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(54) **Atomizing nozzles, SO₂ reactors and flue gas cleaning plants.**

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Description

The invention relates to a nozzle for atomization of a liquid with the aid of an atomizing gas where the liquid consists of a suspension of solid particles, in particular for use in a SO₂-reactor of a flue gas cleaning plant.

Nozzles of different types are used to atomize liquids. One class of nozzles which are used to create a very finely dispersed liquid mist are so-called two-phase nozzles. In these devices, a pressurized gas is used to bring about atomization, which takes place when the gas, which has been accelerated under expansion, acts on a liquid surface that is travelling at a velocity that differs greatly from that of the gas. Two-phase nozzles can be divided into two types, which differ with respect to whether the two phases meet inside or outside the nozzle. In the technical literature, these two types are termed internal-mix and external-mix nozzles, respectively.

Two-phase nozzles of the internal-mix type, to which category the present invention can be assigned, are also characterized by the fact that, given otherwise uniform conditions, a more finely dispersed mist is produced in a nozzle in which the linear dimensions of the atomization zone are of a given size than is the case in a geometrically identical nozzle of larger dimensions. In view of this circumstance, among others, nozzles with small passages are often used to, for example, atomize pure water in connection with the evaporative cooling of a gas, or in connection with the spray-drying of a solution. Nor are such nozzles designed with a view towards the wear that would occur if these nozzles were to be used for the atomizing of liquids with more abrasive properties, e.g. suspensions containing hard, solid particles.

Thus from US—A—3 110 440, such a two-phase nozzle of the internal mix type for the atomization and thereafter for the drying of pastes in slurry form is already known in which the nozzle consists of a symmetrical central body with a cavity into which a central liquid main feeds. This nozzle has a mist orifice having a circular outlet opening and a radially symmetrical atomizing zone with a longitudinal axis which coincides with the longitudinal axis of the mist orifice.

In the case of this nozzle, which possesses only one single mist orifice, the material which is to be atomized and to be dried as well as the compressed air which is used for its atomization is introduced into a cylinder having extremely small openings in the cylinder wall, through which this material and said compressed air is introduced into a chamber which surrounds said cylinder and from there they are guided into the mist orifice. Because of the extremely small openings in said cylinder, during the passage through it of the material to be atomized and of the compressed air, there is a strong drop in pressure in the area of these openings, which leads to a small pressure in the chamber disposed behind said cylinder. This low pressure leads to an uneven

pressure distribution in the atomizing zone and thus to a non-uniform distribution of the material, i.e. the liquid, to be sprayed whereby no even atomization nor a uniform atomization mist is obtained. This disadvantage is increased by the fact that the small openings in the cylinder are subject to a great extent to the danger of becoming clogged up, which leads all the more to an uneven pressure distribution in the atomizing zone. Furthermore, this known nozzle is not designed with a view towards the wear which occurs when atomizing liquids which possess abrasive properties. Due to its plurality of sharp edges, and to its cylindrical screen with extremely small openings, this nozzle would soon be worn out. Furthermore, this known nozzle also has a very low capacity.

Therefore when large quantities of gas are to be cooled evaporatively, for example, normally a number of nozzles of this type is often incorporated in a bank of a large number of nozzles. Such a bank of nozzles has the disadvantage that if the relatively narrow passages in one nozzle become clogged, this contributes relatively greatly towards increasing the flow resistance over the nozzle in question and thereby to an uneven distribution of atomized liquid in the chamber in which the bank of nozzles is located. Thus, two-phase nozzles of the conventional type are not very well suited for the atomizing of large quantities of suspensions containing relatively large gases to remove sulphur dioxide according to the so-called dry scrubbing method, which method is described in greater detail below.

The purpose of the present invention is to specify a nozzle for atomization of a liquid with the aid of an atomizing gas having a symmetrical central body with a cavity into which a central liquid main feeds, that possesses the quality to atomize very large quantities of slurry in a very uniform distribution of the liquid to be atomized in the nozzle with a low risk of clogging of the nozzle.

This is realized with a nozzle that exhibits the characteristics stated in the following patent claim 1. It has surprisingly emerged that this nozzle possesses such characteristics that the distribution of the liquid sprayed through the different mist orifices during operation is particularly uniform, even when a large number of units is supplied through parallel connection to common mains for the supply of both liquid and atomizing gas. For the uninitiated, this might appear to be a somewhat trivial characteristic, but this is not the case. In general, it is extremely difficult to obtain a very uniform distribution of liquid by connecting a number of nozzles in parallel. Furthermore, the risk of clogging of the nozzle has been reduced, which is of very great importance when a suspension of solid particles in a liquid is to be atomized.

