BioAerosol Nebulizing Generator

Operation and Maintenance

User Manual

INTRODUCTION

The BANG or BioAerosol Nebulizing Generator is a unique nebulizer for the generation of aqueous aerosols at a low air flow rate. The design of the BANG minimizes foaming of protein solutions while maximizing aerosol output. A fluid metering pump or a flow restrictor may also be used to regulate the liquid flow rate. Different orifices can be ordered resulting in a choice of aerosol production rates. The standard model operates between 2 to 16 liters per minute depending upon the input air pressure. It may be connected to an optional cyclone to assure that the aerosol produced consists of particles in a specified size range. Direct addition of dilution air is possible as well.

Aerosol is produced when incoming air that may be self aspirated or pumped is forced through a small orifice and meets a flow of incoming solution. As a result, the solution is broken into small droplets. Large droplets fall back into the fluid reservoir for reuse. The smaller droplets are released from the outlet and directed into the desired unit such as the CH Technologies nose-only exposure unit. The baffle or the curved outlet tube regulates the size of the nebulized droplets. The baffle is the outlet tube itself in the BANG model with a curved outlet (FIGURE 5).

UNPACKING THE BANG

When you receive your BANG, you should unpack it carefully and check to make certain that the following parts are all present in undamaged condition:

1 -The BANG itself as seen in Figure 1

Your BANG may vary slightly in appearance depending upon the specific fittings you requested and whether or not you have a standard tubular or a vertical discharge BANG. Figure 1 is a photograph of a vertical discharge BANG.

2 - A package of accessories containing:
a - Spare O-rings
b - Hex wrench
c - Extra or custom fittings should you wish to change them
d - Roll of Teflon tape
e - Drill bit (#80)

The accessories package may vary depending upon what you ordered (Figure 4). Any changes from the standard pieces listed above will be noted on your shipping memo. PLEASE KEEP YOUR SHIPPING MEMO FOR FUTURE REFERENCE. If you find that anything has been damaged in transit, contact the carrier of the shipment immediately in addition to CH Technologies.

INITIAL OPERATION

Your BANG will arrive almost entirely assembled. The glass jar will be packed separately and must be screwed into the bottom of the BANG unit. The ground glass top of the jar and threads have been wrapped with Teflon tape to act as a seal when the jar is screwed into the main portion of the BANG. Do not screw the jar in too tightly or it will damage the O-ring on the inside of the BANG (see Figures 2 & 3) resulting in a loss of the seal. In addition you may want to insert a piece of tubing into the liquid return opening inside the base of the BANG (see Figure 2, #5). Both Figures 1 and 2 show where fittings must be connected to air and fluid. The fittings used depend upon what you have requested. The air inlet is shown in Figures 1 and 2 (#1). The fluid inlet is shown in Figures 1 and 2 (#4). The connection for fluid aspiration is also shown in Figures 1 and 2 (#3).

You should immediately check the operation of the BANG. Connect it to a pressurized air source and fill the glass jar with about 10cc of distilled water. Connect fittings 3 and 4 in Figure 2 together with a short piece of tubing unless you are using a fluid metering pump or refill system. This connection ensures that the system is closed and recirculates the liquid. When the air source is turned on, a mist should appear at the aerosol outlet as shown in Figures 1 and 2 (#2). If a mist does not appear, recheck all your fittings. The operation of the BANG depends upon it being a completely sealed unit.

MECHANISM OF OPERATION

Knowledge of the mechanism of aerosol formation by the BANG will help you in determining the aerosol characteristics as well as being useful for maintenance. The jet plate as shown both in the Figure 2 and 3 is the key to aerosol formation. It contains an orifice. This is a very small hole through which pressurized air flows at a constant velocity. The side arm on the jet plate (Figure 2, #4 and Diagram) delivers fluid going into the BANG. Simultaneously the air inlet (Figure 2, #1 and Figure 3 [fluid in]) carries the air stream going into the BANG. As the flow of liquid and air collide, small droplets of liquid, the aerosol, are formed. The aerosol is then forced up the outlet of the BANG (Figure 2, #2 and Figure 3). In the case of the traditional or curved BANG, the aerosol leaves the open curved part of the tube (Figure 5). As the aerosol flows through the outlet, it encounters a baffle that regulates the size of the particles by causing larger particles to drop back into the reservoir. In the vertical BANG, the baffle is normally not visible. If it is necessary to remove the outlet, release the 4 hex screws, which attach it to the body of the BANG. The baffle can then be removed and cleaned. In the curved BANG, the curve of the outlet serves as the baffle. Because the BANG is "recirculating", liquid returning to the reservoir jar is aspirated up the fluid aspiration tube (Figure 1 and 3) and out of the fitting in Figure 2, #3. This fitting is connected to the fluid inlet on the jet plate by means of a piece of plastic tubing. A liquid recirculation pump or a refill system may be inserted between these two fittings (Figure 2, #3 and #4) if desired. Separate instructions are available for a refillable recirculating BANG system.

