

12 EUROPEAN PATENT APPLICATION

21 Application number: 82110320.7

51 Int. Cl.<sup>3</sup>: B 05 B 1/00

22 Date of filing: 09.11.82

30 Priority: 09.11.81 SE 8106637

43 Date of publication of application:  
 18.05.83 Bulletin 83/20

84 Designated Contracting States:  
 AT BE CH DE FR GB IT LI NL SE

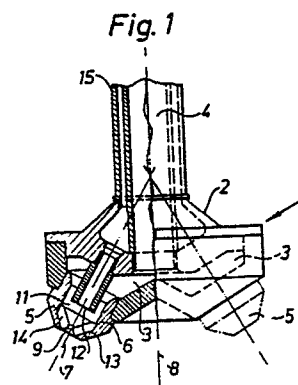
71 Applicant: Fläkt Aktiebolag  
 Sickla Allé 13  
 S-131 34 Nacka(SE)

72 Inventor: Lindau, Leif  
 Lungörtsvägen 5  
 S-352 51 Växjö(SE)

74 Representative: Eitle, Werner, Dipl.-Ing. et al,  
 Hoffmann, Eitle & Partner Patentanwälte  
 Arabellastrasse 4  
 D-8000 München 81(DE)

54 Atomizing nozzles, SO<sub>2</sub> reactors and flue gas cleaning plants.

57 A nozzle for the atomization of a liquid containing a suspension of solid particles with the aid of an atomizing gas, e.g. for use in plants for the removal of sulfur dioxide from flue gases according to the dry scrubbing method. To avoid clogging and non-uniform liquid distribution, the nozzle (1) consists of a symmetric central body (2) with a cavity (3) into which a central liquid main (4) feeds, between three and ten mist orifices (5) being arranged symmetrically around the central body, consisting of tubular housings (6) whose longitudinal axes (7) form an angle ( $\nu$ ) of between 20 and 90° with the longitudinal axis (8) of the central body. Each mist orifice has a circular outlet opening (9) with a diameter of between 1 and 10 mm and with a radially symmetric atomizing zone (11) that is supplied individually with atomizing gas from a tubular gas orifice (12) installed upstream of the outlet opening (9).



- 1 -

ATOMIZING NOZZLES,  $\text{SO}_2$  REACTORS  
AND FLUE GAS CLEANING PLANTS.

The present invention relates to a nozzle for the atomization of a liquid in accordance with the preamble of patent claim 1, to an  $\text{SO}_2$  reactor and to a flue gas cleaning plant.

5 Nozzles of different types are used to atomize liquids. One class of nozzles that 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  
10 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,  
15 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  
20 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  
25 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  
30 for the atomizing of liquids with more abrasive properties, e.g. suspensions containing hard, solid particles. When  
large quantities of gas are to be cooled evaporatively, for example, a number of nozzles are often incorporated in a

- 2 -

bank of nozzles, consisting of a large number of nozzles each of which is supplied with liquid and atomizing gas. 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 solid particles, as in connection with the scrubbing of flue 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 that possesses such qualities that the aforementioned drawbacks are eliminated.

This is realized with a nozzle that exhibits the characteristics stated in the following patent claims. It has surprisingly emerged that the nozzle according to the invention 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 are 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. Further-

more, 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.

5 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

10 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  
15 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  
20 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  
25 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  
30 every mist orifice emanates from the same point on the longitudinal axis 8 of the central body and forms an angle  $\alpha$  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.

5

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/m<sup>2</sup>s figured over the area of the outlet opening 9, and the gas flow over the same area is between 500 and 2 500 kg/m<sup>2</sup>s.

10

15

20

25

30

L 20 000 kg/m<sup>2</sup>s figured over the area of the outlet opening 9, and the gas flow over the same area is between 500 and 2 500 kg/m<sup>2</sup>s.

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 SO<sub>2</sub> 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.