The invention will now be described in greater detail with reference to the appended figures, where figure 1 shows a schematic cross-section of a nozzle according to the invention; and Figure

2 shows the nozzle installed in a flue gas cleaning plant.

In Figure 1, 1 is a nozzle consisting of a symmetric central body 2 with a cavity 3 into which a central liquid main feeds. In the version shown, the nozzle is equipped with three symmetrically arranged mist orifices 5, two of which are shown in the figure. The number of mist orifices can, however, be varied between three and ten depending upon the application. Each mist orifice consists of a tubular housing 6 provided at its outer end with an outlet opening 9, which is circular and has a diameter of between 1 and 10 mm. Inside the mist orifice is an atomizing zone 11 with a radially symmetric shape. A tubular gas orifice 12 is arranged upstream of the outlet opening 9. The ratio between the diameter of the outlet opening 9 and the inside diameter of the gas orifice 12 is between 0.1 and 0.5. The longitudinal axis 7 of the mist orifice coincides with the longitudinal axis of both the atomizing zone and the gas orifice, these together thereby forming a symmetric configuration. Furthermore, the imaginary extension of the longitudinal axis of every mist orifice emanates from the same point on the longitudinal axis 8 of the central body and forms an angle α with this axis of between 20 and 90°. The cavity 3 forms an integral volume together with the liquid main 4, which volume envelops the gas orifices 12 and their atomizing zones 11. The gas orifices 12 are further connected to a common gas distribution line 15, which is concentrically arranged around the liquid main 4.

In brief, the function of the nozzle is as follows: When liquid is supplied through the central liquid main 4, the cavity 3 inside the central body 2 is filled, as are the cavities in the mist orifices. The liquid is supplied at a pressure of between 2 and 12 bar. When atomizing gas of sufficiently high pressure (between 2 and 12 bar, but higher than the pressure of the liquid) is supplied through the gas orifices 12, an atomizing zone 11 is formed in front of each gas orifice. A two-phase flow will therefore exist in the narrowest section of the mist orifice, i.e. at its outlet opening 9. If the pressure inside the mist orifice is sufficiently high, the flow through this section, i.e. in the entire atomizing zone 11, will also be of a critical character. As is evident from the above description, the invention is distinguished by, among other things, the fact that the risk of clogging has been eliminated through the relatively large size of all liquid passages. The zone in which the flow velocity is high is designed so that surrounding boundary surfaces form a small angle to the flow direction, which contributes towards a low wear rate. The area exposed to the greatest wear has further been designed in such a manner that a ceramic insert mounted there as a wear protection liner 14, arranged on a seat 13, exists in a more or less stressless state, which permits the use of material of low tensile strength as a wear protection liner. The nozzle is designed for the atomizing of a liquid flow of between 0 and

20 000 kg/m²s figured over the area of the outlet opening 9, and the gas flow over the same area is between 500 and 2 500 kg/m²s.

Figure 2 shows a flue gas cleaning plant 20 for the cleaning of flue gases from a coal-fired power and/or heating plant (not shown). The flue gases are first conducted to an electrostatic precipitator 21, which separates about 90% of the dust formed by combustion. The still hot and sulphur-dioxide-bearing flue gases are then conducted to an SO₂ reactor 22 in which a finely dispersed lime slurry is sprayed into the flue gases. This is done with the aid of the nozzles 1 mounted in the reactor inlet, which are supplied with lime slurry prepared in a feed tank 23 and pumped at high pressure via a liquid line 24 to the central liquid mains 4 for the nozzles 1 (Figure 1). The lime reacts with the sulphur dioxide and binds it. The amount of water and the temperature are adjusted so that all the water evaporates before the lime reaches the bottom, which results in dry residual products and greatly facilitates their handling. Some sulphur-bearing lime sinks to the bottom, where it is taken out, while the remainder continues to a fabric filter 25, where most of the remaining flue gas particles adhere to the filter material. At regular intervals, the filter bags are blown clean by short pulses of compressed air. The dust that is dislodged falls to the bottom and is discharged. The flue gases—now cleaned from dust, ash and sulphur dioxide—are then discharged via the flue gas fan 26 into the atmosphere through the stack 27. In the plant described here, the flue gases can be cleaned so efficiently—via this dry scrubbing method, where the nozzles according to the invention are employed to provide an effective dispersion of the supplied absorbent suspension—that the leaving sulphur concentration is max. 0.1 grams of sulphur per megajoule of supplied fuel, which is equivalent to a collection efficiency of 70–85%, depending upon the sulphur content of the coal.

