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CORRELATION BETWEEN THE PUBLIC ODOR COMPLAINTS AND TOXIC AIR POLLUTANTS

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ABSTRACT

Air Toxics program of the US EPA foresees the measurement of a long list of trace chemicals, mostly organics in the ambient air. This program covers 188 pollutants to be monitored in the ambient air according to protocols elaborated by the states.

In Kentucky Air Toxics Monitoring Protocol, 77 chemicals are measured every 12th day at a number of stations in the western part of the city of Louisville since July 1999. Presently, the number of stations is six. A large number of industries working with petroleum, petrochemicals and synthetic polymers, and chemicals exist in the industrial region of Louisville next to the Ohio River known as Rubbertown. In the city of Louisville, public complaints were stored in a detailed data file covering a period of more than 10 years.

Screening out the available air toxics data set for unimportant (mostly zero or below detection limit) concentrations ended in only 20 air toxics that were found worth for further studies. Between these concentrations and the complaint data, statistical analyses were performed. Pearson coefficients between concentrations of these gases and the public complaints on the measurement day showed only a few of these chemicals have some dependencies at the ambient levels. The air pollutants that were found of special interest for odor complaints in this study were the acrylonitrile, hexane, methyl acetate, MTBE, benzene, toluene and styrene. Of these, the last three might have been affected by traffic flow around the sites. However, only styrene is one of the sites has a notable correlation coefficient with public complaints.

Key Words: odor complaints, odor threshold, toxic air pollutants

1. INTRODUCTION

Odor annoyance is in connection with chemical stimulation of chemoreceptor cells in the olfactory epithelium of the nose (van Ruth, 2001) by the gas molecules. Evaporation from free surfaces, leaks and regulated emissions of odorous gases create problems in urban and industrial areas. In fact most of the pollution problems in air, soil or water bodies are recognized by the public as “odor” (Miedema et al., 2000; Dincer et al., 2004).

Odor perception is largely dependent on the concentration of the odorous compound in the air, its odor threshold and the pleasantness of the odor which may also change with concentration and the period of exposure. On the other hand, co-presence of several odorous gases may create different perceptions in contrast to the levels of perceptions due to each one of the specific components in pure form at the same concentrations.

This study is carried out in order to find out a correlation between public odor complaints and toxic air pollutants. Complaints and air toxics concentrations in the western Louisville area were taken as the two main independent variable groups. The monitoring data for the chemicals has been taken from the West Jefferson County Community Task Force website (http://www.wjcctf.org/air) and from the University of Louisville. Daily average chemical measurements in the air were paired with the public odor complaint data belonging to the same day as a first step.

2. MATERIALS & METHODS

2.1. Site description

Rubbertown is the largest source of industrial emissions in the Jefferson County area with its petrochemical complex located in west part of Louisville. The complex is composed of 11 large chemical plants that account for approximately 20% of the Kentuck's total industry releasing the air toxics and 42% of all industrial air emissions in Jefferson County. Also, the county's largest wastewater facility is located in close proximity to the Rubbertown.

Products made in Rubbertown are widely used in thousands of different products, including acrylic paint; adhesives for labels and stickers; disposable diapers; ink; bottles; plastic toys, PVC and CPVC pipe and fittings, vinyl house siding, etc.

2.2. Monitoring sites, air toxics and odor characteristics

Presently, 77 toxic chemicals are measured every 12^{th} day at 6 different air pollution monitoring stations in the western part of the city of Louisville. In the city, odor complaints coming from urban dwellers are recorded for the last six years. Among the 77 compounds, 20 compounds were found to be important levels. These compounds include hydrocarbons, aromatic compounds (e.g. benzene, toluene and xylenes), and some chlorinated hydrocarbons (chloromethane, methylene chloride). Freons are non-odorous but are studied anyhow, thinking that they may occur together with an odorous substance that is not monitored but coming from the same industrial source. Table 1 lists these compounds as well as their odor threshold values and odor characteristics. Among these 20 compounds, it is seen that 8 compounds including benzene, chlorinated hydrocarbons and some aromatics are USEPA priority pollutants while 15 compounds are in the USEPA hazardous air pollutants (HAPs) list.

As it can be seen from Table 1, information about odor thresholds and odor characteristics are available only for some compounds. In this table both recognition and detection thresholds are submitted as taken from the literature. The detection

threshold is defined as the lowest concentration at which a specified percentage of the panel (usually 50%) detects a stimulus as being different from odor-free blanks. The recognition threshold is the lowest odorant concentration at which a specified percentage of the panel (again, usually 50%) can ascribe a definite character to the odor. In general, recognition thresholds are approximately two to ten times higher than the detection thresholds (Hellman and Small, 1974).

