A tower distributor receives a stream of working media including pulverized coal and a carrier gas in a coal burning power plant. The tower distributor includes a wall structure and one or more flow directing members including diverters, vane members, and/or protuberances. The wall structure defines a flow passageway for the stream of working media and includes an inlet and an outlet spaced from the inlet in an axial direction. Each flow directing member is provided to alter the flow of the working media through the tower distributor.
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TOWER DISTRIBUTOR IN A COAL BURNING POWER PLANT

CROSS REFERENCE TO RELATED APPLICATION

This application Claims the benefit of U.S. Provisional Patent Application Serial No. 61/432,338, filed January 13, 2011, entitled "DISTRIBUTOR OF PULVERIZED COAL AND CARRIER AIR FOR EXHAUSTOR MILLS", the entire disclosure of which is incorporated by reference herein.

FIELD OF THE INVENTION

The present invention relates to a tower distributor in a coal burning power plant, and more particularly, to a tower distributor including a plurality of working media flow directing structures for providing a generally even distribution of pulverized coal and carrier air to one or more burners of the power plant.

BACKGROUND OF THE INVENTION

In a coal burning power plant, pulverized coal is transported through a pipe or duct system that connects an exhauster mill to one or more burners of a furnace. The pulverized coal is typically transported within the pipe system by a carrier gas, e.g., air, which combines with the pulverized coal to form a heterogeneous stream of working media. As the stream of working media moves through the pipe system, the solid particles of the pulverized coal in the stream of working media tend to concentrate together in a pattern generally referred to in the art as a rope strand. This phenomenon is commonly referred to in the art as "roping".

Due to the roping phenomenon, attempts to split the stream into multiple sub-streams for transport to respective burners in the furnace may not yield equal amounts of working media being supplied to each of the burners. Unstable combustion and reduced efficiency result from such unequal distribution of working media into the respective burners.

SUMMARY OF THE INVENTION

In accordance with a first aspect of the present invention, a tower distributor is provided that receives a stream of working media including pulverized coal and a
carrier gas in a coal burning power plant. The tower distributor comprises a wall
structure and at least one diverter. The wall structure defines a flow passageway for
the stream of working media and includes an inlet and an outlet spaced from the inlet
in an axial direction. Each diverter is located between the inlet and the outlet and is
affixed to an inner surface of the wall structure. Each diverter extends axially and
circumferentially along the wall structure from a first position located at an area of
working media concentration downstream from the inlet to a second position
downstream from the first position. Further, each diverter defines a flow channel to
effect a diversion of a portion of the stream of working media from the first position to
the second position.

In accordance with a second aspect of the present invention, a tower
distributor is provided that receives a stream of working media including pulverized
coal and a carrier gas in a coal burning power plant. The tower distributor comprises
a wall structure and a pair of diverters. The wall structure defines a flow
passageway for the stream of working media and includes an inlet and an outlet
spaced from the inlet in an axial direction. The diverters are affixed to an inner
surface of the wall structure and are located circumferentially adjacent to one
another between the inlet and the outlet of the wall structure. The diverters extend
along the wall structure in the axial direction and extend circumferentially in opposite
directions. The diverters extend from respective first positions located at an area of
working media concentration downstream from the inlet to respective second
positions downstream from the respective first positions. Further, the diverters
define flow channels to effect a diversion of respective portions of the stream of
working media from the respective first positions to the corresponding second
positions. The working media flowing through the tower distributor forms a coal
rope, and the area of working media concentration defines an area of the coal rope
with a higher allocation of pulverized coal than a remaining portion of the coal rope.

In accordance with a third aspect of the present invention, a tower
distributor is provided that receives a stream of working media including pulverized coal and a
carrier gas in a coal burning power plant. The tower distributor comprises a wall
structure, at least one diverter, and at least one adjustable vane member. The wall
structure defines a flow passageway for the stream of working media and includes an inlet and an outlet spaced from the inlet in an axial direction. Each diverter is located between the inlet and the outlet and is affixed to an inner surface of the wall structure. Each diverter extends axially and circumferentially along the wall structure from a first position located at an area of working media concentration downstream from the inlet to a second position downstream from the first position. The area of working media concentration is located on a circumferentially opposed side of the wall structure than an exhauster mill fan that delivers the stream of working media to the tower distributor. Further, each diverter defines a flow channel to effect a diversion of a portion of the stream of working media from the first position to the second position. Each vane member is attached to the wall structure and extends radially inwardly from the inner surface of the wall structure.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the present invention, it is believed that the present invention will be better understood from the following description in conjunction with the accompanying Drawing Figures, in which like reference numerals identify like elements, and wherein:

Fig. 1 is a side plan view of a portion of a coal burning power plant including a tower distributor according to an embodiment of the invention;

Fig. 2 is a cross sectional view of the tower distributor in Fig. 1 taken along line 2-2 in Fig. 1;

Fig. 3 is a cross sectional view of the tower distributor in Figs. 1 and 2 taken along line 3-3 in Fig. 2; and

Fig. 4 is a perspective view of the tower distributor in Figs. 1-3 shown with a wall structure of the tower distributor depicted in phantom lines.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description of the preferred embodiment, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration, and not by way of limitation, a specific preferred embodiment in
which the invention may be practiced. It is to be understood that other embodiments
may be utilized and that changes may be made without departing from the spirit and
scope of the present invention.

Referring now to Fig. 1, a portion of a coal burning power plant 10 is shown. The power plant 10 includes a conventional exhauster mill fan 12, also known as a coal mill fan, a tower distributor 14, and a plurality of conventional burners (not shown) downstream from the tower distributor 14 with respect to a direction of coal flow through the power plant 10, as generally represented by the line-arrows 16 in Fig. 1.

An exhauster mill (not shown) receives coal and a carrier gas, e.g., air, pulverizes the coal for distribution via the carrier gas, and directs the pulverized coal and carrier air toward the tower distributor 14 via the exhauster mill fan 12. The combination of pulverized coal and carrier gas is referred to herein as "working media". The power plant 10 includes one or more feed pipes 18 (one shown in Fig. 1) that is/are provided to distribute the working media from the exhauster mill fan 12 to the tower distributor 14.

Referring to Figs. 2-4, the tower distributor 14 according to aspects of the invention will now be described. The tower distributor 14 comprises a wall structure 20 defining a flow passageway 22 for the stream of working media. The wall structure 20 may comprise one or more conduits, and in the embodiment shown the wall structure 20 comprises first and second conduits 20A, 20B bolted together. The wall structure includes an inlet 24 that receives the stream of working media from the exhauster mill fan 12 via the feed pipes 18. The wall structure 20 further includes an outlet 26 spaced from the inlet 24 in an axial direction of the tower distributor 14, see Figs. 2 and 3. As illustrated in Figs. 2 and 3, the outlet 26 may supply the working media from the tower distributor 14 to a plurality of outlet pipes 28, which each deliver a portion of the working media to a burner.

Referring to Figs. 2-4, the tower distributor 14 further comprises first and second circumferentially adjacent diverters 30, 32 located between the inlet 24 and the outlet 26. The diverters 30, 32 are affixed to an inner surface 34 of the wall structure 20 and are generally L-shaped in cross-section. The diverters 30, 32
define flow channels within the legs of the L-shape to effect a diversion of respective portions of the stream of working media, as will be discussed herein.

The diverters 30, 32 extend axially downstream and circumferentially in opposite directions from one another along the inner surface 34 of the wall structure 20 from entrance portions 30A, 32A of the diverters 30, 32 located at respective first positions to outlet portions 30B, 32B of the diverters 30, 32 located at respective second positions downstream from the first positions in an axial direction of the tower distributor 14 (see Fig. 4). The diverters 30, 32 preferably extend at angles of about 35-55 degrees relative to the axial direction, and each diverter 30, 32 preferably spans at least about 90° of an inner circumference of the wall structure 20.

The entrance portions 30A, 32A of the diverters 30, 32 are advantageously arranged near the inlet 24 of the tower distributor 14, i.e., slightly downstream from the inlet 24, at an area of working media concentration 40 (see also Fig. 1). The area of working media concentration 40 comprises an area within the tower distributor 14 that has been found to comprise a higher allocation of pulverized coal than a remaining portion of tower distributor 14 at the same axial location as the area of working media concentration 40. That is, as the stream of working media flows from the exhauster mill fan 12 toward the burners, the phenomenon of roping occurs, as discussed above. The area of working media concentration 40 defines an area within the tower distributor 14 where the coal rope comprises a large amount of pulverized coal. Due to the placement of the entrance portions 30A, 32A of the diverters 30, 32, the diverters 30, 32 redirect portions of the working media from the area of working media concentration 40 to the second positions at the respective diverter outlet portions 30B, 32B, as will be discussed herein. As shown in Fig. 1, the area of working media concentration 40 is located in close proximity to the inlet 24 of the tower distributor 14 on a circumferentially opposed side of the wall structure 20 than the exhauster mill fan 12.