The technical effect obtained with a nozzle according to the invention can be further illustrated by the following example, which relates to the dry scrubbing method described above.

The distribution of the liquid flow from each mist orifice was studied in the following manner. Four nozzles designed according to the invention, each equipped with five mist orifices with a minimum opening diameter of 4.0 mm, were supplied with compressed air from a common compressor and with a liquid suspension from a common pump. The liquid suspension used in the test consisted of a mixture of 60% water, 30% fly ash from powdered coal firing and 10% of a mixture of calcium sulphite and calcium hydroxide (all percentages by weight). The liquid flow from each of the mist orifices was then measured as the aggregate liquid flow was varied between 1 500 kg/h and 12 000 kg/h. The range of variation in the results, consisting of the liquid flow measured from each of the 20 mist orifices for each aggregate flow, was determined, with the following results:

Aggregate liquid flow kg/h	Range of variation % of mean
1 500	1.3
3 000	1.9
6 000	1.1
12 000	0.7

Claims

1. Nozzle for atomization of a liquid with the aid of an atomizing gas, where the liquid consists of a suspension of solid particles, in particular for use in a SO₂-reactor of a flue gas cleaning plant, which nozzle (1) consists of a symmetrical central body (2) with a cavity (3) into which a central liquid main (4) feeds, and with a mist orifice having a circular outlet opening (9) with a diameter of between 1 and 10 mm and a radially symmetric atomizing zone (11) with a longitudinal axis (7) that coincides with the longitudinal axis of the mist orifice, characterized in the fact that at least three mist orifices (5) are arranged symmetrically around the central body, each consisting of a tubular housing (6) and arranged in such a manner that the extensions of their longitudinal axes (7) converge in a common point on the longitudinal axis (8) of the central body, forming an angle (ν) with this body that is between 20° and 90°; that each atomizing zone is arranged for individual supply with the atomizing gas from a tubular gas orifice (12) located upstream of the outlet opening (9), whereby the ratio between the diameter of the outlet opening (9) and the diameter of the gas orifice (12) is between 0.1 and 0.5; that the longitudinal axis of each gas orifice coincides with the longitudinal axis (7) of the associated mist orifice; and that the cavity (3) forms, together with the central liquid main (4), an integral volume that envelops the gas orifices (12) and their atomizing zones (11).

2. Nozzle according to claim 1, characterized in that each mist orifice (5) has a seat (13) at the outlet opening (9) in which a wear protection liner (14) in the form of an insert is mounted, the gas and liquid pressure imparting a more or less stressless state to the wear protection liner.

3. Nozzle according to claim 1, characterized in that each gas orifice (12) is connected to a common gas distribution line (15) arranged concentrically around the liquid main.

4. Nozzle according to claim 1, characterized in that the mist orifices (5) are arranged for atomization of a liquid flow of between 0 and 20 000 kg/m²s, figured over the area of the outlet opening (9), with a gas flow of between 500 and 2 500 kg/m²s figured over the same area.

5. Nozzle according to claim 1, characterized in that the central liquid main (4) and the gas orifices (12) are arranged to be connected to a liquid/gas source that supplies a pressure of between 2 and 12 bar.

6. Nozzle according to claim 1, characterized in that the number of mist orifices (5) arranged around the central body (2) is between three and ten.

7. Nozzle according to claim 1, where the nozzle is installed in an SO₂ reactor for atomizing of an absorbent suspended in water, characterized in that the liquid main (4) for the nozzle (1) is connected to a liquid line (24) that is common for at least one other nozzle (1) located in the same reactor (22).

