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STACK VENTILATION SOLUTIONS FOR HOMES IN THE TROPICAL CITY OF JAKARTA: CASE STUDY OF A HOUSE AT NORTH JAKARTA

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ABSTRACT

The growing problem of urbanization has led to the expansion of densely populated cities such as Jakarta, resulting in issues including limited green spaces, elevated vehicle pollution, and industrial pollution. Tropical climates with high temperatures and humidity require indoor thermal comfort maintenance, especially due to climate change. An approach to achieving thermal comfort in tropical regions is the use of natural ventilation, such as stack ventilation. This stack ventilation will increase airflow, improve thermal comfort, and reduce electricity use by reducing reliance on air conditioning. Stack ventilation does not require a prevailing wind around the dwelling, as it relies on the upward air movement driven by buoyancy forces. Stack ventilation, being independent of outdoor wind speeds, can also mitigate the pollutants carried by outdoor wind currents, thereby improving indoor air quality and creating a healthier living environment. This study used an exploratory empirical case study approach to study a residence that has effectively utilized stack ventilation and achieved awards for its energy conservation initiatives. Stack ventilation can be effectively utilized in dwellings with a void and in near-isothermal tropical conditions by integrating an induced-solar-heat glass chamber at the apex of the solar chimney. This configuration creates a heated zone that facilitates the ascent of less dense air, which is then expelled from the top of the shaft. This study's findings are a preliminary insight for the implementation of stack ventilation in residential properties. Stack ventilation is suggested for residential homes in densely populated cities like Jakarta, effectively utilizing voids to facilitate the system with an induced solar-heat chimney.

Keywords: *Residential homes, stack ventilation, thermal comfort*

ABSTRAK

Meningkatnya masalah urbanisasi telah mengakibatkan pertumbuhan kota padat penduduk seperti Jakarta, yang menyebabkan berbagai masalah termasuk keterbatasan lahan hijau, peningkatan polusi kendaraan, dan polutan industri. Iklim tropis dengan suhu dan kelembapan tinggi perlu menjaga kenyamanan termal dalam ruangan, terutama karena dampak perubahan iklim. Salah satu pendekatan untuk mencapai kenyamanan termal di daerah tropis adalah penerapan ventilasi alami melalui ventilasi cerobong. Ventilasi cerobong ini akan meningkatkan aliran udara dan dapat meningkatkan kenyamanan termal, dan lebih jauh lagi, mengurangi penggunaan listrik karena ketergantungan pada pendingin ruangan. Ventilasi cerobong tidak memerlukan kecepatan angin yang dominan di sekitar hunian, karena memanfaatkan pergerakan udara keatas yang dihasilkan oleh efek buoyancy. Ventilasi cerobong, yang tidak bergantung pada kecepatan angin luar akan dapat mengurangi polutan yang dibawa oleh arus angin luar sehingga meningkatkan kualitas dan kesehatan udara dalam ruangan. Studi ini menggunakan pendekatan eksplorasi empiris studi kasus untuk meneliti sebuah hunian yang telah secara efektif memanfaatkan ventilasi cerobong dan meraih penghargaan atas inisiatif konservasi energinya. Ventilasi cerobong dapat berhasil diterapkan pada hunian yang memiliki ruang *void* dan lokasi yang dengan perbedaan temperatur yang kecil dapat menggabungkan ruang kaca di bagian atas ruang kosong tersebut, menciptakan area yang dipanaskan yang menghasilkan udara yang lebih renggang kepadatannya akan naik dan keluar melalui lubang di atas cerobong. Temuan studi ini merupakan panduan awal untuk penerapan ventilasi cerobong pada properti hunian. Ventilasi cerobong disarankan untuk rumah tinggal di kota-kota padat penduduk seperti Jakarta, yang secara efektif memanfaatkan *void* untuk memfasilitasi sistem ventilasi alami ini dengan cerobong yang dipanaskan dengan radiasi sinar matahari.

