A nebuliser for use in flame spectroscopy comprises a nebulising nozzle, a cloud chamber, an impact surface located in the cloud chamber in front of the nebulising nozzle, and control means, adjustable from outside the nebuliser assembly, arranged to move the impact surface along the nozzle axis for the purpose of ready adjustment of the nebulising effect during operation. The impact surface is also arranged to be adjusted from outside the nebuliser so that it can be moved to an off-axis position to reduce sensitivity when required.

8 Claims, 2 Drawing Figures
Fig. 1
1 NEBULISER ASSEMBLIES FOR FLAME SPECTROMETRY

This invention relates to an improved nebuliser assembly for use in flame spectrometry.

In flame spectrometry, fuel, oxidant and diluting inert gases, in proportions suitable to sustain an analytical flame, are mixed in a cloud chamber with a fine spray of a solution of the sample under examination. A proportion of the spray passes with the gases to a burner where the solvent evaporates and the sample molecules are broken up into atoms in the flame.

The spray of sample solution is conveniently produced by means of a nebuliser fed with the sample solution and a gas under pressure. The pressurised gas passes through a venturi nozzle in the nebuliser to produce a partial vacuum before exhausting into the cloud chamber. Sample solution is drawn into the region of low pressure through a capillary inlet and is thereby broken up into a fine spray composed of droplets of sample solution. The pressurised gas fed to the nebuliser may either be an oxidant, a fuel or an inert diluent gas depending upon the analytical flame used.

It is well-known that the provision of an impact surface immediately forward of the nebuliser nozzle on the axis of the nozzle improves the performance of the nebuliser by breaking up larger droplets of sample solution in the spray and increasing the proportion of smaller droplets, enabling a greater amount of sample solution to reach the burner. In a nebuliser not provided with an impact surface, larger droplets of sample solution are likely to condense upon the interior walls of the cloud chamber and be lost. Provision of the impact surface enables the concentration of sample atoms in the analytical flame to be increased thus increasing the overall sensitivity of the flame spectrometer in which the nebuliser is employed.

The impact surface is typically a spherical surface mounted symmetrically about the axis of cylindrical symmetry of the nebuliser nozzle and impact surfaces have been proposed which comprise for example a spherically ended rod, or a rod having attached thereto a ball, bead or other spherical device.

In order to obtain an optimum sensitivity under given analytical conditions the impact surface has to be accurately positioned on the axis of the nebuliser nozzle with respect to the nozzle. The position is critical and is dependent inter alia upon the nebuliser configuration, the pressurized gas used with the nebuliser and the solvent employed in the sample solution. It may, however, be desirable to reduce the sensitivity of the flame spectrophotometer and this could conveniently be done by removal of the impact surface from the axial position.

However, in devices hitherto proposed, the position of the impact surface has either not been adjustable or has only been adjustable as a skilled operation.

An object of the invention is the provision of a nebuliser assembly of the kind referred to in which the position of the impact surface is readily adjustable from the exterior of the nebuliser assembly whilst the nebuliser is in operation.

According to the invention there is provided a nebuliser assembly for use in flame spectrosopy including a cloud chamber, a nebulising nozzle directed into said cloud chamber and having means for applying a liquid analytical medium to be nebulised and a gaseous propellant medium for nebulising said analytical medium to said nebulising nozzle, an impact surface mounted within said cloud chamber to lie upon the axis of said nebulising nozzle to receive droplets therefrom, and control means adjustable from outside said nebuliser assembly and arranged to move said impact surface in a direction along the axis of said nebulising nozzle to enable the position of said impact surface to be adjusted during operation of said nebuliser assembly. A gaseous flame-producing medium can be introduced into said cloud chamber through an annular aperture surrounding said nebuliser nozzle.

According to a feature of the invention there is provided a nebuliser assembly as set out in the foregoing paragraph comprising further means, also adjustable from without the nebuliser assembly, adapted to move the impact surface from a position on the axis of the nebulising nozzle to an off-axis position and to return the impact surface thereto.

In order that the invention may be clearly understood and readily carried into effect, an embodiment thereof will now be described by way of example, with reference to the drawings filed with the Provisional Specification, of which:

FIG. 1 shows one form of flame spectrometer employing a nebuliser assembly, and

FIG. 2 shows in longitudinal section, a nebuliser assembly embodying the present invention.

Reference will now be made to FIG. 1, which shows in general form a system for performing atomic absorption measurements including a nebuliser 21, a cloud chamber 22, and a burner 8. The nebuliser 21 is fed with compressed air from a cylinder 9 and with sample solution from a vessel 10. Fuel and auxiliary air are fed from cylinders 11 and 12 through a common line 13. Mixing of the fuel/air mixture and sample solution spray occurs in the cloud chamber 22, and the resulting mixture is fed to the burner 8 which produces an analytical flame 14 wherein evaporation of the sample solution solvent takes place and vapourisation of the sample occurs.

