DRAG SCRAPER ASSEMBLY FOR ELECTROSTATIC PRECIPITATOR

Inventor: Earle Stuart Snader, Pasadena, Md.


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Primary Examiner—Dennis E. Talbert, Jr.
Attorney, Agent, or Firm—Oscar B. Brumback; Boyce C. Dent; Olin E. Williams

ABSTRACT

An improved drag scraper assembly for electrostatic precipitators of the type having an endless chain belt above a particle collection surface of the precipitator and having a top flight advancing in the direction of gas flow through the precipitator and a bottom flight advancing in the direction opposite the gas flow. A drag scraper is secured to the chain belt traverse to the flow of the gas for pushing particles collected on the surface toward a collection hopper for the particles. A baffle assembly extends between the lower portions of adjacent collector electrodes of the precipitator and the particle collection surface for obstructing the flow of gas between the lower portions of the collector electrodes and the collection surface. The baffle assembly includes a first portion which is pivotable by the drag scraper advancing with the top flight to permit passage of the drag scraper through the baffle assembly. The baffle assembly further includes a second portion which is pivotable by the drag scraper advancing with the lower flight to permit passage of the drag scraper and the particles through the baffle assembly. The improvement comprises a platform beneath the first portion of each of the baffle assemblies for preventing the flow of gas between the first portions and fixed portions of the baffle assembly during pivotable movement of the first portion as the drag scraper passes through the baffle assembly.
DRAG SCRAPER ASSEMBLY FOR ELECTROSTATIC PRECIPITATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to gas separation by electrostatic precipitators and more particularly to an improved drag scraper assembly in electrostatic precipitators for removing particles from a collection surface on the bottom of the precipitator.

2. Description of the Prior Art

The removal of particles from a gas stream by an electrostatic precipitator is well known in the art. A typical electrostatic precipitator of the plate type which removes particles from the gas flowing therethrough is illustrated in Ragland U.S. Pat. No. 3,425,190. In such precipitators, gas flows through an inlet port into the precipitator and through gas passages formed between rows of vertical collecting electrodes. Suspended within each of these gas passages are a plurality of discharge electrode wires which are electrically insulated from the shell. As the gas passes through the gas passages between the collector electrodes, the discharge electrodes ionize the particles in the gas and the particles are attracted to and collected on the collector electrodes. The particles which collect on the collector electrodes are then removed in any conventional manner such as by rapping the collector electrodes causing the particles to be dislodged from the plates and fall to the bottom of the precipitator. As shown in the Ragland Patent, the bottom of the precipitator contains a number of hopper bins into which the dust particles fall and are collected and then removed through the bottom of the hopper to the outside of the precipitator.

In many situations, it is undesirable to use hoppers at the bottom of the precipitator for removal of dust particles. In many industrial areas, the space in which a precipitator can be constructed is limited and the hopper concept for removal of the particles may not be practical. In such situations, the hoppers are replaced by a horizontal floor or collection surface in the bottom of the precipitator. The particles from the collecting plates fall to the floor and are collected thereon. The preferred manner of removing the particles from the collecting surface on the bottom of the precipitator is to employ an endless chain and scraper system just above the collection surface. The endless chain has a plurality of spaced scrapers secured thereon which run transverse to the flow of gas through the precipitator. As the endless chain belt revolves, the scraper blades contact the dust in the bottom of the precipitator and push the dust particles to one end of the precipitator where the dust can be collected in a single short hopper or pushed onto a removal conveyor means, or removed in any other convenient manner.

The removal of the particles by the use of an endless chain and scraper system does have a number of disadvantages. For an electrostatic precipitator to properly remove particles suspended within the gas, the gas must remain in the gas passages between the collector electrodes. Since the collection surface of the precipitator is below the bottom of the collector electrodes, there is a space between the collection surface and the collector electrodes where gas coming into the precipitator may flow to the opposite side of the precipitator; thus, this gas is not cleaned because it never passes between the collector electrodes. Since it is desirable to have a high degree of efficiency in an electrostatic precipitator, this gas flowing along the bottom of the precipitator is extremely undesirable as it reduces the efficiency of the precipitator. In addition, the gas flowing along the bottom of the precipitator will tend to re-entrain those particles which have been precipitated out of the gas and have fallen to the collection surface of the precipitator.

