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J. S. LAGARIAS

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METHOD OF OPERATING A HIGH VELOCITY IRRIGATED PRECIPITATOR

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3 Sheets-Sheet 1

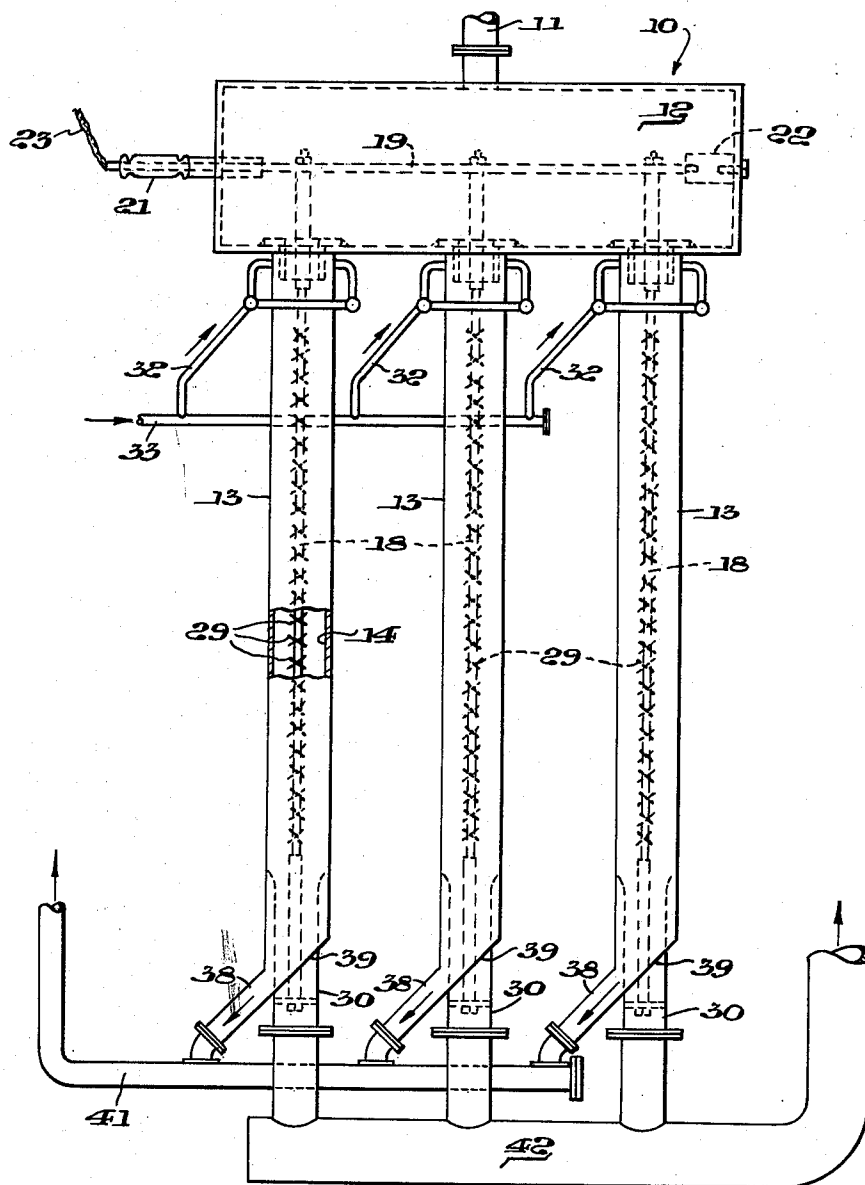


Fig. 1.

INVENTOR.
JOHN S. LAGARIAS.
BY
Leo L. MacLuski.
his
ATTORNEY.

