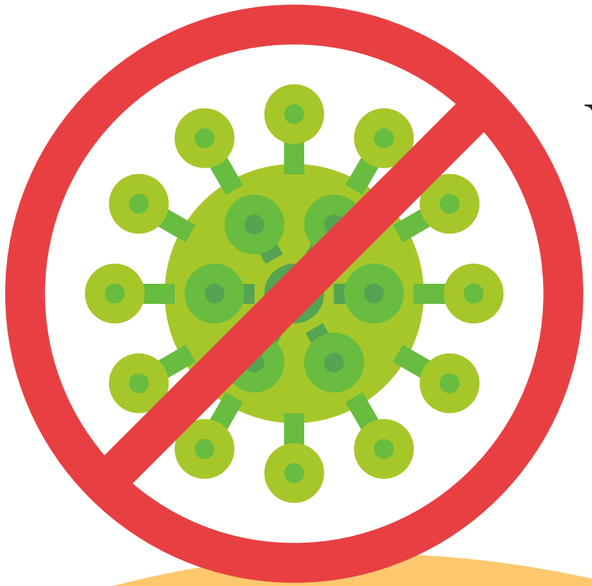
Ventilation & Air Quality Lesson

SWEHSC CEC

Southwest Environmental Health Sciences Center
College of Pharmacy
Arizona

Amid the COVID-19 crisis, having proper ventilation (the amount of outdoor air coming indoors) can help lower the spread of the virus when combined with other safe practices.

Why do you think that is?

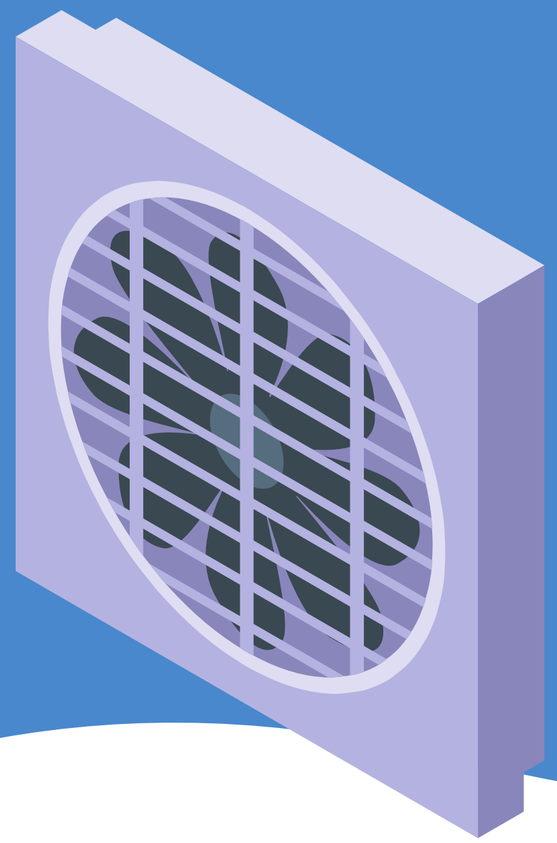


Ventilation for COVID-19 Mitigation

- Allow virus particles to exit the space, lessening its concentration

- Allow virus particles to spread out instead of being concentrated in one place.
- Reduces surface contamination by removing some virus particles before they can fall out of the air and land on surfaces.

Ventilation for Indoor-Air Quality



- Ventilation can also help improve our air quality, allowing us to breathe cleaner air that is essential to maintaining our health.

- Ventilation can help remove indoor air pollutants or airborne contaminants (e.g. toxic smoke, other viruses) by reducing its concentrations.

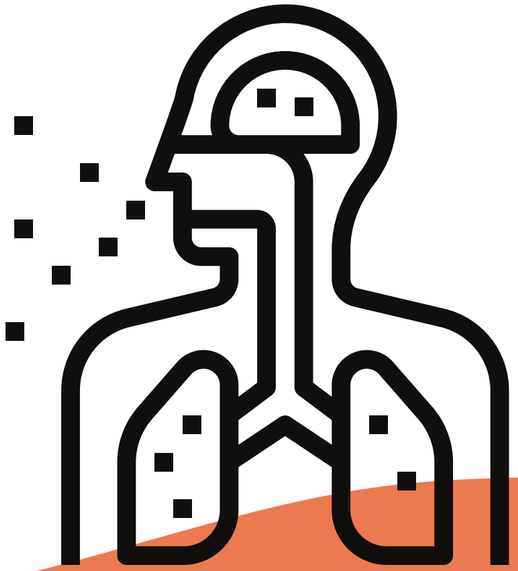
What other air pollutants do you know of?