To obstruct the flow of the gas below the collector electrodes and to force the gas back up into the gas passages between the collector electrodes, a plurality of baffle systems are suspended between the adjacent collector electrodes and collection surface of the precipitator. These baffle systems have a plurality of pivotable or flexible baffles so that when the endless chain revolves and the scrapers contact the pivotable baffles, the baffles will flex or pivot and allow the scraper to pass thereunder. However, it has been found that when the scraper on the top flight of the endless chain contacts and rotates the pivotable baffle, gas will flow through a large gap underneath the scraper into the next section between the baffles without being forced back up into the gas passages or will flow upward over the next baffle and back down into the next section without being cleaned. In addition, as the gas flows around the scraper blade when it is pivoting the baffle out of the way, the gas will tend to re-entrain the particles that have been collected on the collection surface thus decreasing the efficiency of the precipitator system.

It is not now difficult to make an electrostatic precipitator having a collection efficiency of 90%. However, it is much more difficult and highly expensive to increase the efficiency from 90% to 100%. In an electrostatic precipitator having the drag scraper and baffle system previously described, the efficiency of the precipitator is approximately 97.6%. Although this seems to be extremely efficient, it is desirable to reach as high an efficiency as possible in order to insure the least amount of air pollution. Therefore, a means is desired wherein the collection efficiency of the precipitator can be increased even higher.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an electrostatic precipitator with a particle removal system that will overcome the aforementioned disadvantages and others; thus, this invention provides an electrostatic precipitator with an improved drag scraper assembly which includes an improved baffle system for increasing the collection efficiency of an electrostatic precipitator to substantially 98.8%.

This is generally accomplished by providing an electrostatic precipitator with an improved drag scraper assembly which includes an endless chain means above a particle collection surface of the precipitator having a top flight advancing in the direction of gas flow through the precipitator and a bottom flight advancing in a direction opposite to the gas flow; scraper means secured to the chain means traverse to the flow of the gas for pushing particles collected on the surface toward a collection hopper for the particles; and baffle means extending between lower portions of adjacent collector electrodes of the precipitator and the particle collection surface for obstructing the flow of gas between the lower portions and the collection surface, a first portion of the baffle means being pivotable by the scraper.
means advancing with the top flight to permit passage of the scraper means through the baffle means, and a second portion of the baffle means being pivotable by the scraper means advancing with the lower flight to permit passage of the scraper means and the particles through the baffle means, the improvement comprising: a plate means beneath the first portion of each baffle means for preventing the flow of gas between the first portions and fixed portions of the baffle means during pivotable movement of the first portion as the scraper means passes through the baffle means.

The above and further objects and novel features of the invention will appear more fully from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood however, that the drawings are not intended as a definition of the invention but are for the purpose of illustration only.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, wherein like parts are marked alike:

FIG. 1 is a schematic illustration in side elevation of an electrostatic precipitator generally showing the improved drag scraper assembly of the present invention;

FIG. 2 is a schematic end view of the improved drag scraper assembly of FIG. 1 taken along the lines II—II showing the endless chains, scraper, and fixed and pivotable baffles; and

FIG. 3 is an enlarged view of the drag scraper assembly of FIG. 1 showing the endless chain and scraper assembly and the baffle assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the invention generally comprises of an improved drag scraper assembly, denoted generally by numeral 12, for use in electrostatic precipitators, denoted generally by numeral 10, having an endless chain 14 above a particle collection surface 16 of precipitator 10 and having a top flight 18 advancing in the direction of gas flow, as shown by the arrow in FIG. 1, through precipitator 10 and having a bottom flight 20 advancing in the direction opposite to the gas flow, as shown by the arrow in FIG. 1. A scraper 22 is secured to endless chain 14 and is movable in a transverse to the flow of the gas for pushing particles 24 collected on collection surface 16 toward a collection hopper 26 for disposal of particles 24. A baffle assembly, denoted generally as numeral 28, extends between lower portions 29 of adjacent collector electrodes 30 of precipitator 10 and the particles collection surface 16 for obstructing the flow of gas between the lower portions 29 of collector electrodes 30 and the collecting surface 16. The baffle assembly 28 includes a first portion, denoted generally by numeral 32, which is pivotable by scraper 22 which advances with top flight 18 to permit passage of scraper 22 through baffle assembly 28. Baffle assembly 28 further includes a second portion denoted generally by numeral 34 which is pivotable by scraper 22 which advances with lower flight 20 to permit passage of scraper 22 and particles 24 through baffle assembly 28. The improvement comprises a plate assembly, denoted generally by numeral 36, beneath first portion 32 of each of the baffle assemblies 28 for preventing the flow of gas between first portion 32 and a first fixed portion 38 and a second fixed portion 40 of baffle assembly 28 during pivotable movement of first portion 32.

