Vacuum-cleaning System for Isolation Chambers

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To encourage the utilization of the isolation chamber as a research tool, the cost of its use should be lowered. Methods and devices must be developed which make more efficient use of the space within the isolator and allow the operator to work more effectively in this confined area. A simple vacuum-cleaning system is described; it consists of a nozzle and flexible hose which connect through the isolator wall to an externally placed waste tank, attached by way of its outlet filter to a source of vacuum. The cylindrical waste tank [48 inches (1.219 m) high and 36 inches (0.914 m) in diameter] was sterilized in a large autoclave. During a 9-month test period, the system was used to remove soiled corn cob bedding from a large isolator containing 90 adult monocontaminated rats. During this period, the microbial flora of the isolator was unchanged, and the time required to clean the cages was reduced by 50%. This vacuum-cleaning system is a safe, convenient, and economical means of increasing the efficiency of an isolation chamber.

An increasing number of isolation chambers are being used for an expanding variety of applications. Several factors have contributed to crowded working conditions in these isolators. The high cost of the equipment has tended to decrease their size. The working area has often been limited by the length of a glove or the reach of an operator. The time involved in removing or locking out waste materials has led to their storage within the isolator. To reduce the cost of research conducted in isolation chambers, methods and devices must be developed which make more efficient use of the space within the isolator and allow the operator to work more effectively in this confined area.

To increase our efficiency in caring for a colony of germ-free rats, a vacuum-cleaning system for removing waste from an isolator in a safe, convenient, and economical fashion was devised. The purpose of this paper is to describe the system and evaluate its performance.

MATERIALS AND METHODS

The principal component of the vacuum-cleaning system is a large auxiliary waste tank which connects through its outlet filter, to an industrial vacuum cleaner (Fig. 1). The inlet to the tank connects through the isolator wall to a hose and nozzle (Fig. 2).

The 18-gauge, stainless-steel nozzle has a 4 by 1.5 inch (10.16 by 3.81 cm) rectangular orifice, is 7 inches long (17.78 cm), and attaches to a 10 ft long (3.04 m) light-weight plastic vacuum cleaner hose [inside diameter (ID), 1.5 inch (3.81 cm)]. The hose connects to a straight connector fitted into a vinyl flare [ID, 2 inches (5.08 cm)] on the side of the isolator. A piece of radiator hose [ID, 2 inches (5.08 cm)] connects the isolator to an inlet in the top of the waste tank.

The cylindrical tank is made of 16-gauge, type 304 stainless steel and is 48 inches (1.21 m) high and 36 inches (0.914 m) in diameter. It rides on a removable circular base with four casters. The top of the tank has a 2-inch (5.08-cm) lip which fits snugly over the outside of the tank, the junction being sealed airtight with several turns of pressure-sensitive vinyl tape [Slipknot no. 44; width, 1.5 inches (3.81 cm); Plymouth Rubber Co., Inc., Canton, Mass.]. The inlet on the top of the tank is a 16-gauge, 90° radius elbow [outside diameter (OD), 2 inches (5.08 cm)]. The outlet [OD, 2 inches (5.08 cm)] attaches to a modified outlet filter (3), with a surface area of 204 square inches (1,316.2 cm²), containing four, 0.5 inch (1.27 cm) thick pieces of FM-004 fiberglass filter material (Owens-Corning Fiberglas Corp., Toledo, Ohio). An 8-inch (20.32 cm) square of 0.5 inch (1.27 cm) thick plate glass is fastened into an opening on the top of the tank with silicone rubber sealant (type RTV-106; General Electric Co. Silicone Products Dept., Waterford, N.Y.).

The outlet of the filter connects through a flexible hose to a heavy duty industrial vacuum cleaner (model D-140; Multi-clean Products, Inc., St. Paul, Minn.) modified so that its motor can be activated by a foot switch. The vacuum cleaner can be quickly detached from the filter so it may be used with other waste tanks or in the general laboratory.

The waste tank, with its attached outlet filter and inlet radiator hose, was sterilized as a unit in a large steam autoclave for 3 hr at 122 C. After sterilization, the radiator hose was attached to the connector in the wall of the isolator and the interface was sterilized with a 2% peracetic acid solution. The lightweight vinyl vacuum cleaner hose was placed in a cuboidal...
sterilizing chamber (2), sterilized with ethylene oxide gas, and locked into the isolator.

This vacuum-cleaning system was used during a 9-month period to remove the soiled corncob bedding, twice a week, from the cages in a large isolator containing 90 adult monocontaminated rats. Samples of all supplies and the urine and feces from the animals in this isolator were cultured weekly in the following media: (i) fluid thioglycolate medium aerobically at 37 and 55 C and anaerobically at 37 C; (ii) tryptose blood-agar base plates both aerobically and anaerobically at 37 C; and (iii) Sabouraud dextrose-agar slants aerobically at room temperature (22 C).

RESULTS

Subjectively, the vacuum-cleaning system was an instant success. The animal caretakers noted the ease with which the cages could be cleaned and the convenience of the extra storage area now available within the isolator. On one occasion, very thick gummy feces partially blocked the vacuum hose at a 90° bend. Under normal working conditions, there were no problems. The system could also be used to remove waste water from the isolator.

Objectively, the findings were equally pleasing. Throughout the test period the isolator remained in its monocontaminated state. In servicing these large production isolators, about two-thirds of an animal caretaker's working time within the isolator was expended in cleaning the cages. The vacuum-cleaning system decreased this cage cleaning time by 50% and lowered the total working time within the isolator to 6 min per adult rat per month.

By changing the bedding in each cage twice a week, about 280 g of corncob bedding was used per rat per week. The 90 rats produced over 260 kg of soiled bedding every 45 days, at which time the waste tank was nearly filled. It was quickly disconnected from the isolator, rolled to a waste disposal area, unloaded, then moved to a clean area, washed, reassembled, pushed into a large autoclave, sterilized, cooled, and reattached to the isolator. This turn-around time required 1.9 man-hours of labor.

DISCUSSION

The size and shape of the waste tank can be changed without affecting the system's performance. However, the diameter of the vacuum cleaner hose, the size of the filter, and the power of the vacuum unit are interrelated. These parameters must be adjusted to adequately move materials of a given size and weight through the vacuum-cleaning system.

As the cost of the isolators used to house germ-free animals has gradually decreased through the use of new materials (1), a larger portion of the purchase price of the animals is represented by the cost of labor. Methods must be developed which enable one to safely, conveniently, and rapidly care for the germ-free animals, if their cost is to continue to fall and their applications to widen. The vacuum-cleaning system for isolation chambers described in this paper is an effort in this direction.

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LITERATURE CITED

