

## Update on an exposure system for particles in the diagnosis of occupational asthma

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*Update of an exposure system for particles in the diagnosis of occupational asthma. Y. Cloutier, J-L. Malo.*

**ABSTRACT:** We have previously designed a system for exposure to particles and described the preliminary results in 20 subjects exposed to occupational sensitizers in powder form (Cloutier Y, *et al.* - *Eur Respir J*, 1989; 2: 769). Modifications have been made to the particles generator, exposure chamber and sampling ports. Furthermore, in order to improve the stability of concentrations in the exposure chamber and to make the system easy to operate by a technician, it has been completely automated using closed-loop feedback regulated by a computer program.

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Specific inhalation challenges using occupational sensitizers were proposed in the 1970s by PEPYS and HUTCHCROFT [1] for investigating occupational asthma. These tests have since become the gold standard for confirming the diagnosis. Occupational sensitizers are in particle form in approximately one-third of our challenges. In an effort to improve the safety of the test and to obtain information on the concentration and diameters of inhaled particles, we designed a new aerosolization device [2].

In this work, we describe a technical modification to the system.

### Material and results

#### Apparatus

The previous and new versions of the apparatus are shown in figures 1 and 2. The following changes can be seen:

1. The rotating plate has been removed. The endless screw used to bring the particles to the rotating plate has been replaced by a brush in the vertical position. The bottom of the cylinder has a hole at the centre, the entry for an 8 cm long cylinder channel. A brush attached to a rotating shaft, centred on the cylinder axis, is partially immersed in the dust and completely crosses the channel. When it rotates, the brush carries the dust through the aspiration inlet of the Venturi system, which resuspends the dust.

At the outlet of the Venturi system, the newly constituted aerosol is directed towards the exposure chamber inlet. This ensures that all types of sensitizers in powder form can be generated.

2. A 2 l empty container (cyclone) is used to eliminate the excess of the outgoing aerosol between the generator and the exposure chamber. The exposure chamber has also been modified. Instead of being horizontal, the 1.5 m long and 15 cm diameter cylindrical room has been set vertically in order to prevent sedimentation in the exposure chamber itself, as well as in the various sampling ports (photometer, cascade impactor, orofacial mask). The diameters of all the sampling ports have also been modified in order to minimize losses due to particle inertia during the sampling process.

3. Finally, in order to improve the stability of the concentration of particles in the exposure chamber and to make the system easy to operate by a technician, it has been completely automated using closed-loop feedback regulated by a computer program. The program was designed to automatically adjust all system parameters (flows, opening valves in degrees, pressure inside the chamber and generator, concentration, temperature and humidity in the chamber) to achieve the concentration set by the operator. It instantaneously displays the concentration, the flows and the valve position on a screen.

These modifications result in more satisfactory control over the stability of the aerosol concentration (fig. 3). Furthermore, it is easier for the technician to handle.