Patentansprüche

1. Düse für die Zerstäubung einer Flüssigkeit mit Hilfe eines Zerstäubungsgases, bei der die Flüssigkeit aus einer Lösung fester Teilchen besteht, speziell für den Einsatz in einem SO₂-Reaktor einer Rauchgasreinigungsanlage, wobei die Düse (1) aus einem symmetrischen Hauptteil (2) mit einem Hohlraum (3) besteht, in den eine zentrale Flüssigkeitshauptleitung (4) fördert, und mit einer Nebelöffnung, die eine kreisförmige Auslaßöffnung (9) mit einem Durchmesser zwischen 1 und 10 mm aufweist und einer radialsymmetrischen Zerstäubungszone (11) mit einer longitudinalen Achse (7), die mit der longitudinalen Achse der Nebelöffnung zusammenfällt, dadurch gekennzeichnet, daß zumindest drei Nebelöffnungen (5) symmetrisch um das Hauptteil angeordnet sind, von denen jede aus einem rohrförmigen Gehäuse (6) besteht und derart angeordnet ist, daß die Verlängerungen ihrer longitudinalen Achsen (7) in einem gemeinsamen Punkt auf der longitudinalen Achse (8) des zentralen Hauptteils zusammenlaufen und einen Winkel (ν) mit diesem Hauptteil bilden, der zwischen 20 und 90° liegt, daß jede Zerstäubungszone für eine individuelle Versorgung mit Zerstäubungsgas aus einer rohrförmigen Gasöffnung (12) angeordnet ist, die oberhalb der Auslaßöffnung (9) angeordnet ist, bei denen das Verhältnis zwischen dem Durchmesser der Auslaßöffnung (9) und dem Durchmesser der Gasöffnung (12) zwischen 0,1 und 0,5 liegt, daß die longitudinale Achse einer jeden Gasöffnung zusammenfällt mit der longitudinalen Achse (7) der dazugehörigen Nebelöffnung und daß der Hohlraum (3) zusammen mit der zentralen Flüssigkeitshauptleitung (4) ein zusammenhängendes Volumen bildet, das die Gasöffnungen (12) und deren Zerstäubungsdüsen (11) einschließt.

2. Düse nach Anspruch 1, dadurch gekennzeichnet, daß jede Nebelöffnung (5) eine Aufnahme (13) an der Auslaßöffnung (9) besitzt, in der eine Abnutzungsschutzeinlage (14) in Form eines Einsatzes befestigt ist, wobei der Gas- und Flüssigkeitsdruck einen mehr oder weniger belastungsfreien Zustand der Abnutzungsschutzeinlage gewährleistet.

3. Düse gemäß Anspruch 1, dadurch gekennzeichnet, daß jede Gasöffnung (12) mit einer gemeinsamen Gasverteilungsleitung (15) verbunden ist, die konzentrisch um die Flüssigkeitshauptleitung angeordnet ist.

4. Düse gemäß Anspruch 1, dadurch gekennzeichnet, daß die Nebelöffnungen (5) für die Zerstäubung eines Flüssigkeitsdurchflusses zwischen 0 und 20.000 kg/m² · s angeordnet sind,

bemessen über die Fläche der Auslaßöffnung (9) mit einem Gasdurchsatz zwischen 500 und 2500 kg/m² · s, bemessen über dieselbe Fläche.

5. Düse gemäß Anspruch 1, dadurch gekennzeichnet, daß die zentrale Flüssigkeitshauptleitung (4) und die Gasöffnungen (12) derart angeordnet sind, daß sie an eine Flüssigkeits-/Gasquelle angeschlossen sind, die einen Druck zwischen 2 und 12 bar bereitstellt.

6. Düse gemäß Anspruch 1, dadurch gekennzeichnet, daß die Zahl der Nebelöffnungen (5), die um den zentralen Hauptteil (2) angeordnet sind, zwischen drei und zehn liegt.

7. Düse gemäß Anspruch 1, wobei die Düse in einem SO₂-Reaktor zur Zerstäubung eines in Wasser suspendierten Absorbers installiert ist, dadurch gekennzeichnet, daß die Flüssigkeitshauptleitung (4) der Düse (1) an eine Flüssigkeitsleitung (24) angeschlossen ist, die gemeinsam für zumindest eine weitere Düse (1) ist, die in demselben Reaktor (22) angeordnet ist.

