A PERSONAL AIR PURIFIER FOR SCHOOLCHILDREN

Kazukiyo KUMAGAI[1], Kazuhide ITO[2], Kiyoshi TAKAHARA[3], Mikio HASHIDA[3], Huaipeng TANG[4] and Yukio YANAGISAWA[5]

[1]The University of Tokyo, Japan
[2]Tokyo Polytechnic University, Japan
[3]Shinryo Eco Business, Co.Ltd., Japan
[4]Shinryo Corp., Japan
[5]The University of Tokyo, Japan

ABSTRACT

There are many schoolchildren who have a minor chemical sensitivity and cannot go to school just because of the activities taken place such as arts & craft, waxing the floor or just opening the textbook. The solution for those children to go school is to protect them from those chemicals. However a renovation to make the whole classroom into a chemical free room is not a realistic solution for just one child not just because of it's cost but also the effect to the other schoolchildren going in and out from chemical free room because of the risk of rebound. Hereby in this paper we will propose a personal air purifier which would be effective for the children who have minor chemical sensitivity so that they could go to school and study with their schoolmates. This personal air purifier is available to attach and detach easily to a schoolchildren's chair, which are regularly used in schools. In addition, the air stream from the outlet of the personal air purifier to the breathing zone of the sitting child will be determined.

INDEX TERMS

Personal Air Purifier, VOC, Schoolchildren, Air Stream Measurement, Air Stream Visualization

INTRODUCTION

There are many schoolchildren whom cannot go to school because of chemical sensitivity. Among those chemical sensitive schoolchildren, some have severe chemical sensitivity and for those it is not easy to live a normal life, however some of them are in a mild case. For those school children who have a mild chemical sensitivity can live with their normal daily life without difficulty. However there are many activities, especially in lower grades, which will emit chemical that might become a trigger of chemical sensitivity e.g. arts & craft, waxing the floor or even the textbook itself. However a renovation to make the whole

classroom into a chemical free room is not a practical solution not just for it's cost but also the effect to the other schoolchildren going in and out from chemical cleanroom is not known. Subjected to the strong desire of the parents whom have a chemical sensitivity child, our wish is to see the child study and play with their schoolmates in school, and we have started to think seriously about developing a personal air purifier which would be effective for the children who has minor chemical sensitivity whom can almost go to school.

This paper will propose a personal air purifier, which could be attached and detached to a schoolchildren's chair, which is regularly used in schools. Moreover the air stream measurement and visualization from the air purifier to the breathing zone will be determined.

METHODS

SPECIFICATION OF PERSONAL AIR PURIFIER

The personal air purifier was made to be able to attach on most kind of chairs for schoolchildren. The personal air purifier is made of 2 components, the air purifying unit and the air-handling component. The air purifying component is made of stainless steel which the size is W x D x H = 405(mm) x 305(mm) x 400 (mm). The outlet capacity of the fan is 0.45m^3/min. (=27m^3/h) and the static pressure of the fan is 4.2 kPa. There is an activated carbon for VOCs and the air supplied from the outlet will be as low as 30 ug/m^3 in TVOC.

Table 1 Specification of The Personal Air Purifier

Main Air Purifiing Unit	Size : W x D x H = 405 x 305 x 400mm Material: Main Air Purifying Unit and the duct is made of stainless steal
Supplied Air Volume	0.45 m^3/min. (27.0 m^3/h)

