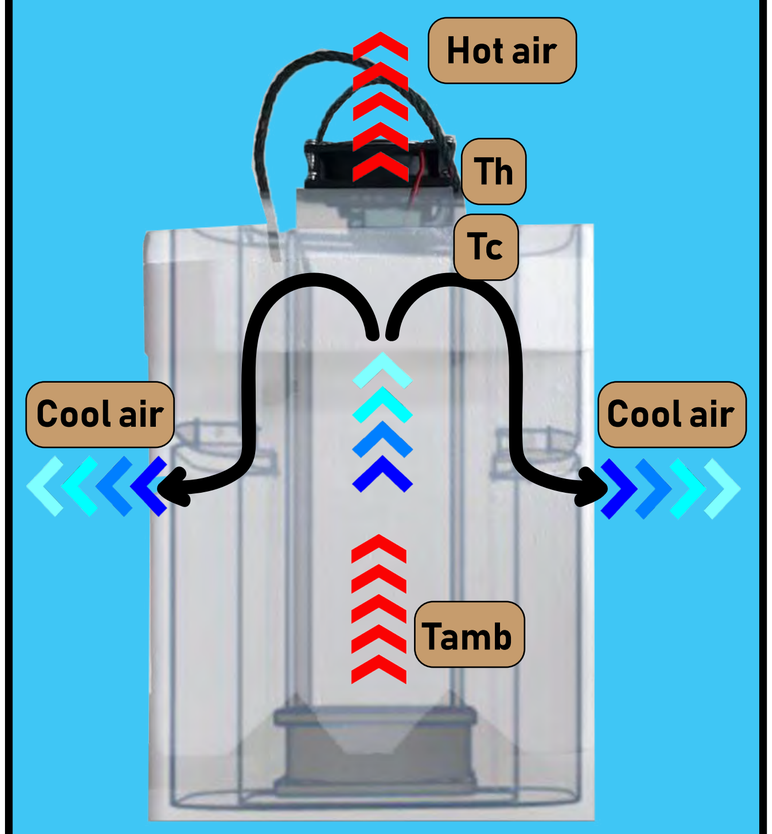
PORTACON

Objective:

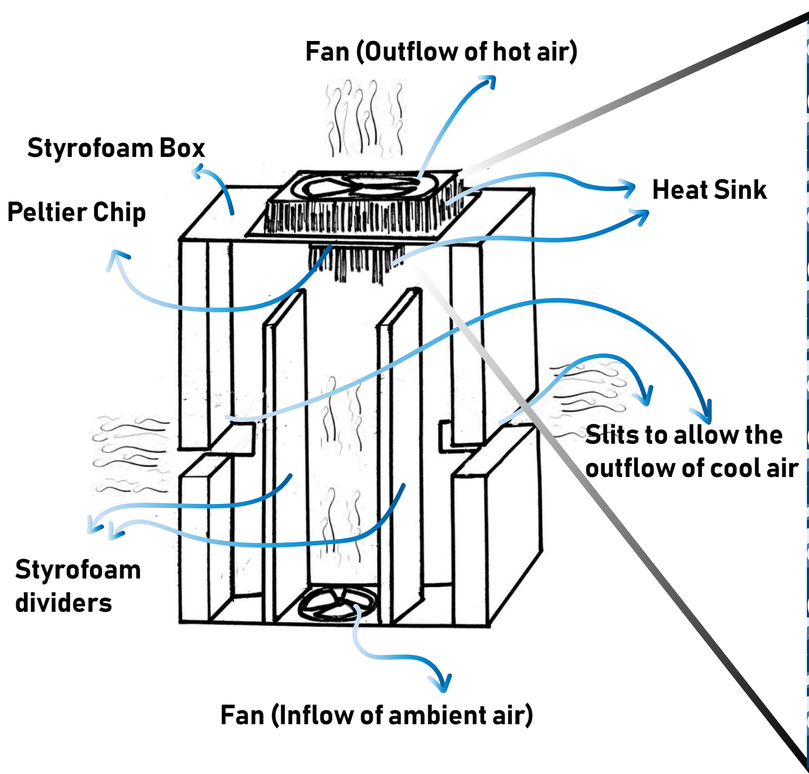
To develop a product that can provide a conducive environment in which students can focus on their learning, even in the absence of an air-conditioner. The product should be able to cool down the temperature of the area the students are studying at and keep the students cool for at least 3 hours.