Kata Kunci: Kenyamanan termal, rumah tinggal, ventilasi cerobong

INTRODUCTION

Pollution issues and restricted green spaces in densely populated metropolitan areas like Jakarta are inevitable. Research indicates Jakarta's average Particulate Matter 2.5 (PM2.5) levels frequently fail to meet global air quality guidelines (Aulia, 2024). Furthermore, research indicates that Jakarta's temperature has risen by 1.1°C over the past 47 years, averaging an increase of 0.23°C each decade (Suwarman et al., 2022). A study conducted in low-income apartments in Indonesia indicates that the use of natural ventilation will reduce reliance on air conditioning, thereby lowering household expenses (Miyamoto et al., 2024).

Previous studies on natural ventilation performance in actual urban residences, such as apartments in Jakarta (Bramiana et al., 2022) and SOHO High-rises in Malaysia (Mostofa et al., 2019), confirm that indoor health and thermal comfort in residential dwellings are essential, particularly in hot and humid climates. The application of natural ventilation is particularly relevant in tropical and humid climates and is well employed in vernacular buildings (Siti et al., 2023).

One approach to achieving thermal comfort for occupants is to use natural ventilation in the house. Consequently, it is imperative to reduce or eliminate contaminants in outdoor air and maintain a pleasant indoor temperature. Natural ventilation systems facilitate the entry of outdoor air into the building, thereby lowering indoor temperatures and achieving an acceptable comfort level for occupants. Enhanced comfort levels may lead to reduced reliance on air conditioning, hence lowering energy use.

Natural ventilation is a passive design suited to the climatic context. It maximizes the use of natural resources, such as sunlight and wind, as studied in the context of thermal comfort in naturally ventilated residences (Siti et al., 2023). The efficiency of inclined solar chimneys (Mufida, 2021) demonstrates that refining chimney design and angle can significantly improve indoor air velocity and reduce temperatures in tropical climates. The sizes of the inlet and exit openings significantly influence both wind-driven and stack ventilation. Wind-driven airflow depends on prevailing wind speed, which is notably low in densely populated urban areas (Moey et al., 2021).

In architectural research, particularly in tropical metropolitan settings, achieving thermal comfort through natural ventilation poses significant challenges due to elevated ambient temperatures and densely built structures that restrict airflow. However, research on practical, energy-efficient architectural solutions utilizing stack ventilation is limited, especially in near-isothermal tropical areas such as Jakarta. This research seeks to bridge this gap by providing empirical data and design guidelines for architects to efficiently integrate stack ventilation systems into residential structures, thereby improving indoor comfort and reducing reliance on mechanical cooling.

Stack ventilation, often referred to in physics as the stack effect, is driven by buoyancy forces and promotes upward air movement within a building. Its effectiveness depends on temperature differentials between the interior and exterior, vertical height elements such as staircases, atriums, and shafts, and openings at the top and bottom of the shafts. In locations with near-isothermal conditions, such as Jakarta, where the temperature difference between outdoor and indoor environments is minimal, it is recommended to use an induced solar heat chimney to achieve a significant temperature difference.

A study on stack ventilation in residential homes in Malaysia, including a central atrium analogous to a chimney, revealed, through simulation, that the size and position of the inlet and outlet areas significantly affect wind flow patterns. One should avoid the "neutral plane," the height of the building at which internal and external pressures are equal, resulting in no horizontal air movement there. This study suggests that openings should have comparable dimensions at both the top and the bottom to maximize airflow and enhance ventilation (Wahab et al., 2016).

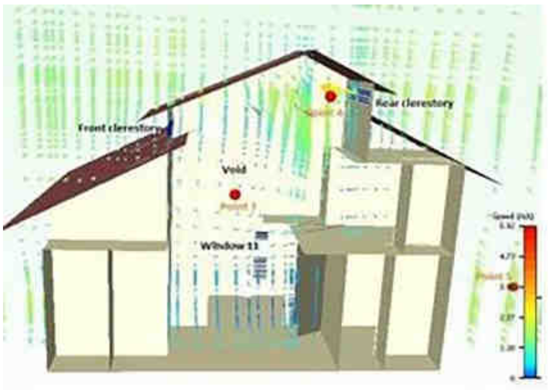

Figure 1. Simulation stack ventilation at daytime
Source: (Wahab et al., 2016)

