MITOCW | MITRES_LL-004S22_2_Filtration.mp4

[MUSIC PLAYING] COVID-19 is a respiratory disease caused by the transmission of the virus SARS-CoV-2.

The primary mechanism of transmission is through aerosol particulates from mucus or saliva that contain the virus and are emitted during breathing, talking, singing, coughing, or sneezing.

MIT Lincoln Laboratory conducted a study to investigate how aerosols are dispersed and potential mitigation techniques in mass transit vehicles.

The objective was to determine how changes in the operating conditions of the vehicle affected how aerosols are dispersed inside the vehicle so that transit operators could determine actions to lower the risk of infection to occupants.

We aerosolized a safe liquid in a way that mimicked a person coughing and a variety of sensors were distributed throughout the vehicle.

To measure the size and the number of aerosols detected at each location over time.

A critical operating condition investigated was how a vehicle's air filtration system affected the aerosol dispersion.

Not all air filters are created equal.

They're categorized by filtration efficiency ratings, also known as MERV ratings.

Depending on what size aerosols they can filter effectively from the air.

For example, common MERV 8 or 9 filters can efficiently remove most pollen and other very large particles.

Unfortunately, an infected person can emit aerosols containing SARS-CoV-2 in a wide range of sizes from hundreds of microns, which is the width of a human hair, down to tens of nanometers or 10 times smaller than a single red blood cell.

These smaller respiratory aerosols require higher efficiency MERV ratings, such as MERV 13 or higher, in order to increase the likelihood of removing the SARS-CoV-2 laden aerosols.

The trade off is that these higher efficiency filters are also costlier and typically slow down air movement. We can apply several aspects of this study to help solve another related problem.

How to obtain clean water by creating a water filtration system?

One of the most important things to understand before creating a solution to any problem is the requirements.

What problem are we trying to solve?

How efficient does this filtration system need to be?

How large or small must it be?

What is the budget?

How much time do we have to complete this project?

After determining the requirements, we can start to build a team and define tasks.

To have a successful team, it is important to have team members with the correct types of expertise and a clear roadmap to fulfill these requirements, accompanied by well-defined tasks and roles.

When thinking about how to build a water filtration system, consider the trade offs that each material or component may have.

For our study, one key trade off was between filtration efficiency and airflow.

When trying to remove sediments from water with your filtration system, a wire mesh may allow water to exit the filter at a higher flow rate, but may only capture the larger granular particles.

On the other hand, a cotton ball may remove finer sediments but may have a slower flow rate.

As you can imagine, there may be several options or combinations of options that can solve the same problem.

Determining which options would create a water filtration system that meets all of the requirements, considering the constraints and trade offs of size, time, and budget, are all part of the fun in engineering.