Hands-on Activity
2.6.1 Mathematical Modeling with MATLAB Water Filtration Model

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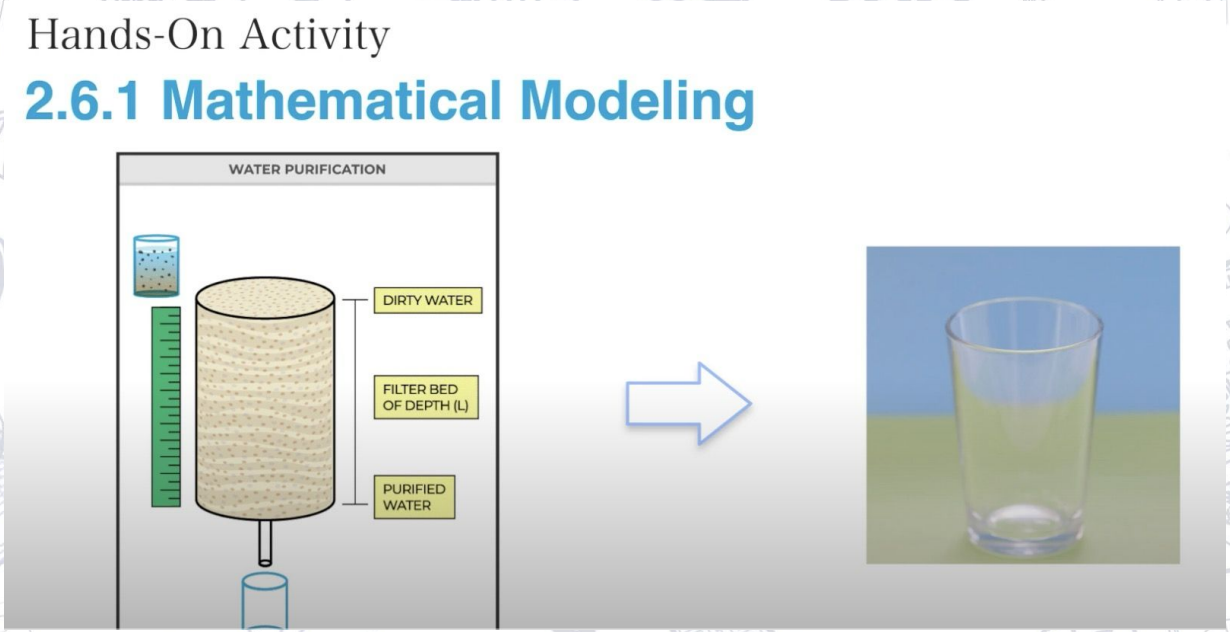
01 Goals

Hands-On Activity

2.6.1 Mathematical Modeling



[MATLAB Study Instructions]

01 Goals

What is happening

How Water is Treated
Relations with the Community

What is the problem

Engineering Design Process
Defining the Water Problems

What is the solution

Brainstorming the Solution
Mathematical Modeling →
Building the Physical Prototypes
Testing and Iterating the Models

Develop a comprehension of the filtration parameters

Inform students' prototype building and iterating phase

02 MATLAB

User friendly interface

Here the variables are:

1) Media diameter ranging from 0.4 to 2 mm (or 0.0004 to 0.002 m) in diameter:

1.588

2) Choose your filter material to specify the porosity:

fine gravel

3) Gravitational Acceleration (m/s^2):

Choose a location: Earth

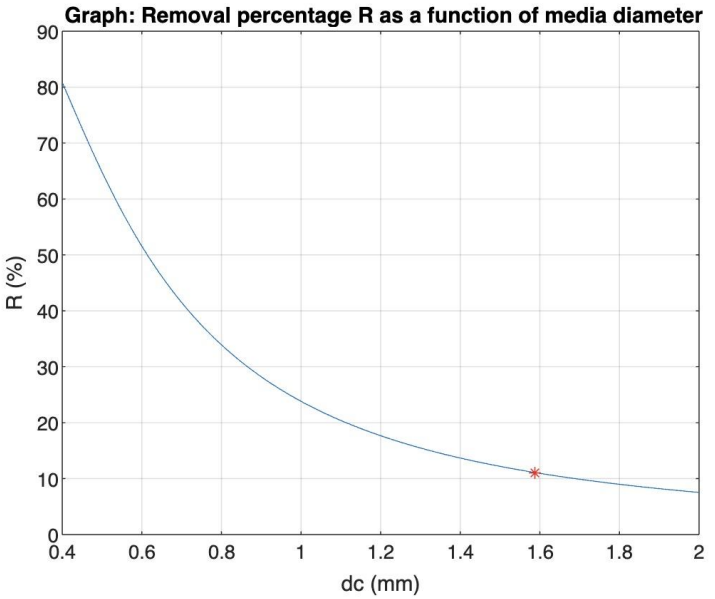
4) Length of the filter bed (L) in meters (m):

