that the present invention is, by no means, limited to the specific method described but also comprises any modifications within the scope of the appended claims.

What we claim is:

1. In a method of hydraulically conveying minerals and ores through pipes, which includes the steps of: dividing the goods to be conveyed into at least two components namely a specifically lighter component and a specifically heavier component, respectively crushing said components to different sizes while selecting the ratio of the medium grain size of the specifically heavier component of said components to the medium grain size of the specifically lighter component of said components so that the medium sink velocity of the particles of said specifically heavier component will not exceed the sink velocity of the medium sized particles of said specifically lighter component, and introducing the said components into a carrier liquid for conveying said components to a desired station.

2. A method according to claim 1, in which the crushing of said components is carried out in separate crushing operations.

3. A method according to claim 2, in which the said components are crushed so that said components respectively have different quantities of finest granulars.

4. A method according to claim 1, which includes precrushing the goods to be conveyed prior to dividing them into specifically lighter and specifically heavier components.

5. In a method of hydraulically conveying minerals and ores through pipes, which includes the steps of: dividing the goods to be conveyed into at least two components namely a specifically lighter component and a specifically heavier component, respectively crushing said components in separate crushing operations and to different sizes while selecting the ratio of the medium grain size of the specifically heavier component of said components to the medium grain size of the specifically lighter component of said components so that the medium sink velocity of the particles of said specifically heavier component will not exceed the sink velocity of the medium sized particles of said specifically lighter component, adding to at least one of said components a substance affecting the surface of the goods to be conveyed, and introducing the said components with said substance into a carrier liquid for conveying the components to a desired station.

References Cited in the file of this patent

UNITED STATES PATENTS

2,791,471	Clancy	May 7, 1957
2,791,472	Barthauer	May 7, 1957
2,920,923	Wasp	Jan. 12, 1960

FOREIGN PATENTS

567,079	Great Britain	Jan. 26, 1945