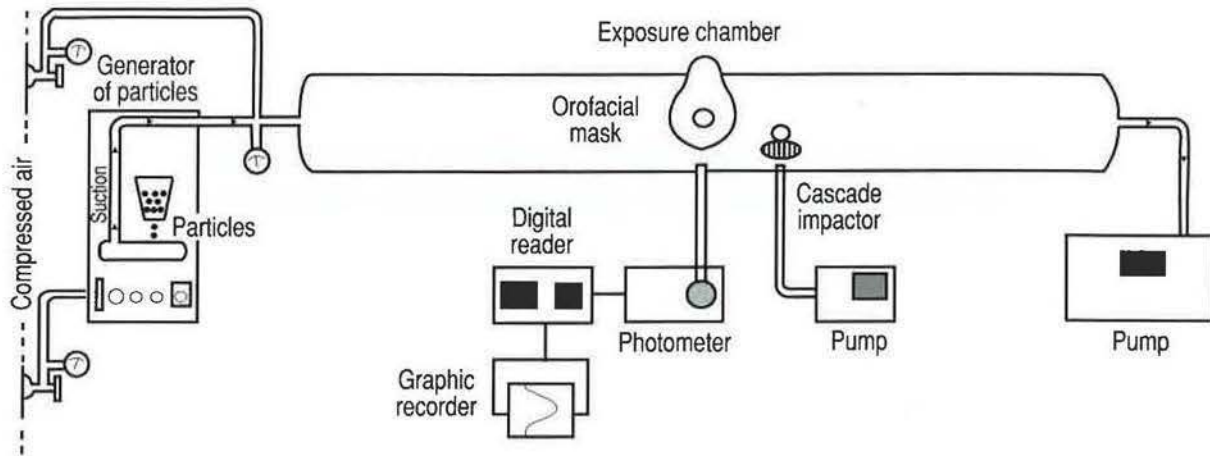


Fig. 1. — Aerosolization device in three parts: 1) the generator of particles on the left hand end in which the particles are vibrated, taken to the rotating plate by an endless screw and sucked out; 2) the exposure chamber, a 100 cm long plexiglass cylinder with three holes in the centre, one for the orofacial mask, one for the photometer probe and one for the cascade impactor probe; 3) the recording instruments, *i.e.* the photometer and the cascade impactor.

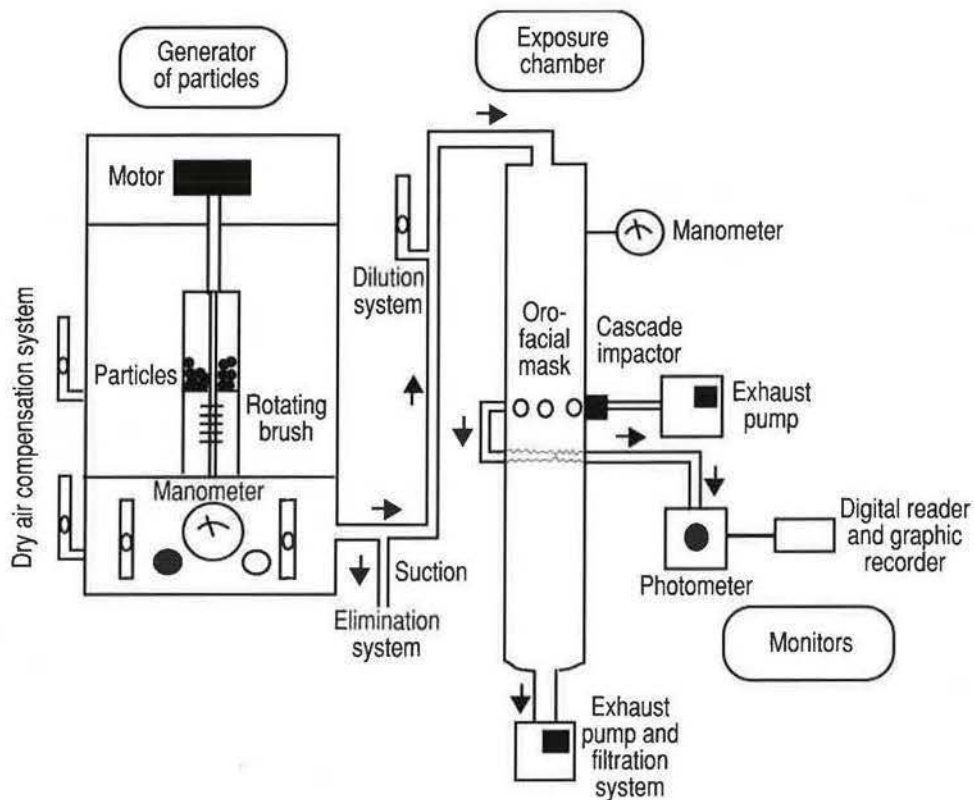


Fig. 2. — Modifications to the original aerosolization device shown in figure 1: 1) a brush instead of an endless screw is used to bring particles to the exposure chamber; 2) the rotating plate has been removed and a 2 l empty container is used to eliminate the excess of the outcoming aerosol (elimination system); 3) the exposure chamber is set vertically instead of horizontally to minimize sampling losses due to particle inertia. Not illustrated, the system is automated so that the concentration of particles can be adjusted by controlling the speed of the motor that activates the brush and/or the negative pressure suction in the chamber and in the generator, which is fed with dry air.