Research on stack ventilation in a four-story residential dwelling in Iran indicates that indirect ventilation methods, such as stack ventilation, are more effective than direct ventilation methods, such as wind-driven ventilation. Stack ventilation can utilize the space between the ceiling and floor slab (horizontal roof channel) to horizontally circulate warm air, directing it to the shaft and thereafter ascending to the top of the shaft. This channel facilitates the collection and discharge of hot air that accumulates on rooftops or ceilings. The shaft, impacted by solar heat, requires the correct orientation. The findings indicate that a stack height of 2.4 meters from the roof is optimum, as it can increase stack airflow from 90 to 142 liters per second, underscoring the significance of vertical height. Enhancing the dimensions of the roof inlet vent to 6 m x 0.4 m can augment the air flow (ACH) to 100 liters per second (Rezadoost et al., 2023).

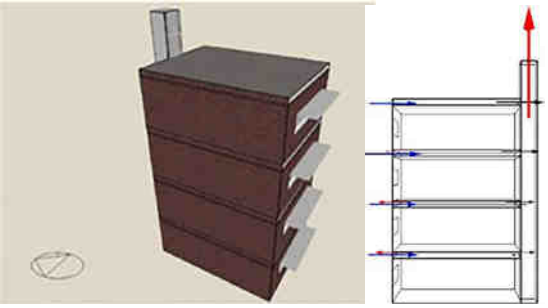

Figure 2. Stack ventilation using roof channel
Source: (Rezadoost et al., 2023)

A research study investigates the effectiveness of solar chimneys in Malaysia's hot, humid climate, using an experimental setup featuring a 3.5-meter-tall PVC tube with a 0.15-meter diameter and sensors to measure temperature and airflow. The field measurement is later employed in CFD modeling to determine the optimal chimney geometry: a height of 3.5 m, a length of 3.5 m, and a width of 1 m, which can enhance air velocity by 30%, boosting it from 0.1 m/s to 0.22 m/s (Nugroho, 2016).

Research utilizing computational models in Australia indicates that having a temperature differential between the interior and exterior of a structure facilitates air circulation through specially designed openings. Research indicates that solar chimneys may be more efficient in single-room applications. The study suggests using thermal mass in chimney walls, including glazed walls and solar absorbers (Zhang et al., 2021). A study using a mathematical modeling approach in a multi-story structure with a heating system indicates that an unheated atrium exhibits undesired flow regimes, resulting in reverse flow through the top story and exchange flow at the atrium outlet, as depicted in the diagram below.

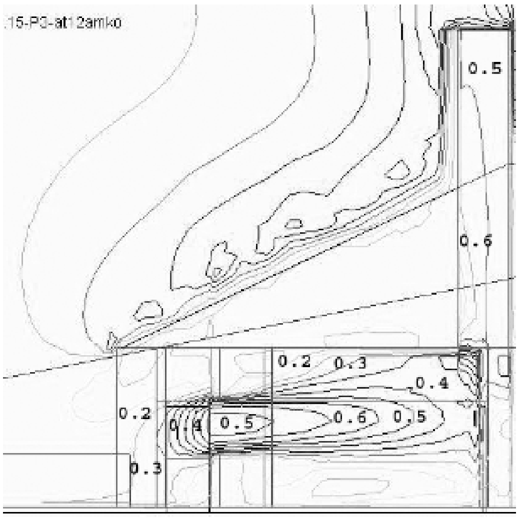

Figure 3. Predicted air velocity pattern
Source: (Nugroho, 2016)

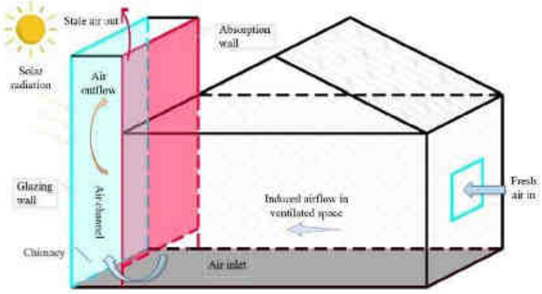

Figure 4. Chimney configuration
Source: (Zhang et al., 2021)

This issue arises from the atrium outlet's cross-sectional area being either too small or too large. This flow regime occurred in a subtropical climate that employed an internal heating system.

