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Case Studies

A New Manicure Table for Applying Artificial Fingernails

Dawn Tharr, Column Editor

Reported by Steve Lee, Jane McCammon,
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Introduction

The National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from Trinidad State Junior College (TSJC), Trinidad, Colorado. TSJC requested that NIOSH evaluate exposure to chemicals used by cosmetology students for applying artificial fingernails. Recommendations to reduce exposures resulted in the development of a new multiple workstation manicure table with effective downdraft ventilation. The new table was developed through the combined efforts of the TSJC programs of Occupational Safety, Building Trades, and Cosmetology and Cobb Mechanical Contractors, Colorado Springs, Colorado. Although NIOSH has previously reported the development of a single workstation ventilation system for applying artificial fingernails, this case study describes an effective multi-station system that may be more cost effective for workplaces where several clients are served simultaneously.

Background

Artificial fingernails are constructed on the natural fingernail using acrylate polymers. Before the artificial nail is applied, the natural nail is filed to create a rough surface and it is coated with a primer to promote adhesion. The acrylic fingernail is formed with a small brush that is dipped into a liquid nail product and a powder polymer. The liquid and powder mixture is dabbed onto the natural nail, and formed into the general shape of a fingernail before the chemical mixture hardens. When the artificial

nail has hardened sufficiently, it is filed to a smooth and refined shape. The finished artificial fingernail is coated with a primer, color, and a protective covering. Application of a full set of artificial nails takes about one hour to complete.

The material safety data sheets (MSDS) for the acrylic liquids used at TSJC state that the products contain unspecified quantities of ethyl methacrylate monomer, methyl ether of hydroquinone, and ethylene glycol dimethacrylate. The MSDS for the primer states that it contains methacrylic acid and methyl ether of hydroquinone and the MSDSs for the acrylic powders list ethyl and methyl methacrylate polymers, benzoyl peroxide, and titanium dioxide.

Previous studies have found low exposures to the substances used for making artificial nails, however, documented cases of occupational asthma among nail technicians have prompted recommendations to reduce exposures.⁽¹⁾ Recirculating downdraft manicure tables for a single work-station are commercially available for \$1200-2000, but they must be modified to provide effective ventilation.⁽¹⁾ The modifications may cost up to an additional \$300.

The new manicure table at TSJC is 19 feet long and 2 feet wide, and it has 6 work stations. Each station consists of a 15 × 15 inch grill with downdraft ventilation where the customer rests her hands during the application of artificial nails. The system uses a three-fourths horsepower fan rated for 990 cubic feet per minute (cfm) at a static pressure of 0.75 inches. The manicure table was constructed for about \$2500 (Figure 1).

Health Effects

Ethyl methacrylate has been the main volatile component of artificial

nail products since 1974, when the Food and Drug Administration banned the use of methyl methacrylate for this application.⁽²⁾ Methyl methacrylate is a potent sensitizer⁽³⁾ that has been linked with occupational asthma.⁽⁴⁾ Little research has been done on the health effects of ethyl methacrylate and no exposure limits have been developed. Ethyl and methyl methacrylate are chemically similar and share some toxicologic properties. Monomers of both compounds can cause dermatitis,⁽⁵⁾ and irritation of the eyes and respiratory tract.⁽³⁾ The polymers are thought to be inert and nontoxic.⁽³⁾ In 1990, the Colorado Department of Health reported five cases of physician-diagnosed occupational asthma among cosmetologists working with artificial fingernails.⁽¹⁾

Ethyl methacrylate is less volatile and is thought to be less toxic than methyl methacrylate, but industrial hygiene recommendations are the same for both compounds.⁽³⁾ A permissible exposure limit of 100 ppm has been established by OSHA for methyl methacrylate. ACGIH[®] has proposed, in the Notice of Intended Changes for 1999, that the TLV[®] for methyl methacrylate be lowered to 50 ppm as an eight-hour TWA.

Employee exposure to ethyl methacrylate provides the best measure for evaluating the control of artificial nail emissions. Even when applying nails without any local exhaust ventilation, exposure to other artificial nail products has been found to be at or below the sampling and analytical limits of detection.^(1,6,7)

Methods

Before the New Manicure Table

Bulk samples of the liquid acrylic product and the nail primer used at TSJC were analyzed for ethyl and methyl

methacrylates by gas chromatography according to NIOSH Method 2537.⁽⁸⁾ Both the pink and the white acrylic powders used at TSJC were analyzed for benzoyl peroxide by high performance liquid chromatography according to NIOSH Method 5009.⁽⁸⁾

Four personal breathing-zone (PBZ) air samples were collected from cosmetology students during the time they applied artificial nails and taught new students how to apply artificial nails. A total of two sets of nails were applied by each student during the sampling period. Nails were applied on tables without local exhaust ventilation (LEV). Air samples were collected on XAD-2 solid sorbent tubes (#226-30-06, SKC, Inc., Eighty Four, Pa.) using Gilian air sampling pumps at flow rates of 0.05 to 0.1 liters/minute (Lpm). The samples were analyzed for ethyl methacrylate and methyl methacrylate by gas chromatography according to NIOSH Method 2537.⁽⁸⁾

A HNU Model DL-101 photo ionization analyzer equipped with a 10.2 electron volt (ev) lamp was used to measure hydrocarbon concentrations generated while the fingernails were applied. This direct-reading instrument will measure any chemicals that have an ionization potential of 10.2 electron volts or less, including methyl and ethyl methacrylate.

A MET One Laser Particle Counter was used to demonstrate the impact of the process on airborne dust. This direct-reading instrument/stores particle counts in internal data loggers. This counter gave cut points of 0.5, 1.0, 2.0, 5.0, and 10.0 micrometers (μm). These cut points provided counts of airborne particles with sizes in the range of 0.5–1.0 μm , 1.0–2.0 μm , etc. The counter was set to sample for a 30-second period every five minutes.