As shown in Figs. 2 and 4, a gap G having a component in the circumferential direction is formed between entrance portions 30A, 30B of the respective diverters 30, 32. Preferably, the circumferential component of the gap spans about 1-10% of the inner circumference of the wall structure 20.
The tower distributor 14 further comprises first and second adjustable vane members 46, 48 attached to the wall structure 20, see Figs. 2-4. The vane members 46, 48 extend radially inwardly from the inner surface 34 of the wall structure 20 and each are associated with a corresponding handle 50, 52 located outside of the tower distributor 14, see also Fig. 1. The handles 50, 52 can be manipulated from outside of the tower distributor 14 to adjust the orientation of the corresponding vane member 46, 48 during operation of the power plant 10 to effect a change in flow direction of a portion of the working media flowing through the wall structure 20 near the corresponding vane member 46, 48, as will be discussed herein. In a preferred embodiment, the handles 50, 52 each have a plurality of preset positions, each preset position corresponding to a particular orientation of the corresponding vane member 46, 48. The preset positions may be defined, for example, by a handle tine 50A, 52A (Figs. 3 and 4) engaged in one of a plurality of holes 55 formed in respective bars 54A, 56A of the handles 50, 52 supported on the wall structure 20.

The combinations of the first and second vane members 46, 48 and their corresponding handles 50, 52 are referred to herein as first and second vane assemblies 54, 56, see Figs. 3 and 4.

As shown most clearly in Fig. 2, the first vane assembly 54 is located in the circumferential direction between the respective entrance portions 30A, 32A of the first and second diverters 30, 32, i.e., the first vane assembly 54 is generally circumferentially aligned with the gap G formed between the entrance portions 30A, 32A. Further, the first vane assembly 54 may be generally axially aligned with the outlet portions 30B, 32B of the first and second diverters 30, 32. As will be described herein, a portion of the working media that passes through the gap G flows toward the first vane member 46, wherein the first vane member 46 may alter the direction of the portion of working media.

The second vane assembly 56 is located axially downstream from the first vane assembly 54 and is located in the circumferential direction generally midway between respective outlet portions 30B, 32B of the diverters 30, 32. Further, the second vane assembly 56 may be located axially downstream from the first vane assembly 54 and downstream from a radially outwardly tapered downstream end 21
of the first conduit 20A. As will be described herein, the second vane member 48
may alter the direction of working media flowing nearby.

The tower distributor 14 further comprises first and second protuberances 60,
62, which are generally circumferentially aligned with and are downstream from the
respective first and second vane members 46, 48 in the embodiment shown. The
protuberances 60, 62 extend radially inwardly from the wall structure 20 and include
angled, lower surfaces 60A, 60B and 62A, 62B, see Fig. 4. The angled surfaces
60A, 60B and 62A, 62B deflect portions of the working media flowing by the
protuberances 60, 62, as will be discussed herein.

During operation of the coal burning power plant 10, coal and carrier air are
delivered to the exhauster mill. The exhauster mill pulverizes the coal and the
exhauster mill fan 12 distributes the pulverized coal and the carrier air to the tower
distributor 14 through the feed tubes 18.

The stream of working media forms a coal rope in the tower distributor 14, as
described above. The formation of the coal rope creates the area of working media
concentration 40 near the inlet 24 of the tower distributor 14 on the opposite side of
the wall structure 20 from the exhauster mill fan 12. Portions of the working media in
the area of working media concentration 40 enter the flow channels defined by the
diversers 30, 32 at the respective diverter entrance portions 30A, 32A. These
portions of the working media follow the flow channels defined by the diversers 30,
32 around the inner circumference of the wall structure 20 and are released by the
diversers 30, 32 at the second positions by the diverter outlet portions 30B, 32B, i.e.,
the respective flows of working media are diverted by the diversers 30, 32.

As the working media released by the diverter outlet portions 30B, 32B flows
axially downstream, portions thereof may flow past the second vane member 48.
The orientation of the second vane member 48 can be adjusted by the second
handle 52 as needed to modify the flow angle of the working media. A determination
may be made for a desired angle of the second vane member 48 using an online
monitoring system 70, schematically shown in Fig. 1. The online monitoring system
70 may monitor conditions within the outlet pipes 28. For example, the online
monitoring system 70 may indicate that a higher percentage of the working media is passing into one or more of the outlet pipes 28 than one or more other ones of the outlet pipes 28, in which case the second vane member 48 can be adjusted to modify the flow of the working media through the tower distributor 14, thus effecting a change in the amount of working media passing into each of the respective outlet pipes 28. The online monitoring system 70 may monitor one or more operating conditions within the tower distributor 14 or within the outlet pipes 28 to determine the amount of working media passing into the outlet pipes 28, as will be apparent to those skilled in the art.