Optimal airflow across all levels is attained when the area of the atrium outlet vent is comparable in scale to the combined floor- and ceiling-level vents on each level, approximately within the same order of magnitude.

Two critical factors must be considered to avoid undesirable flow regimes. Firstly, avoid undersizing atrium outlets. If the atrium outlet is disproportionately small compared to the story vents, the outlet flow may become obstructed, causing "reversed flow through the top story," where air moves in the opposite direction, leading to recirculation and heat discomfort. Secondly, avoid oversizing atrium outlets. If the atrium outlet vent is excessively big relative to the story vents, "exchange flows" (bidirectional flows at the outlet) may occur, compromising ventilation efficiency and perhaps leading to indoor air quality concerns (Acred & Hunt, 2016).

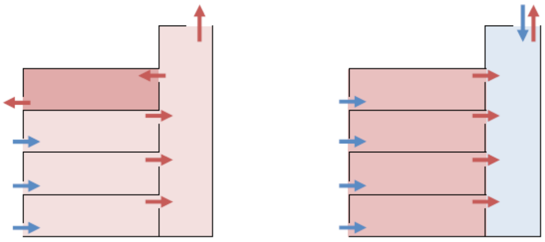

Figure 5. Undesirable flow regimes
Source: (Acred & Hunt, 2016).

Furthermore, external airflow introduces contaminants, and increased temperatures must be acknowledged and monitored (Wahab et al., 2016). Conversely, stack ventilation employing buoyancy-driven airflow is minimally dependent on external air currents; the upward airflow moves from areas of cooler, denser air to warmer and less dense air at the top of the solar chimney in the stack ventilation system (Wahab et al., 2023)(Nugroho, 2016).

Pressure differentials between the base and top of a chimney in stack ventilation can occur due to variations in temperature and height (Zhang et al., 2021; Acred & Hunt, 2016). The chimney's design is essential for generating the stack effect, which relies on the variations in height and temperature between the base and top of the solar chimney (Jarzabska, Pawłowski, & Niedostatkiewicz, 2021).

Temperature differentials in chimney chambers can be augmented by introducing generated solar heat that conducts to the wall (Nguyen et al., 2022) or by solar radiation that penetrates glass walls or windows (Mostofa et al., 2019). This process of heating air in a vertical shaft, such as a solar chimney, by solar energy is known as solar induction. It reduces air density, causing it to ascend and generating a natural convection current that draws cooler air from below to the top of the chimney.

Previous studies on stack ventilation and thermal comfort in tropical climes have often relied on simulations or generic experimental setups that do not fully represent the specific environmental conditions of densely populated urban living in Jakarta. The novelty of this study lies in the field measurements conducted on the stack ventilation system in a previously unexamined site. This study fills the gap by providing actual data collected from a three-story apartment in North Jakarta, a densely populated area known for its typical tropical near-isothermal climate.

The strength of this study lies in its execution within actual residences rather than in simulated environments. Research questions are studied to determine the solutions:
1. What is the practical application of the stack ventilation system in residential homes in Jakarta?
2. What guidelines are necessary for implementing stack ventilation procedures in residential homes?

The objective of this study is to provide guidelines for implementing stack ventilation in residential homes, using voids as a substitute for chimneys and a solar induction chamber at the rooftop to create temperature differentials.

This project will enhance architectural knowledge and home development by providing design guidelines for natural ventilation and residential comfort. For the government, it is a basis for regulating energy-efficient housing. This study provides empirical evidence on the effectiveness of buoyancy-effect ventilation in near-isothermal tropical environments within densely populated urban housing, a context inadequately addressed in the current literature.

METHOD

The research approach is a case study of an existing residence in North Jakarta that has effectively implemented stack ventilation and was awarded the ASEAN Energy Award in 2014. The house is situated in a densely populated housing complex in North Jakarta, with coordinates 6°07'21.7" S, 106°47'12.3" E.