How does it work?

Each portacon is equiped with 2 fans and a TEC flanked by 2 heatsinks. The TEC is contained in an insulated styrofoam box. The cool side of the TEC is facing inwards and the hot side is facing outwards. Ambient air is sucked into the unit from the bottom with the help of the fan. The air is then cooled by convection and passed through the heatsink on the cool end of the TEC. The cool air is pushed out through the 2 slits on the sides of the styrofoam box. The hot air is dispensed out through the fan on the top of the box.



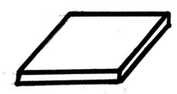
Schematics diagram of the prototype:



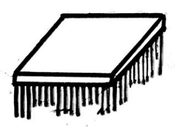
Components:

Fan:
To increase the flow of hot air out of the box

Heat sink (above peltier chip):
To increase the surface area for more efficient heating



Peltier Chip:
To cool down the ambient air

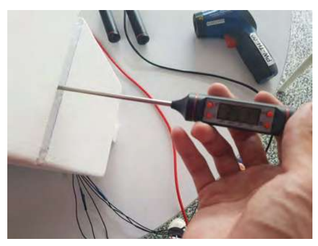


Heat sink (below peltier chip):
To increase the surface area for more efficient cooling

Styrofoam material:
Styrofoam is a good insulator. Therefore, it traps air in small pockets, blocking the flow of heat energy and re-

Data Obtained:

Th = 42.8°C



Temperature output (cool air) = 29.1°C

Current(I) = 3.88A
Voltage(V) = 11.6V

Tc = 12.9°C

Ambient temperature = 30.5°C

Strengths:

- small, lightweight and portable
- soundless and peaceful
- efficient cooling and convenient usage

Limitations:

- speed of the fan cannot be adjusted

Calculations:

Density of air = 1.225kg/m^3
Area of styrofoam box = 11.2 x 11.2
= 125.44cm^2
= 0.012544m^2
Velocity of air = 1m/s
Specific heat in constant volume of air = 0.718kJ/kg.K

Power required(W) = I x V
= 3.88 x 11.6
= 45.0W (3s.f.)

Mass flow rate of air (m) = Density x Cross sectional area of air intake column(A) x Velocity of air(v)
= 1.225 x 0.012544 x 1
= 0.0153664kg/s

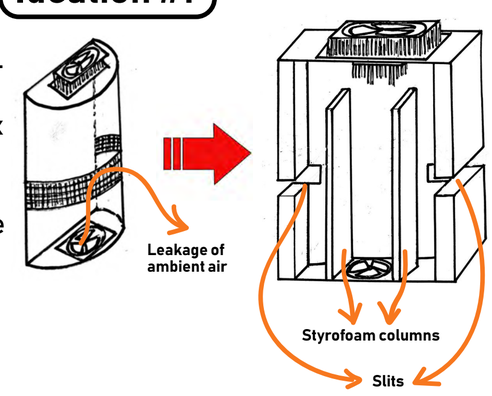
$Q_c = mc_v(T_h - T_c)$
= (0.0153664)(0.718)(30.5 - 29.1)
= 0.015423kJ/s
= 15.423J/s

Efficiency = Qc/W
= 15.423/45
= 0.343(3s.f.)

Modification to preliminary analysis and prototype:

Initially, our idea was to cut and place meshes along the sides of a semi-circle styrofoam box. However, we realised that it will result in a leakage of ambient air from the front of the box through the meshes, which is not desirable.

Hence, in our final prototype, we decided to use a rectangular box. We included two styrofoam columns to separate the ambient air from the cool air and cut two slits at the two ends of the box to allow the outflow of the cool air.



Future Works:

1. convert the wirings to usb cables to allow students to be able to connect it to a portable charger or their computers
2. Include variable resistors to adjust the fan speed according to the consumers' preference

References:

https://sciencing.com/why-styrofoam-good-insulator-4898717.html

Youtube Link:

https://youtu.be/2sUDTc1smPE

Conclusion:

From our data obtained, our product has an efficiency of 0.343 and hence, we can conclude that PortaCon is a relatively efficient cooling system. Our prototype has the capability of cooling the environmental temperature by 1.4°C within a short span of time. Therefore, it is able to provide a conducive and efficient learning environment for the students, even in the absense of the air-conditioner.