International Journal of Mechanical and Industrial Technology **ISSN 2348-7593 (Online)**
Vol. 8, Issue 2, pp: (28-34), Month: October 2020 - March 2021, Available at: www.researchpublish.com

Aerosol Box with Thermoelectric device

Buhn Alay Colorado[1], Ramon Pitao[2], Roosvelt Mendoza[3] , Neil Sereño[4], Victor Cañezo[5]

[1,2,3,4,5]Biliran Province State University

Abstract: **The study is about making a sample Aerosol box which could answer the present problems of the latest Aerosol box especially on its function to trap the breath air of a patient with contagious disease. The study used a thermoelectric device to answer the present problem. The study fabricated a proposed sample Aerosol box that will trap the breath moist. The result of the experiment was that the thermoelectric device that was used is not sufficient to control the temperature and humidity of the bigger room with the dimension of 381 millimeters by 381 millimeters by 381 millimeters. However, when the dimension is shirked to smaller dimension of 101.6 millimeters by 076.2 millimeters by 50.8 millimeters the humidity is controlled.**

Keywords: **Sample Aerosol box, Thermoelectric, Humidity, Temperature, and Dimension.**

I. INTRODUCTION

The mechanism of the mutation of virus is categorized as Pathogenesis. The virus has genetical code of its Ribonucleic acid (RNA) to be injected with the cell of a living organism. This virus has virion which function is to transmit the codes to the cell receptor. Once the cell allows the virus to penetrate then the virus would try to inject its Ribonucleic acid (RNA) code on the nucleus of the cell to make some changes on the Ribonucleic acid (RNA) or Deoxyribonucleic acid (DNA) composition of the cell. Once the disruption happened on the Ribonucleic acid (RNA) or Deoxyribonucleic acid (DNA) composition then the cell will become the agent to multiply the virus on the living organism.

A new virus arise namely COVID-19 has infected for more than 4.3 million cases and 290,000 deaths around the world, according to Maria Nicola, Zaida ALsafi, Catrin Sohrabi, Ahmed Kerwan, Ahmed Al-Jabir, Christos Losifidis, Maliha Agha, and Riaz Agha. Safety measures and restrictions are made to control the spreading of the virus. These had caused a big economic down fall upon the loss of job, closing of schools, stopping of manufacturing, while supplies for medical demands are greatly increased. Another socioeconomic effect to different countries is the panic buying of foods. On top of the panic buying food production is reduced due to lessening of social engagement of the people

According to the study of Sijia Tian and all the other authors that the most prominent virus of this year 2020 is the COVID-19 which is known to originate in Wuhan, China. The study found out that fever, headache, fatigue, and dyspnoea are the most common symptoms of being infected of the virus. The study found out that the manifestation of the infected patient of the COVID-19 is 6.7 days.

According to the World Health Organization the ways to prevent being infected of Covid-19 are making a regular hand washing, social distancing, wearing of Personal Protective Equipment, reduce contacts with people, and keeping vigilant from all information related to Covid-19.

According to Barney Graham the development of vaccine is hard because of the intelligently calculating the risk of producing one because it might contribute to the spreading of the virus as it mutates to human body. While on the study of Lawrence Corey and his team the development of vaccine is already started by US National Institutes of Health and it needs time for number of randomized trials.

Thus, the current best way to fight Covid-19 infection is prevention thru reducing the transmission of virus, one of the ways is the implementation of the preventive measure to not spread the virus. And as the transmission of virus is concerned the patients of confirmed cases of being infected of the virus are the major area where transmitting of virus happens. Hospitals and buildings with Covid-19 patients are the places where the most active transmission starts and being produced. Thus, a prevention of virus transmission from the very patients are very great help in pacifying the spread

of the virus in times where vaccine is not yet safe and currently unavailable. On the rise of Covid-19 a machine is introduced to solve one of the important matters to control the transmission of virus from the major area of transmitting the virus. This machine tends to trap the vapor and air from the breath of the Covid-19 patient and this is the Aerosol box.

