

BACKGROUND

The BMS BDC vivarium is currently utilizing three different types of caging to maintain our mouse colonies. These are: 1) Innovive Innorack™ IVC Mouse 3.0 ventilated rack with Innocage™ Mouse Pre-Bedded cage bottoms with papertwist-enriched corn cob bedding, Innocage IVC Mouse Dual Filter lid, and mouse metal feeder, in which we put Lab Diet Isopro 5P75 pellets. On these cages we use the Hydropac® Watering System pouches by Lab Products. (Hydropac AWS 2500, kept at pH range 2.3-2.8, tested at each start-up and after every ~500 pouches made.) Per manufacturer recommendations, the bottoms are changed every 14 days, and the lids are changed every 28 days.

2) Allentown® individually- ventilated racks with a 160 cage capacity, with JAG75 mouse cage bottoms containing a mixture of Sanichip 7090A and Paperchip Soft Texture bedding with filter-top lids and metal grids that hold Lab Diet Isopro 5P75 pellets, and utilize the in-house Edstrom Chlorine Injector Station/Repressurization Automatic Watering System, kept at 2.3 mg/L chlorine in the system water, and checked weekly. These cage bottoms are changed weekly, except for breeding cages with pups over 10 days old, which are changed on a more frequent, as needed basis. The metal grids are changed every 3-4 weeks, and the filter tops are replaced as needed.

3) Ventilated Rack #3 (undisclosed vendor) with individually-ventilated mouse cages with filter-top lids. On these, we use the mouse metal grids to hold Lab Diet IsoPro 5P75 food and fitted with a plastic sleeve to hold the Hydropac® Watering System pouches. These cage bottoms are changed every 7 days, except for singly-housed mice, which are changed every 2 weeks. The metal grids are changed every 3-4 weeks, and the filter tops are replaced as needed. The air supply and exhaust for all cage types is HEPA filtered in and out. All ventilated racks are exhausted through a thimble connection to the building HVAC system. All racks are set for 30-35 air changes per hour, and the rooms are set for 10-12 air changes per hour.

The Guide recommends cage change frequency for solid-bottom mouse cages of at least once per week, which may be extended in certain circumstances.¹ Our goal is to see if we can standardize our cage change intervals and to determine an appropriate cage change frequency for all caging systems based on ammonia monitoring within the cage environment. This will enable us to have more efficient use of equipment, technician husbandry time, and available space.

PURPOSE AND HYPOTHESIS

Currently, our cage change SOP states that all non-disposable caging is to be changed on a weekly basis, except for singly-housed mice and breeding cages. Since it is also required for a minimum of 2 technicians to check each cage daily, we spend a significant amount of time observing the mice and the cage environment. Based on our observations, we have found that the amount of fecal material and moisture that accumulates in the cage after 1 week is minimal, therefore, we feel it may be possible to extend the cage change frequency for non-breeding cages to once every 2 weeks.

Innovive®™ Ventilated Rack #1 – Holding cage 2 week cage change interval 24 hr exposure (5 mice)



Allentown Ventilated rack #2: Holding cage 2 week cage change interval 24 hr exposure (2-5 mice)



Ventilated Rack #3: Holding cage 2 week cage change interval 24 hr exposure (5 mice)



Allentown Ventilated Rack #2: Breeding cage; 1week cage change interval 24 hr exposure (7-12 pups)



BIBLIOGRAPHY

- 1 Guide for the Care and Use of Laboratory Animals, 8th edition. Washington (DC): National Academies Press (US); 2011. (pp.70-72)
- 2 United States Department of Labor. Occupational Safety & Health Administration. Exposure Limits and Health Effects; OSHA Permissible Exposure Limit (PEL) - General Industry (Ammonia) 29 CFR 1910.1000 Table Z-1
- 3 Centers for Disease Control and Prevention. Doc. for Imm. Dangerous To Life or Health Cons (IDLHs). Ammonia CAS number: 7664-41-7

MATERIALS AND METHODS

We utilized the Chromair System Ammonia Monitor by Morphix® Technologies (Part Number: 380003), which is a patented, passive, direct-read autogenic exposimeter. "The device is constructed from six cells attached on one side to a flat indicator layer and on the other side to a series of different diffusive resistances. Ammonia gas diffuses to the cells through the different diffusive resistances and reacts with the indicator layer, producing color change from beige to black. The color produced on the indicator layer is a direct measure of the exposure dose." The monitor measures an exposure range of 4 – 300 parts per million per hour via color change from beige to black. Using 3M Scotch-Blue™ Painter's Tape for Multi-Surfaces #2090, these monitors were taped inside the lids of the IVCs. On the Innovive cages, the monitor was taped directly to the inner surface of the cage lid, near the feed bin, so that the mice could not chew on the monitor. For the other 2 cage types, the monitor was taped to the filter of the cage lid, with the metal grid denying mice access to the monitor. We also took photographs of the cages at the various time points, once the cages were opened to remove the ammonia monitors from the lids. For all 3 cage types, we initially placed monitors in cages 1 week after a cage change and left them in for 1 hour. We tested cages containing 1, 2, 3, 4 and 5 adult mice, and cages containing breeding pairs with a varying number of pups at different ages. Except for the breeding cages, we saw no color change on the monitors. We repeated these same density parameters again, leaving the monitors in for 4 hours. Again, this resulted in no color change except in the breeding cages. We then repeated the tests in all densities, leaving the monitors in for 24 hours. We chose this 24-hour time frame to capture the nocturnal "activity" period of the mice, not just the daytime "quiet" period. For all cage types, on the 1 week tests, the monitors did not register a color change, indicating an ammonia level of less than 4 ppm. The only color change observed was in breeding cages with pups. These cages are changed on an individual schedule, depending on the age of the pups, which may turn out to be more than once a week, after the pups reach 10 days of age. For all other cage types and densities except breeding cages, after waiting 14 days from the previous cage change, a monitor was placed in the lid of the closed cage for 24 hours, and then removed for reading. For the 2 week tests, there was only a color change at the 4-20 ppm/hour range indicator.

RESULTS

As seen in the photos of the ammonia monitors and their corresponding cage pictures, the color change is only in the area of the 4-20 ppm/hour circle. Dividing this ppm/hr exposure by the 24 hours the monitor was in the cage, the mice exposure to ammonia is less than 1 ppm/hour. We used the human OSHA Permissible Exposure Limit (PEL) - General Industry of 50 ppm/hr (8 hr TWA)² as a reference. The RD50 of ammonia exposure in mice is 303ppm³. We are well below these reference points at the 14-day cage change timeframe.

CONCLUSIONS

Based on the readings we obtained, we feel it will be safe to allow a 14-day cage change interval for all caging systems, except for breeding cages with litters, and those visually deemed in need of change during their daily check. We presented this to our IACUC, received approval of the extended interval, and have incorporated these new standards into our Cage Changing SOP.

* Product names used with permission from vendors