A double canopy island hood

Commercial Kitchen Ventilation Guidelines

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Introduction

Most of the exhaust air from commercial kitchens contains the following:

- Carbon monoxide accumulated due to incomplete combustion in fired appliances.
- Heat generated during the cooking process.
- Fumes given off during the cooking process and from the burning of fuel.
- Steam generated due to the cooking process.
- Smoke due to charcoal and charbroil.
- Smoke, oil and grease aerosol generated during cooking and frying.

Designing a Commercial Kitchen Ventilation System

In a commercial kitchen, the walls and floors of kitchen and dish wash areas get heated due to radiation and residual heat built up during the cooking and washing processes, and cause discomfort to the working staff. This heat is particularly difficult to deal with. Due to very high sensible load in the cooking area, air conditioning is not recommend in Indian conditions. Ventilation, achieved by extracting exhaust air and supplying makeup air, is the preferred way to create comfort conditions in the kitchen. In commercial kitchens, extraction of exhaust air is carried out with canopy hoods, ducting and centrifugal fans.

A good commercial kitchen ventilation system design accomplishes the following:

- Air movement, i.e. exhaust air and makeup air velocity.
- Discharge of treated exhaust air into the atmosphere.
- Extraction of heat and effluents generated by the cooking process.
- Provision of cool and clean air as makeup air.
- Removal/reduction of odours resulting from the cooking process.

Canopy Hoods

Canopy hoods are suspended above the cooking appliances. They are selected based on architectural layout of the kitchen, cooking load and the type of cooking process.

Cooking processes are categorised into dry and wet cooking. Dry cooking processes, where oil is not used, include baking, boiling, frying and hot beverage preparation. Wet cooking processes include cooking of rice, dal, non-vegetarian and vegetarian foods, curries, oily snacks like burgers, samosas, potato dumplings, omelettes, fried chicken and fish. Canopy hoods are

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selected as per the cooking application and kitchen requirement.

Canopy hoods work on the updraft principle, capturing contaminated hot air, cooking oil fumes and greasy vapours generated during cooking, and releasing them into the atmosphere. These emissions, settled on walls and ceilings, would create a highly flammable coating and foster bacterial growth. A canopy hood is ideal for reducing this coating, conduction heat and relative humidity generated while cooking, and for creating a comfortable working environment in the kitchen.

There are two broad types of canopy hoods:

Type I

Type I canopy hoods are designed to collect and exhaust emissions from all types of cooking equipment. The following Type I canopy hoods are in use:

- Wall mounted canopy
- Single island canopy
- Double island canopy
- Eyebrow
- Proximity hoods, which include back shelf and passover

Type II

Type II canopy hoods are designed to collect and remove only steam, vapours, heat and odours. They are of two kinds:

- Oven hood
- Condensate hood

All the above kinds of canopy hoods are mounted at different heights relative to the cooking equipment and in different capture areas. They are described below.

Wall Mounted Canopy Hood

Photo 1: Wall mounted canopy hood

The wall mounted canopy hood is installed where the cooking equipment is placed against a wall. It uses less airflow than island type equipment. Most hood manufacturers provide 3" space with the hood, enabling it to be placed against the wall. A minimum hood overhang of 6" from the cooking equipment is recommended on each end of the hood. Larger overhang increases capture and containment.

Single Island Canopy Hood

The single island canopy hood is installed over a single line of cooking equipment, placed where no wall exists. It has four exposed finished sides. It is more susceptible to cross draft and spillage, and is dependent only on thermal updraft heat from the cooking equipment. It overhangs from the cooking equipment by a minimum of 6" on all four sides. To eliminate the front to back airflow, a 'V' bank of filters improves capture and contamination by directing the containment air to the centre of the hood.