From the study of Begley an Aerosol box is intended upon using tracheal intubation is one of the novel devices arises to protect medical professionals from being transmitted by the virus. The Aerosol box was used by different medical practitioners while everyone has successfully done their work. According to the study the Aerosol box did not become an obstacle to do the work of all the medical practitioners. There are designs of Aerosol box that has four holes from two of its sides, two every sides. These big holes are for hand entrance. The front side of the Aerosol box is where the patient's head enters in the opening.

The current Sample Aerosol box is subject for improvement. The Sample Aerosol box of this study directs to be airtight or almost seal typed box. However, because it is almost sealed type box air ventilation is lesser and without air ventilation temperature might not be controlled and air vapor or the humidity will accumulate inside. Because of this a Peltier is installed inside the airtight Sample Aerosol box. The said Peltier is connected to different devices that would make it able to produce a cold side inside the sample Aerosol box.

II. REVIEW OF RELATED LITERATURE

According to Jefferey Dalli, Mohammad Kahn, Brian Marsh, Kevin Nolan And Ronan Cahill, the Aerosol box is made to address the said Corona 19 virus. According to their observation the Aerosol box has been promoted in many multimedia. Yet the purpose of their study is to assess the function of the device. And on their assessment the present Aerosol box is not successful on its function. In other words, there is no advantages or problem being solved by the present Aerosol box.

A study of Simpson, Wong, Carter, and Chan about the present Aerosol box assessed the particle exposure upon using the said latest device. According to them the present Aerosol box was inspired by the COVID-19 virus. On the findings of the study it was found out that particles from air are 0.3-5.0 microns if there is an Aerosol box compared to without. This means that the Sample Aerosol box is not practically helpful in lessening the airborne particles. And this study recommends to remove the Sample Aerosol box from using until further development. Another study is conduct on the novel Aerosol box in assessing the elimination of kinetics particles and proposes a new improvement on the novel Aerosol box. On the study conducted by Samuel Hellman, Grant Chen, and Takeshi Irie they had added a filter on the Aerosol box yet it is not an airtight Aerosol box. The Sample Aerosol box has vacuum to suck the air in order to filter.

In the year 1958 an aerosol container was filled a patent by Kold to use in controlling the air for spraying mist. The said container is tightly closed and even can hold pressure. Since the year 1976 a container is patented to be a seal type membrane by fabricating the container to be a closed room for air.

III. METHODOLOGY

A. Prototype Fabrication

The proposed Sample Aerosol box is intended to put Peltier as temperature control. According to the book of Thermoelectric Cooling and Power Generation authored by Francis DiSalvo, the Peltier or the thermoelectric device has a positive and negative charge. Once the electric current flow on one side of the device then it becomes hot and the other one becomes cold. The cooling side of the device has advantage than the other cooling device on the perspective that there is no mechanical movement need. And as early as year 1999 the author foresee that the electronic device will become not only useful for electronic parts or robotics but also for refrigeration industry. Lakshya Dwivedi, Animesh Mishra, and Anshuman Tyagi concludes that Thermoelectric Peltier Module is better than refrigerants such as ammonia, Freon, Sulfur dioxide, and hydrocarbon because it does not cause greenhouse effect. Thus, using Thermoelectric cooler such as Peltier is protecting the environment.

An invention was patented by Uttam Shyamalan Ghoshal on making the cooling state of the Peltier on maximum state on furring its passive state and reducing the cooling losses. The invention was adopted by International Business Machines Corporation. Although there are also other possible ways of controlling temperature wherein the most common is the usage of freon.