All the primary rooms in this three-story building have no air conditioning; only the main bedroom is equipped with it. This three-story house has a typical floor plan with dimensions of 10 m by 20 m per floor.

The studied house is in North Jakarta, a highly urbanized and densely populated region marked by scarce natural areas, elevated building density, and significant local pollution sources, including heavy traffic and industrial operations. These conditions intensify indoor environmental issues, including increased temperatures and inadequate air quality, adversely affecting occupant comfort and health. Moreover, Jakarta's tropical near-isothermal climate, characterized by persistently high temperatures and humidity, poses significant challenges for achieving natural thermal comfort without relying heavily on energy-intensive mechanical cooling systems.

Figure 6. Case study location
Source: Google Earth, 2026

The house's climate is characterized by near-isothermal tropical conditions, with minimal temperature variation between the interior and outdoor environments.

Our methodology employs precise measurements of temperature and airflow velocity, which are critical for evaluating the effectiveness of stack ventilation systems. By focusing on these critical factors within a particular housing type, we can effectively evaluate the performance of stack ventilation in light of local climatic and architectural conditions. This practical, field-based approach significantly enhances theoretical or laboratory research, enabling architects and designers to develop more reliable, context-specific design strategies that enhance indoor thermal comfort and reduce dependence on mechanical cooling in similar tropical urban environments.

Figure 7. Case study house
Source: Author, 2025

The device used for field measurements is the 5-in-1 environmental meter from Krisbow, which measures temperature, humidity, sound, light, and airflow, as depicted in the image below. This study covers the measurement of air temperature and air velocity.

Figure 8. Measurement tools
Source: Author, 2025

This measurement equipment comprises specifications for a thermometer and an anemometer, as detailed below.

Table 1. Tool specifications

Function	**Range**	**Accuracy**
Air temperature	10°C-30°C	± 2°C
	31°C-60°C	± 1°C
Air velocity	0.1m/s-30m/s	±(3%+0.20 m/s)

Source: Krisbow manual, 2025

Field measurements were conducted on 28 August from 08:00 to 17:00 under dry, clear-sky conditions. This investigation measured temperature and air velocity in the primary space at each floor and at the top of the chimney.

Observations were conducted on the solar chimney configuration and rooftop spatial arrangement, which are intentionally heated by solar energy to generate less-dense air than the floor below, facilitating upward airflow from the bottom of the void to the top of the solar chimney.

The findings from the exploratory empirical case study analysis, along with the research indicators, provide advice for architects in architectural design who employ stack ventilation.

RESULTS AND DISCUSSION

As seen in the illustration below, the U-shaped staircase creates a void in the living room.

Figure 9. Void in the living room
Source: Author, 2025

This staircase ascends to the concrete roof of the house, which is enclosed by a 2-by-6-meter room with glass walls and a glass roof. This design leads to heat buildup from solar radiation, causing temperatures in this space to rise, with measurements reaching up to 49.1°C at the time of observation.

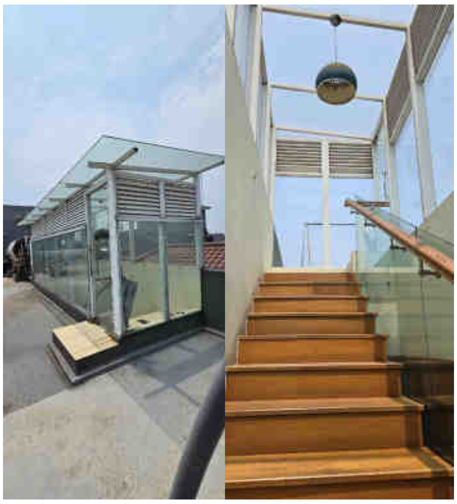

Figure 10. Glass room at the roof top
Source: Author, 2025

The vertical distance from the bottom floor to the top of the glass room is 15 meters. Measurements indicate an outdoor temperature of 33° Celsius, resulting in a potential temperature differential of 16° Celsius between the lower levels and the top of the chimney.

The rising temperature in the glass room reduces air particle density, driving air movement upward within the building and causing it to exit through the louvers at the top of the glass room.