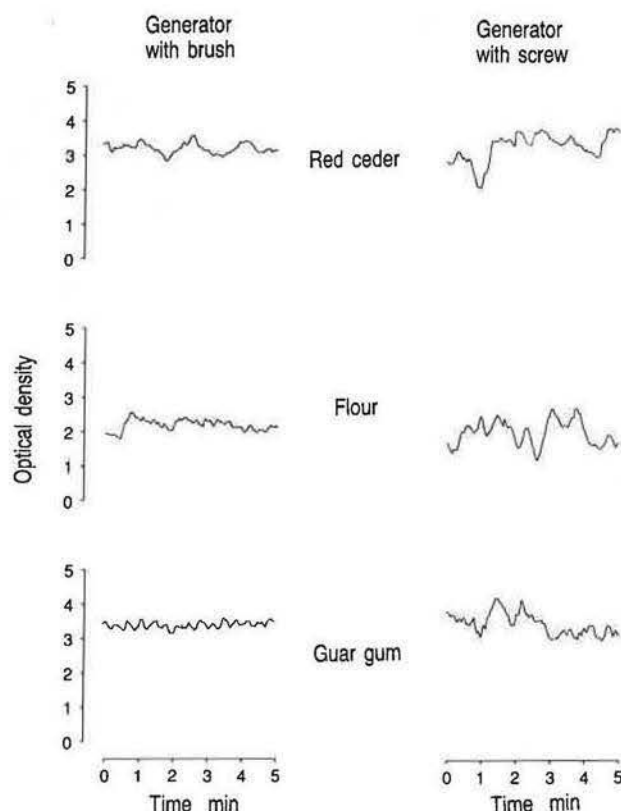


Fig. 3. — Comparison of the stability of the readings on the photometer using three different occupational sensitizers in particle form. Stability with the new generator using a brush is slightly superior compared with the generator using a screw.

### Discussion

Asthma is now the most common occupational respiratory ailment [3, 4]. Considering the frequency of this condition and the significant sociomedical implications of the diagnosis, it is essential that objective tools be used to confirm the diagnosis. Neither a medical questionnaire [5], nor immunological testing, or assessment of bronchial responsiveness [6], are sufficient to confirm the diagnosis. Monitoring of peak expiratory flow rate (PEFR) is a more accurate tool, although it is open to criticism due to the need for honesty and collaboration from the subject [7, 8]. It is, therefore, expected that specific inhalation challenges, either in the laboratory as described in this report, or at work under direct supervision, will be used more often in confirming the diagnosis.

In the original proposal for these tests [1], subjects were exposed to agents in powder form by tipping dust from one tray to another. There are, however, several pitfalls to this approach, as discussed in a previous report [2]: 1) The level of concentrations can be erratic and high at times. This can result in unduly severe immediate reactions and make differentiation between "irritant" and "sensitizing" reactions difficult, especially in subjects with marked bronchial hyperresponsiveness. The pattern of recovery from the bronchoconstriction of immediate reactions caused by pharmacological agents or unconditioned air cannot be

distinguished from that described for common or occupational sensitizers, for which the mechanism can be immunoglobulin E (IgE) or non-IgE mediated. 2) It is difficult to draw a dose-response curve since the concentration of particles cannot be set. 3) There is a risk that the personnel conducting the tests will be sensitized. We have previously described an apparatus that makes exposure to particles at stable, low concentrations possible and have shown that dose-response curves can be generated [2].

We have now modified the apparatus to ease the aerosolization of particles and control the concentration of particles by setting it automatically. This modification may also result in a slightly improved stability of concentrations.

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