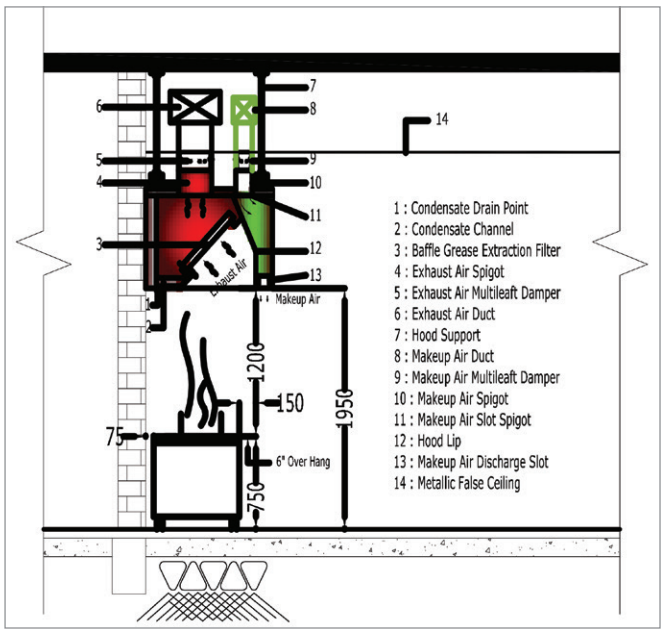

Figure 1: Typical wall canopy hood with spot cooling

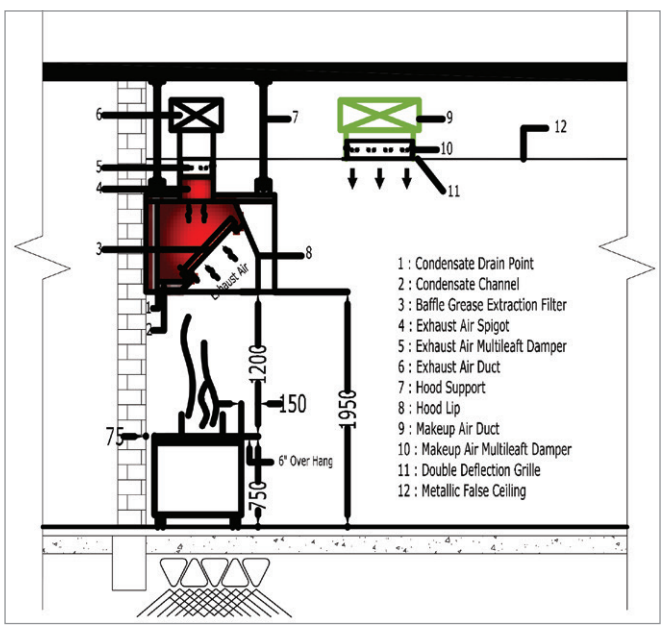

Figure 2: Typical wall canopy hood without spot cooling

Double Island Canopy Hood

A double island canopy hood is installed over a double line of cooking equipment placed back to back. The configuration is two wall canopy hoods placed back to back, thus creating two finished sides. Its performance is similar to the wall canopy hood due to two thermal plumes rising against each other; but it is susceptible to cross drafts. The desirable hood overhang is 6" on all four sides of the hood.

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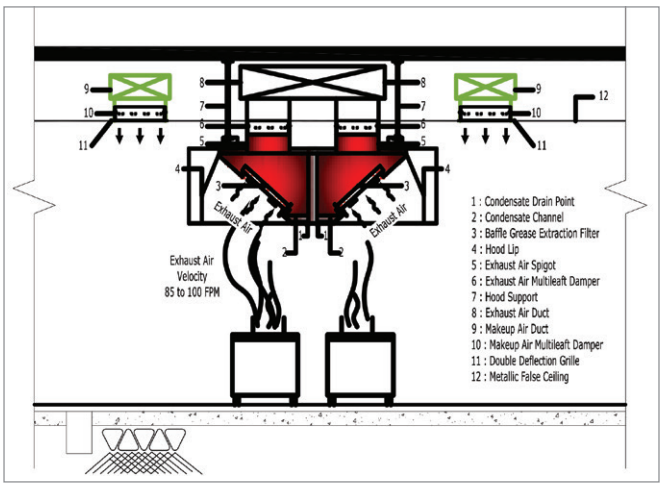