OPERATION

Operation of the BANG is as described above under INITIAL OPERATION. However, the distilled water is replaced by the solution to be aerosolized such as saline or a solute solution. Take extreme care not to allow any large particles or dried material to enter the system; they may block the critical orifice and stop aerosol formation.

CLEANING THE BANG

Your BANG should perform indefinitely if it is cleaned and maintained properly. The only change that may be necessary is replacement of the O-rings. After each use, drain your solution from the BANG and glass jar as you normally would in any glass vessel. Then rinse with distilled water and air dry by blowing air through the BANG.

— Wash Jars in Laboratory Grade Biodegradable, Non-phosphate Detergent
— Rinse with ASTM Type 1 De-ionized Water
— Oven Dry and Reassemble in Contaminate-free Environment

MAINTENANCE AND ADJUSTMENT

Because the standard BANG is made of stainless steel, it is chemically resistant. However the rubber O-rings may wear out eventually. We have provided extra O-rings if you need to replace them. The location of the O-rings is shown in the Diagram. There is one on the inside of the top of the jar. The other is on the inside of the end plate. These should be checked first if there is any problem with aerosol production. To gain access to the O-ring in the end plate, remove the 4 hex head screws on the end plate with the hex wrench provided (Figure 3). At the same time you can check the critical orifice in the jet plate. If this orifice is occluded, use the drill bit provided to clean the orifice out. When reassembling the BANG, be certain to put the jet plate back in the correct orientation with respect to the main part of the BANG. This is ascertained by lining up the etched mark on the jet plate with a similar mark on the body of the BANG. Finally examine the Teflon tape on the top of the jar and replace it if it is abraded or worn. A roll of Teflon tape is provided in the accessories package. After changing O-rings and/or cleaning the orifice, make certain that the BANG is operating correctly before using it for an aerosol exposure.

STORAGE

Store your BANG only after it has been cleaned and dried. It is advisable to store it with the accessory package and instructions.

WARRANTY

CH Technologies, Inc. certifies that each BANG has been thoroughly tested and inspected before shipment. Each BANG is warranted against defects in materials and workmanship for a period of 6 months after purchase. This requires that the user has complied with the above instructions on use, cleaning and maintenance. Contact CH Technologies for further advice and assistance if your BANG is not functioning properly.

