

## Comparative Performance of Hot Gas Reheat and Electric Reheat Systems for Humidity Control in Operating Rooms

San Homkinchan<sup>1</sup>, Chaiporn Supahitanukool<sup>2</sup> and Supapradit Marsong<sup>3</sup> \*

Faculty of Engineering and Technology, Pathumthani University<sup>1</sup>

Corresponding author: supapradit.m@ptu.ac.th

### 1. Abstract

This study experimentally compared the performance of hot gas reheat and electric reheat systems for humidity control in an operating room under tropical climate conditions. The experiment was conducted in an ISO Class 7 cleanroom equipped with an air handling unit (AHU) system under identical operating conditions. The inlet air was maintained at 28 °C and 80% RH, while the initial indoor condition was set at 24 °C and 95% RH, with a control target of 24 °C and 50–60% RH (ASHRAE, 2021). The results indicated that both systems effectively reduced relative humidity from approximately 95% RH to 52–56% RH within a comparable time frame. The humidity reduction showed a rapid initial decrease followed by a gradual stabilization, consistent with condensation behavior on cooling coils (Chai et al., 2022). Both systems maintained indoor temperature within 23.3–24.5 °C, indicating effective thermal control. However, the hot gas reheat system demonstrated more stable humidity control with smaller fluctuations compared to the electric reheat system. Overall, both systems achieved effective humidity control, but the hot gas reheat system provided superior stability and is more suitable for operating room applications requiring precise environmental control (Nguyen et al., 2021).

**Keywords** Hot Gas Reheat, Humidity Control, Operating Room, Electric Reheat, Cleanroom, HVAC System

### 2. Introduction

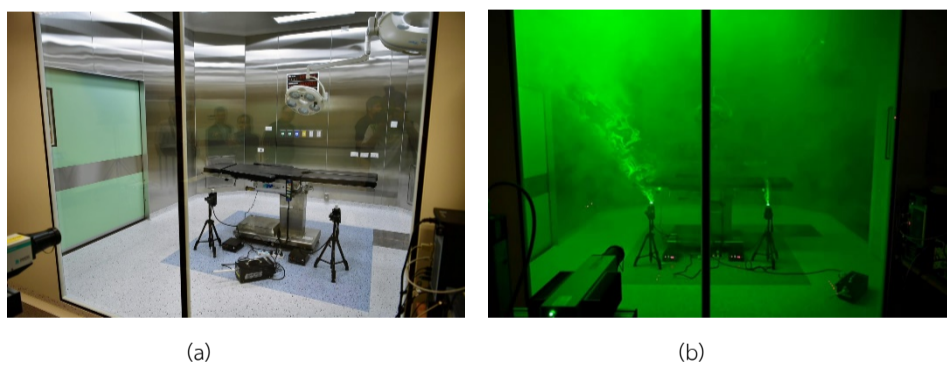
Maintaining precise indoor environmental conditions in operating rooms is critically important for ensuring patient safety, infection control, and optimal working conditions for medical personnel. Standard guidelines recommend maintaining temperatures between 20–24 °C and relative humidity within 30–60% RH (ASHRAE, 2021). In hot-humid climates, such as those in Southeast Asia, humidity control becomes particularly challenging due to high latent loads (Nguyen et al., 2021; Zhao et al., 2020). Conventional HVAC systems typically employ a cooling and reheat process, where electric reheat is widely used but results in high energy consumption (Baek et al., 2020; Mallay, 2024). Alternatively, hot gas reheat systems utilize waste heat from the condenser, offering improved energy efficiency (Nguyen et al., 2021; Zhang et al., 2023). However, experimental studies directly comparing these two systems under controlled operating room conditions remain limited.

### 3. Objective

This study aimed to experimentally compare the performance of hot gas reheat and electric reheat systems for humidity control in an operating room environment. The comparison focused on key performance indicators, including the rate of humidity reduction, the time required to reach the target setpoint, and the stability of temperature and relative humidity.

### 4. Research Methodology

The experiment was conducted in an ISO Class 7 cleanroom designed to simulate an operating room, equipped with an air handling unit (AHU) system incorporating both hot gas reheat and electric reheat configurations. The system operated under controlled and identical conditions, with inlet air maintained at 28 °C and 80% RH. The initial indoor condition was set at 24 °C and 95% RH, while the target control condition was defined at 24 °C and 50–60% RH. Environmental parameters, including temperature, relative humidity, and electrical current, were continuously monitored using calibrated sensors. Each system was tested independently under the same conditions to ensure a fair and reliable comparison.



**Figure 1** (a) Cleanroom laboratory, Faculty of Engineering, Kasetsart University, (b) Airflow visualization using laser light and fog generator.