The study creates a new model of Sample Aerosol box to test the proposed technology. The intended Sample Aerosol box is to trap the air from escaping outside the box. While the air is trap inside the box a device called Peltier is installed to pull the temperature down when needed. The Peltier will also absorb the humidity theoretically. On the said prototype

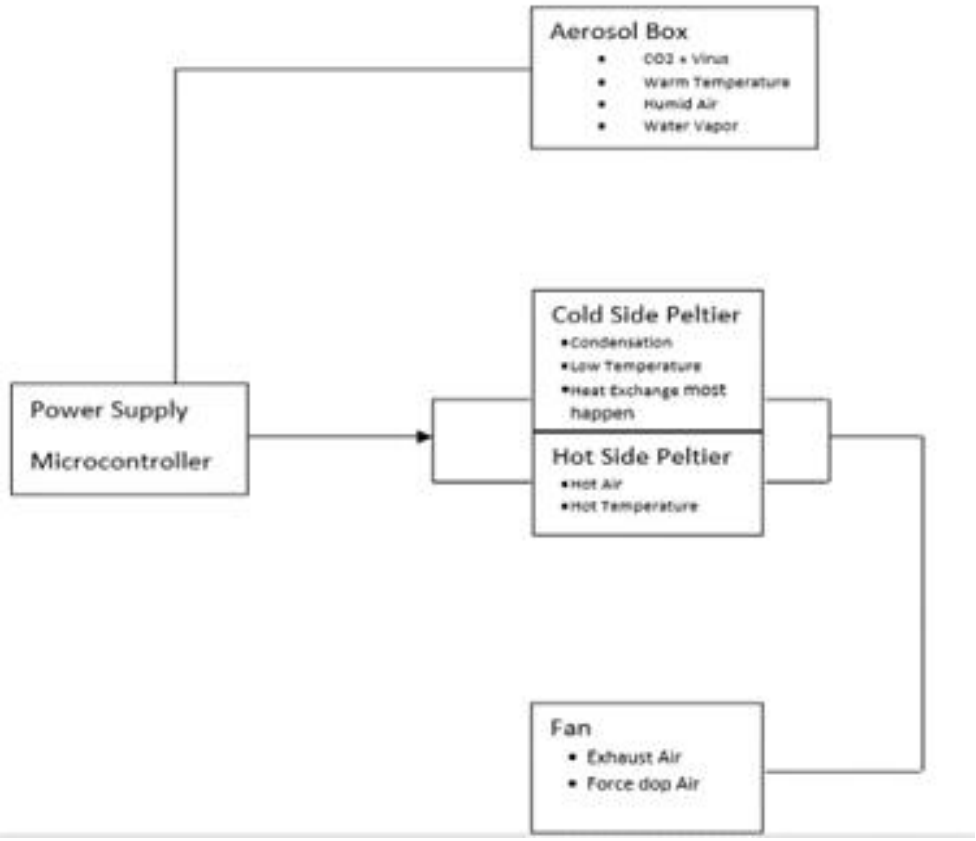
there is no circulation of air. The entrance hole of the Aerosol box is covered as well as the hole where the Peltier is attached.

In making a model of the device the study needs a cubic hard paper box with the dimensions of 381 millimeters by 381 millimeters by 381 millimeters, a cubic hard paper box with the dimensions of 101.6 millimeters by 76.2 millimeters by 50.8 millimeters,1 piece Peltier, 1piece of 12 volts fan, 1 piece of 12 volts output and 220 input power supply,1 tube of thermopaste, 1 humidifier sensor, 1 Arduino microcontroller, cutter for the box, and 2 pieces of heatsink.

The Sample Aerosol box is create to the following procedures: first is to prepare the hard paper box, second is cut the two holes for the head and cut the entrance of the Peltier, third is paste the Peltier and the heatsink while being placed on the box, fourth is assemble the blower to the heatsink outside the box, fifth is assemble the power supply and connect to the blower and Peltier, sixth is to put the humidifier sensor inside the box, seventh is connect electronically the sensor with the Arduino microcontroller, eight is create the codes to let the sensor work, and ninth is to attach the heatsink to the Peltier.

Another Sample Aerosol box was created but with different dimension of box.

