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Indoor Air Quality of Beauty Parlours and Salons

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Abstract—*The business of beauty parlour has played a major role in generating employment for many people all over the world, and in India. In order to remain profitable and successful, this growing business needs to meet and maintain high standards of hygiene, health and safety, so that no risk is posed to the customers and workers. Parlour workers, a population dominated by women, are exposed to a myriad of chemicals of concern everyday in their workplaces. Hair sprays, hair colours, bleaches, permanent waves, acrylic nail application, and numerous other parlour products contain ingredients associated with asthma, dermatitis, neurological symptoms and even cancer. Cosmetologists may be exposed to high concentrations of a mixture of volatile organic compounds. These levels of volatile organic compounds could be decreased significantly by following good practices such as appropriate ventilation of the areas, closing the packages of the beauty products when not in use and finally selecting safer beauty products without strong odour. Due to the concerns associated with the beauty salons, this study was conducted to identify health issues experienced by the workers and customers that may be associated with the environment of beauty parlour. Based on the results of the physical survey conducted to correlate the impacts of the environment along with the health concerns experienced by the workers, the present study proposes possible improvements in the design and ventilation systems in parlours as a measure to address and reduce the adverse health effects related to the environment of the salons.*

1. INTRODUCTION

Precise statistics on the beauty parlour workforce are difficult to obtain given the nature of the industry. A KPMG Wellness sector report launched in April 2016, projected that the size of India's beauty and wellness market would nearly double to Rs 80,370 crore by 2017/18 from Rs 41,224 crore in 2012/13[1]. Also, the report estimates that workforce requirement in the beauty and salon segment will grow from 3.4 million in 2013 to 12.1 million in 2022[1].

Parlour and salon workers may be exposed to a range of chemicals often encompassing a wide range of products. The exposure could be over widely varying time periods in their work environment, often without adequate ventilation, or the use of personal protective equipment. The inherent properties of cosmetics and their ingredients support the concern about the health of people working often very long work weeks in salons. Additionally, the potential for human exposure via inhalation, skin contact, or skin absorption is also apparent.

2. LITERATURE REVIEW

Parlour workers are potentially exposed to a range of hazards in their work environment. The strong chemical odours emanating from parlours have generated complaints to health departments and have stimulated environmental, health, and community advocates to raise concerns about potentially hazardous chemicals used in parlour products. As a result, there is more and more demand for exposure assessment in parlours to determine if the smells, vapours, and dusts in parlours are just a "nuisance" or if they are hazardous to the health of workers and patrons.

According to the guideline proposed by the level of Total Volatile Organic Compounds (TVOC) should not exceed 200 $\mu g/m^3$[2], in order to ensure human comfort. So, the chemical ingredients present in the products used for various beauty and hair treatments may toxicate the parlour environment. Table 1 gives an idea about the interior environmental exposure limiting conditions of parlours and salons [2].

Table 1: Chemicals and exposure limit [2]

Chemical Compound	Concentration (max)
Dibutyl phthalate	5 mg/m3
Toluene	187.5 mg/m^3
Formaldehyde	1 mg/m^3
P-phenylenediamine	0.1 mg/m^3
Acetone	2400 mg/m^3
Titanium dioxide	10 mg/m3

The toxicity of many ingredients in products is clearly established in Table 2 [3,4]. Occupational skin and respiratory disorders, and disputable reproductive and genotoxic effects have been linked to the chemical exposure of beauty and salon products.

Table 2: Chemicals of Concern [3][4]

Chemical name	Found in	Health concerns
1,4-dioxane	Shampoo, liquid soap.	Cancer, birth defects.

Benzophenone	nail polish, foundations, sunscreens, fragrance, shampoo, conditioner, hair spray, moisturizer	Developmental and reproductive toxicity, ecotoxicity .
Butylated Compounds	hair products, makeup, sunscreen, creams .	Endocrine disruption
Ethanolamine Compounds	shampoos, hair conditioners and dyes,	Cancer, bioaccumulation, organ system toxicity
Formaldehyde	Nail polish, nail glue, eyelash glue, hair gel, hair-smoothing.	Cancer, skin irritation
Octinoxate	Hair color products and shampoos, nail polish,	Endocrine disruption, reproductive and developmental
Acetone	Nail polish removers	organ toxicity and cance
Toluene	Nail polish, nail glue, hair dye,	Liver damage, kidney damage, birth defects, pregnancy loss
Titanium Dioxide	Sunscreen, pressed and loose powders	Cancer (Inhalation Exposure Only)
Parabens	Shampoos, conditioners, lotions, facial and shower cleansers and scrubs .	Pregnant women and young children