Air Ventilation and Filters

* Often times, ventilation such as the ones in homes or schools are accompanied by air filters.

Air filter can help catch Particulate Matters (PM) such as dust, pollen, mold, bacteria, smoke, and suspended airborne virus and remove it from the air.

PM is tiny air pollutant (around less 10 micrometers in size). The ones that are less than 2.5 micrometer in size are the most dangerous ones for human health since it can settle in a deep part of our lung.



Did you know?
HEPA Air Filter have been shown by some studies to reduce airborne SARS-CoV-2.

Box Fan Air Filter System - Real World Applications

Aka The Healthy Hooghan Project

Healthy Hooghan Project Infographic V4 - updated 02/09/2022

NAVAJO HEALTHY HOOGHAN PROJECT

"REDUCING HOUSEHOLD AIR POLLUTION AND ASTHMA SYMPTOMS IN NAVAJO NATION CHILDREN"

THE WORD "HOOGHAN" MEANS HOME IN THE DINÉ (NAVAJO) LANGUAGE.

THE "NAVAJO HEALTHY HOOGHAN" PROJECT AIMS TO GREATLY REDUCE THE AMOUNT OF INDOOR AIR POLLUTION WITHIN HOMES TO RELIEVE ASTHMA SYMPTOMS IN CHILDREN ON THE NAVAJO NATION (NN).

PROBLEM STATEMENT

1 in every 5 Diné children has asthma.

- Within the last year, nearly 50% of NN children w/ asthma experienced symptoms that required use of an inhaler.

Illustrations by Paula Falco; design by UIC Institute for Healthcare Delivery Design

Chronic exposure to indoor air pollutants, like particulate matter (PM) 2.5, is a known risk factor for asthma prevalence & severity.

- PM 2.5 has an aerodynamic diameter less than 2.5 microns, that's 30 times smaller than the width of a strand of hair.
- When inhaled, PM 2.5 can penetrate deeply into the lungs; irritating and damaging lung tissue.

Navajo Nation residents rely on indoor wood/coal burning stoves to heat their homes, particularly in the winter.

- This increases the risk of household PM 2.5 exposure & subsequent respiratory symptoms.

Indoor wood/ coal burning stoves are a source of high PM 2.5 emissions.

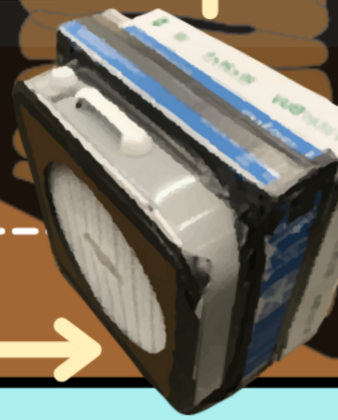
Smoke from indoor wood/coal burning stoves releases PM 2.5 into the household air.

The PurpleAir monitor measures real-time PM 2.5 concentrations.

The BFF system's effectiveness at reducing indoor air pollution will be measured using the PurpleAir monitor.

The "BFF" system will be placed within 10 Diné homes of children with asthma.

*Final design will include a child safety enclosure.



THE SOLUTION

Household air pollution will be reduced through the in home use of a "box-fan filter" or "BFF" system.

- We believe that BFF air cleaners can reduce indoor PM 2.5 levels in Diné homes using wood/coal stoves by more than 90%.

MATERIALS & ASSEMBLY

The "BFF" system is built using the 3 key materials shown below & are being built by the engineering department at Navajo Technical University (NTU).

Standard 20" Box Fan (w/ Cardboard Box)

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20" x 20" 5-in deep MERV-13 Air Filter

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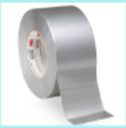

Duct Tape

=

The "BFF" system.

- An affordable & accessible clean air solution.

Navajo Technical University · Berkeley University of California · University of Colorado Anschutz Medical Campus · National Jewish Health · Asthma & Airway Disease Research Center · Southwest Environmental Health Sciences Center, College of Pharmacy, University of Arizona

