

Design Challenge - Low-Cost Water Treatment

Chemical engineers are known as 'universal engineers'. They transform raw materials into useful products on large, industrial manufacturing scale, aiming to get the best results at the least cost and with the lowest possible impact on the environment. Today, you will be working to design and operate a low-cost, low-energy filtering system to treat water for a remote village.

The winning team will produce the cleanest water at the lowest cost, within the design objectives and constraints described below:

- The dirty water contains inert kaolin clay particles (around 23-40 μm in size).
- The filter column is 1 L. Only half can be filled with filtration media.
- Your team has a maximum of \$5 to buy media. Bonus points if you spend less money.
- The final test will be to treat 100 mL of water in 1 min.
- Treated water will be measured by turbidity. The lowest turbidity wins!
- The media available to use is listed below. They all cost \$1 per 100mL.

| Media | Size (mm) |
|--------------------------------|-------------|
| Sand A | 0.1-0.5 |
| Sand B | 0.45 - 0.55 |
| Sand C | 0.56 - 0.7 |
| Sand D | 1.5 - 3 |
| Sand E | 3 - 6 |
| Filter coal (activated carbon) | 0.8-1 |

Step 1: Design your water filter column (25 min)

- In your team, discuss the most appropriate column design to remove kaolin (and kaolin only). You can use the internet to obtain relevant information.
- Critically assess the role (or treatment mechanism) of the different media in the removal of kaolin. What are the pros and cons of your design ideas, given the constraints of today challenge?

Step 2: Buy and rinse your media (20 min)

- Bring your money and few beakers to buy your media from our "shop".
- Load your media in the appropriate order in the column using the funnel.
- Completely fill the column with clean water. Open the valve under the column to rinse the media and collect water in bucket. If time allows, repeat the rinsing so to collect clean water.

Step 3: Test your design with dirty solution (15 min)

- Once all clean water has passed, fill your column with dirty water.
- After 2-3 min of filtration, call the demonstrator to test the quality of your product with the turbidity meter (which will measure the relative concentration of kaolin).