TABLE I: FONT AND PARAGRAPH SPECIFICATIONS



The conceptual framework shows that the Sample Aerosol box contains carbon dioxide and virus. Because when the patient with contagious disease breath out the by-product of its breath is carbon dioxide and virus. Normally the breath of any human carries a warm temperature with water vapor from its moist. That's why the characteristics of a Sample Aerosol box are warm temperature, high humidity because of produced water vapor, carbon dioxide as by-product of human breath, and virus which is mixed with the breath. Inside the Sample Aerosol box there is sensor that monitors the humidity and temperature. These sensors would record the progress of lessening the humidity and temperature.

The Sample Aerosol box is being intervened by the Peltier to control its environment. The Peltier has Cold side and Hot side. Once the Peltier is supplied by electricity automatically the cold side produces cold temperature at same time the hot side produces hot temperature. The cold side is placed inside the Sample Aerosol box while the hot side is intentionally placed outside the box.

The Cold side of the Peltier is where the condensation of the water vapor happens. Because the water vapor from the human breath is warm while the cold side of Peltier is cold so the water vapor is turned into liquid thru condensation. Because of the produced cold temperature by the Peltier primarily in the cold side so it causes a higher value of temperature difference. This temperature difference causes to lower the temperature on the area of Sample Aerosol box. As well as the humidity of the area inside the Sample Aerosol box will decrease because of the condensation. On this area where the cold side is placed is where the most of heat exchanged happened inside the Sample Aerosol box. The cold side of the Peltier is mounted to the hot side of the Peltier. Once the electric current flows to these two sides the cold side colds while the hot side produces heat. Because of the heat on the hot side the coldness in the cold side is being neutralize. To stop the neutralization of heat and cold between the cold side and the hot side a fan is used to release the heat on the heat side. Thus, the fan would be turned on if the Peltier is being used. That if ever the cold side is needed to use the fan is needed to turn on as well.

The Hot side is inevitable if the Peltier needs to produce coldness on the cold side. Because of the mechanism that the electrical current will pass thru the both sides in order to make polarity of charge that's why it is inevitable to have a hot side. To take away the heat from the hot side an exhaust fan is used.

The exhaust fan is to release the heat from the Peltier while the air moved by the fan should not enter the Sample Aerosol box.

All the electronic device is electrically connected to the power supply. The power supply may vary depending on the needed power input. However, on this study used the Peltier which is being supplied by twelve volts direct current and the sensor is being supplied by the microcontroller. The microcontroller used is Arduino uno. The microcontroller is being supplied of twelve volts direct current as well. Even the electric supply of Peltier is being controlled by the microcontroller.

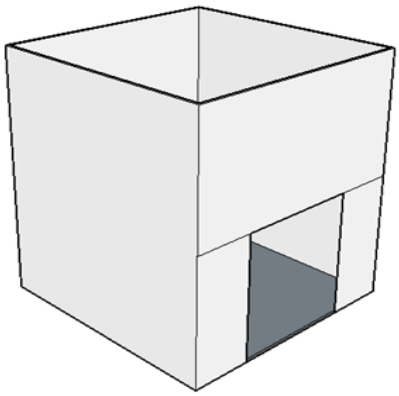


Figure 2 (A)

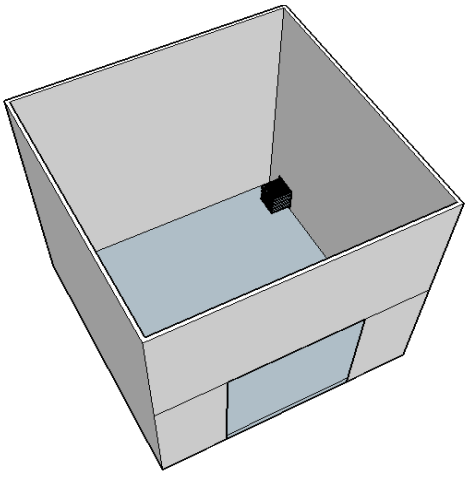


Figure 2 (B)

Figure 2(A) is the isometric view of the prototype Sample Aerosol box. There is an opening in box where the human head can be put inside the Sample Aerosol box that has a dimension of 381 millimetre by 381 millimeters by 381 millimeters. It actually has a transparent roof to easily see what is inside the sample Aerosol box. The function of it is to easily monitor the patient by looking to its human head.