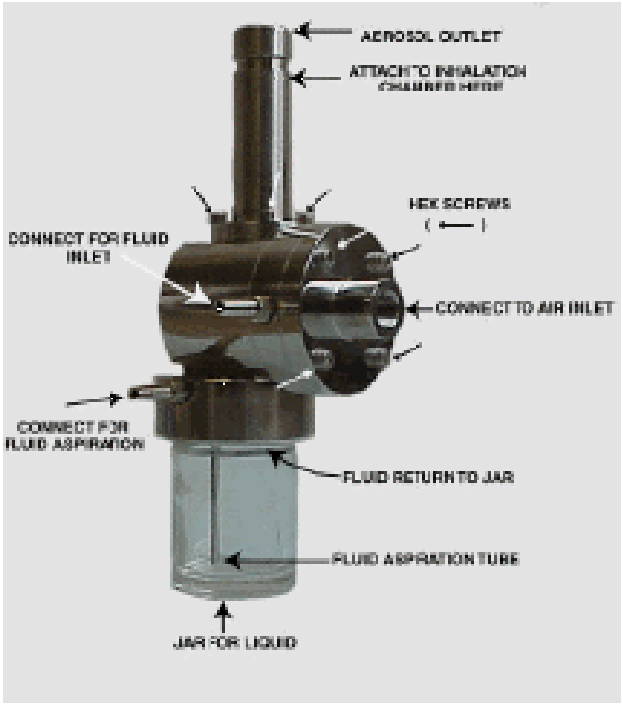

Figure 1: Vertical BANG

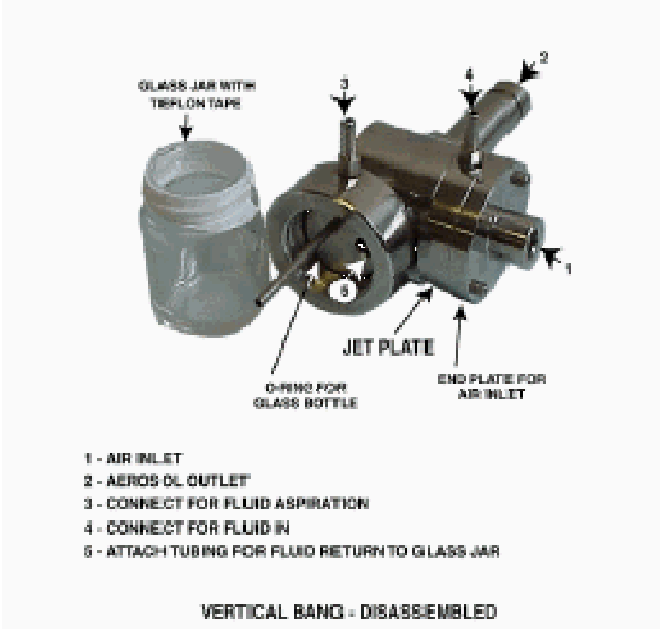

Figure 2: Disassembled Vertical BANG

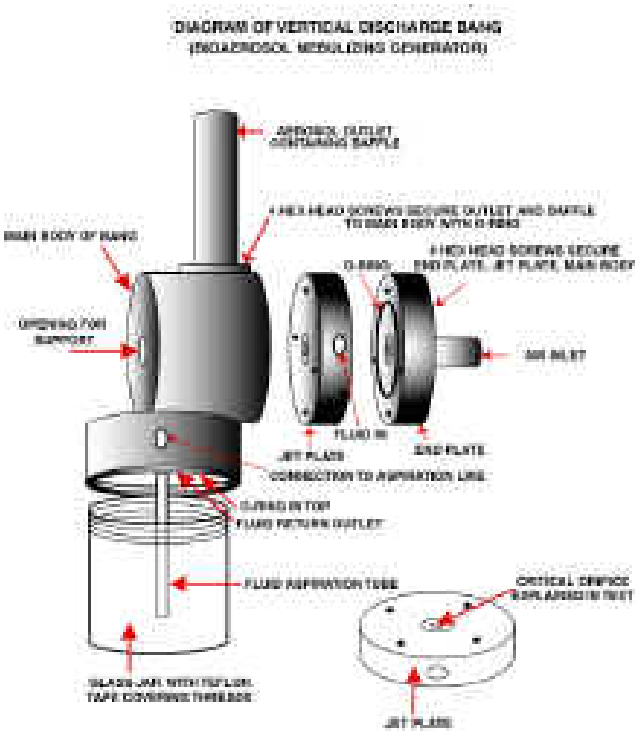

Figure 3: Diagram of parts of BANG

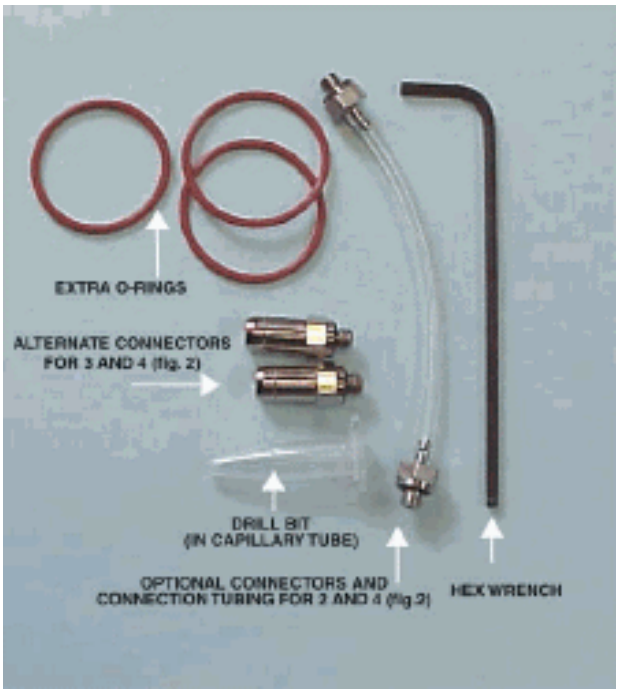

Figure 4: Accessories for BANG

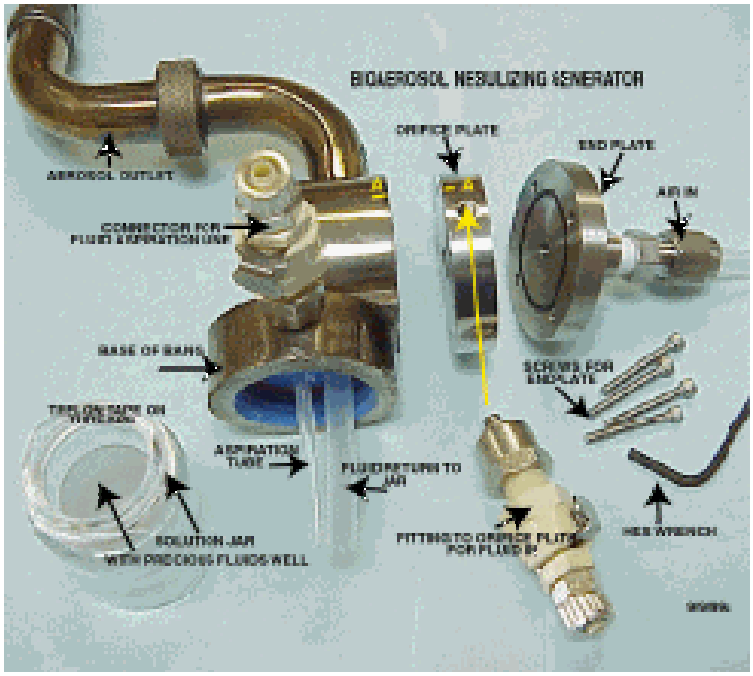

Figure 5 - BANG with curved baffle (aerosol outlet)

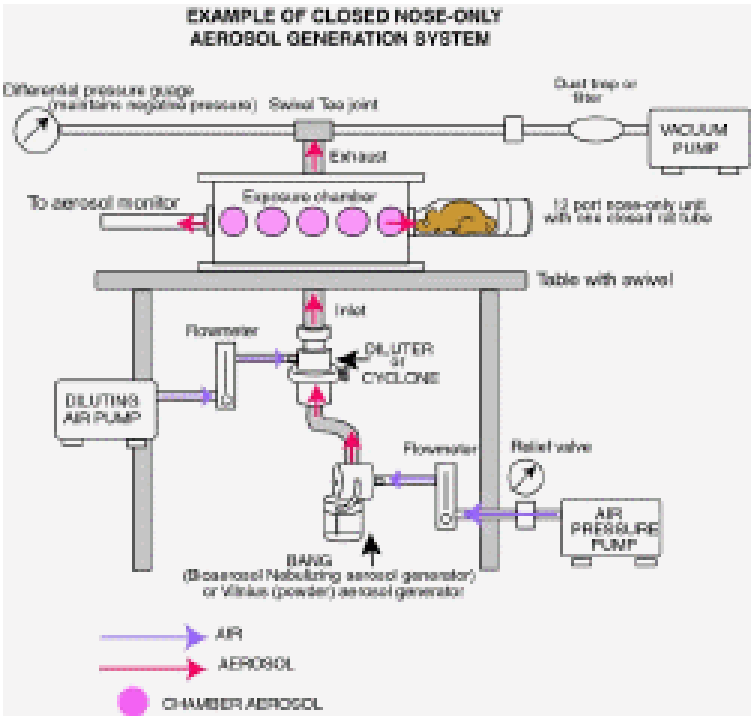

Figure 6: Example of placement of BANG in a closed nose-only inhalation system.

INSTRUCTIONS FOR THE BANG (BioAerosol Nebulizing Generator) **FLOW CONTROL AND REFILL SYSTEM**

The purpose of the flow control meter and refill system is to add fluid to the BANG without interrupting the production of aerosol. This system is used when the BANG runs out of sample fluid before the end of the designated exposure time. The BANG is normally a closed recirculating or single pass system for aerosol production and does not usually require refilling during experimental procedures. The flowmeter can also be used as an additional means of regulating the flow control system of the BANG.

The Diagram shows the parts of the system and the directions of fluid flow when viewed externally. The yellow box containing the flowmeter is enlarged in the following photo and described further.