Figure 3: Single island canopy hood

Photo 2: Double island canopy hood

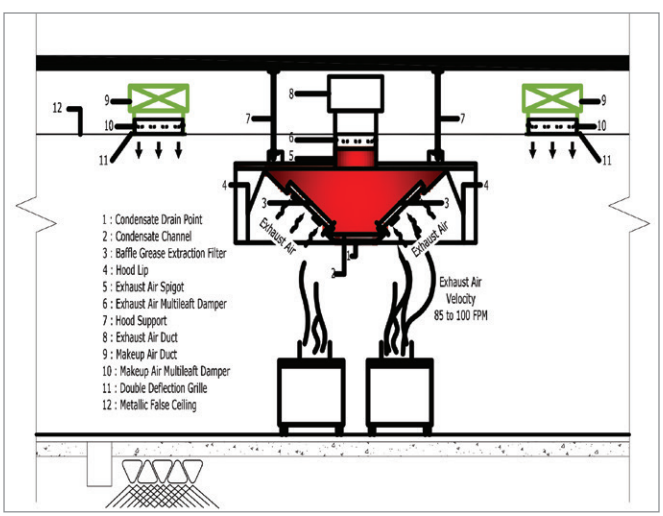

Figure 4: Double Island Canopy Hood

Eyebrow Hood

An eyebrow hood is installed to capture the vapours and heat escaping from the open doors of cooking equipment.

Back Shelf and Proximity Hoods

The hoods are installed behind the cooking equipment, and do not overhang on the front side of the equipment. They are used where overhead canopy hoods cannot be installed due to low ceiling height. It is shorter in height and depth compared to typical canopy hoods, hence not suitable for open flame equipment such as char broilers. Back shelf hoods are mounted in close proximity to the cooking surface, hence require less exhaust air quantity. They are not suitable for large skillets and ovens.

Oven Hood

An oven hood is installed to capture and release to the atmosphere heat, fumes and steam (not grease) generated in the equipment.

Condensate Canopy Hood

A condensate canopy hood performs as an exhaust hood, having an exhaust duct collar to extract heat, moisture and odour, with condensate baffle plates to improve the performance. It is suspended on the dishwashing machine. For capture and containment of large plumes of heat and steam, 18" to 25" of overhang is recommended.

UL Listing

Hoods that comply with accepted national standards, approved and evaluated by Underwriters Laboratories are marked and listed by UL. These hoods are operated at lower exhaust rates than unlisted hoods of comparable size and type (see *Table 1* and *2*).

Hood Construction

Canopy hoods are generally fabricated from GSS or SS 304. GSS hoods are more economical, but have shorter life spans because of corrosion. SS hoods are aesthetically better and last longer.

Canopy hoods are factory assembled with fully folded construction, and seam welded with non-visible mechanical fixing. This leaves a smooth easily cleanable surface. All metal edges are rolled smooth and free of sharp edges and projections.

The hood depth should be a minimum of 24", and should not exceed 36". Larger hood height improves capture efficiency.

A condensation channel is provided at the bottom edge of the back of the canopy.

Baffle Grease Extraction Filter

The most common type of filter used in a canopy hood is the baffle grease extraction filter. It is constructed from SS 304 and is resistant to aggressive detergent. It is designed to extract oil and oil vapours from the cooking area. Its semi-circular channel

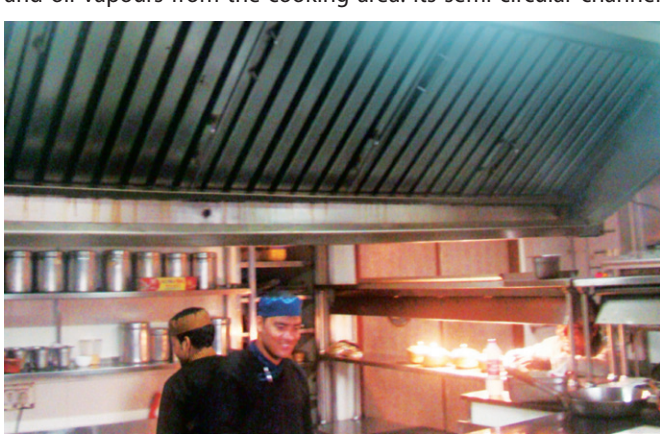

Photo 3: Baffle grease extractor

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construction increases the effective filter face area. A number of interlocking vanes create a centrifugal force in the filter.