The figure 2B is a simple presentation what are inside the box. Wherein, Inside the box the cold side Peltier is placed. The Cold side Peltier is mounted on the bottom-right side of the Sample Aerosol box wall. The Peltier is placed to the bottom-right side on one of the Sample Aerosol box's side walls. It is placing there so the head would not bump with the Peltier. The Electrical supply is also located outside of the Sample Aerosol box so to make more area for placing the human head inside the Sample Aerosol box. Once the Peltier and Fan is being supplied by electricity the heatsink inside the box will be colder. The cold heatsink will help lower the temperature and absorb moist.

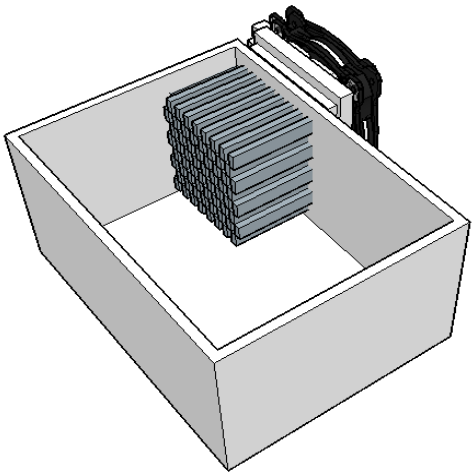


Figure 3

Figure 3 shows another Sample Aerosol box is made with the dimension of 101.6 millimeters by 076.2 millimeters by 50.8 millimeters. The placement of Peltier, heatsink, and Fan are same with the first Sample Aerosol box. The power supply of every devices is just the same with the first Sample Aerosol box only the dimension is not the same.

IV. RESULT AND DISCUSSION

A. Prototype Fabrication

In this study the research made the fabrication on the following step: First the researchers gathered the different materials. These materials are the cardboard box with the dimension of 381 millimeters by 381 millimeters by 381 millimeters, second cardboard box with the dimension of 101.6 millimeters by 076.2 millimeters by 50.8 millimeters, cutter, Peltier, heatsink, electric fan, wires, microcontroller (Arduino), power supply, adhesive solution (Elmer's Glue) and humidifier sensor. After gathering the materials, the researcher cut the rectangular hole on the bottom right side of one of the sides of the box. The rectangular hole is just enough to fill in the Peltier size. The cold side of the Peltier is placed on the rectangular hole of the Sample Aerosol box. The cold side of the Peltier is placed towards inside the Sample Aerosol box while the Hot side of the Sample Aerosol box is place towards outside the Sample Aerosol box. After placing the Peltier on the intended sides of the box, the researcher attached the heatsink on the cold side of the Peltier. Upon attaching the heatsink of the cold side of the Peltier, the Peltier is being hold by another hand so while attaching the heatsink the Peltier can be hold. The heatsink is attached to the cold side of the Peltier using adhesive solution. Although the advised adhesive solution is thermopaste adhesive solution still the research has just used a common adhesive solution such as Elmer's glue. Upon letting the adhesive solution to dry, the side on which the Peltier and heatsink is being attached, was being laid down on flat surface. Because if the Peltier is not holding the Peltier and the heatsink will depart with each other and fall on the base-ground. It is hard for the fabricators to hold for a period of time until the adhesive solution dries so to bind the Peltier and heatsink. After the Peltier and heatsink have been bind, the researcher pastes the hot side of the Peltier to another heatsink. When the paste was spread to the Hot side of the Peltier and attach the surface of the heatsink, the bracing of the heatsink is mounted to the fan. As the bracing of the heatsink is mounted to the fan, then the heat sink is being hold by the fan for the fan is being laid down on the ground-base. After the hot side of the Peltier is bind to the heatsink while the frame of the heatsink is mounted to the fan, then the researcher connects the electrical wires to the

