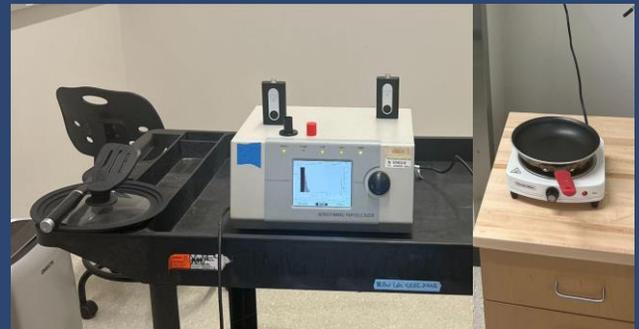
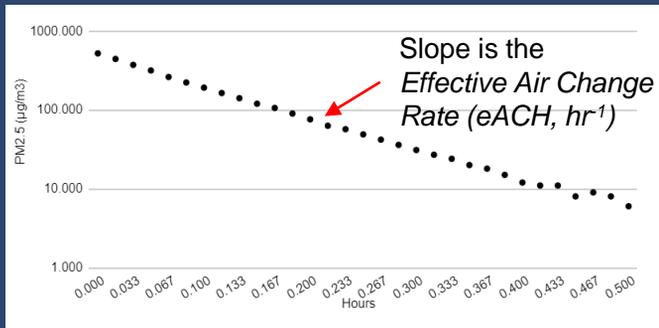


DIY Air Cleaner Design for North Denver Communities

The Social Justice and Environmental Quality – Denver (SJEQ-D) study is working to improve indoor air quality in the Colorado communities of Globeville, Elyria-Swansea, Cole, and Clayton. Do-it-yourself (DIY) solutions using box fans and furnace filters taped together are a low-cost option for effective air cleaning. We studied DIY air cleaner designs to optimize air cleaning capacity, reduce cost, and minimize build time and physical size.



The clean air delivery rate (CADR), or the volume of clean air produced per minute by an air cleaner, was measured to assess the effectiveness of different designs. The figure above on the right shows the testing facility.

To measure the CADR, we first estimated the effective air changes per hour (eACH) of particulate matter removal provided by each air cleaner in a test room at the University of Colorado Boulder. We filled a test room with cooking pollution from frying a hamburger in canola oil. We measured how fast each air cleaner design reduced $PM_{2.5}$ concentrations using two Atmotube Pros and calculated the eACH from the slope of the removal curve (see figure above).

We then calculated CADR for each design: **CADR = Test Room Volume [1366 ft³] x eACH [hr⁻¹] / 60 [min/hr]**.

We tested six air cleaner designs with 20x20" MERV13 filters: a 4-filter cube, a 2-filter triangle, and 1-filter designs with filters of differing depths (4", 2", 1"). A fan shroud was used in some designs, intending to improve efficiency. In the table below we compare CADR, ease of build, size, and cost of our designs to determine the best one for North Denver communities. Initial costs include the price of the fan (\$49) and filters, and annual costs include the price of changing the filters every 6 months.

| | 1-MERV13 Filter, 20x20x1" (shroud) | 1-MERV13 Filter, 20x20x2" (shroud) | 1-MERV13 Filter, 20x20x4" (shroud) | 1-MERV13 Filter, 20x20x4" (no shroud) | 2-MERV13 Filters, 20x20x2" (shroud) | 4-MERV13 Filters, 20x20x2" (shroud) |
|--|------------------------------------|------------------------------------|------------------------------------|---------------------------------------|-------------------------------------|-------------------------------------|
| CADR (PM _{2.5}) [ft ³ /min] | 108 😞 | 127 😊 | 127 😊 | 149 😊 | 230 😊 | 415 😊 |
| Ease of Build | Medium 😊 | Medium 😊 | Medium 😊 | Easiest 😊 | Hardest 😞 | Hard 😞 |
| Size | Small 😊 | Small 😊 | Small 😊 | Small 😊 | Medium 😊 | Large 😞 |
| Initial (Annual) Cost (\$) | \$59 (\$20) 😊 | \$65 (\$32) 😊 | \$72 (\$46) 😊 | \$72 (\$46) 😊 | \$81 (\$64) 😞 | \$113 (\$184) 😞 |
| CADR/Initial Cost [ft ³ /min-\$] | 1.8 😞 | 2.0 😊 | 1.8 😞 | 2.1 😊 | 2.8 😊 | 3.7 😊 |
| CADR/Annual Cost [ft ³ /min-\$] | 5.4 😊 | 4.0 😊 | 2.8 😞 | 3.2 😊 | 3.6 😊 | 2.3 😞 |

OPTIMAL AIR CLEANER DESIGN

We chose the **1-filter design using a 20x20x4" MERV13 filter and no fan shroud**. The 1-filter designs are less time consuming to build, take up less space in a room, and have lower initial and annual costs. Of the 1-filter designs, the 4" filter depth had the highest CADR. Activated carbon was added to the design to remove volatile organic compounds (VOC's) and ozone.