Once past the second vane member 48, the working media flows into the second protuberance 62. The angled surfaces 62A, 62B of the second protuberance 62 deflect the working media to further separate the flow of working media into substantially equal portions for delivery into the respective outlet pipes 28.

A portion of the working media in the area of working media concentration 40 that is not diverted by the diverters 30, 32 flows through the gap G between the diverter entrance portions 30A, 32A. As this portion of the working media flows axially downstream, it flows past the first vane member 46. The orientation of the first vane member 46 can be adjusted by the first handle 50 as needed to modify the flow angle of this portion of the working media. A determination may be made for a desired angle of the first vane member 46 using the online monitoring system 70, as described above.

Once past the first vane member 46, the working media flows into the first protuberance 60. The angled surfaces 60A, 60B of the first protuberance 60 deflect the working media to further separate the flow of working media into substantially equal portions for delivery into the respective outlet pipes 28.

The tower distributor 14 described herein is believed to deliver a substantially equal amount of working media to each of the outlet pipes 28 by changing the configuration of the coal rope, such that substantially equal amounts of working media are delivered to each of the respective burners. In an embodiment where the outlet pipes 28 feed multiple fuel injectors (not shown) in a common burner, a substantially equal amount of working media is believed to be supplied to the
respective fuel injectors.

By delivering a substantially equal amount of working media to each of the outlet pipes 28, emission levels of unwanted products, such as CO, NOx, and unburned carbon are believed to be reduced. Also, areas of high heat flux within the burners are believed to be reduced, since none of the burners have excessive amounts of pulverized coal. Moreover, air imbalance within the burners is believed to be minimized, thus substantially preventing high airflow velocities at fuel nozzle outlets and subsequent unstable combustion.

Additionally, since the tower distributor 14 of the present invention merely diverts portions of the working media flowing therethrough, and does not mechanically disrupt the flow of working media, a pressure drop of the working media effected by the tower distributor 14 is believed to be reduced, thus increasing the efficiency of the power plant 10. Further, since the flow directing components within the tower distributor 14 do not directly impede the flow of the working media but rather redirect or divert the flow of working media, erosion damage to the flow directing components is believed to be reduced.

While the tower distributor 14 disclosed herein comprises two diverters 30, 32, two vane members 46, 48, and two protuberances 60, 62, it is noted that additional or fewer ones of these respective components could be included in the tower distributor 14.

While a particular embodiment of the present invention has been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.
CLAIMS

What is claimed is:

1. A tower distributor that receives a stream of working media including pulverized coal and a carrier gas in a coal burning power plant, the tower distributor comprising:
   - a wall structure defining a flow passageway for the stream of working media,
   - the wall structure including an inlet and an outlet spaced from the inlet in an axial direction; and
   - at least one diverter between the inlet and the outlet and affixed to an inner surface of the wall structure, wherein the at least one diverter:
     - extends axially and circumferentially along the wall structure from a first position located at an area of working media concentration downstream from the inlet to a second position downstream from the first position; and
     - defines a flow channel to effect a diversion of a portion of the stream of working media from the first position to the second position.

2. The tower distributor of claim 1, wherein the area of working media concentration is located on a circumferentially opposed side of the wall structure from an exhauster mill fan that delivers the stream of working media to the tower distributor.

3. The tower distributor of claim 2, wherein the area of working media concentration is located in close proximity to the inlet of the wall structure.

4. The tower distributor of claim 3, wherein the working media flowing through the tower distributor forms a coal rope, and wherein the area of working media concentration defines an area of the coal rope with a higher allocation of pulverized coal than a remaining portion of the coal rope.
5. The tower distributor of claim 1, wherein the at least one diverter comprises two circumferentially adjacent diverters extending axially downstream and extending circumferentially in opposite directions.

6. The tower distributor of claim 5, wherein a gap having a component in the circumferential direction is formed between entrance portions of the respective diverters, the circumferential component of the gap being about 1-10% of an inner circumference of the wall structure.