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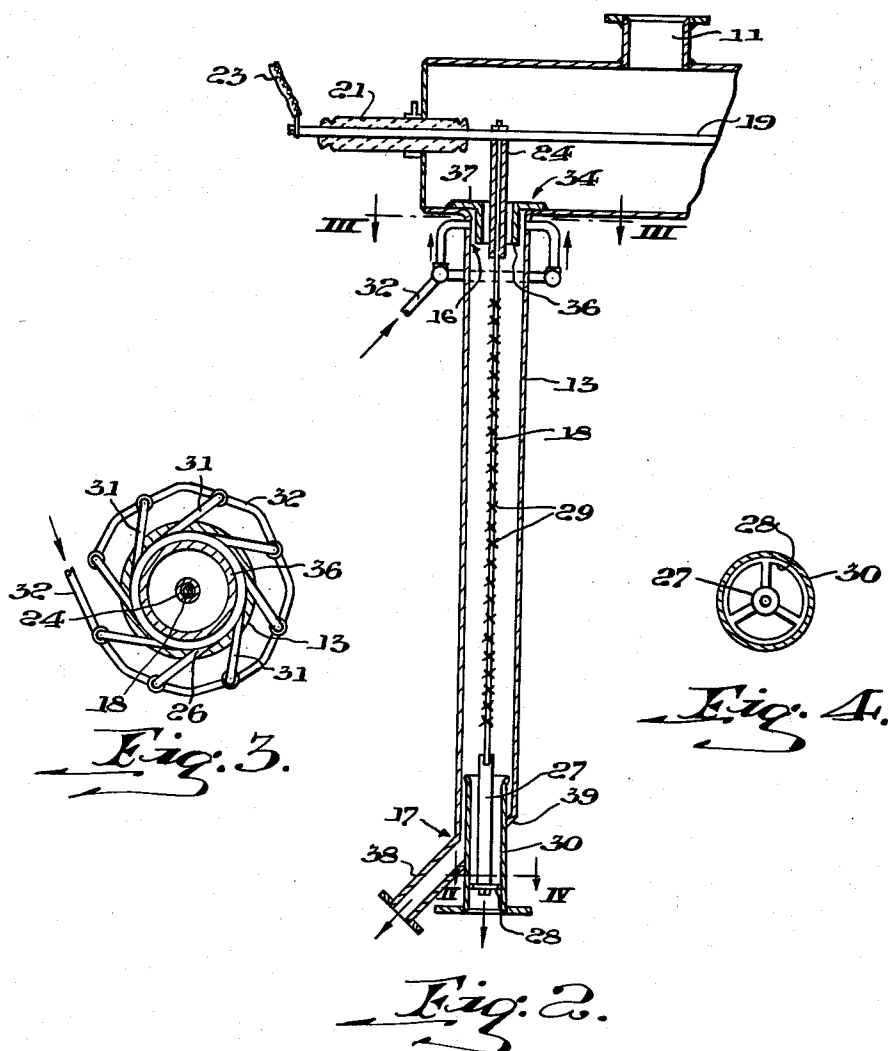
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INVENTOR.
JOHN S. LAGARIAS.
BY
Leo J. MacLossi.
his
ATTORNEY.