More specifically, and referring again to FIG. 1, electrostatic precipitator 10 includes a plurality of collector electrodes 30 which are spaced apart and are suspended within electrical precipitator 10 in the conventional manner. Collector electrodes 30 are spaced within precipitator 10 to form gas passages (not shown) therebetween for directing the particle laden gas through precipitator 10 between collector electrodes 30. Suspended between the spaced collector electrodes 30 and in the gas passages are a plurality of discharge wire electrodes 48. The discharge electrodes 48 are suspended within electrostatic precipitator 10 in any conventional manner so that they are insulated from the shell of precipitator 10. Weights 50 are attached to the bottom of each of the discharge electrodes 48 to keep the wires straight and to keep them from oscillating due to the electrical field around each discharge wire 48. As the particle laden gas flows between spaced collector electrodes 30 in the gas passages, discharge electrodes 48 are energized which cause particles 24 in the particle laden gas to be ionized. These ionized particles 24 are then attracted to and collect on the surface of collector electrodes 30. After a predetermined length of time a certain amount of particles 24 from the particle laden gas are collected on collector electrodes 30. The collector electrodes 30 are then rapped in the conventional manner to dislodge particles 24 from the collector electrodes. The particles 24 fall to the bottom of precipitator 10 where they are collected on collection surface 16.

Referring now to FIGS. 1, 2, and 3, once particles 24 are collected on collection surface 16, a means must be employed to remove particles 24 from collection surface 16 of precipitator 10 for disposal outside the precipitator system. To accomplish the removal of particles 24, a drag scraper assembly 12 is utilized. Drag scraper assembly 12 consists of a plurality of endless chain systems 14 (see FIG. 2) spaced traversely to the gas flow; each endless chain system 14 is spaced between lower portion 29 of collector electrodes 30 and collection surface 16. Each endless chain system 14 includes a pair of aligned sprockets 52 (FIG. 1) positioned at each end of precipitator 10. The traversely spaced sprockets 52 of each endless chain system 14 are connected by a shaft 54 which extends the width of precipitator 10 traverse to the gas flow. The ends of shafts 54 are supported in conventional bearing mounted supports (not shown) secured to the shell of precipitator 10. Shafts 54 are free to rotate within the bearing mounted supports. Surrounding and connecting each of the aligned sprockets 52 is an endless chain 17 as shown in FIGS. 1 and 3. Endless chain 17 has a top flight 18 which travels in the same direction as the gas flow and a bottom flight 20 which travels counter to the direction of gas flow. An end of one of the shafts 54 is connected to an electric motor (not shown) for rotating shaft 54 and consequently sprockets 52 and endless chain 17, in the direction and at the speed desired.

Endless chain 17 has a plurality of circumferentially spaced sprockets 22, as shown in FIGS. 1, 2 and 3, which are attached to the endless chain 17 in any conventional manner and extend traversely to the gas flow as shown in FIG. 2. Scrapers 22 may be a single scraper extending the entire width of precipitator 10 but preferably comprises a plurality of scraper segments 22 traversely aligned as shown in FIG. 2. As shaft 54 is ro-
tated by the motor in the direction shown by the arrows in FIGS. 1 and 3, scrapers 22 are also rotated by endless chain 17. As scrapers 22 on bottom flight 20 traverse the length of precipitator 10 counter to the direction of the gas flow, scrapers 22 push particles 24 along surface 16 of the bottom of precipitator 10 towards hopper 26. Scrapers 22 continue to push particles 24 until they fall into hopper 26 where they are disposed of in the conventional manner outside the precipitator system.

Referring to FIG. 1, between adjacent collector electrodes 30 and collection surface 16 is a plurality of baffle assemblies 28 which run transversely to the gas flow and obstruct the gas from flowing along collection surface 16 of precipitator 10 to prevent the particle laden gas from flowing out of precipitator 10 without being cleaned by discharge electrodes 48 and collector electrodes 40. The baffle assemblies 28 are designed to force the particle laden gas upward and into the gas passages between collector electrodes 30 so that the particle laden gas can be cleaned prior to exiting from precipitator 10.