This flowmeter is usually used for recirculation rates of 10 to 50 cc/min of water, but other rates such as 50 to 200 cc/min water may be used. The photo shows the back of the flowmeter with a stainless steel connector (compression fitting) at the top flow port (1) and a stainless steel T connector at the bottom port (2). The T connector (2) is further attached to both a compression fitting at (3) and the addition point for more sample (4). Arrows in the photo indicate the directions of fluid flow. Fluid recirculates by entering (4) and leaving (1) with the BANG in the center of this circuit. Additional fluid is added as needed by a syringe or syringe pump at point (3). A standard luer syringe fitting can be used to add fluid. Finally compression-fitting adapters are attached to the free ends of the tubing from points (1) and (3). These adapters are connected to the BANG as detailed next. Connect the adaptors first, and then add tubing to make a leak-proof seal. Confirm that the seal is leak proof.

Please note that when finished with use of the flow controlling unit it should be rinsed with deionized water or another appropriate (plastic safe) solvent dependent upon the sample solution so that it will work properly the next time it is required.

Connecting the Flowmeter and Refill system to the BANG:

The Diagram below is a schematic of the refill system and BANG. (More detailed diagrams of the BANG can be found in the separate BANG instructions)

First existing hose barb connectors must be removed from the BANG using an adjustable wrench. These are the usual connectors that are supplied or connected to tubing or hose for fluid recirculation in the closed system. The flowmeter system and tubing are now attached together at Points A and B in the Diagram. Thus the fluid from the top of the flowmeter enters into the top of the BANG at Point A and the fluid from the BANG leaves at Point B returning to the bottom of the flowmeter.

Compression fittings attached to the free ends of the tubing from the BANG (described previously) make the above described connections secure. Finally the tubing connected at Point C in the Diagram or 4 in the photo is connected to the external fluid reservoir

whether it is a syringe or syringe pump. A connector has been added to this tubing in order to seal the system when the syringe or pump is being refilled.

Please note that when attaching the flowmeter assembly to the BANG it is important not to overtighten the connections to the BANG. In addition, the flowmeter must be kept in a vertical position. As the BANG operates, fluid may be added as required as described earlier. Flow may be further regulated by use of the valve at the front of the flowmeter. It is also very important to start with the valves fully open.

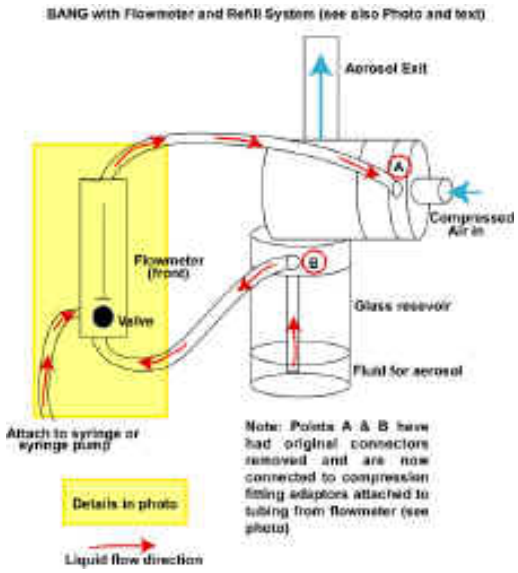

Figure 1: Diagram of refill system and BANG

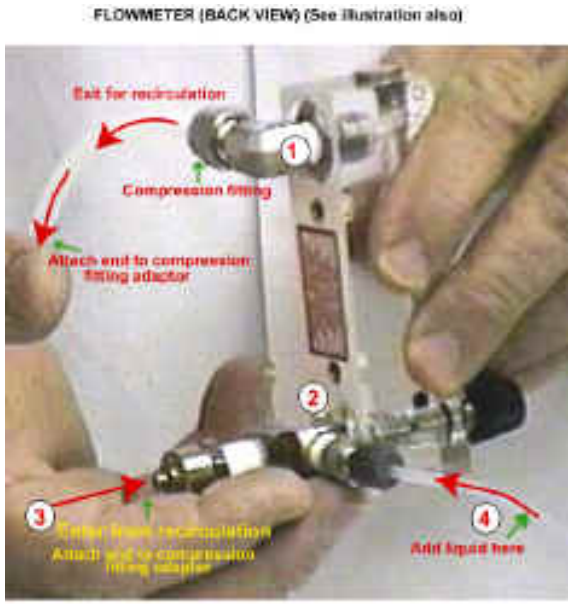

Photo: Enlargement of flowmeter (back) from refill system.