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3 Sheets-Sheet 3

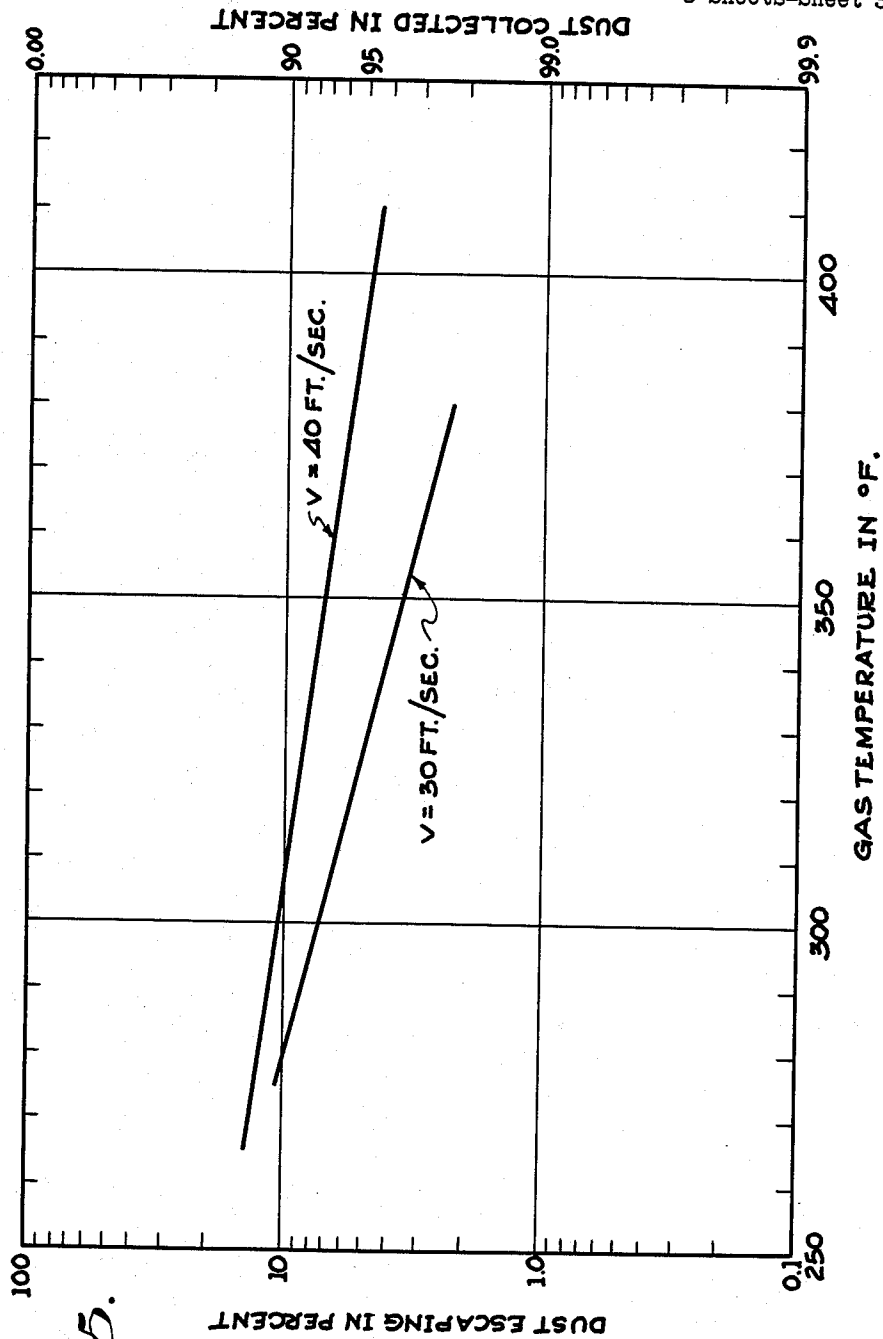


Fig. 5.

INVENTOR.

JOHN S. LAGARIAS

BY

Leo J. MacLrossi

his ATTORNEY

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**METHOD OF OPERATING A HIGH VELOCITY
IRRIGATED PRECIPITATOR**

John S. Lagarias, Pittsburgh, Pa., assignor to Koppers
Company, Inc., a corporation of Delaware
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1 Claim. (Cl. 55—13)

This invention relates to a process for removing suspended particles from gas, and more particularly to the type of electrical precipitation in which a film of liquid is maintained on the surfaces of the collecting electrodes during the operating cycle.

The construction of an electrical precipitator wherein the collecting surface of the collecting electrode is flushed with liquid is described in U.S. Patent No. 2,956,640, granted to Tuche et al. As shown and described herein the present invention has improved the device disclosed in Tuche et al. and its operation in such a manner as to eliminate for all practical purposes the wasteful expense of corrosion of the precipitator components.

Therefore, a principal purpose of the present invention is to provide a process for an irrigated electrical precipitator wherein the incidence of corrosion is substantially eliminated.

Another object of the present invention is to provide a process for operating an electrical precipitator having liquid-flushed collecting electrodes which process maintains a high dew point in the apparatus during the operating cycle.

It is a further object of the present invention to increase the power input into an electrical precipitator employing irrigated collecting electrodes to permit shorter residence times for the gas being treated and thereby limit the amount of moisture entrained therein from the irrigating liquid film.

More particularly, the present invention provides a process whereby corrosion of the collector walls is substantially prevented wherein the dew point of the gas during treatment is maintained sufficiently high as to preclude saturation of the gas or interruption of the liquid film irrigating the collector walls. The retention of the gas above the dew point temperature is accomplished by employing high operating temperatures coupled with increased power input in order that the residence time of the gas within the precipitating chamber is reduced to a minimum.

With these and other objects in view, as will hereinafter more fully appear, and which will be more particularly pointed out in the appended claim, reference is now made to the following description taken in connection with the accompanying drawings in which:

FIG. 1 represents a front elevational view of an electrical precipitator embodying the present invention;

FIG. 2 shows one of the precipitator chambers of FIG. 1 in cutaway view to expose the underlying details;

FIG. 3 is a view taken along the line III—III of FIG. 2 to show the details of the liquid irrigating mechanism;

FIG. 4 is a view taken along line IV—IV of FIG. 2 showing the means for positioning the lower end of the discharge electrode in the precipitator chamber, and

FIG. 5 is a graph showing the effect of temperature on the efficiency of electrical precipitation in a high velocity irrigated precipitator.