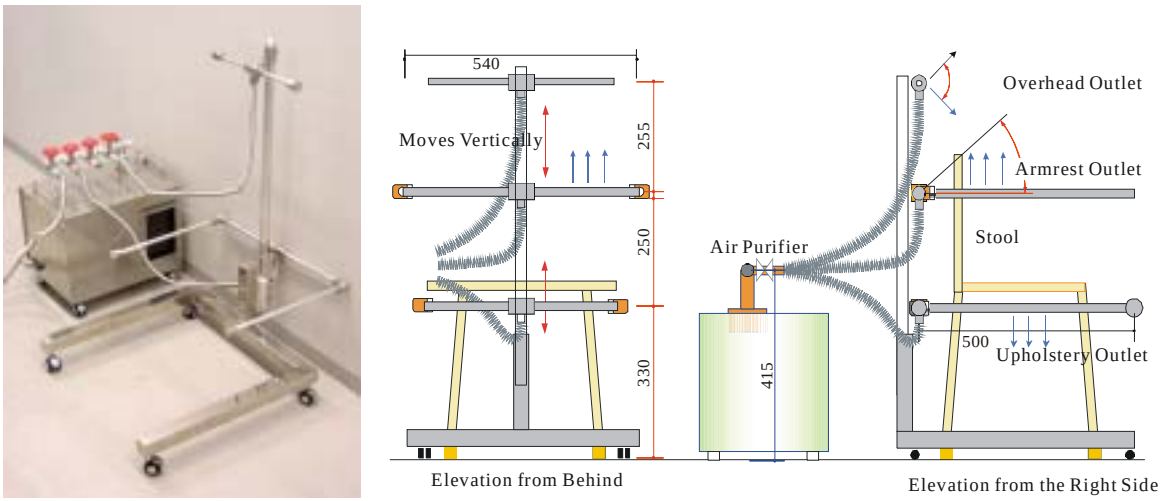


Fig.1 Diagram of the Personal Air Purifier

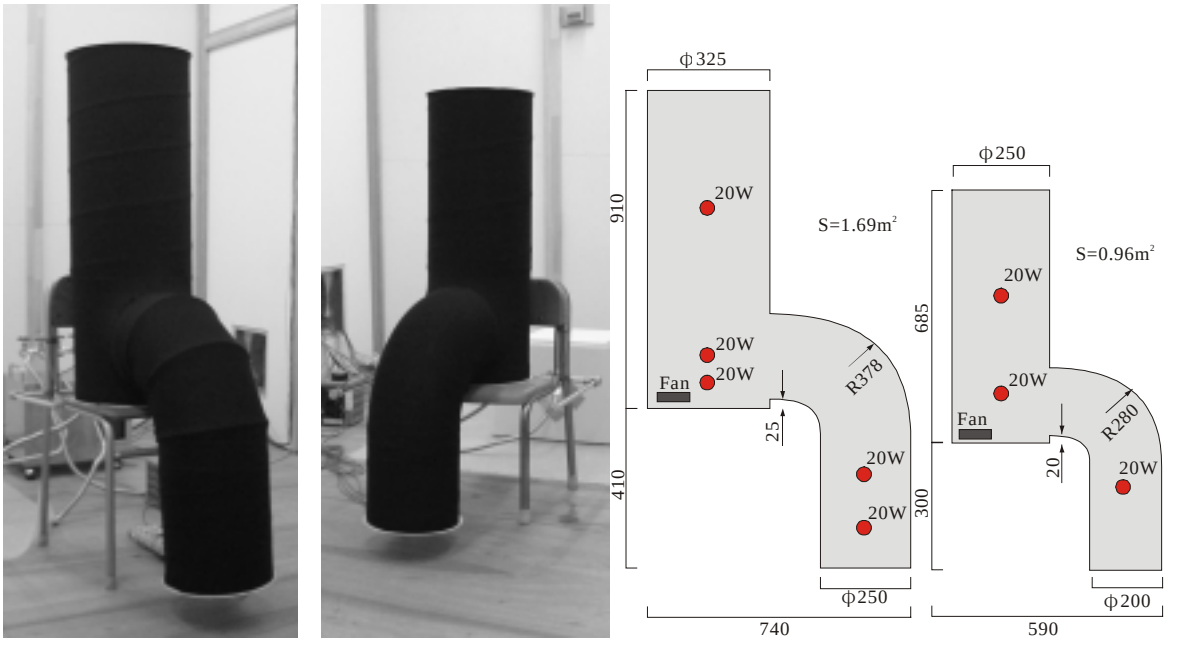
The chemicals, which might be adsorbed on all of the parts of the component, were purged and baked out before it was connected to the components.

THE HUMAN HEAT LOAD SIMULATOR

The personal air purifier introduced in this study is assumed as a countermeasure for the children who cannot go to school because of chemical sensitivity. Whereby, the size of the student varies much among the students in elementary school. In this study, 2 human heat simulator, which one representing the size of an 8 years old child and the other of an adult was made and the air distribution surrounding the simulator or the human was measured. The heat load simulator will be shown in figure 2. A sitting human model will be used because the air purifier will be used when seated. The human heat load simulator developed by Mattsson (1999) was subjected as an adult. However no human heat model for a child has been reported so the model used in this study is a model which the human surface area and the human heat load was scaled down to a 8 years old child referring Mattsson's model. The model is made of a metal duct with a light bulb inside it as a dummy sensible heat load. A fan was place inside the model to diffuse the air and to prevent the generation of a heat layer inside the model. The model is covered with a cloth, which is equivalent to 0.3 clo.

AIR STREAM MEASUREMENT

The airflow distribution was measured by a 3 dimension ultrasonic anemometer. Each airflow rate datum of 1 position was the average data of 10Hz per 1 position. The air purifier and the heat load simulator was place in a isothermal condition which was set to 25℃ to simulate a steady state condition.



Picture of Adult Model Picture of Child Model Scheme of Adult Model Scheme of Child Model

Fig. 2 Heat Load Simulator

AIR STREAM VISUALIZATION

The air stream surrounding the child model and the air stream from the personal air purifier to the breathing zone of the model was measured by laser light sheet. A 4W Argon-Ion Laser (SpectraPhysics Stabilite 2017, U.S.A.) was used as a laser light source and was passed through a cylindrical lens to a laser radiation sheet. Seeding particles were generated by a smoke generator (SAFEX F2010, Germany), which was supplied from the outlets of the personal air purifier. The experiment was taken place in an isothermal condition, which was set to 20 ℃ to fulfill the tranquility condition. The angle of the outlet was set to 90 degrees.