Revendications

1. Buse pour l'atomisation d'un liquide à l'aide d'un gaz d'atomisation, où le liquide consiste en une suspension de particules solides, en particulier pour une utilisation dans un réacteur à SO₂ d'une installation d'épuration de gaz de cheminées, cette buse (1) consistant en un corps central symétrique (2) muni d'une cavité (3), dans laquelle débouche une canalisation centrale (4) d'amenée de liquide, et d'un orifice de pulvérisation comportant une ouverture de sortie circulaire (9) ayant un diamètre compris entre 1 et 10 mm et une zone d'atomisation (11) radialement symétrique avec un axe longitudinal (7) qui coïncide avec l'axe longitudinal de l'orifice de pulvérisation, caractérisée par le fait qu'au moins trois orifices de pulvérisation (5) sont disposés symétriquement autour du corps central, chaque orifice consistant en un élément tubulaire (6) et étant disposé de manière telle que les prolongements de leurs axes longitudinaux (7) convergent en un point commun sur l'axe longitudinal (8) du corps central, en formant avec ce corps un angle (v) qui est compris entre 20° et 90°; que chaque zone d'atomisation est agencée en vue d'une alimentation individuelle en gaz d'atomisation à partir d'un orifice tubulaire (12) d'amenée de gaz situé

en amont de l'ouverture de sortie (9), le rapport entre le diamètre de l'ouverture de sortie (9) et le diamètre de l'orifice (12) d'amenée de gaz étant compris entre 0,1 et 0,5; que l'axe longitudinal de chaque orifice d'amenée de gaz coïncide avec l'axe longitudinal (7) de l'orifice de pulvérisation associé; et que la cavité (3) forme, conjointement avec le conduit central principal (4) d'amenée de liquide, un volume d'un seul tenant qui englobe les orifices (12) d'amenée de gaz et leurs zones d'atomisation (11).

2. Buse selon la revendication 1, caractérisée par le fait que chaque orifice de pulvérisation (5) comporte un siège (13) à l'ouverture de sortie (9) dans laquelle est montée un garnissage (14) de protection contre l'usure sous la forme d'une pièce rapportée, la pression du gaz et du liquide communiquant un état plus ou moins exempt de contraintes au garnissage de protection contre l'usure.

3. Buse selon la revendication 1, caractérisée par le fait que chaque orifice (12) d'amenée de gaz est raccordé à une canalisation commune (15) de distribution de gaz disposée concentriquement autour de conduit principal de liquide.

4. Buse selon la revendication 1, caractérisée par le fait que les orifices de pulvérisation (5) sont conçus en vue d'une atomisation d'un débit de liquide compris entre 0 et 20.000 kg/m²s, calculé sur la superficie de l'ouverture de sortie (9), avec un débit de gaz compris entre 500 et 2500 kg/m²s calculé sur la même surface.

5. Buse selon la revendication 1, caractérisée par le fait que le conduit central principal (4) d'amenée de liquide et les orifices (12) d'amenée de gaz sont conçus de manière à être raccordés à une source de liquide/gaz qui fournit une pression comprise entre 2 et 12 bars.

6. Buse selon la revendication 1, caractérisée par le fait que le nombre d'orifices de pulvérisation (5) disposés autour du corps central (2) est compris entre trois et dix.

7. Buse selon la revendication 1, où la buse est installée dans un réacteur à SO₂ pour atomiser un absorbant en suspension dans de l'eau, caractérisée par le fait que le conduit principal (4) d'amenée de liquide pour la buse (1) est raccordé à une canalisation (24) d'amenée de liquide qui est commune pour au moins une autre buse (1) placée dans le même réacteur (22).

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Fig. 1

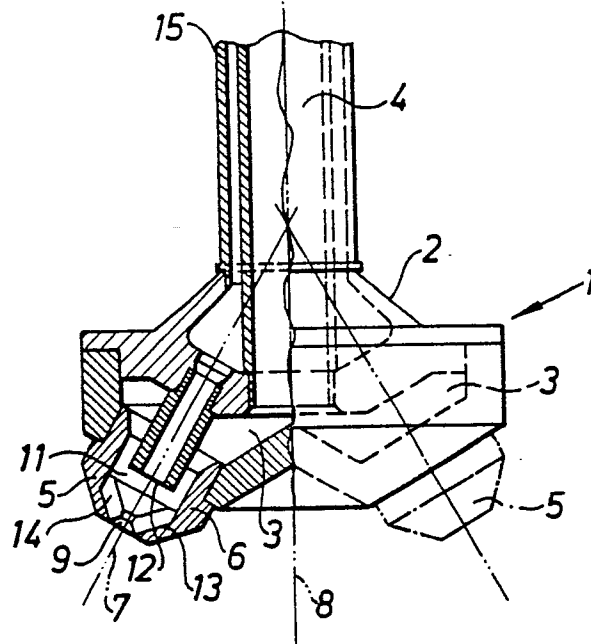


Fig. 2