Referring now to the drawings there is disclosed a precipitator 10 having a main gas inlet 11 communicating with plenum chamber 12. Connected to the lower wall of plenum chamber 12 are a plurality of elongate vertically disposed tubular precipitating chambers 13, wherein the wall 14 of each chamber serves as a collecting electrode. In the units shown, chambers 13 are

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of uniform circular cross-section. Each of the chambers 13 is provided with a gas inlet 16 and with an outlet designated generally as 17.

Disposed axially within each of the chambers 13 are discharge electrodes 18. Each discharge electrode 18 is connected at its upper end to a conducting rod 19 extending horizontally through the plenum chamber 12. Rod 19 is supported in insulators 21 and 22. Connected to the terminal end of rod 19 is lead 23 extending from a suitable source of power (not shown). The upper end of electrode 18 is covered by an insulating shield 24 of suitable ceramic material. Shield 24 extends into precipitating chamber 13 to a point below liquid ports 26 located adjacent inlet 16. The lower end of electrode 18 is positioned by means of insulating rod 27 mounted on or forming part of open web spider 28 which in turn is disposed in the clean gas discharge tube 30.

Discharge electrode 18, as is shown, is provided with barbs 29. It is conventional to employ discharge electrodes with barbs spaced $2\frac{1}{2}$ inches to 5 inches apart. In dry electrostatic precipitators it has been shown that reduction of the barb spacing from 5 inches to $2\frac{1}{2}$ inches frequently results in impaired precipitator performance and reduced precipitator efficiency. This has led those skilled in the art to assume that further reduction in barb spacing in either a dry or an irrigated precipitator would simply increase the cost of the electrodes with no assurance of increased performance. Contrary to expectations, it has been discovered that in an irrigated precipitator a barb point spacing of as little as 1 inch plus or minus $\frac{1}{2}$ inch actually produces an augmented average field strength without affecting the conducting irrigating film on the surface of the collecting electrode.

Liquid is introduced into precipitating chambers 13 through liquid ports 26 which are tangentially disposed so as to eject a liquid therefrom to form a thin uniform continuous film covering the inner walls of the precipitator chamber. It is particularly important in the prevention of corrosion to insure maintenance of an uninterrupted liquid film covering the inner surface of the precipitator wall 14. This irrigating film serves to wash collected particles from the collector electrode surface carrying the particles so collected and concentrated toward outlet 17.

As is shown in FIG. 3, the inlet ports 26 are equally spaced around the periphery of each cylindrical precipitating chamber 13, each port 26 having connected thereto one end of a tube 31. The other end of each tube 31 is connected to a manifold pipe 32, which pipe 32 is in turn connected to a main line 33 leading from a suitable source of irrigating liquid (not shown).

The precipitating chamber 13 is provided with shielding member 34 adjacent the inlet 16, which shielding member 34 has a downwardly extending annular flange 36 spaced from the inner surface of wall 14 and projecting past liquid ports 26. The horizontal flange 37 of shielding member 34 is fastened to the inner surface of the lower wall of the plenum chamber 12 by welding or other means. Downwardly extending flange 36 serves to shield the ports 26 from the turbulence which normally occurs when the gas enters precipitating chamber 13 from plenum 12. Such turbulence when transmitted to the liquid leaving ports 26 tends to prevent the formation of a smooth continuous film on the inner surface of wall 14. However, by causing the gas to pass by liquid ports 26 while still confined within flange 36, the liquid leaving ports 26 is free to initiate its flow in such a manner that a smooth continuous film is formed before the entering liquid is contacted by the turbulence of the entering gas. Once the continuous film has been formed on the inner surface of wall 14 the deleterious effects of the gas turbulence are substantially reduced. In addition, shielding

member 34 prevents the accumulation of particles at the entrance to chamber 13 from plenum 12 by conducting the gas stream further into the precipitating chamber 13 through a zone of increased velocity.

Each of the precipitating chambers 13 has at its lower outlet 17 means provided for conducting and discharging the cleaned gases from precipitator 10 separately from the irrigating liquid containing in suspension the particles previously suspended in the gas.

Thus, the clean gas discharge tube 30 projects coaxially up into outlet 17 in spaced relationship with the inner surface of wall 14 in order that the irrigating liquid carrying the precipitated particles will pass by the opening of discharge tube 30. This particle-laden irrigating liquid leaves the precipitating chambers 13 by way of fluid discharge conduit 38 which receives the liquid via inclined base 39 of precipitating chamber 13. Manifold pipe 41 collects the liquid discharged from the several fluid discharge conduits 38 and removes this liquid for disposal or further treatment. Clean gas discharge tubes 30 each communicate with a collecting manifold 42 which conducts the gas to storage or disposal facilities.