5 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  
10 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  
15 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 | Range of variation |
|----|-----------------------|--------------------|
|    | kg/h                  | % of mean          |
|    | 1 500                 | 1.3                |
|    | 3 000                 | 1.9                |
| 25 | 6 000                 | 1.1                |
|    | 12 000                | 0.7                |

## PATENT 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, characterized in that the  
nozzle (1) consists of a symmetric central body (2)  
5 with a cavity (3) into which a central liquid main (4)  
feeds, at least three mist orifices (5) arranged sym-  
metrically 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)  
10 converge in a common point on the longitudinal axis (8)  
of the central body, forming an angle ( $\nu$ ) with this  
body that is between 20 and 90°; that each mist orifice  
has a circular outlet opening (9) with a diameter of  
between 1 and 10 mm and a radially symmetric atomizing  
15 zone (11) with a longitudinal axis that coincides with  
the longitudinal axis (7) of the mist orifice; 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); that the  
20 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).  
25
- 2 Nozzle according to patent claim 1, characterized  
in that 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.

- 3 Nozzle according to patent claims 1-2, 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  
5 liquid pressure imparting a more or less stressless  
state to the wear protection liner.
- 4 Nozzle according to patent claims 1-3, characterized  
in that each gas orifice (12) is connected to a  
10 common gas distribution line (15) arranged concentrically  
around the liquid main.
- 5 Nozzle according to patent claims 1-4, characterized  
in that the mist orifices (5) are arranged for  
15 atomization of a liquid flow of between 0 and  
20 000 kg/m<sup>2</sup>s, figured over the area of the outlet  
opening (9), with a gas flow of between 500 and 2 500  
kg/m<sup>2</sup>s figured over the same area.
- 20 6 Nozzle according to patent claims 1-5, 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.
- 25 7 Nozzle according to patent claims 1-6, characterized  
in that the number of mist orifices (5) arranged  
around the central body (2) is between three and ten.
- 30 8 Nozzle according to patent claims 1-7, where the nozzle  
is installed in an SO<sub>2</sub> reactor for atomizing of an  
L absorbent suspended in water, characterized in

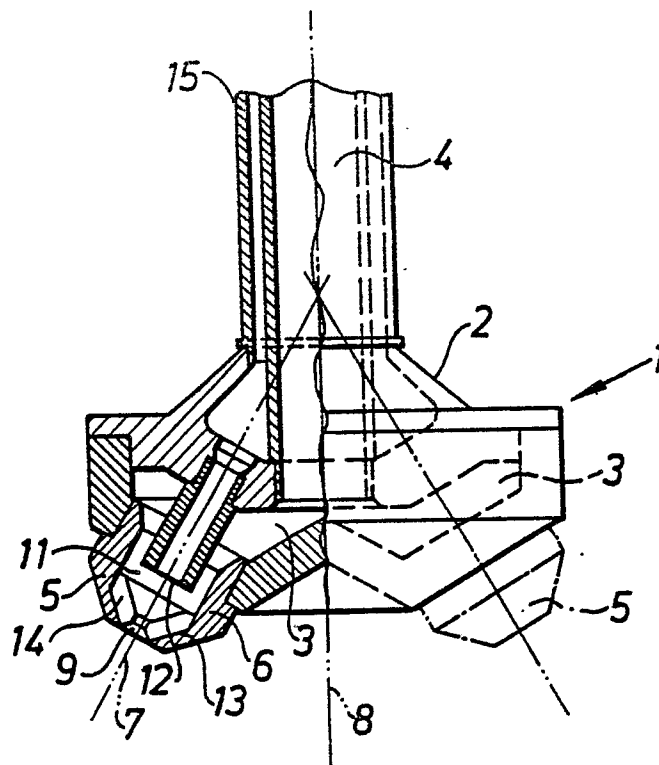
that the liquid main (4) for the nozzle (1) is connected to a liquid line (24) that is common for at least one other nozzle (1) located in the same reactor (22).

5

9 An SO<sub>2</sub> reactor for atomizing of an absorbent suspended in water and characterized by at least one nozzle according to any one of claims 1 to 8.

10 10 A flue gas cleaning plant characterized by a reactor according to claim 9.

*Fig. 1*



*Fig. 2*