Referring now to FIGS. 2 and 3, which show the preferred construction of baffle assemblies 28, a support beam 56 is spaced between lower portion 29 of collector electrodes 30 and top flight 18 of endless chain 17. Support beam 56 is positioned so it is in alignment with the space between adjacent electrodes 30. Support beam 56 is secured to side walls 42 and 44 of precipitator 10 such as by welding. A first fixed portion 38, which is preferably a solid plate, is secured to support beam 56 such as by welding and extends substantially the width of precipitator 10 and extends upward between adjacent collector electrodes 30. First fixed portion 38 deflects the particle laden gas which flows below the bottom of collector plates 30 upward and into the gas passages between collector electrodes 30 to insure proper cleaning of the gas. A plurality of plates 58 are secured to a side of support beam 56 such as by welding as shown in FIG. 3. A chain link 60 is preferably used as a hinge for allowing first portion 32 to pivot. Chain link 60 is preferred as the hinge because it provides a pivot and is not adversely affected by the hot, corrosive, and dusty atmosphere within precipitator 10; conventional hinges tend to bind up within a short time after being exposed to such atmosphere. Chain link 60 is hung from plate 58 through a hole 59 and supports pivotable baffle 64 through hole 61 in the baffle. Upper baffle plate 64 spans the width of precipitator 10 transverse to the direction of gas flow. Preferably, upper baffle plate 64 is made in sections as shown in FIG. 2. However, upper baffle plate 64 may be made as one piece and extend the entire width of precipitator 10. Preferably upper baffle plate 64 should extend downward to a point just above endless chain 17 to make as small a gap as possible between them to restrict the flow of gas therethrough. In addition, this will allow upper baffle plate 64 to freely pivot without contacting endless chain 17.

Plate assembly 36 includes a second fixed portion 40, preferably an I-beam as shown in FIG. 3, and is spaced between top flight 18 and bottom flight 20 of endless chain 17. Second fixed portion 40 is secured at each end of sides 42 and 44 (FIG. 2) of precipitator 10 such as by welding. A chain guide channel 68 (FIG. 3) is positioned on top of fixed portions 40 and extends substantially between aligned sprockets 52 in vertical alignment with top flight 18. Chain guide channel 68 slidably supports top flight 18 of endless chain 17 as it traverses the length of precipitator 10 in the direction of gas flow. Chain guide channel 68 prevents top flight 18 of endless chain 17 from flexing up and down as it travels the length of precipitator 10.

Plate assembly 36 further includes a platform plate 66 which substantially extends across the width of precipitator 10 transverse to the direction of gas flow. Platform 66 is secured to the top of second fixed portion 40 such as by welding. Platform 66 extends in height substantially the same as the top of top flight 18 of endless chain 17, and is notched to receive chain guide channel 68 through which endless chain 17 passes. The top of platform 66 is in lateral alignment with the top of top flight 18 to provide a smooth sliding surface for scraper 22 to slide against when it travels the length of precipitator 10 in the direction of gas flow. Platform 66 extends downstream from second fixed portion 40 a distance needed so that the downstream edge 46 of platform 66 is beyond the disengagement point where scraper 22 no longer contacts upper baffle plate 64 when it passes thereunder. That is, as endless chain 17 moves scraper 22 in the direction of the gas flow, scraper 22 will contact and pivot baffle 64 upward. As scraper 22 pivots baffle plate 64 upward, scraper 22 will be in sliding engagement with the top of platform 66. When scraper 22 travels downstream and passes beyond upper baffle plate 64, it will still be in sliding engagement with platform 66. As scraper 22 clears upper baffle plate 64, and baffle plate 64 pivots downward, scraper 22 passes the downstream edge of platform 66 and is disengaged from platform 66.

The lower second baffle portion 34 includes an angle bracket 70 which is secured to the lower edge of second fixed portion 40 such as by welding. A second chain link 60 supports baffle plate 72 from bracket 70 in the same manner as described for baffle plate 64. A plurality of traversely spaced lower baffle segments 72 must be used rather than a single baffle traversing the width of precipitator 10 since baffles 72 must extend below lower flight 20 of endless chain 17. Thus there will be a slight gap between lower baffles 72 to allow lower flight 20 of endless chain 17 to pass therethrough. This allows baffles 72 to hang down below bottom flight 20 of endless chain 17 so that the lower end of lower baffles 72 extend to a point just above collecting surface 16 as shown in FIG. 1.

In operation, a particle laden gas enters precipitator 10 through an inlet port (not shown). The particle laden gas flows through the gas passages (not shown) between collector electrodes 30. The discharge electrodes 48 are energized causing particles 24 within the gas to be ionized. Particles 24 are attracted to and collect on collector electrodes 30. Collector electrodes 30 are rapped in the conventional manner to dislodge particles 24 therefrom which fall to collection surface 16 at the bottom of precipitator 10. The particle laden gas which is flowing through precipitator 10 will also flow along the bottom of precipitator 10 below lower portion 29 of collector electrodes 30. When the particle laden gas contacts baffle assembly 28, it is deflected upward so that it re-enters the gas passages between collector electrodes 30 to be properly cleaned.