The filters are placed at an angle of approximately 45° in the canopy and are easily removable. The grease collects in the lowest part of the filter, preventing clogging and maintaining an even extraction over the entire length of the ventilation system. The extracted grease is collected in the grease-gutter/condensate channel within the hood. The efficiency of the filter depends on the particulate size being filtered. Normally, it is 65 to 80% by weight.

Another function of the baffle grease filter is preventing cooking flames from entering the exhaust air duct. The exhaust air keep the filter's surface temperature around 200°F (93°C) in a wet kitchen.

Overhang

Canopy hoods are ceiling suspended and overhung. Hood overhang must be at least 6" beyond the outer edge of the cooking surface on all open sides. This distance is measured from the inside lip of the hood.

Installation Height

Hoods are installed at minimum 6'-6" and maximum 7' above finished floor level. This height may vary as per site conditions. For optimum performance, the height between the lower lip of the hood and the cooking surface should not exceed 4'.

Static Pressure Loss

Light and medium duty hoods have baffle grease extraction filters, with static pressure loss range from 2" to 2.5" Wg.

Ventilation Air Quantity

The appropriate exhaust air rate depends on the type of cooking equipment under the hood, the type of hood selected and how the makeup air is introduced into the kitchen.

The capacity of an exhaust hood is measured in cubic feet per minute (cfm). The exhaust air rates are based on the cooking application, canopy hood selection and length of hood (cfm per linear foot). The minimum exhaust rates for listed hoods as per ASHRAE Standard 154 and International Mechanical Code (IMC) are given in *Table 1*.

Table 1: Minimum exhaust flow rate for listed hoods (cfm per linear foot of hood)

Type of Hood	Light Duty	Medium Duty	Heavy Duty	Extra-heavy Duty
Wall Mounted Canopy	150 to 200	200 to 300	200 to 400	350+
Single Island	250 to 300	300 to 400	300 to 600	550+
Double Island (per side)	150 to 200	200 to 300	250 to 400	500+
Eyebrow	150 to 250	150 to 250	-	-
Back Shelf/ Proximity/Pass-Over	100 to 200	200 to 300	300 to 400	Not Recommended

The minimum exhaust rates for unlisted hoods are given in *Table 2*.

Table 2: Minimum exhaust flow rate for unlisted hoods (cfm per linear foot of hood)

Type of Hood	Light Duty	Medium Duty	Heavy Duty	Extra-heavy Duty
Wall Mounted Canopy	200	300	400	550
Single Island	400	500	600	700
Double Island (per side)	250	300	400	550
Eyebrow	250	250	Not Allowed	Not Allowed
Back Shelf/Proximity/ Pass-Over	300	300	400	Not Allowed

Note: To find out the required exhaust air flow in cubic feet per minute, multiply the cfm rate with hood length in feet.

Sample Calculations for Exhaust Air Quantity

Sample Calculation 1

Type of hood: Wall mounted, unlisted
Cooking process: Medium duty
From *Table 2*, exhaust air rate = 300 cfm per linear foot
Hood length: 17 feet
Overhang at each end: 6 inch
Total linear length = 17 + 1 = 18 feet
Hence, exhaust air quantity = 18 x 300 = 5400 cfm

Sample Calculation 2

Type of hood: Wall mounted, UL listed
Cooking process: Medium duty
From *Table 1*, exhaust air rate = 200 cfm per linear foot
Hood length: 17 feet
Overhang at each end: 6 inch
Total linear length = 17 + 1 = 18 feet
Hence, exhaust air quantity = 18 x 200 = 3600 cfm

Summarizing, for the same shape, size and geometry of wall mounted canopy hood, the exhaust air quantity for UL Listed hood is less compare to unlisted hood.

Makeup Air

Makeup is the forced or passive air entering the kitchen area that replaces the air extracted from the area. Makeup air has a significant impact on hood performance and comfort level. Depending on the architectural layout, it may be possible to transfer air from the dining hall to the kitchen as makeup air (assuming the dining hall air is cooler than the kitchen, and free of smoke and dust).This would reduce external makeup air requirement accordingly.