7. The tower distributor of claim 1, wherein the at least one diverter extends at an angle of about 35-55 degrees relative to the axial direction.

8. The tower distributor of claim 1, wherein the at least one diverter extends along at least about 90° of an inner circumference of the wall structure.

9. The tower distributor of claim 1, further comprising at least one adjustable vane member attached to the wall structure, each vane member extending radially inwardly from the inner surface of the wall structure.

10. The tower distributor of claim 9, further comprising a handle for each vane member, each handle being located outside of the tower distributor for adjusting the orientation of the corresponding vane member during operation of the power plant to effect a change in flow direction of a portion of the working media flowing through the wall structure near the corresponding vane member.

11. The tower distributor of claim 10, wherein each handle has a plurality of preset positions, each preset position corresponding to a particular orientation of the corresponding vane member.

12. The tower distributor of claim 9, further comprising at least one protuberance generally axially aligned with each respective vane member, each protuberance extending radially inwardly from the wall structure downstream from the respective vane member.
13. A tower distributor that receives a stream of working media including
pulverized coal and a carrier gas in a coal burning power plant, the tower distributor
comprising:

a wall structure defining a flow passageway for the stream of working media,
the wall structure including an inlet and an outlet spaced from the inlet in an axial
direction; and

a pair of diverters affixed to an inner surface of the wall structure and located
circumferentially adjacent to one another between the inlet and the outlet of the wall
structure, wherein the diverters:

extend along the wall structure in the axial direction and extend
circumferentially in opposite directions, the diverters extending from
respective first positions located at an area of working media concentration
downstream from the inlet to respective second positions downstream from
the respective first positions; and

define flow channels to effect a diversion of respective portions of the
stream of working media from the respective first positions to the
corresponding second positions; and

wherein the working media flowing through the tower distributor forms a coal
rope, and wherein the area of working media concentration defines an area of the
coal rope with a higher allocation of pulverized coal than a remaining portion of the
coal rope.

14. The tower distributor of claim 13, wherein the area of working media
concentration is located in close proximity to the inlet of the wall structure on a
circumferentially opposed side of the wall structure from an exhauster mill fan that
delivers the stream of working media to the tower distributor.

15. The tower distributor of claim 13, wherein:

a gap having a component in the circumferential direction is formed between
entrance portions of the respective diverters, the circumferential component of the
gap being about 1-10% of an inner circumference of the wall structure; and
the diverters extend at angles of about 35-55 degrees relative to the axial
direction and extend along at least about 90° of the inner circumference of the wall
structure.

16. A tower distributor that receives a stream of working media including
pulverized coal and a carrier gas in a coal burning power plant, the tower distributor
comprising:

a wall structure defining a flow passageway for the stream of working media,
the wall structure including an inlet and an outlet spaced from the inlet in an axial
direction;

at least one diverter between the inlet and the outlet and affixed to an inner
surface of the wall structure, wherein the at least one diverter:

extends axially and circumferentially along the wall structure from a first
position located at an area of working media concentration downstream from
the inlet to a second position downstream from the first position, the area of
working media concentration being located on a circumferentially opposed
side of the wall structure than an exhauster mill fan that delivers the stream of
working media to the tower distributor; and

defines a flow channel to effect a diversion of a portion of the stream of
working media from the first position to the second position; and

at least one adjustable vane member attached to the wall structure, each
vane member extending radially inwardly from the inner surface of the wall structure.

17. The tower distributor of claim 16, wherein the at least one diverter comprises
two circumferentially adjacent diverters extending axially downstream and extending
circumferentially in opposite directions, and wherein a gap having a component in
the circumferential direction is formed between entrance portions of the respective
diversers.

18. The tower distributor of claim 17, wherein the at least one vane member
comprises two vane members, the first vane member being located in the
circumferential direction between the respective entrance portions of the diverters
and the second vane member being located in the circumferential direction generally midway between respective outlet portions of the diverters.

19. The tower distributor of claim 16, further comprising a handle for each vane member, each handle being located outside of the tower distributor for adjusting the orientation of the corresponding vane member during operation of the power plant to effect a change in flow direction of a portion of the working media flowing through the wall structure near the corresponding vane member, wherein each handle has a plurality of preset positions, each preset position corresponding to a particular angle of the corresponding vane member.

20. The tower distributor of claim 16, further comprising at least one protuberance generally axially aligned with each respective vane member, each protuberance extending radially inwardly from the wall structure downstream from the respective vane member and deflecting working media passing thereby.