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(54) **A method of drying particulate material and a spouted bed drier therefor.**

(57) A spouted bed drier is adapted for application of an R F field to particulate material being dried prior to movement of the material through the spout thereby to assist in drying of the material.

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Description

A METHOD OF DRYING PARTICULATE MATERIAL AND A SPOUTED BED DRIER THEREFOR

The present invention relates to a method of drying particulate material and in particular the use of a spouted bed drier in such a method.

It is well known to dry particulate material by blowing a drying gas, typically hot air, upwards through a bed of the material in a vessel.

In one known method the flow of drying air is evenly distributed across the bed and is arranged effectively to fluidise the bed so that all particles of material in the bed are exposed to the drying gas flow. However, there are many particulate materials which are difficult to fluidise, especially when wet. For such materials, another method, using a so-called spouted bed drier, is used, in which the drying air is directed upwards from a nozzle usually centrally located in the base of the vessel which is shaped as an inverted cone. The gas stream emerging upwards from the nozzle produces a central column or spout where the particles are relatively loosely packed and rise entrained in the upward stream of gas. Surrounding the spout region the particulate material lies relatively densely packed, slowly descending downwards to the bed to re-enter the spout. In this way, all particles in the bed are exposed to the stream of drying air as they are conveyed upwards in the spout.

In one form of spouted bed drier of this type, for example as shown in Fig. 16 of FR-A-1264123, a so-called draft tube is included, comprising an open ended tube located above the nozzle in the base of the vessel and through with the main upwardly flowing gas stream passses, together with the entrained particulate material. The draft tube effectively separates the rising spout region of material from the falling densely packed region and permits the bed of material to be made considerably deeper.

With such spouted bed driers with a draft tube, the heat transfer to effect drying of the particles of the material is by convection from the hot gas. Within the individual particles moisture is transferred outwards to the surface of the particle as the outer surfaces are dried, by the effect of partial pressure gradients. Thus, there is a limit to the rate at which the material can be dried without over heating and damaging the outer surfaces of the particles. Moisture is removed only from the surface of the particles and there is a maximum rate at which moisture from inside the particle migrates to the surface.

It is known (see for example GB-A-2123537) to use radio frequency or microwave energy for drying sheet or web materials, by combining radio frequency with hot air convective drying to produce a very substantial improvement in the overall drying efficiency. By the addition of radio frequency heat energy comprising only a small proportion (typically 10 to 25%) of the total heat energy in the drying process including the hot air, drying speeds can be improved dramatically. It is believed this improvement arises because the R.F. energy is absorbed internally in the thickness of the material being dried and has the effect of forcing moisture outwards to the surface where it can readily be evaporated in the hot air stream. As a result the efficiency of hot air convective drying when applied to a wet surface, is maintained for substantially the whole of the drying cycle.

According to one aspect of the present invention there is provided a method of drying particulate material, comprising forming a bed of the material, and blowing drying gas upwards through the bed to produce a rising spout region of relatively loosely packed particles entrained in the gas and a falling region of relatively densely packed particles descending to the bed, characterised by the step of applying an R F field substantially only to said falling densely packed region to assist in drying of the particulate material.

According to another aspect of the present invention there is provided a spouted drier comprising a vessel containing a draft tube assembly separating a rising spout region from a falling relatively densely packed region, characterised by a first electrode between the rising spout region and the falling relatively densely packed region, a second electrode outside the falling relatively densely packed region, and a source of R F energy connected to the first and second electrodes whereby an R F electric field is set up substantially only in the falling relatively densely packed region to assist in the drying process.

By confining the R F field to the relatively densely packed region of the spouted bed, the efficiency of applying the R F energy to assist the drying process is maximized.

Conveniently, the draft tube assembly has cylindrical symmetry about an upwardly extending axis, and comprises an inner cylindrical member confining the rising spout region and an outer cylindrical member forming the first electrode and defining the axially inner surface of the falling relatively densely packed region.

The inner cylindrical member should be located and have a diameter selected to meet the necessary aerodynamic requirements of the draft tube. The outer cylindrical member should be positioned radially spaced from the inner cylindrical member, so as to maximise the efficiency of generation of the R F Field in the relatively densely packed region.

The second electrode may form an outer cylindrical containment wall for the falling relatively densely packed region. Then the second electrode may be connected to earth potential, thereby to act also as an outer screening cage for the R F field.

The present invention will now be described by way of example with reference to the drawing which is a cross sectional view in elevation of a spouted bed drier according to the invention.