To remove particles 24 from collection surface 16 of precipitator 10, shafts 54 and consequently sprockets 52 are rotated so that the top flight 18 of endless chain
17 moves in the direction of the arrows shown in FIG. 1, that is, in the direction of gas flow. The bottom flight 20 of endless chain 17 moves in the direction counter to the direction of gas flow as shown by the arrow in FIG. 1. As endless chain 17 moves, so does scraper 22. When scraper 22 is on top flight 18 of endless chain 17, it will move in the direction of the gas flow. As shown in FIG. 3, top flight 18 of endless chain 17 moves within chain guide channel 68. As scraper 22 approaches baffle assembly 28, scraper 22 will contact the top part of platform 66 and slide along. As scraper 22 contacts platform 66, it also contacts upper baffle plate 64. Since upper baffle plate 64 is connected to chain link 60, scraper 22 will pivot upper baffle plate 64 upward as scraper 22 continues to move in the direction of the gas flow. As long as scraper 22 is in contact with upper baffle plate 64, it remains in sliding engagement with platform 66 thereby preventing any particle laden gas from escaping between scraper 22 and platform 66 thus maintaining a gas seal while upper baffle plate 64 is pivoted. As scraper 22 continues to travel in the direction of the gas flow, it will release upper baffle plate 64 and allow it to pivot downward so that it is again slightly above platform 66. Scraper 22 then passes beyond the downstream edge 46 of platform 66 and continues to travel in the direction of the gas flow.

As scraper 22 passes around sprocket 52, it will continue its travel along bottom flight 20 of endless chain 17 counter to the direction of gas flow. As scraper 22 travels counter to the direction of gas flow, it contacts and pushes particles 24 in the direction of hopper 26 as shown in FIGS. 1 and 3. As scraper 22 continues to travel along bottom flight 20, it will also contact lower baffle plate 72 and pivot it upward so that scraper 22 may pass thereunder. Since scraper 22 is traveling counter to the direction of gas flow, a good gas seal will be maintained between the second fixed portion 40 and the bottom surface 16. As scraper 22 continues to travel, it will pass from under lower baffle plate 72 and allow lower baffle plate 72 to pivot downward so that it returns to a position slightly above collection surface 16. Scraper 22 continues to push particles 24 counter to the direction of gas flow until the particles 24 fall into hopper 26 where they are disposed of outside the precipitator system. Scraper 22 then passes upward around sprocket 52 and starts its travel over again on top flight 18 of endless chain 17.

The foregoing has presented a novel drag scraper assembly for use in electrostatic precipitators. The problem of a particle laden gas passing beneath the collector electrodes along the length of the precipitator and out to a gas stack without being sufficiently cleaned has been substantially eliminated by providing a baffle system which will substantially prevent the particle laden gas from flowing the length of the precipitator outside the influence of the collector electrodes by deflecting the particle laden gas upward and into the gas passages between the collector electrodes where the cleaning process takes place. The problem of having a substantial air gap through the baffle system when the scraper on the drag scraper assembly pivots the upper baffle out of the way has been substantially eliminated by providing a platform plate having a downstream length sufficient to assure that the scraper is always in contact with the platform while it is pivoting the baffle thereby maintaining a gas seal between the platform and scraper.

Accordingly, the invention having been described in its best embodiment and mode of operation that which is desired to be claimed by Letters Patent is:

1. An improved drag scraper assembly for electrostatic precipitators of the type including:
   endless chain means above a particle collection surface of said precipitator having a top flight advancing in the direction of gas flow through said precipitator and a bottom flight advancing in a direction opposite to said gas flow;
   scraper means secured to said chain means transverse to the flow of said gas for pushing particles collected on said surface toward a collection hopper for said particles;
   baffle means extending between lower portions of adjacent collector electrodes of said precipitator and said particle collection surface for obstructing the flow of gas between said lower portions and said collection surface,
   a first portion of said baffle means being pivotable by said scraper means advancing with said top flight to permit passage of said scraper means through said baffle means,
   a second portion of said baffle means being pivotable by said scraper means advancing with said lower flight to permit passage of said scraper means and said particles through said baffle means,
   the improvement comprising:
   plate means beneath said first portion of each of said baffle means for preventing the flow of gas between said first portions and fixed portions of said baffle means during pivotable movement of said first portions.

2. The apparatus of claim 1 wherein said plate means extends from said fixed portions in the direction of gas flow through said precipitator.

3. The apparatus of claim 2 wherein a downstream edge of said plate means terminates beyond a downstream edge of said first portion when said first portion is pivoted by said scraper means.

4. The apparatus of claim 3 wherein said plate means slidably supports said scraper means during advancement of said scraper means through said baffle means in the direction of gas flow.

5. The apparatus of claim 4 wherein said plate means is secured to said fixed portions of said baffle means.