RESULTS AND DISCUSSIONS

ORGANIC CHEMICALS REMOVAL CHARACHTERISTICS OF THE PERSONAL AIR PURIFIER

The VOCs concentration from the outlet of the personal air purifier was measured when it was placed in a condition where the VOCs concentration was steady. The TVOC and Aldehydes concentration of the background were 380 ug/m^3 and 89 ug/m^3 and those concentrations from the outlet were 10 ug/m^3 and 35 ug/m^3.

Table 2 Results of the VOCs Removal Test

	TVOC (ug/m^3)	Aldehydes (ug/m3)
Background	380	89
Outlet	10	35

AIR STREAM MEASUREMENT

The results of the air stream measurement will be shown in figure 3. A vertical stream was observed in both the adult and the child model, from the armrest out and following the heat simulator towards the breathing zone. When the supplied air volume was set to 15.0 m^3/h, the airflow from the armrest outlet exceeded the rising flow cause by the heat from the body that resulted as a reverse stream above the heat load simulator. However the air stream around the breathing zone was heading upward which means the purified air is delivered will be inhaled. Moreover the mean airflow of 0.1 m away from the heat load from the hip to the chest was 0.6m/s, which means no draft will be observed.

AIR STREAM VISUALIZATION

The result of the air stream visualization when the laser light sheet was beamed to the supplied air from the armrest outlet will be shown in figure 4. The supplied air from the armrest outlet following the heat load model to the breathing zone in both the adult model and

the child model, which is similar to the result of the measurement of the airflow and stream. Unfortunately this is not described in the picture but the air supplied from the armrest outlet was observed being mixed with the vertical flow made by the human heat and to flowing to the head of the model in the adult heat model during the experiment.

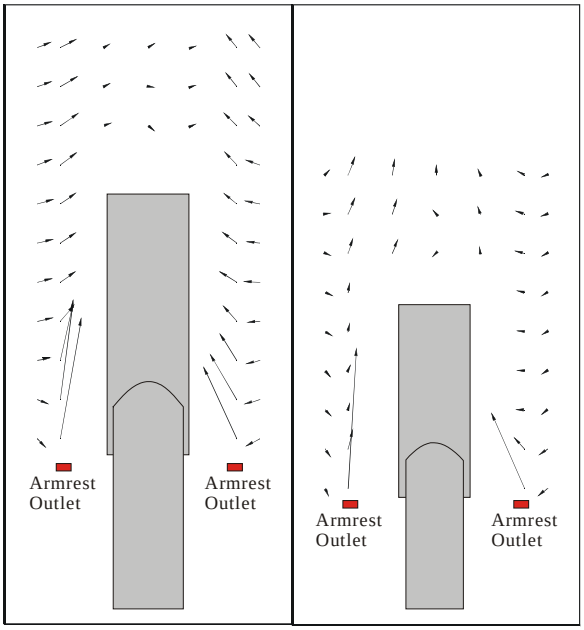


Fig. 3 Result of Air Stream Measurement
(Left: Adult, Right Child)

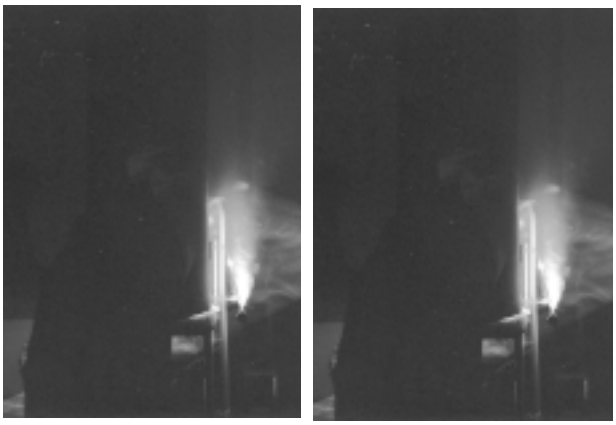


Fig. 4 Result of Air Stream Visualization
(Left: Adult, Right Child)

CONCLUSION

An attachable air purifier for a schoolchildren's chair was proposed. The concentration of TVOC and Aldehydes from the outlet was 10 ug/m^3 and 35 ug/m^3. A vertical stream from the armrest to the breathing zone was confirmed both in the air stream measurement and visualization, which means clean air is supplied to the breathing zone. The mean airflow rate of the vertical flow was 0.6 m/s that means there would be no draft. However, there was a reverse flow area around the upper part of the model because the airflow from the outlet overtook the vertical flow.

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REFERENCES

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