Two PBZ air samples for benzoyl peroxide were collected on mixed cellulose ester filters and analyzed by high performance liquid chromatography according to NIOSH method 5009.⁽⁸⁾ Two PBZ air samples for total dust were collected on preweighed polyvinyl chloride (PVC) filters attached to air sampling pumps

calibrated at a flow rate of 2.0 Lpm. Three PBZ air samples for respirable dust were collected on preweighed PVC filters in 10 mm nylon cyclones at a flow rate of 1.7 Lpm.

After the New Manicure Table

After the new manicure table was built, PBZ air samples were collected from five cosmetology students while each of them applied one set of artificial nails at the new table. These air samples were collected at a flow rate of 0.05 Lpm and analyzed for ethyl methacrylate according to NIOSH Method 2537.⁽⁸⁾

Capture velocities at each of the work stations were measured with a Kurz Mini Anemometer Model 490, and the effective capture zones of the system were visually observed using smoke tubes.

Results/Discussion

Before the New Manicure Table

Bulk sample analyses showed that the liquid acrylic contained 91 percent ethyl methacrylate and 0.006 percent methyl methacrylate. The primer contained 0.6 percent ethyl methacrylate and 0.005 percent methyl methacrylate. Both acrylic powders were found to contain about 0.08 percent benzoyl peroxide.

Exposure to ethyl methacrylate among four persons applying and teaching the application of artificial fingernails ranged from 1.0 to 11 ppm (Table I). Concentrations of methyl methacrylate were below the analytical limit of detection (0.9 $\mu\text{g}/\text{sample}$).

HNU readings were generally 2–3 ppm during formation of the nail, and

4–6 ppm during the transfer of liquid monomer from bulk containers to application containers. The readings reached as high as 14 ppm during the transfer of liquids during the second round of fingernail application.

While particle counts during most of the nail application process were not substantially different from background, particle counts were noticeably higher when full sets of finished nails were being filed. The most substantial particle difference between background and nail application was that particle sizes were larger (5 to 10 microns) during the nail application.

PBZ air sampling results indicated that exposure to benzoyl peroxide, total dust, and respirable dust was low. Exposure to benzoyl peroxide was below the sampling and analytical limit of detection ($<0.1 \mu\text{g}/\text{m}^3$). Exposures to total and respirable dust were all below 0.06 mg/m^3 . These results are consistent with other NIOSH studies that have found very low exposure to all artificial nail products except for ethyl methacrylate.^(1,6,7)

After the New Manicure Table

Five cosmetology students using the new table were exposed to ethyl methacrylate concentrations ranging from non-detectable to 0.16 ppm (Table II).

Capture velocities of the LEV system, measured at about one inch above each station, ranged from 125 to 150 feet per minute. Smoke tube observations indicated effective capture zones up to 10 inches above each station at the time of the NIOSH visit.

TABLE I
Exposure to ethyl methacrylate without LEV

Student			
Location	Sample time (minutes)	Sample volume (L)	Ethyl methacrylate (ppm)
#1	101	5.1	9
#2	97	9.7	11
#3	299	30	1.0
#4	120	6.0	1.8

TABLE II
Exposure to ethyl methacrylate with LEV

Student location	Sample time (minutes)	Sample volume (L)	Ethyl methacrylate (ppm)
Station 1	87	4.4	0.13
Station 2	110	5.6	<0.03
Station 3	82	4.1	0.13
Station 4	99	5.0	<0.03
Station 5	80	4.0	0.16

After one year of operation, examination of the LEV system found no settled material in the ducts. This indicates that the designed duct velocity of 1500 fpm is adequate for this system.

Conclusion

The new manicure work table was effective in reducing exposure to ethyl methacrylate among cosmetology students. Smoke tube observations showed that the LEV system effectively kept contaminants out of the manicurists' breathing zones. The air sampling results obtained from before and after the LEV system was installed are not directly comparable due to differences in the skill levels of the students and the number of nails they applied during air sampling. Nevertheless, the results indicate a considerable reduction of exposure to ethyl methacrylate among students using the new LEV system. Exposures to other contaminants (e.g. acrylic fingernail dust) were also likely to be greatly reduced.

In schools or workplaces where multiple sets of artificial nails may need to be applied simultaneously, construction of a multiple work-station manicure work table is probably more cost effective than installing and modifying multiple units of commercially available single-station manicure tables.

Recommendations

NIOSH recommended that any changes in the manicure work stations should probably focus on improving the

comfort and vision of the manicurists. Some of the students' safety glasses were found to be badly scratched, resulting in poor vision. Applying artificial nails requires a great deal of visual acuity and some of the students were having problems that caused them to either bend down closely to the customers' hands, or pull the customers' hands up closer to see them more clearly. This could cause additional exposure if the hand is pulled outside the capture zone of the LEV system. NIOSH recommended that the following measures be used to keep exposure to manicuring contaminants as low as possible:

- The students should be provided with new safety glasses. Glass lenses are more resistant to scratching than plastic lenses.
- The lighting of the work stations should be improved. This might be best accomplished by providing individual desk lamps at each work station.
- Nail liquid containers should have as small an opening as possible to help reduce evaporation of the product.
- Floor fans, ceiling fans, open windows, or any other possible source of air disturbance around the LEV system should be avoided.
- No eating, drinking, or smoking should be allowed during the application of artificial nails.

- Makeup air may be required for the LEV system to operate properly or to prevent negative pressure areas that may cause drafts. When makeup air is introduced, the outside air intake should enter the building at a distance from the exhausted air so that the exhaust is not reintroduced into the room.

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