Referring to the drawing the illustrated drier comprises a cylindrical vessel 10 made from a non-magnetic metal enclosed at the bottom and vented at the top. A nozzle 9 is located centrally in the base of the vessel 10 to direct drying air upwardly, substantially along the axis of the vessel. A draft tube assembly 11 is mounted axially inside the vessel 10 by means of electrically insulating support struts 12. The draft tube assembly 11 has an inner cylindrical tube 13 which is aligned with the nozzle 9. An outer cylindrical member 14 is mounted coaxial to the inner tube 13, and is connected thereto by frusto-conical surfaces 15 and 16 at respective ends of the assembly.

In use, a batch of particulate material to be dried is put into the vessel 10 forming a relatively densely packed bed of the material in the annular space between the outer element 14 of the draft tube assembly 11 and the vessel 10. The bed extends downwards to a base defined by an inverted frusto-conical element 17 which tends to deflect the particulate material towards the axis of the vessel over the nozzle 9. Drying air blown into the vessel 10 through the nozzle 9 disturbs an axial region of the bed at the base and produces a spout of relatively loosely packed particulate material entrained in the air rising upwards from the nozzle 9 and through the inner tube 13 of the draft tube assembly 11. The frusto-conical member 16 at the lower end of the draft tube assembly 11 is an inverted cone, as illustrated in the drawing, tending to concentrate the spout formed by the nozzle 9 into the inner tube 13. The upper frusto-conical member 15 is shaped to deflect particulate material leaving the upper end of the inner tube 13 and tending to fall back again from the spout, outwards to the surface of the relatively densely packed region of the bed.

It will be appreciated that as material is swept up in the spout along the inner tube 13 and deposited on top of the relatively densely packed region of the bed, the material progressively falls towards the base of the vessel 10, at which it is deflected inwards to be swept up again by the drying air from the nozzle 9. In this way the particulate material is continuously circulated experiencing successive periods in the spout in the inner tube 13 during which efficient convective drying can take place.

The above described operation is typical of known spouted bed driers with draft tubes, except that known driers do not have the outer cylindrical member 14 of the draft tube assembly 11 as described.

The outer cylindrical member 14 is made of non-magnetic metal and is connected as indicated at 18 to a source of radio frequency energy, whilst the vessel 10 is connected to earth potential. In this way, a radio frequency field is set up in the annular region between the outer cylindrical element 14 and the vessel 10. The R F electric field is selected to be at a suitable frequency to cause losses to occur in the moisture in the particulate material in the relatively densely packed region of the bed, thereby providing heat to assist the drying process. The material is exposed to the electric field as it slowly falls in the relatively densely packed region towards the base of the vessel, and during the course of this exposure moisture from within the particles tends to migrate to the surface of the particles under the influence of the R F heating. As a result the particles are presented again to the spout in the inner tube 13 with substantial surface wetness which is efficiently evaporated during the residence of the particles in the spout rising up in the inner tube 13.

The vessel 10, being at earth potential, provides not only one of the electrodes of the R F heating system but also a Faraday cage confining the electric field to within the drying vessel.

There are substantially no electric fields produced inside the outer cylindrical member 14 so that the rising spout region of the bed is not exposed to R F heating. The inner tube 13 of the draft tube assembly 11 may be electrically connected to the outer cylindrical member 14.

The radial spacing between the inner tube 13 and the outer cylindrical member 14 of the draft tube assembly 11 is selected to optimise both the aerodynamic requirements of the draft tube and the electrical requirements of the R F heating system.

In order to control the transfer of R F energy to the densely packed region of the bed, an appropriate matching circuit is included in the R F supply. A typical frequency for the R F energy is 27.12 MHz.

Claims

1. A method of drying particulate material, comprising forming a bed of the material, and blowing drying gas upwards through the bed to produce a rising spout region of relatively loosely packed particles entrained in the gas and a falling region of relatively densely packed particles descending to the bed, characterised by the step of applying an R F field substantially only to said falling densely packed region to assist in drying of the particulate material.