Filter bed 2.35

5) Impurities to be removed:

Impurity chosen: E. Coli Bacteria

Create Graph



02 MATLAB

“Hide code” vs “show code”

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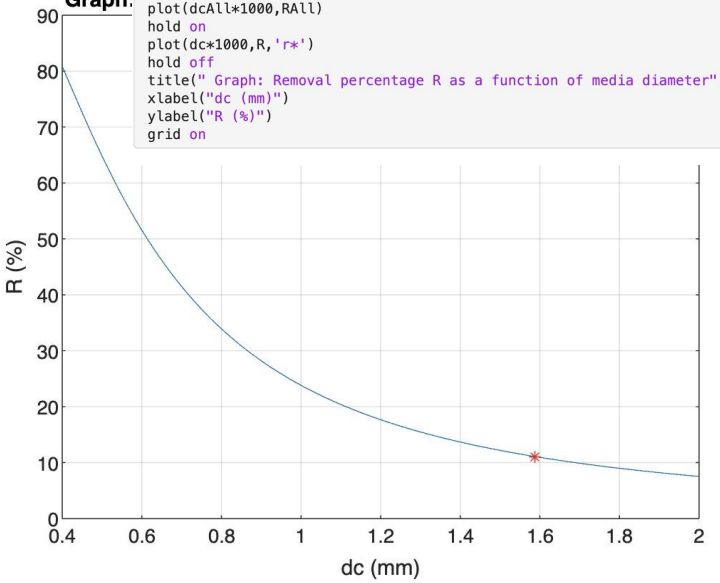
Create Graph

Graph Note: This performance curve shows the percentage of the impurities removed out of the water (y-axis) as a function of the media diameter (x-axis). The higher the removal percentage, the higher the water purity. The red dot reflects the media diameter you have chosen on that performance curve. In the case of the example given earlier, the %R is about 10% at a media diameter of about 0.4mm.

```
% consider all media diameters (m)
dcAll = (0.4:0.001:2)/1000; %all the points of interests define the size of the matrix
[LRV,R] = setUpParameters(dc,e,L,g,dp) ;
[LRVAll,RAll] = setUpParameters(dcAll,e,L,g,dp);
plot(dcAll*1000,RAll)
hold on
plot(dc*1000,R,'r*')
hold off
title(" Graph: Removal percentage R as a function of media diameter")
xlabel("dc (mm)")
ylabel("R (%)")
grid on
```

Graph:



03 Read the Result

Here the variables are:

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fine gravel

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Choose a location: Earth

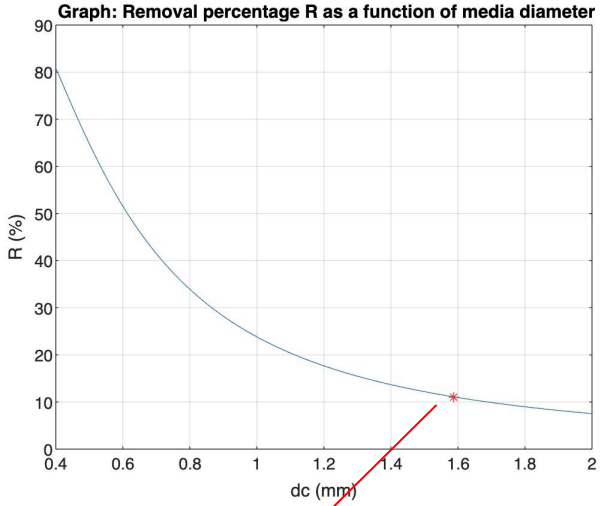
4) Length of the filter bed (L) in meters (m):

Filter bed 2.35

5) Impurities to be removed:

Impurity chosen: E. Coli Bacteria

Create Graph



We will design a water filter, in which the **fine gravel** will be the filter material. Its diameter will be **1.58 millimeters** and the length of the filter bed will be **2.35 meters**. We will place it on the **earth**.

If we would like to observe the removal efficiency concerning **e. coli bacteria**, it reveals a removal rate of **10%**.

Based on this outcome, it is advisable for students to conduct additional trials in order to achieve a higher removal rate.

03 Read the Result (Practices)

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MATLAB Activity Link

If we design a water filter, in which **sand** will be the filter material. Its diameter will be **2 millimeters** and the length of the filter bed will be **3 meters**. We will place it on the **moon**.

If we would like to observe the removal efficiency concerning **COVID-19**, it reveals a removal rate of **??%**.

If have time: Try to design a water filter by yourself and see the removal efficiency.

04 Previous Feedback

Students indicated that the MATLAB model was directly related to their design outcomes, helping them measure different materials and providing results.

Others recognized some of the benefits of MATLAB, which included clear and informative graph displays, as well as easy access to the platform.

Students believed there was still a gap between the simulation and the actual building of prototypes.

They expressed a need for more comprehensive testing to enhance real-world modeling relevance.


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Q & A