In the operation of an electrical precipitator such as the device described herein corrosion of the collector walls has posed a serious problem. One approach to this problem has been that of using more expensive corrosion-resistant collecting electrodes. Such measures increase the investment required in precipitator facilities and, at best, only partially increase resistance to corrosion.

Applicant has, on the contrary, concluded that the more advantageous approach to the solution of this corrosion problem lies in changing the method of operation generally employed with such equipment. Thus, in most installations irrigated precipitators are operated at temperatures in the range of 70 to 170° F. It has been discovered that when operating under such temperature conditions, corrosion becomes a serious problem whenever acid vapors or solids are present. Concentrations of these troublesome factors are encountered in significant quantities in the exhaust gases from various steel-making processes and the concentration of acid constituents is particularly high in the gaseous products of those open hearth operations wherein high velocity oxygen is injected through an oxygen lance.

It is significant that as long as the dew point in the precipitator chambers 13 is maintained high enough that the gas being treated does not become saturated and condensed, corrosion can be prevented. Retention of the gas stream above the dew point temperature is accomplished by maintaining the temperature of the gas being operated upon above the boiling point of the flushing liquid. When water is used as the irrigating liquid, temperatures are preferably maintained in the range from about 370° F. to 750° F. In addition, the gas must be passed through the precipitator at high velocity in order to achieve a short residence time of the gases within the precipitating chambers 13. A range of velocity of gas flow between 20 and 60 feet per second will suffice to produce a residence time of less than 0.75 second. In addition, it is imperative that the maximum possible power, in excess of 50 kilovolts, be introduced into the precipitator in order to maintain high efficiency. As mentioned above, the medium employed to produce a greater average field strength is to employ 4-point barbs 29 on discharge electrode 18 spaced at 1 inch plus or minus ½ inch intervals.

Moisture in the gas passing through precipitating chambers 13 may originate directly at the source, such as in the blast furnace or open hearth furnace, or it may be introduced into the gas by means of sprays which are employed at some point ahead of the scrubber (not shown). Moisture which is sprayed into the gas prior to its entry into the scrubber serves to regulate the gas volume and temperature so that a substantially constant volume of gas passes through the scrubbing unit. The advantage of such constant-volume delivery through the scrubber is that a result thereof substantially uniform cleaning of the gas within the precipitating chambers 13 results.

In experimentation carried out in the cleaning of open hearth gas it was determined that the moisture content of this gas upon leaving the furnace was from 8% to 12% by volume and that such gas may contain up to 20% moisture by volume without corrosive effect on the collector walls. This means that in the temperature ranges normally employed (70 to 170° F.) 20% moisture content by volume can be tolerated. However, since it is customary to use sprays as discussed above to insure constant volume delivery, the moisture content is commonly far in excess of 20% by volume. Experimentation has shown that when water is employed as the flushing liquid, if the temperature is increased to 350° F., the moisture content can be increased to a little below 40% by volume without corrosive effect.

The unusual aspect of this method of high temperature operation is the fact that although the operating temperatures are substantially higher than the boiling point of the irrigating liquid a continuous liquid film is maintained on the collecting surfaces. The presence of this continuous film, of course, is necessary to the defeat of the problem of corrosion.

Thus, a series of inter-related factors cumulatively produce the desired elimination of corrosive effects; high temperatures (above the acid dew point temperature), a short residence time and high power input.

In the preferred form of carrying out the invention ordinary tap water may be used as the liquid. However, under some circumstances process water, black liquor, oil or the like may also be used.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claim.

What is claimed is:

The process of separating suspended particles from gases comprising the steps of passing a stream of gas to be treated at a temperature in the range of between 370° F. and 750° F. between a cylindrical collecting electrode surface having an aqueous film uniformly applied thereover and an axially disposed discharge electrode having barbs thereon spaced about 1 inch apart, and applying a voltage to said discharge electrode in excess of 50 kilovolts, said stream of gas having a rate of flow between 20 and 60 feet per second and a residence time of less than 0.75 second.

References Cited in the file of this patent

UNITED STATES PATENTS

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2,505,907	Meston	May 2, 1950
2,956,640	Tuche et al.	Oct. 18, 1960