Radiation from a source 15 provides a beam of radiation having one or more characteristic spectral line(s). The beam of radiation emitted by the source 15 is focussed and passed through the flame 14 containing the vapour of the sample solution containing an unknown quantity of the material under examination, into a monochromator 16. Certain spectral lines are absorbed by the vapour of the sample from the beam of radiation indicating the presence of a particular element in the vapourised solution if the beam of radiation is of a specific wavelength corresponding to the energy required to excite atoms which have been vapourised, from their ground state to the resonant energy level.

Adjustment of the monochromator 16 to the wavelength of the spectral lines which are to be absorbed gives a beam of radiation of narrow bandwidth about that wavelength. The resultant beam of radiation is directed onto a radiation sensitive device 17 which provides an output signal which is amplified by an amplifier 18 and applied to a meter 19 which provides an indication of the intensity of the radiation leaving the monochromator 16. The degree of absorption of radiation of a given wavelength may be measured by comparing the indication displayed by the meter 19 when unknown samples are introduced into the flame 14 and when no sample is introduced into the flame 14.
Referring now to FIG. 2 a nebuliser assembly comprising a nebuliser generally indicated at 21, a cloud chamber 22 (shown in part) and a cloud chamber cap 23 is provided with an impact surface 24 in the form of a spherical bead 25 mounted upon a rod 26 to lie upon the axis of cylindrical symmetry of the nebuliser 21 in the manner shown. The nebuliser 21 is mounted within a bore in the cloud chamber cap 23, a shoulder 27 coating an O-ring 28 to provide a gas-tight seal. The nebuliser 21 is provided with a capillary sample conduit 29 and a nozzle 30. The forward portion 31 of the nozzle 30 projects through a recess 32 in the cloud chamber cap 23 and through a member 33 which serves to seal the recess 32 except for an annular passageway 34 surrounding the forward portion 31 of the nozzle 30. The cloud chamber 22 is mounted on the cap 23 by means of a screwed collar 35 and a sealing ring 36 is arranged to provide a gas-tight seal. A portion 37 of the cloud chamber cap 23 is provided with a machined sump 38 communicating with a drain tube 39 passing through the cap 23.

The rod 26 is rigidly mounted upon a control rod 40, passing as a rotation fit through the cap 23 and a control assembly 41, and is terminated by a knob 42 mounted thereupon, an O-ring 43 co-operating with the wall of the surrounding bore to provide a gas-tight seal.

The control assembly 41 comprises a screwed bush 44 mounted in the cloud chamber cap 23 and contains a coil spring 45 seated about the control rod 40 and held in slight compression between a shoulder 46 and a circlip 47 mounted on the rod 40. A cap 48 is attached to the bush 44 by means of screws 49 and 49'. The control rod 40 includes a flattened portion 50 which co-operates with a flat-ended insert 51 held in place by means of a coil spring 52 and a screw cap 53.

In operation the nebuliser assembly of FIG. 2 is fed with air, fuel and sample solution in the manner described with reference to FIG. 1 of the drawings. Compressed air enters a chamber 60 of the nebuliser assembly and exhausts through the nozzle 30 into the cloud chamber 22. Passage of the compressed air produces a partial vacuum in the region adjacent the outer end of the capillary sample conduit 29, the outer end of which is connected to a source of sample solution, drawing the sample solution through the conduit 29 and at the same time causing it to break up into a fine spray. The spray strikes the impact surface 24 of the bead 25 when the latter is in the position shown.

Pre-mixed air and fuel gas is introduced into the recess 32 and further mixing takes place between the fuel gas and the air in passing through the annular passageway 34 before the mixing with the compressed gas and sample spray in the cloud chamber 22. The fuel gas used depends upon the nature of the analysis as does the proportion of fuel gas to air and the type of compressed gas used to feed the nebuliser. The mixed gases and sample solution spray pass through the cloud chamber 22 to the burner 8 as shown in FIG. 1. Any droplets of sample solution which collect on the walls of the cloud chamber 22 will drain into the sump 38 and will be exhausted via the pipe 39.

As previously explained, the position of the impact surface 24 on the axis of the nebuliser nozzle 30 is critical and must be adjusted for optimum sensitivity of each analysis. This is readily achieved in the embodiment described, by rotation of the cap 48 mounted on the bush 44 which imparts an axial force to the circlip 47 and hence to the control rod 40 which is thus moved axially within the cloud chamber cap 23 causing a corresponding movement of the bead 25 along the axis of the nebuliser nozzle 30. The limit of this travel is determined by the length of the machined portion 50 of the rod 40. Rotation of the rod 40 is prevented by cooperation between the insert 51 under the pressure exerted by the coil spring 52, and the machined portion 50 of the rod 40.