Figure 11. Glass room on the rooftop
Source: Author, 2025

Field measurements were conducted on each floor and on the top of the chimney (glass room). Temperature measurement in the glass room reaches 49.1 degrees Celcius.

Figure 12. Temperature at the glass room
Source: Author, 2025

The temperature in the first-floor living room is the same as that of the terrace, both measuring 33° Celsius. However, the airflow velocity on the terrace is significantly lower at 0.1 m/s, whereas in the living room it is 1.25 m/s. Consequently, living room maintains a comfortable environment despite the same outdoor temperature, thanks to airflow.

Figure 13. Measurement at the 1st floor
Source: Author, 2025

Like the air velocity on the first floor, the air flow velocity on the second story is 1.51 m/s. Air speed is higher compared to other floors.

Figure 14. Measurement at the 2nd floor
Source: Author, 2025

The air flow velocity on the third floor is 1.20 m/s.

Figure 15. Measurement at the 3rd floor
Source: Author, 2025

Velocity of airflow: airflow velocity on each floor exceeds 1 m/s, indicating that, despite the same external air temperature, comfort levels are maintained.

Table 2. Field measurement results

	Temperature	Air velocity
Outdoor	33°C	0.1 m/s
1st floor	33°C	1.25 m/s
2nd floor	33°C	1.51 m/s
3rd floor	33°C	1.2 m/s
Roof top	49.1°C	

Source: Author, 2025

Below is the diagram of the stack ventilation system that utilizes a void. Airflow on each floor will be enabled by operable inlet windows situated on every level. When the inlet windows are opened, the stack ventilation mechanism will activate, creating an air pull from the base to the top of the chimney. The air at the top of the chimney is intentionally heated to decrease its density. It facilitates the rising of air within the chimney.

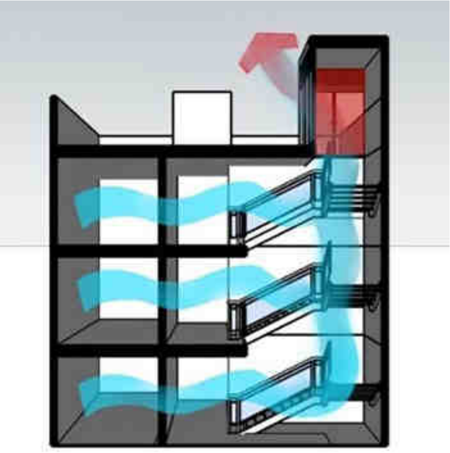

Figure 16. Diagram of stack ventilation
Source: Author, 2025

The process of stack ventilation is illustrated in the diagram above, where: Airflow on each floor (A) comes from the operable inlet windows, circulates through the rooms, and exits into the void (B), where warm air ascends to the glass chamber (C) at the apex of the chimney. This process will persist as long as the inlet ports remain open and there is a temperature differential between the inside environment and the top of the chimney.

The stack effect mechanism can be calculated from the formula:

$$Q = C \times A \times \sqrt{(2 \times g \times h \times \left(\frac{Ti-To}{Ti}\right))}$$

Source: (Owen, 2009)

Where:
Q = stack effect draft/draught flow rate (m^3/s)
C = discharge coefficient for openings (usually taken to be from 0.65 to 0.70)
A = cross sectional area of openings (m^2)
g = gravitational acceleration (9.81 m/s^2)
h = height of difference (m)
Ti = average indoor temperature (°K)
To = outdoor air temperature (°K)/T average chimney temperature

The formula indicates that air velocity is equal to Q/A, indicating that it is significantly influenced by the chimney height (h) and the temperature differential between the indoor (Ti) and outdoor (To) temperatures. Greater differences in temperature and elevation will result in higher air velocity.

Field data shows
$A = 0.5 \times 2 \times 6 = 6\ m^2$
$h = 4+4+4+3 = 15$ m
$Ti = 33°C$ (306.15 K)
$To = (33+33+33+49.1)/4 = 37°C$ (310.15 K)
Turns out $Q = 7.65\ m^3/s$ and
$v = Q/A = 7.65/6 = 1.275$ m/s
The computed stack effect air speed is close to the field measurement (1.2 m/s–1.5 m/s).