This infographic was designed by University of Arizona SWEHSC coordinator, Zonnie Bah Olivas (Diné)
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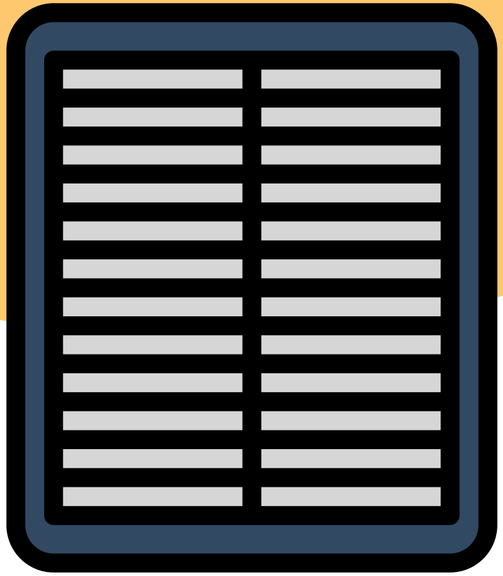
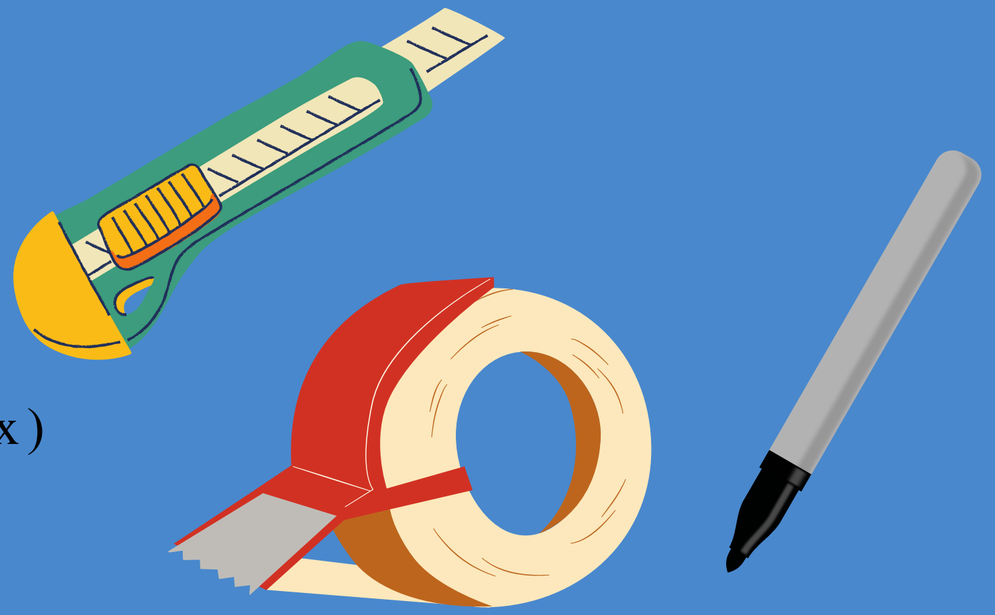
Building Our Own Air Filter



We will be learning about how to make our own simple air filter that can be used in homes or other places where proper ventilation is needed, such as when burning wood at home. This air filter can help reduce PM that are 2.5 micrometers or less in size (PM 2.5).

STEP 1: Gather All of Your Materials



1. One Standard 20' Box Fan and its cardboard box)
2. One 5-inch deep 20' x 20' MERV-13 air filter
3. Box cutter
4. Duct Tape
5. Tape Measure
6. Marker

STEP 2: Make a plenum

Get the cardboard box where the fan came in and on one side, cut a square that is a 1/2 inch smaller than the air filter size.

On the other side, cut a square with rounded corners that is 1/2 inch smaller all around compared to the fan's size.

STEP 3: Make the shroud

With the cardboard piece we just set aside, trace a circle with a 15-inch diameter in the center of the cardboard and cut it out with the box cutter.

You can do this by first setting your measuring tape to 7.5 inch. Then, mark the center of the cardboard and rotate the tape around in a circular motion with a pen at the end of the ruler.

Science behind the design!

The plenum and shroud are included to increase airflow through the BFF air purifier unit. Maximizing airflow through the BFF means that more room air will be passed through the air purifier to get cleaned-- and this is what we want!

The shroud reduces backflow (ie- prevents air from flowing back into the fan, rather than out of the fan as desired), which can occur at the corners of the box fan. This is because the round fan is in a square box, and the positive airflow pressure from the fan creates negative pressure at the perimeter of the fan blades. The gaps at the corners of the box fan (between the tips of the fan blades and the interior of the box fan frame) are where negative pressure results in the backflow. We can reduce this undesired effect by blocking off the corners with the cardboard cut-out shroud.

The plenum acts as a "pressure equalizer" between the filter and the fan's intake, which increases the total airflow through the BFF unit and also promotes more even dust loading across the filter. Equalizing the pressure eliminates the high pressure regions across the filter face, and boosts the low pressure regions where pressure would be close to zero (near the fan's hub, for example). This increases the overall flow through the BFF unit.

STEP 4: Assemble the unit

Tape the air filter (with the arrow on top of the filter facing toward the plenum) to the side of the plenum that matches the filter's face dimension

Tape the back of the fan to the free side of the plenum

Tape the shroud to the other side of the fan that is not attached to the plenum.