If makeup air is introduced close to the hood capture zone, it may create air draft and turbulence, resulting in obstruction to combustion, flame spread over, failure in thermal plume capture and containment. Canopy hoods have the facility to introduce makeup air from slot holes provided at the top, to create a comfort zone for the working staff. These slot holes create the effect of spot cooling, and operate as an air curtain between

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the cooking equipment and working staff. The system designer should maintain the makeup velocity through these slots holes within the range of 30 fpm to avoid cross draft. However it has been observed that at site the velocity is more than 30 fpm, and it is not discharged in a linear path and develops cross draft. Hence makeup air injected through slot holes is not advisable.

Cross draft is developed if makeup air from the dining hall or other surrounding areas is not routed or mixed properly with the main stream of makeup air. Local wall mounted and pedestal fans in the kitchen area also create unwanted cross draft. Wrong selection and location of makeup air grille, and high velocity of makeup air can also be reasons for cross draft. It can have a detrimental effect on the performance of hoods and combustion.

Evaporative Cooling

In dry climates, evaporative cooling is an effective way to supply makeup air. This has the advantage of keeping the staff comfortable. However, it has the disadvantage of high moisture content causing deterioration in the quality of crisp food items like biscuits, breads, chocolates and *papad*.

Pressurization in Kitchen Area

Adequate negative pressure must always be maintained in the kitchen area compared to the dining hall and surrounding area, to prevent kitchen odours and fumes from spreading into the latter. The dining and surrounding area should have positive pressure. However it is important that this area should be clean and free from pests, insects, dust or any type of contaminants.

Replacement makeup air volume should be 80% of the extracted air, to create negative pressure within the kitchen area. However, this ratio it not applicable to the dish wash area, vegetable cleaning, sorting and cutting area, grocery storage area, etc. Makeup air velocity at grease filter inlet surface should be 85 to100 fpm.

Makeup Air Quality

Makeup air needs to be filtered before entering the kitchen to remove airborne contaminants, bacteria, bugs, insects, pests, etc.

Makeup Air Handling Unit Selection

The makeup air fan should be forward or backward curved, DIDW, centrifugal type, energy efficient and AMCA certified.

Filters and fan should be housed in an AHU with double skin PUF panel construction. Filtration levels should be 10µ in the pre-filter and 5µ in the final filter.

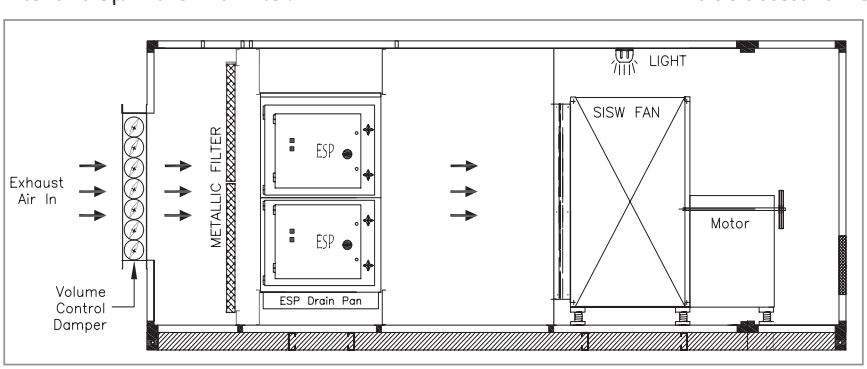

Figure 5: Exhaust AHU with ESP

Makeup Air Ductwork

Ducts should be rectangular in cross section. In main duct pieces, bends and branches should be fabricated with galvanized steel sheet and should comply with IS 277 and IS 655. Low leakage airfoil multi-leaf volume control damper should be used for balancing and controlling air flow. Double deflection grilles are recommended for makeup air distribution. The maximum face discharge velocity of the grille should not exceed 150 fpm closest to the kitchen hood. The ductwork for makeup air should be designed at 1200 fpm.

Where the makeup air duct is installed at a terrace or in the open air, externally mounted close cell elastomeric rubber insulation should be considered. Open cell fibreglass or glass wool insulation is not permitted.

Exhaust Air

Exhaust Air Handling Unit Selection

The selection of exhaust AHU is related to kitchen activities.

Exhaust AHU for a dry kitchen should have a metallic GI five ply washable filter before discharging the effluent to the atmosphere. However, the type of filter and filtration level may be changed as per site conditions and user requirement. In a wet kitchen area, oil and grease content is very high, hence electrostatic precipitator (ESP) should be provided as a dry scrubber. The exhaust AHU should have double skin PUF insulated sandwich panel construction.