The Outcome of this calculation is that with a differential height of 15 m, and the solar-induced chamber, the temperature reaches 49.1°C, which gives temperature differences between the bottom and top of the chimney of about 16°C and can produce stack effect airflow speeds of 1.2 m/s – 1.5 m/s.

Air speeds ranging from 1.0 m/s to 1.5 m/s will remain acceptable in warm weather; however, they can get slightly to uncomfortably drafty (Siti et al., 2023).

This case study and field measurements yield the following results, mostly for use in architectural design.

1. The performance of this stack ventilation system in near-isothermal conditions relies on the presence of a solar heat-induced chimney capable of generating warmer temperatures during the daytime. Intentionally generate warmer air within the section of the chimney encased in glass enclosures.
2. Increased the chimney height by extending it above the roof, as the building height is fixed. The height of the glass chamber in this case study is three meters from the roof elevation. It exceeds the prior research recommendation by more than 2.4 meters from the top of the structure.

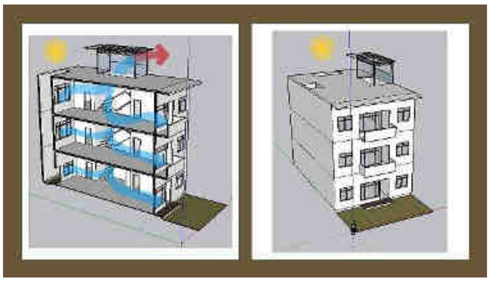

Figure 17. Diagram of stack ventilation
Source: Author, 2025

3. The cross-sectional area of the chimney must be equal to or greater than that of the inlet or outlet apertures. Compared with the previous study's findings, the actual cross-sectional area in the case study is virtually the same and exhibits a thinner configuration of 6 meters by 2 meters. The prior study suggested dimensions of 3.5 meters by 1 meter.
4. According to prior research, the inlet area should be equivalent to the outlet area, and appropriate sizing is necessary to prevent undesirable flow regimes.
5. Air movement due to the stack effect cannot occur when the inlet openings are closed. This is why operable windows are necessary on the façade facing outdoor air.
6. It is observed that although the outdoor air speed is very low, the indoor air velocity exceeds 1 m/s.
7. Outlet openings must be sufficiently large and may utilize permanently open configurations, such as louvers.
8. Most prior studies are conducted in diverse geographical contexts; further research on stack ventilation within the local context is necessary.
9. Further research is required on the stack effect in residential typologies, along with additional empirical experiments rather than reliance on modeling simulations.

There are some challenges related to this research, primarily that it is conducted solely during the daytime due to the stack ventilation system, which relies on the induced solar chimney system, and the condition when external temperatures exceed internal temperatures. Further research may be required to examine the process of stack ventilation when outdoor temperatures are lower than inside temperatures or during nighttime. Second, the study is based on specific contextual sites, which may exhibit variations in solar radiation levels and peak solar hours compared to other areas. Thirdly, the study did not address occupant comfort and behavior, as the stack ventilation system used in this study increased airflow velocity. Furthermore, the study does not address overheating at the top of the solar chimney. Therefore, these drawbacks are recommended for future research on this topic.

The results of this study complement and extend prior research on solar chimney experiments using PVC tubes to measure temperature and airflow in Malaysia, confirming that increased air velocity correlates with variations in temperature and chimney height (Nugroho, 2016). The study concurs that the buoyancy impact is not significantly dependent on the prevailing outdoor air speed, which is why it mitigates pollutants carried by outdoor air (Wahab et al., 2016). This work also employed a glass wall to induce solar heat in the solar chimney (Zhang et al., 2021). The findings of this study contrast with certain research on undesirable flow regimes, which reported that they occurred solely in multi-story structures (Acred & Hunt, 2016). These study results indicate several architectural designs associated with the stack ventilation system. The void can serve as the configuration for a chimney, as illustrated below.

Figure 18. Void as a chimney's form
Source: Author, 2025

U-shaped stairs define the chimney's structure.