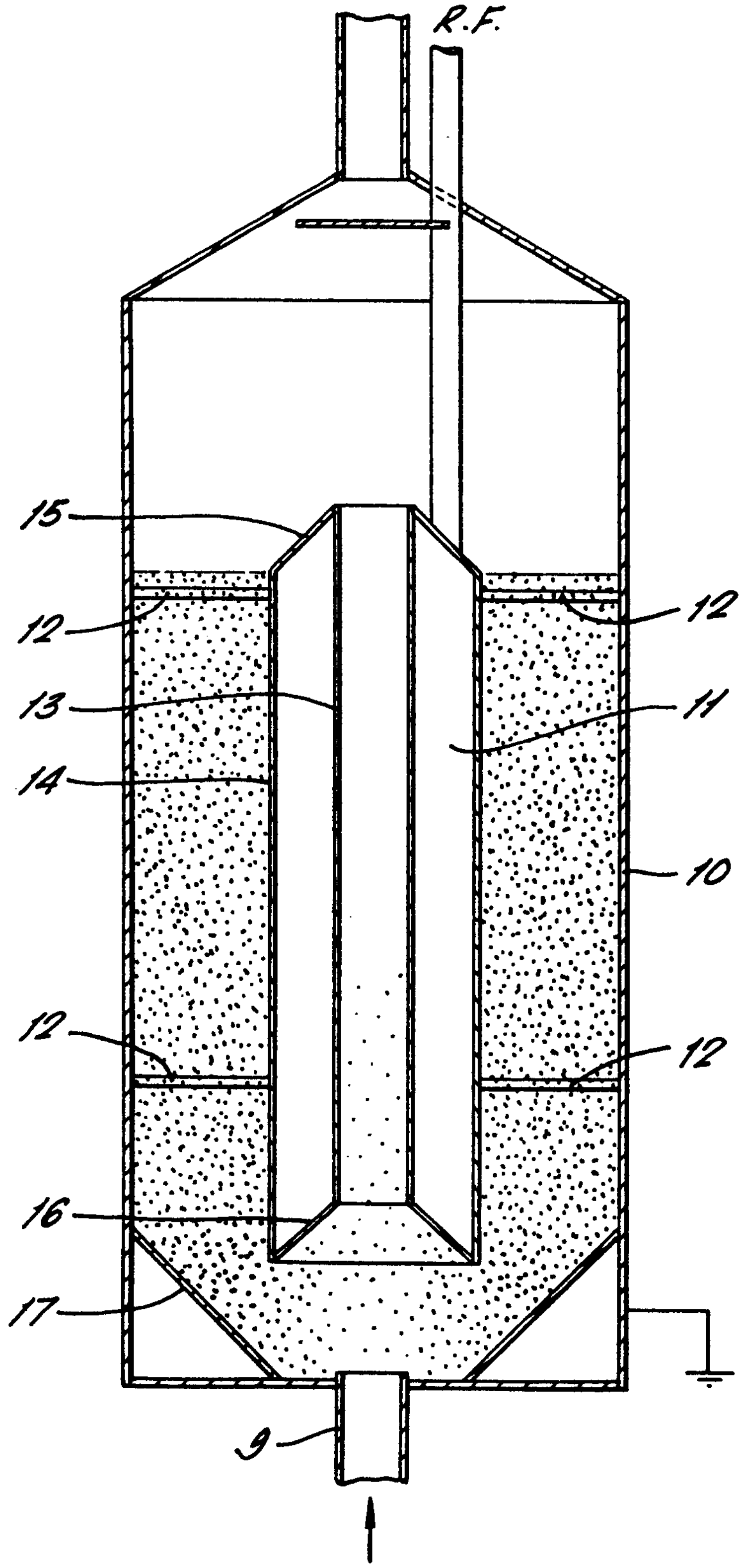
2. A spouted bed drier comprising a vessel containing a draft tube assembly separating a rising spout region from a falling relatively densely packed region, characterised by a first electrode (14) between the rising spout region and the falling relatively densely packed region, a second electrode (10) outside the falling relatively densely packed region, and a source of R F energy connected to the first and second electrodes (14, 10) whereby an R F electric field is set up substantially only in the falling relatively densely packed region to assist in the drying process.

3. A spouted bed drier as claimed in Claim 2, characterised in that the draft tube assembly (11) has cylindrical symmetry about an upwardly extending axis, and comprises an inner cylindrical member (13) confining the rising spout region and an outer cylindrical member (14) forming the first electrode and defining the axially inner surface of the falling relatively densely packed region.

4. A spouted bed drier as claimed in Claim 2 or Claim 3, characterised in that the second electrode (10) is constituted by the vessel.

5. A spouted bed drier as claimed in Claim 2, Claim 3 or Claim 4, characterised in that the

second electrode (10) is connected to earth potential.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EUROPEAN SEARCH REPORT

Application number

EP 86 30 8135

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	DE-A-2 135 619 (BÜTTNER-SCHILDE HAAS) * Whole document *	1	F 26 B 3/347 F 26 B 7/00 F 26 B 9/08
A		2-5	
Y	FR-A-1 264 123 (BARBOUR & GASSTON) * Whole document *	1	
A	GB-A- 854 025 (SHAWINIGAN CHEMICALS) * Whole document *	1	
A	US-A-4 349 967 (JONES et al.)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

F 26 B
B 01 J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22-12-1986	DE RIJCK F.

CATEGORY OF CITED DOCUMENTS

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