To remove the bead 25 from the axial position shown in FIG. 2 a rotary motion is imparted to the control rod 40 by means of the control knob 42 causing the insert 51 to ride out of the machined portion 50 of the control rod 40. The bead 25 is held in an adjacent off-axis position by the pressure of the insert 51 upon the control rod 40. The return of the bead 25 to its original axial position is effected by a reverse rotation of the knob 42, causing the insert 51 to ride back into the flat 50, thus locating the bead 25 in its original position. In this way the mechanism returns the impact surface accurately to the position previously set by means of the control assembly 41.

In certain circumstances the impact surface 24 of the bead 25 can project into the mouth of the nozzle 30 preventing the translation of the bead 25 into an off-axis position by a simple rotary action. To allow for this the control knob 42 is pushed axially inwards against the pressure of the coil spring 45 to cause the axial movement of the bead 25 away from the nozzle 30 before the rotary motion is imparted to the control rod 40. To return the bead 25 to the original axial position, inward axial pressure must again be applied to the control knob 42 before rotation.

Provision of the control assembly described and illustrated in FIG. 2 enables the position of the impact surface 24 to be precisely and easily adjusted from the exterior of the nebuliser assembly and permits the translation of the impact surface to an off-axis position also from the exterior of the assembly. In addition, adjustment of the position of the impact surface in either sense may be effected whilst the nebuliser is in operation and a flame established on the burner 12. Provision of the control assembly makes the removal and replacement of the bead and the positioning of the bead on the nebuliser axis a simple operation under the direct control of the user of the instrument, which has hitherto not been the case.

The nebuliser assembly must, to prevent contamination of the sample solution, be constructed of substantially inert materials. In the embodiment of FIG. 2 the main body of the nebuliser is machined of stainless steel, the nozzle 30 of tantalum and the rod 26 of titanium or stainless steel coated with an inert plastic material. The bead 25 is constructed of titanium or sapphire and the capillary sample conduit 29 of platinum/tinidium alloy.

What I claim is:
1. A nebuliser assembly for use in flame spectroscopy, comprising:
   a. a cloud chamber;
   b. a nebulising nozzle directed into said cloud chamber;
   means for applying to said nebulising nozzle a liquid analytical medium to be nebulised and a gaseous
5 propellant medium for nebulising the analytical medium; an impact surface; a rod rotatably mounted through a wall of said cloud chamber with the rotation axis of said rod parallel to but displaced from the axis of said nebulising nozzle, said rod also being axially slidable; and means within said cloud chamber mounting said impact surface to said rod at a radial distance equal to the displacement between said axes, said impact surface facing said nebulising nozzle to receive droplets therefrom when substantially is in an axial position therewith, whereby rotating said rod moves said impact surface into and out of an axial position with respect to said nebulising nozzle and axial sliding of said rod moves said impact surface along the axis of said nebulising nozzle.

2. A nebuliser assembly as claimed in claim 1 wherein said rod is of circular cross section.

3. A nebuliser assembly as claimed in claim 1 further comprising urging means which tends to restore said impact surface to an axial position with respect to said nebulising nozzle.

4. A nebuliser assembly as claimed in claim 3 wherein said urging means comprises a pin urged by a spring radially against said rod, the radius of the portion of said rod contacting said pin when said rod is in a position where said impact surface lies on the axis of said nebulising nozzle being less than the radius of portions adjacent thereto.

5. A nebuliser assembly as claimed in claim 4 wherein the surface of said rod facing said pin when said impact surface is in the vicinity of the axis of said nebulising nozzle is flat and said flat surface is perpendicular to said pin when said impact surface lies on the axis of said nebulising nozzle.

6. A nebuliser assembly as claimed in claim 1 further comprising:
   an axially positionable cap, thread mounted outside said cloud chamber, said rod extending through said cap and having a flange portion opposing an inside shoulder of said cap; and a spring urging said flange portion of said rod against said shoulder of said cap.

7. A nebuliser assembly as claimed in claim 1 further comprising an annular aperture surrounding said nebuliser nozzle through which a gaseous flame-producing medium may be introduced into said cloud chamber.

8. A nebuliser assembly as claimed in claim 7 wherein said aperture directs the gaseous flame-producing medium toward a point on the axis of said nebulising nozzle to further direct droplets from said nebulising nozzle against said impact surface.

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