A limited number of studies have conducted indoor air monitoring in parlours to better scharacterize the potentially hazardous chemicals found in the air that salon workers and their clients breathe. The data from air monitoring studies have routinely shown, that certain chemicals tend to be present in parlour air at disproportionately higher levels than other places such as offices or homes.

Research is needed to better understand the potential synergistic or additive effects of multiple simultaneous exposures in parlours.

The indoor air quality has become a major concern in recent years. Chemicals released from various cosmetics and the architecture of parlour together may cause hazardous health effect to workers and customers. Table 3 shows Indoor Air Quality (IAQ) standards as included in US National Ambient Air Quality Standards (NAAQS) [5].

Indoor air pollution is bigger killer than outdoor air pollution in India with the recent global burden of diseases report listing the former as second biggest killer and latter as fifth largest. According to a report, around 1.3 million people died of indoor air pollution in 2010 whereas death because of outdoor air pollution was around 0.62 million[6]. Indoor air pollution is second biggest killer after high blood pressure in India. A small percentage of the population may be sensitive to a number of chemicals in indoor air, each of which may occur at very low concentrations. This condition is known as Multiple Chemical Sensitivity (MCS).

Table 3: Indoor Air Quality Standards [5]

Components	Limits (maximum)	
	Residential	**Sensitive Areas**
Ammonia	0.4mg/m^3 (24 hr)	0.4mg/m^3 (24 hr)
Carbon monoxide	4mg/m^3 (1 hr) 2mg/m^3 (8 hr)	2mg/m^3 (1 hr) 1mg/m^3 (8 hr)
Repairable particulate matter a) Size < 10 µm b) Size < 2.5µm	 100µg/m^3 (24 hr) 25 µg/m^3 (24 hr)	 75µg/m^3 (24 hr) 25µg/m^3 (24 hr)
Suspended particulate matter	200µg/m^3 (24 hr)	100µg/m^3 (24 hr)
NO_x	80µg/m^3 (24 hr)	30 µg/m^3 (24 hr)
Ozone	100µg/m^3 (8hr)	100 µg/m^3 (8hr)

One technique for controlling odours and contaminants is to dilute them with outdoor air. Dilution can work only if there is a consistent and appropriate flow of supply air that mixes effectively with room air.

HVAC (Heating, ventilation and air conditioning) is the technology of indoor and vehicular environmental comfort. Its goal is to provide thermal comfort and acceptable indoor air quality.

Another technique for isolating odours and contaminants is to design and operate the HVAC system so that pressure inside the rooms is controlled. This control is accomplished by adjusting the air quantities that are supplied to and removed from each room. If more air is supplied to a room than is exhausted, the excess air leaks out of the space and the room is said to be under positive pressure. If less air is supplied than is exhausted, air is pulled into the space and the room is said to be under negative pressure.

A third technique is to use local exhaust systems (sometimes known as dedicated exhaust ventilation systems) to isolate and remove contaminants by maintaining negative pressure in the area around the contaminant source.

An air change is how many times the air enters and exits a room from the HVAC system in one hour. Or, how many times a room would fill up with the air from the supply registers in sixty minutes, a method of measuring the volume of air moving through a ventilation system or other space is known as “Cubic Feet per Minute” CFM. Table 4 gives the air change rates for rooms/buildings.

Table 4: Air Change Rates for buildings [7]

Room	Air change rates/ hour
Auditorium	8-15
Barber Shop	6-10
Beauty Shop	6-10
Cafeteria	12-15

Uniformity of temperature is important to comfort. If air is not properly mixed by the ventilation system, the temperature near the ceiling can be several degrees warmer than at floor level. CFM calculation gives us an idea about the mechanical ventilation (AC) required to maintain the air quality inside the salons. Engineering room airflow may present a real challenge when balancing an HVAC system. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommend that beauty salons maintain 25 CFM of fresh air per person via mechanical ventilation.