power supply and microcontroller. The wire of the Peltier passes thru the wall of the Sample Aerosol box, while on the area where the wire passes thru is being covered by the Adhesive solution to make it seal from passing in and out of the air. The Wire of the Peltier is connected to the twelve volts direct current power supply. While the Fan is connected to six volts direct current power supply.

Another Sample Aerosol box was made with a different dimension of the box. However, all other characteristics such as the placement of the Peltier, fan, and power supply is identically the same with the first Sample Aerosol box. Even the design of placing the hot side of the Peltier is towards outside of the Sample Aerosol box while placing the cold side of the Peltier is towards inside the Sample Aerosol box is the same with the first Sample Aerosol box that has bigger dimension. Same as to the procedure of making the second Sample Aerosol box has the same procedure of making the First Sample Aerosol box. The dimension of the box of this second Sample Aerosol box is 101.6 millimeters by 076.2 millimeters by 50.8 millimeters

B. Experimental Procedure

As the researcher starts the experiment, the Researcher would place the humidifier sensor at the middle of the Sample Aerosol box. The Research would record the initial temperature before supplying electricity to the Peltier in order to produce cold temperature and absorb humidity. The entrance hole where the head and neck are supposed to enter inside the box is closed using a rectangular card board to stop the passing thru of air from the outside of the Sample Aerosol box to the inside of the Sample Aerosol box because the temperature and humidity may vary. And this is the very purpose of the intended Sample Aerosol box and that is to lessen the passing thru of the air by containing the air within the walls the Sample Aerosol box. After five minutes of recording the temperature and humidity inside the box the research would now turn on the power supply. The Fan is supplied with six volts direct current while the Peltier is supplied with twelve volts direct current. As both of the devices are supplied so the cold side of the Peltier would cool the heatsink. The Research will now place the humidifier sensor at the middle of the Sample Aerosol box. The Research now would record the Temperature and Humidity every Minute. Another experiment was conducted to another Sample Aerosol box. The second Sample Aerosol box has a dimension of 101.6 millimeters by 076.2 millimeters by 50.8 millimeters. With the same procedure of Experiment with the first box that has dimension of 381 millimeters by 381 millimeters by 381 millimeters.

C. Result

The result of the observation was the temperature is 26 degrees Celsius and humidity of 76 when the humidifier reads the 381 millimeters by 381 millimeters by 381 millimeters dimension of box, then the fan is electrically on while the Peltier is not then after 3-5 mins the temperature goes down to 25 degree Celsius and the humidity by 75, then when the Peltier is electrically opened with the fan 3-5 mins after the temperature goes down to 24 degrees Celsius and the humidity by 74.

On the second experiment the result of the observation was the temperature is 29 degrees Celsius and humidity of 95 when the humidifier reads the 101.6 millimeters by 076.2 millimeters by 50.8 millimeters dimension of box, then the fan is electrically on while the Peltier is not then after 3-5 mins the temperature is the same to 29 degree Celsius and the humidity by 94, then when the Peltier is electrically opened with the fan 3-5 mins after the temperature goes down to 29 degrees Celsius and the humidity by 75.

Based on the theories, literature, and experiment the study concludes that the Peltier was able to pull the temperature down by 1 degree. The heat transfer is not big to sustain the volume of the box with dimension of 0.381 meters by 0.381 meters by 0.381 meters. The Peltier was able to pull the humidity down by 1 degree. The absorption of moist is not big to sustain the volume of the box with dimension of 381 millimeters by 381 millimeters by 381 millimeters. However, when the dimension shrinks to 101.6 millimeters by 76.2 millimeters by 50.8 millimeters the temperature doesn't go down but the going down of Humidity surfaced. Probably the temperature does not go down because heat exchanging is not good but absorption of vapor is clear.