Fan selection for dry and wet kitchens depends on the type of discharge effluent. The fan should be backward curved SISW centrifugal type, to avoid direct hot air flow on fan drive motor. The fan should be AMCA certified.

Since fast food and tandoor kitchens are likely to create high temperature exhaust air with high oil and grease content, the fan drive motor should be mounted out of the air stream. Generally, Class F insulation is recommended up to exhaust air temperature of 155°C. However, up to 130°C, Class B insulation may be suitable.

Metallic washable filters are recommended for a dry kitchen. ESP is recommended for a wet kitchen. ESP should be a part of the exhaust air unit, and should be suitable for removing aerosol, oil, mist, vapour and kitchen exhaust gas contaminants. Electrostatic efficiency should be 90 to 95%. Pressure drop across the ESP should not exceed 75 pascal.

Filter housing should be constructed with 1.6mm electro-galvanized steel sheet finished with powder coating, with hinged side access for removable doors to access the filter. The pre-filter should be washable type in aluminum mesh.

Exhaust air velocity should be low (around 150 fpm), so the dust particles, grease and oil charged particles settle on collector plates. These particles settle down in the form of ash, and are collected in the drain chamber.

Ductwork for Exhaust Air

Exhaust air ducts should be constructed from galvanized steel sheet or stainless steel with a minimum thickness of 0.8 to 1.0mm. Longitudinal joints should be air tight and leak proof, ideally fully welded, or formed by

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a grooved or lock seam. The gasket should be fire retardant type. The joints should be sealed with high temperature food grade sealant for leak tight installation.

Horizontal ducts should have a proper slope towards a grease reservoir, with drain outlet at the bottom of the duct housing to permit drainage of grease.

The following accessories should be avoided in the exhaust air ductwork:

- Multi-leaf volume control dampers and turning vanes, as they will form grease traps.
- Back draft shutters.
- Fire dampers.

The makeup air delivered at low velocity diffuses and displaces extracted air at the outlet of a canopy hood. While designing the exhaust air, ensure 85 to 100 fpm velocity at the suction surface area of the hood, so that cooking range flame is not disturbed. Low velocity reduces the effect of cross draft and equipment surges. Ensure that air draft due to high velocity close to the cooking equipment does not cause discomfort.

The ductwork for exhaust air should be designed for 1000 fpm. Ensure that the distance between extraction outlet and makeup inlet is at least 8m. The extract outlet should be positioned to ensure that the extracted fumes cannot be pulled back into the kitchen area by any nearby intake fan. The exhaust air duct should be non-insulated. However, epoxy paint coating is recommended to protect it from rain water and moist air. If it runs through cold or air conditioned areas of the building, it should have externally mounted insulation to avoid condensation within the duct.

Ventilation System for Dish Wash Area

A commercial dishwasher has a combination of hot water, cold water spray, hot water boiler, hot water dryer, etc. During the cleaning process hot air is spread out in the surrounding area, resulting in higher temperature and humidity. While calculating exhaust air quantity in this area, the following points must be taken into consideration:

- Heat dissipation (kW) of dishwasher.
- Surface temperature of hot water generator tank.
- Hot air exhaust quantity.
- Residual heat from dishwasher.
- Ambient condition.
- Desired comfort condition required by the user.
- Supply air grille velocity should be around 650 -700 fpm.
- Overhang from dishwasher outlet should be around 12".
- Exhaust and supply air quantity should be in the ratio of 80%.
- Avoid negative pressure in dishwasher area.

Conclusion

Design engineers need to ensure that kitchen air is extracted close to the cooking equipment, and that unwanted air drafts from makeup air, windows and doors do not create discomfort and unsafe conditions. The ventilation system must dilute and remove odours, vapours and steam from the cooking process. Cooled clean air must be introduced as makeup air so as to create comfortable working environment and to help reduce stress on the working staff. Sufficient air must be provided for complete combustion at the burning application. Cooking odours must be prevented from spreading beyond the kitchen.

(Canopy hood photos courtesy The Maharaja Business Hotel.) ❄