3. RESULTS AND DISCUSSION

As mentioned earlier, adequate ventilation is necessary in public and workplaces, and in beauty salons. In the present study, data was collected from three parlours. The internal environmental survey data of the parlours are presented is shown in Table 5.

Table 5: Case studies

	Parlour A	Parlour B	Parlour C
Mechanical ventilation	**Yes (AC unit)**	**Yes (AC unit)**	**No**
Ventilation working	Yes	Yes	Yes
Local exhaust	No	No	Yes (exhaust fan)
Other ventilation (using)	No	No	No
Shop volume (ft^3)	5,000	3,300	1,500
Area (ft^2)	500	330	150
No. of occupants	168/day	96/day	48/day
Chemical odour	High	High	Low

Two of the parlours had mechanical ventilation with no open window ventilation. Although it was not verifiable that these systems were appropriate for the present poor condition observed in the salon. The salons and parlours have elevated level of VOCs, also with nuisance of strong chemical odors. Having proper ventilation system will provide a continuous supply of fresh outside air, maintain the temperature and relative humidity level, reduce explosion hazards, and reduce or remove airborne contaminants.

Also, the external environment annually in the same region is shown in Table 6.

Table 6: External Environment

Parameters	Limits/Range
Temperature	Summer - 45˚C (max) Winter- 13˚ C (min)
Relative humidity	30-65%
Air movement	0.8 feet/s or 0.25 m/s

Calculation for CFM

The required CFM was calculated using the following equation:

$$CFMs = (V \times ACR)/ 60$$

Where: ACR = air change rate per hour

CFM = air flow through the room (ft^3/min)

V = volume of the room (ft^3)

As shown in Table 4, the air change/hr for beauty shops is in the range of 6 to 10. Assuming this air change rate for the three parlours, CFMs were estimated for the three parlours and are given in the following table.

Table 7: Estimated CFMs for the parlours

Parlour	CFM (taking air change/hr =6)	CFM (taking air change/hr = 10)
A	500	833.3
B	330	550
C	150	250

The dimensions and the room volumes of each Parlour are given below:

Parlour A: L=25ft., W=20ft, H=10ft

Volume = 4917 ft^3

Parlour B: L=22ft., W=15ft, H=10ft

Volume = 3300 ft^3

Parlour C: L=15ft., W=15ft, H=10ft

Volume = 1500 ft^3

Assuming one ton (1T) air conditioner handles 400 CFM in one sweep, loads (tonnage) of the required ACs are estimated for air change rates of 6/hr and 10/hr, respectively. The estimated values are given in Table 8.

Table 8: Estimated Air Conditioner Loads

Parlour	Ton (air change/hr =6)	Ton (air change/hr = 10)
A	1.25	2.08
B	~ 1	1.5
C	~ 0.5	1

For big parlours having area approximately 5000 ft^3 an air conditioning unit of 1.25 ton (6 hr) and 2.0 ton (10 hr) is minimal requirement of mechanical ventilation to maintain the air quality. For parlour having volume 3300 ft^3 required AC is 1 ton (6 hr) and 1.5 ton (10 hr) and for parlour having small capacity 1500 ft^3 the required AC unit is 0.5 ton (6 hr) and 1 ton (10 hr).

Additionally, gas detectors can be installed in the rooms where the products are being stored and used. This will facilitate in detecting higher levels of emitted gas from the product than the pre-set level which would automatically turn on the ventilation system leading to dilution or exhausting the air.

The recent alarm regarding the delhi air quality index was highlighted when the PM2.5 peaked at an extremely large value of 883μg/m^3. This was more than 14 times the standard value of 60 μg/m^3[9]. It should be noted that the air quality within commercial salons resembles the aforementioned poor quality standards at most times. Therefore, the manufacturer can be considered to be responsible to create and produce safe cosmetic products. This will facilitate to control the air quality in the commercial parlours and also assist in mitigating hazardous health outcomes among workers.

Additionally, if green chemistry is employed to reformulate products that contain the most troublesome chemicals will substantially reduce the health hazards associated with the poor air quality presently observed in the parlours. As suggested in the present study, the parlours should be well ventilated. Assessment of the interior environment of the parlours may lead to commercial salons being distinguished between “better” and “worse” parlours from the perspective of workers and customers.

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