Another observation on the experiment was there is pressure building inside the Aerosol box that would like to escape on the made holes of the box. This pressurize air that caused by the accumulated air will eventually increase and would try to find the weakest spot of the Sample Aerosol box to spill out the pressure. Because of this the study would like to recommend to place an outlet where the accumulated air pressure could be spilled out, provided that the outlet should have a filtering device that could kill the virus. The said filtering device would be heating the spilled air up to sixty degrees Celsius.

V. CONCLUSION

The study recommends to use bigger unit of Peltier and use better material to not let the cool air escape as well as the breath vapor from the patient. It is also advised to put electric fan inside the box to foster the heat exchanging. Another recommendation is that there must be a moist collector after enlarging of the Peltier because it will condense bigger amount of moist more of it unlike to the experiment of the prototype, in real situation a hotter air with additional moisture is being added to the Sample Aerosol box which comes from the breath of the patient. Another recommendation of the study is the supply of oxygen because the room is design to be almost closed for the air outside not to easily enter the Sample Aerosol box. It is the design to trap the air inside and lessen the spreading of the moist the comes from the patient's breath that have virus particles. However, because the design was seal type the supply of oxygen may deplete. This is very crucial especially the patient need a bigger amount of oxygen while the oxygen inside the Sample Aerosol box because is reducing to carbon dioxide as the patient breath in the available oxygen inside the Sample Aerosol box and breathe out carbon dioxide. To solve this while using the proposed Sample Aerosol box to hold the moist and virus of the patient's breath then this study would recommend to supply oxygen while using this proposed Sample Aerosol box. The oxygen is supplied to the patient coming from the oxygen tank going to the patients' mask. Another recommendation of the study is to make an additional filter to the Sample Aerosol box that would pull out the trapped air inside the Sample Aerosol box. Because the Sample Aerosol box would accumulate air as the oxygen is being supplied coming from the tank and the exhaled breath of the patient would be added to the Sample Aerosol box, then pressure would be built up inside the Sample Aerosol box.

REFERENCES

[1] S. Barion, M. Fons, and T. Albrecht, "Viral Pathogenesis", University of Texas Medical Branch at Galveston, 2010.

[2] S. Tian, H. Nan, J. Lou, K. Chen et al, "Characteristics of COVID-19 infection in Beijing", Journal of Infection, vol. 80, no. 4, pp. 401-406, 2020.

[3] M. Nicola, Z. Alsafi, C. Sohrabi, A Kerwan et al, "The Socio-Economic Implications of the Coronavirus and COVID-19 Pandemic: A Review", International Journal of Surgery, vol. 78, no.78, 2020.

[4] Graham, "Rapid COVID-19 vaccine development", Science, 2020.

[5] J.L. Begley, K.E. Lavery, C.P. Nickson, and D.J. Brewster, "The aerosol box for intubation in coronavirus disease 2019 patients: an in-situ simulation crossover study", Anaesthesia, vol. 75, no. 8, pp.1014-1021, 2020.

[6] S. Hellman, GH. Chen, and T. Irie, "Rapid clearing of aerosol in an intubation box by vacuum filtration", British Journal of Anaesthesia, vol. 125, no. 3, pp e296-e299, 2020.

[7] F.J. DiSalvo, "Thermoelectric Cooling and Power Generation", Science, vol. 285, pp. 703-306, 1999.

[8] L. Dwivedi, A. Mishra, and A. Tyagi, "Air Conditioning Using Thermoelectric Based Peltier Modules", Journal of Basic and Applied Engineering Research, vol. 5, no. 7, pp.529-532, 2018

[9] Y. Zhao, H. Sun, and D. Tu, "Effect of mechanical ventilation and natural ventilation on indoor climates in Urumqi residential buildings, Building and Environment, vol. 144, pp.108-118, 2018.