Table 1. Odor thresholds and odor characteristics of monitored VOCs in Lousville (AIHA, 1989; USEPA, 1992)

Compound	Odor Thresholds (ppm)	Odor characteristics
1.2.4-trimethylbenzene	n.i.	
1,3 butadiene	1.6 (D)	Aromatic/rubber
Acetone	100 (R)	Chemical, sweet, pungent
Acrylonitrile*	21.4 (R)	Onion, garlic, pungency
Benzene*	61 (D)	Aromatic/sweet/solvent
Carbon Disulfide	0.21 (R)	Vegetable sulfide/medicinal
Carbon Tetrachloride *	141 (D)	Sweet/dry/cleaner, distinctive
Chloroform*	133 (D)	Sweet/suffocating, characteristic
Chloromethane*	10 (D)	Faint sweet smell
Chloroprene	n.i.	
Freon 12	n.i.	
Freon 22	n.i.	
Freon 113	n.i.	
Hexane	130 (D)	Faint peculiar odor
m,p xylenes*	0.12 (D)	
Methyl acetate	n.i.	
Methylene Chloride*	1.2 (D)	Sweet/ethereal, penetrating
Methyl Ethyl Ketone	2 (D)	Sweet/sharp, acetone like
Methyl Methacrylate	0.21 (D)	Pungent, sulfidy
MTBE*	n.i.	
Styrene	0.033 (D)	Sharp/sweet/aromatic, unpleasant
Toluene*	0.021 (D)	Sour/burnt, benzene-like
Vinyl chloride*	3000 (D)	mild, sweet

n.i.: No information
* : USEPA priority pollutant
+ : recognition threshold

3. RESULTS & DISCUSION

During the monitoring period of air toxics between 1999-2005, totally 424 odor complaints were recorded in the city of Louisville mostly around the monitoring sites. The original size of the complaints data obtained from Air Pollution Control District (APCD) of Louisville Metro administration is 6000. this database is consisted of public complaints and include some Air Pollution Control District (APCD) investigation reports (http://www.apcd.org). Numbers of usable complaint

reports belonging to the air toxics on the sampling days at the six monitoring sites have been reduced to 53 for Site I, 76 for Site C, 75 for Site A, 74 for Site E, 74 for Site F and 72 for Site M after pairing the datasets.

In order to find out a correlation between the odor complaints and air toxics concentrations, Pearson statistical analyses were performed. The Pearson coefficients of each air pollutant at the monitoring sites and the corresponding number of complaints were found and presented in Table 2.

Table 2. Pearson coefficients between the number of complaints and pollutant concentrations

Pollutant	Site I	Site C	Site A	Site E	Site F	Site M
1.2.4-trimethylbenzene	*	*	*	*	*	*
1,3 butadiene	0.12	*	0.17	*	*	*
Acetone	*	*	*	0.14	*	*
Acrylonitrile	*	*	**0.29**	*	**0.25**	*
Benzene	*	*	**0.29**	*	*	*
Carbon Disulfide	*	*	**0.24**	*	**0.25**	*
Carbon Tetrachloride	**0.24**	*	*	0.12	*	*
Chloroform	*	*	*	*	**0.29**	*
Chloromethane	**0.23**	*	*	*	*	*
Chloroprene	*	*	*	**0.20**	*	*
Freon 12	*	*	*	0.12	*	*
Freon 22	*	*	*	**0.30**	*	*
Freon 113	0.18	*	*	0.13	*	*
Hexane	*	*	**0.32**	*	*	*
m,p xylene	*	*	**0.23**	*	0.10	*
Methyl acetate	0.12	*	*	*	**0.46**	*
Methylene Chloride	*	*	*	0.12	*	*
Methyl Ethyl Ketone	*	*	*	*	**0.23**	*
Methyl Methacrylate	*	*	*	-	*	*
MTBE	0.12	*	*	**0.23**	**0.34**	**0.28**
Styrene	*	*	*	-	*	**0.54**
Toluene	**0.43**	*	*	-	*	0.10
Vinyl chloride	**0.23**	*	**0.23**	-	0.13	0.13

* no correlation
- insufficient concentration data at the monitoring site

In Table 2, statistical dependencies between odor complaints and air toxic measurements for the compounds are shown in bold. The Pearson coefficient values for the correlations suggest that 20-54% of the variance in odor complaints can be explained by some of the air toxic levels in the city. All of these compounds are in the USEPA hazardous air pollutants (HAPs) list. These air toxics or any other compound that was not monitored routinely but coming from similar sources should be controlled for the maintenance of a better life quality for the urban dwellers.

4. CONCLUSIONS

Odor is a human sensory experience usually caused by mixtures of compounds. The human nose is a highly sensitive instrument capable of detection even at extremely low concentrations of certain chemicals. Very low concentrations of an odorous substance can produce an odor sensation indicating the presence of odorous vapors and gases depending on its odor threshold.

Studies which have reviewed community odor and health problems caused by air toxics reveal that a variety of nuisance records and public complaints are related to exposure of odorants. In many cases, this occurs even though the identified odorant is way below the thresholds for toxicity. This indicates that further studies are necessary to define the link between odor complaints and chemical exposure of air toxics. This requires more controlled studies for the odor annoyance part than the public complaint records in this study.

In this study the public complaints database has been evaluated to pair the odor sensing with the concentrations of toxic substances in the air. The 12 day intermittency of the air toxic determination caused several losses in pairing the datasets. Also the random and subjective character of the public complaints data created rather low correlation coefficients between the concentrations versus the number of complaints on a specific day.

Yet, the rather weak correlations for a few airborne gases such as styrene, MTBE, methyl acetate, hexane and toluene at the stations near the petroleum industries could be interpreted as the important starting points for more controlled studies. However, it must also noted that some of these compounds also might have originated from heavy traffic lanes around the monitoring sites.

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