For comparison, a [Coway Airmega AP-1512HH](#) (\$197) air cleaner provides a CADR of 233 ft³/min for smoke (1.2 ft³/min-\$ CADR/initial cost) with \$115/year of filter replacement costs (1.9 ft³/min-\$ CADR/annual cost).



HOW TO INSTALL AND MAINTAIN YOUR AIR CLEANER

1. Install the filter where you spend a lot of time or in your kitchen. If you already have an air cleaner installed in your kitchen or living room, consider putting your new air cleaner in the other room or in your bedroom. Place the air cleaner on the floor or on a table without obstructing the front or back (e.g., not against a wall).
2. Set the air cleaner to run on **level 3** for maximum air cleaning and leave it running whenever you are home.
3. For long term maintenance, the filter and activated carbon should be replaced every 6-12 months:

REMEMBER: THE AIR CLEANER IS NOT WEATHERPROOF AND EITHER SIDE SHOULD NOT BE BLOCKED!

Replacement 20x20x4" MERV13 filters: <https://www.amazon.com/FilterBuy-20x20x4-Pleated-Furnace-Filters/dp/B00CK06AI4/>

Replacement activated carbon: <https://www.amazon.com/Breathe-Naturally-Universal-Activated-Purifiers/dp/B0835Y27YG/>

OPTIONAL UPGRADES FOR YOUR AIR CLEANER

You can install wire mesh on the front of the fan to keep fingers out.

To pet-proof and/or improve aesthetics, you can cover the rest of the cardboard with duct tape.

There are many creative ways of decorating DIY air cleaners to improve the way they look!

If a 2- or 4-filter design is desired, you can remove the single filter and upgrade to other designs:

Alternative DIY air cleaner designs: <https://cleanaircrew.org/boxfanfilterfaq/>

CALCULATING AIR CHANGES IN YOUR HOME

The air changes per hour (ACH, hr⁻¹) of a room is the number of times that most of the air in the room is replaced with clean air in one hour. As ACH usually relates to gas removal, when calculating particulate matter removal in a room with an air cleaner installed, we use the term effective ACH (eACH).

To calculate the eACH that your air cleaner is adding to your home, use this equation (units are in brackets):

$$\mathbf{eACH [hr^{-1}] = (CADR [ft^3/min] \times 60 [min/hr]) / (Room Volume=length [ft] \times width [ft] \times height [ft])}$$

For a 220-ft² living room with 8-ft ceilings, the DIY air cleaner that we built for you and delivered to your home (CADR=149 ft³/min) will provide **5 eACH**: $149 [ft^3/min] \times 60 [min/hour] / (220 [ft^2] \times 8 [ft]) = 5 \text{ eACH}$

ADDITIONAL INFORMATION ABOUT HOME INDOOR AIR QUALITY

Ventilation rates in homes are usually very low (less than 1 ACH, <https://www.epa.gov/indoor-air-quality-iaq/how-much-ventilation-do-i-need-my-home-improve-indoor-air-quality>).

Adding an air cleaner increases the particle removal rate in most homes.

If your home has a ventilation system, setting your thermostat to always run the fan helps remove particles by constantly passing home air through the ventilation filter. It is recommended to replace the filter in your ventilation system seasonally, every 3 months.

Cooking can generate highly elevated particulate matter concentrations. Turning on your stove hood when cooking helps remove cooking emissions, as long as it vents the air outside.

When outdoor air pollution is low, opening windows can also reduce indoor air pollution concentrations.

INDOOR AIR QUALITY RESOURCES

- DIY Air Cleaner (also known as a Corsi-Rosenthal Box) User Guide in English and Spanish:
https://aghealth.ucdavis.edu/sites/g/files/dgvnsk261/files/inline-files/DIY%20Air%20Purifier%20Directions_English.Spanish_0.pdf
- US EPA Tips to Improve Indoor Air Quality:
<https://www.epa.gov/indoor-air-quality-iaq/improving-indoor-air-quality>
- US EPA Guide to Air Cleaners in the Home:
<https://www.epa.gov/indoor-air-quality-iaq/air-cleaners-and-air-filters-home>

If you are having issues with your air cleaner or if you have questions about how to install or operate your air cleaner, please contact the SJEQ-D research team for help!



<https://www.sjqdenver.com>