

PATENT SPECIFICATION

DRAWINGS ATTACHED

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(54) METHOD AND APPARATUS FOR SEPARATING SUSPENDED
 PARTICLES FROM A GAS

(71) We, ALFA-LAVAL AKTIEBOLAG, a company organised under the Laws of Sweden of Postfack, Tumba, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method and an apparatus for separating dust or other suspended particles from a gas. The invention could be used either for purifying a gas, or for recovering substances suspended in a gas. In the food-stuff industry, for example, the invention may be used for recovering, from air or another gas used in so called fluidised-beds for drying a mashed product, particles of this product which have been conveyed from the fluidised-beds by the gas and cannot be separated out in a cyclone or any other normally used separator.

In separating dust particles out of gas, an effective separation is desired with a pressure drop of the flowing gas which is as small as possible. This is very difficult, in that the effectiveness of separation is proportional to the pressure drop. It is thus especially difficult to separate dust particles out of gases which cannot, for one reason or another, be allowed to meet any substantial flow resistance in a separating apparatus. One difficult separating operation is for instance the removal from chimney gases of soot particles and the like. For separating operations of this kind there is, at present, no effective apparatus involving only small pressure losses for the flowing gas. Attempts have been made in such cases to use previously known apparatus of a type in which the gas to be freed from dust particles is allowed to flow upwards through a foam-forming liquid, there being formed on the liquid surface a foam layer which acts like a filter for the through flowing gas. However, even the through flow resistance

caused by this type of apparatus is not sufficiently small for the gas in question and this type of apparatus cannot therefore be used for purifying chimney gases.

The invention provides a method of separating particles from a first gas in a treatment zone having an inlet and an outlet for the said gas comprising the steps of forming foam from a liquid and a gas other than the first gas, charging the treatment zone with the foam at a distance from the inlet for the first gas, and passing the first gas through a substantially stationary layer of the foam to filter the particles from the first gas.

By "foam" is here meant a colloid system in which a gas is dispersed in a liquid.

Preferably a part of the foam in the conduit is broken down, e.g. mechanically, and the liquid thus achieved, which contains dust particles, is caused to run off the foam. Then the part of the foam which has been broken down is replaced by new foam so that the separating operation may go on continuously. It is also possible, however, to refrain from breaking down the foam positively, but to wait until the foam has been saturated with dust particles and starts to break down by itself. New foam may be supplied continuously, or discontinuously with predetermined time intervals.

The gas after having been freed from dust particles may be passed through a gas permeable blocking means, e.g. in the form of a perforated plate, adapted to prevent foam from being conveyed by the gas out of the conduit. The foam supplied to the conduit may be kept in motion by means of a mechanical agitator, or by vibration, so that incoming foam will be rapidly distributed all over the cross sectional area of the conduit. Mechanical agitation may be used also for breaking down foam already consumed for separating out dust particles.

An extremely good separation has been

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achieved in a conduit which tapers in the flow direction of the gas.

A foam suitable for the object here in question may be formed by dispersing air in liquid in such a proportion that the liquid contact will be 2—10% by volume, of all the foam.

The invention also provides apparatus for separating particles from a first gas, which comprises a treatment chamber for through flow of the said first gas, the chamber having a foam inlet, foam-forming means including a source of a liquid and a gas other than the said first gas, the foam-forming means being positioned to charge the chamber through the foam inlet to form a foam layer in the chamber means for supporting the foam layer in the chamber, and means for directing the said first gas into the foam layer at a distance from the foam inlet.

A preferred method and apparatus in accordance with the invention are described below with reference to the accompanying drawing which shows, schematically, an apparatus for freeing chimney gases from soot particles and the like.

The apparatus comprises a tube 1 which is intended to be placed so that it constitutes an extension of a chimney for the through-flow of chimney gas upwards from below, as illustrated by arrows in the drawing. The tube 1 is provided on its inside surface with an upwardly directed annular flange 2 whereon there is arranged a sleeve 3 extending co-axially with the tube 1. On the top of the sleeve 3 there is placed a net or perforated screen 4, and a little bit higher in the tube 1 there is arranged another net or perforated screen 5. Between the two screens 4 and 5 the tube 1 has a section 6 of upwardly decreasing cross-sectional area.

Just above the lower screen 4 means are connected to the tube 1 for charging the latter with foam. These means comprise a fine-meshed net 7 covering an opening in the tube wall, and a nozzle 8 arranged outside the tube. Air and a foam-forming liquid are supplied to the nozzle 8 under pressure, through a conduit 9, and are sprayed on to the net 7. On the inside of the net 7 a foam is formed, which gradually is spread out in the tube 1 and fills it entirely between the two horizontally arranged screens 4 and 5.

The chimney gas flowing through the tube 1 is thus caused to pass through the foam, soot particles and the like contained by the gas then being filtered out by the foam. The flange 2 effectively prevents the gas from flowing up all along the tube walls and failing to be filtered through the foam. When the foam is saturated with soot particles, it is broken down and returned to liquid form. Liquid containing soot will then run downwards along the walls of the tube 1 and be

collected in a groove formed by the flange 2, the outer surface of the sleeve 3, and the inside surface of the tube just beneath the lower screen 4. From this groove the liquid is discharged continuously from the tube through a conduit 10. The form of the tube section 6 guarantees a uniform density of the foam between the two screens 4 and 5, as the decreasing cross-sectional area of the section 6 compensates for the breaking down of foam, which increases in the direction of flow of the gas.

The above described method has many advantages:

1. The foam supplied to the tube offers an extremely low flow resistance to the gas flowing through it, and it blockades effectively the path for the dust particles contained by the gas. It is thus possible to achieve an effective separation with a pressure drop for the gas, amounting to only a few millimeters head of water.