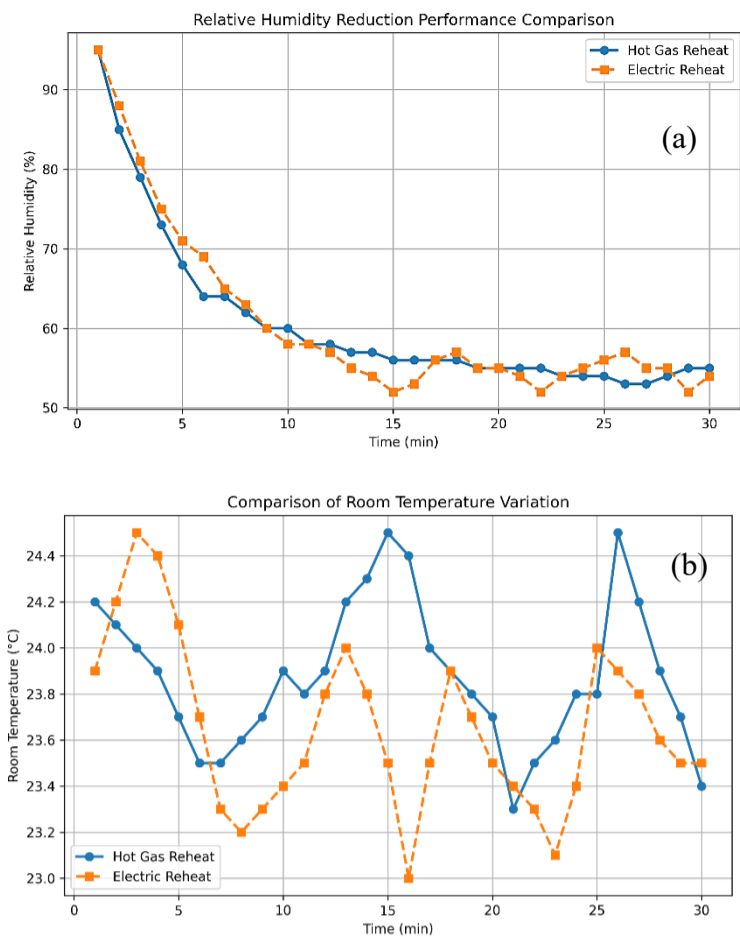


**Figure 2** Camfil air filtration unit, Faculty of Engineering, Kasetsart University.

### 5. Research Results

The results showed that both systems effectively reduced relative humidity from approximately 95% RH to the target range of 52–56% RH within a comparable time frame. The humidity reduction exhibited a rapid initial decrease followed by a gradual stabilization, consistent with condensation behavior on cooling coils (Chai et al., 2022; Akhtar et al., 2024). Indoor temperature remained stable within 23.3–24.5 °C for both systems, indicating effective thermal control. Notably,

the hot gas reheat system demonstrated more stable humidity control with smaller fluctuations compared to the electric reheat system.



**Figure 3** (a) Indoor RH variation over time, (b) Indoor temperature variation over time (hot gas reheat).

**Table 1** Sample Experimental Data (Hot Gas Reheat)

Time Step	Temperature (°C)	Relative Humidity (%RH)
1	24.2	95
5	23.7	68
10	23.9	60
15	24.5	56
20	23.7	55
25	24.5	53
30	23.4	55

**Table 2** Summary of Humidity Control Performance

Parameter	Hot Gas Reheat	Electric Reheat
Initial RH (%RH)	95	95
Final RH (%RH)	53–55	54–56
Temperature Range (°C)	23.3–24.5	23.5–24.7
RH Reduction Behavior	Rapid initial, stable final	Rapid initial, slight fluctuation
Stability (RH fluctuation)	More stable	Less stable

### 6. Discussion

The humidity reduction observed in this study was primarily governed by condensation at the cooling coil, with a rapid initial decrease due to high vapor pressure differences (Chai et al., 2022). As equilibrium was approached, the reduction rate decreased due to reduced thermodynamic driving force (Akhtar et al., 2024). Both systems maintained stable temperature conditions; however, the hot gas reheat system provided more stable humidity control due to continuous heat recovery and smoother system response. In contrast, the electric reheat system operated intermittently, resulting in noticeable fluctuations (Mallay, 2024). These findings are consistent with previous studies highlighting the benefits of heat recovery in improving HVAC performance and control stability (Nguyen et al., 2021; Dermentzis et al., 2024).

### 7. Conclusions

This study demonstrated that both hot gas reheat and electric reheat systems are capable of achieving effective humidity control in operating room environments under high latent load conditions. However, the hot gas reheat system showed superior stability and more consistent performance, making it a more suitable option for applications requiring precise environmental control. This study provides experimental validation of HVAC performance in a controlled cleanroom environment, highlighting the advantages of heat recovery mechanisms in hot-humid climates.

### 8. References

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