Figure 19. U-shaped staircase as a chimney's form
Source: Author, 2025

For near-isothermal conditions, an induced solar chimney constructed with a glass compartment is required to generate heated air.

Figure 20. Solar-induced glass room chimney
Source: Author, 2025

Openings must be designed as operable windows on the façade that faces the outdoors.

Figure 21. Operable windows used as inlet openings
Source: Author, 2025

The top of the solar chimney should have an opening, such as louvres.

Figure 22. Louvres windows used as outlet openings
Source: author, 2025

CONCLUSION

Conclusions can be drawn to address research questions. Implementation of the stack ventilation system in residential properties in near-isothermal conditions, such as Jakarta, is outlined below. The residential architecture in Jakarta is a three-story building with a floor-to-floor height of 4 meters, incorporating a stack chimney with voids and a stack chamber of 2 meters by 6 meters at the top of the chimney. This house, situated in high-density tropical regions of North Jakarta, must ensure thermal comfort through natural ventilation while addressing external air pollution and heat transfer from ambient temperatures. Moreover, the prevailing wind speed in the city's urban area is very low, making wind-driven natural ventilation impractical; hence, stack ventilation is a suitable solution. Since 2014, this house has effectively utilized stack ventilation, eliminating the need for air conditioning in nearly all its rooms.

Stack ventilation is driven by buoyancy forces, in which air from the floors rises to the top of the solar chimney, where it is released outside. This stack ventilation system does not use any electrical ventilation devices, such as exhaust fans; it relies solely on airflow generated by the stack effect throughout the day. Under nearly isothermal conditions, this stack ventilation system employs an induced solar-heat glass chimney at its top, where the reduction in air density caused by elevated temperatures throughout the day generates upward airflow from the base of the chimney.

Windows that face outdoors must be opened to activate the stack ventilation system. When windows are opened, the internal air velocity can reach 1 m/s or more, enhancing thermal comfort in the house even when the indoor temperature matches the outdoor temperature. It is recommended to use a non-air-conditioning system when utilizing stack ventilation.

Chimneys in residential homes can use the void in the center of the room, extending vertically to the roof. Wind-driven height and temperature differentials between the base and apex of the chimney can achieve the stack effect. The upper section of the glass chamber requires exposure to solar radiation, which is provided by a transparent wall and roof.

Suggested guidelines for implementing stack ventilation in residential houses in Jakarta are outlined below :

1. The fundamental components of a stack ventilation system are the chimney, which can be formed from a continuous void extending to the roof.
2. A U-shaped staircase creates a void resembling a chimney.
3. An induced solar heat chimney can be implemented by constructing a glass enclosure on top of the chimney, which will rest on the slab roof and protect the stairwell from rainfall.

Guidelines for inlet or outlet shaft ventilation are explained below.

1. Inlet openings may consist of operable windows that face outdoor air. To facilitate airflow, windows facing the exterior must be operable; installing fixed glass windows is not advisable because they do not allow the ventilation needed to maintain indoor air quality and comfort in tropical climates. Outlet openings at the top of the chimney may be configured as louvers along the lateral sides of the chimney's top.
2. In tropical architecture, the presence of Chimneys in residences are uncommon; However, a chimney-like form can be achieved through the incorporation of voids within the interior space. To facilitate heat induction from solar radiation, the chimney must reach the roof. The top of the chimney can utilize a staircase cover surrounded by a glass wall and a glass roof. Additionally, it is necessary to have louvers or openings for air ventilation. Direct sunlight is important for heating the top of the chimney; it should be noted that it can penetrate to lower floors, necessitating the provision of an object capable of withstanding direct sunlight. The object may be a staircase or a concrete floor.
3. The chimney area must be sufficiently large to allow air to circulate from the bottom floor to the top floor. The configuration of a U-shaped staircase can form indirect voids. An outlet opening must be installed at the top of the chimney, utilizing a louver approximately 50 cm in height surrounding the glass wall.

The findings of this study may serve as a guide for implementing stack ventilation in residential homes in tropical regions. This work is specifically for the residential typology, enabling further research on other typologies. Additionally, research utilizing computational fluid dynamics (CFD) with local context may be employed to augment this study.

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