2. As a foam has a volume several times larger than the liquid from which it is formed, the amount of liquid resulting from foam having been broken down will be very small, and this facilitates the removal and/or recovery of dust particles separated out.

3. As the foam has a volume several times larger than the liquid from which it is formed, it will be obvious that the amount of liquid which has to be supplied for compensating for the foam having been broken down will be very small, too.

4. This method enables the use of an apparatus which may be very easily installed in existing plants providing a flow of gas containing dust particles, and it results in no substantial change in the pressure of the flowing gas. There is, thus, no need to change fans, or to build higher chimneys.

5. By this method it is even possible to purify gases coming from very small combustion units, without auxiliary fans.

6. A similar method may be employed very easily when the gas to be freed from dust particles flows through a horizontal tube. In the known type of apparatus initially described the gas has to pass through a horizontal foam-forming liquid layer, and this may sometimes complicate the arrangement of the apparatus.

WHAT WE CLAIM IS:—

1. A method of separating particles from a first gas in a treatment zone having an inlet and an outlet for the said gas, comprising the steps of forming foam from a liquid and a gas other than the first gas, charging the treatment zone with the foam at a distance from the inlet for the first gas, and passing the first gas through a substantially stationary layer of the foam to filter the particles from the first gas.

2. A method according to claim 1 com-

achieved in a conduit which tapers in the flow direction of the gas.

A foam suitable for the object here in question may be formed by dispersing air in liquid in such a proportion that the liquid contact will be 2—10% by volume, of all the foam.

The invention also provides apparatus for separating particles from a first gas, which comprises a treatment chamber for through flow of the said first gas, the chamber having a foam inlet, foam-forming means including a source of a liquid and a gas other than the said first gas, the foam-forming means being positioned to charge the chamber through the foam inlet to form a foam layer in the chamber means for supporting the foam layer in the chamber, and means for directing the said first gas into the foam layer at a distance from the foam inlet.

A preferred method and apparatus in accordance with the invention are described below with reference to the accompanying drawing which shows, schematically, an apparatus for freeing chimney gases from soot particles and the like.

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Just above the lower screen 4 means are connected to the tube 1 for charging the latter with foam. These means comprise a fine-meshed net 7 covering an opening in the tube wall, and a nozzle 8 arranged outside the tube. Air and a foam-forming liquid are supplied to the nozzle 8 under pressure, through a conduit 9, and are sprayed on to the net 7. On the inside of the net 7 a foam is formed, which gradually is spread out in the tube 1 and fills it entirely between the two horizontally arranged screens 4 and 5.

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collected in a groove formed by the flange 2, the outer surface of the sleeve 3, and the inside surface of the tube just beneath the lower screen 4. From this groove the liquid is discharged continuously from the tube through a conduit 10. The form of the tube section 6 guarantees a uniform density of the foam between the two screens 4 and 5, as the decreasing cross-sectional area of the section 6 compensates for the breaking down of foam, which increases in the direction of flow of the gas.

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WHAT WE CLAIM IS:—

1. A method of separating particles from a first gas in a treatment zone having an inlet and an outlet for the said gas, comprising the steps of forming foam from a liquid and a gas other than the first gas, charging the treatment zone with the foam at a distance from the inlet for the first gas, and passing the first gas through a substantially stationary layer of the foam to filter the particles from the first gas.

2. A method according to claim 1 com-



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- prising replacing consumed foam by charging the treatment zone with new foam to maintain a foam layer in the said zone.
3. A method according to claim 1 or 2, comprising retaining the foam in the treatment zone until the foam is broken down to a liquid, and then removing the broken down foam liquid and particles suspended therein from the treatment zone.
4. A method according to claim 1, 2 or 3 comprising passing the said first gas after being freed from particles, through a blocking zone for preventing foam from being conveyed by the first gas from the treatment zone.
5. A method according to any preceding claim, comprising mechanically agitating the foam within the treatment zone to distribute the incoming foam rapidly over the cross-sectional area of the zone.
6. Apparatus for separating particles from a first gas, which comprises a treatment chamber for through flow of the said first gas, the chamber having a foam inlet, foam-forming means including a source of a liquid and a gas other than the said first gas, the foam-forming means being positioned to charge the chamber through the foam inlet to form a foam layer in the chamber, means for supporting the foam layer in the chamber, and means for directing the said first gas into the foam layer at a distance from the foam inlet.
7. Apparatus according to claim 6 in which the foam-supporting means comprises a perforated member positioned in the path of the said first gas flowing through the chamber.
8. Apparatus according to claim 7 in which the perforated member is positioned so that the said first gas flows through the perforated member before penetrating into the foam layer.
9. Apparatus according to claim 6, 7 or 8 in which the cross sectional area of the chamber decreases in the flow direction of the said first gas.
10. Apparatus according to claim 6, 7, 8 or 9 in which the foam-forming and charging means include a fine-meshed element adjoining the chamber and a nozzle located outside the chamber for spraying the said other gas and foam-forming liquid against the fine-meshed element.
11. Apparatus according to any one of claim 6—10 in which the chamber is provided with an internal groove for collecting liquid drained from the foam.
12. Apparatus according to any one of claims 6—11 in which the chamber is formed by a vertically disposed tube.
13. Apparatus according to claim 12 comprising an upwardly and inwardly directed annular flange in the tube, the flange at least partly defining a groove extending around the inside of the tube for collecting liquid draining from the foam.
14. Apparatus according to claim 13 as appended to claim 7 in which the flange is arranged to direct the said first gas along the central portion of the tube just below the perforated element.
15. A method of separating dust particles from a gas, substantially as herein described.
16. Apparatus for separating dust particles from a gas, substantially as herein described with reference to the accompanying drawing.

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