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A Study on Risk Assessment of Benzene as one of the VOCs Air Pollution

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ABSTRACT: Weather and climate have considerable influence on the concentration of air pollutants such as particles and gases. The range and concentration of these particles and gases are very dependent on prevailing weather conditions and air currents. This research concentrates on health effects of benzene, one of the air pollutants of Tehran, as a major city. The concentration of benzene emission to air due to deficient oxidation of fuel in vehicles or evaporation of gasoline at gas stations and the gas tanks of the automobiles, at market station in Tehran shows significantly high values than EPA guidelines that is used in Iran. The result of calculation of risk assessment was 3.6×10^{-5} (3.6 cancers per 100000).

Key words: Benzene, Air Pollution, Risk Assessment, Tehran, Iran.

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INTRODUCTION

Information and its management are moving towards the centre of development thinking and development action. Nowhere this is truer than in the environmental sector. Policy-makers, planners, managers, and activists are calling for greater investment in the generation of data and information, and its subsequent use (Ballantyne, 1995). Despite legal or moral requirements to manage the environment sustainably, human is now changing the environment at such a rate scale that risks to society from ignorance, inappropriate policy directives and action are more pervasive, costly and potentially catastrophic than ever before (Vitousek, *et al.*, 1997). Given the increasing speed and breadth of human interactions with the environment, it is of little surprise that processes that allow us to understand and manage these are becoming increasingly information intensive (Carley, 1994). As problems become more complex involving spatially and temporally dynamic environmental, social and economic systems, gathering and analyzing more and better quality information in order to identify problems and create knowledge basis from which strategies, policies, programmes and projects can be developed and implemented is becoming a complicated imperative (Russell and Powell, 1996; Vitoseuk, *et al.*, 1997). While not a panacea in itself, since political agendas, governance mechanisms and individual and institutional capacities play a large part in public policy processes, access to the right sort of information and the ability to comprehend it are critical in the development of policy to manage the effects of human activities (Crewe and Young, 2002). Knowledge and information are now widely recognized and promoted as key features of economic growth, economic competitiveness and sustainable development (Lundvall and Johnson, 1994; French, 200). Indeed, throughout the world considerable effort is being directed toward the development of institutional and individual capacity and expertise for generating, managing and utilizing economically, socially and environmentally valuable information and knowledge. An important feature of the emerging discourse on sustainable development and the knowledge society is the emphasis on data quality and the development of procedures and processes to quantify data accuracy (Zoller and Scholz, 2004). Regardingless of the data type, if its quality is unknown then the accuracy of the data is in question and its usefulness compromised. For example, to have confidence in data that shows spatial or temporal variability in air quality, instrument or processing errors must identified and quantified and where possible reduced. It is for reasons of data quality and interpretation that there is increasing emphasis among decision-makers, interest groups and citizens alike for science-based environmental policy and more direct involvement of scientists in the policy arena (Steel, *et al.*, 2004). Vehicle emissions contain chemicals and particulate matter that are toxic to most life forms, including humans, at certain exposure concentrations and frequencies. Air pollution and its impacts on human health and natural ecosystems is a major environmental problem worldwide (Seinfeld, 1986) and in Iran. Emissions of main atmospheric pollutants result from anthropogenic and natural activities and have short and long-term effects on the environment. These include the acidification problem, air quality degradation, global warming, climate change, damage and soiling of buildings and other structures, stratospheric ozone depletion, human and ecosystem exposure to hazardous substances.

We can now say with a very high degree of certainty that as this century proceeds, climate change will have an increasing impact on human society. Also it is known that there is a very strong trend towards an increasing proportion of the world's population living in cities. Thus many of the impacts of climate change will be experienced through the ways in which they affect the lives of our urban population. There are at least three good reasons why it is useful to think about the issue of climate change specifically in terms of how it relates to cities: 1) Over 75%of energy consumption is directly related to cities, 2) In many cases cities are highly vulnerable to the impacts of climate change, 3) Cities have a great potential to instigate novel and easily replicable solutions.

Population Growth and industry development leads to different environmental pollutions which is the main problem of most societies. Most countries established special legislations as a standard for permitted amount of pollutant emotions, and tried to reduce the pollutions so that in an amount below the permitted, there would be no harm for human health and environment.

Worldwide, the increasing deterioration in urban air quality due to emissions of air pollutants has created the need for greater capacity in air quality management and more comprehensive knowledge about the sources and spatial and temporal distribution of vehicle emissions, without which impact studies and subsequent mitigation policy cannot be formulated. In recent years, one area that has been increasingly highlighted in the international air quality literature, as a critical to air quality policy decisions is validated emissions data. Understanding and qualifying emissions of air pollutant is the first, essential step in understanding, controlling and mitigating air pollution. Source emissions data (i.e., chemical and physical data) is a key pre-requisite to accurate impact analyses, forecasting, and the development of effective abatement strategies.

MATERIALS & METHODS

According to NIOSH (National Institution of Occupation on Safety and Health) and OSHA (Occupational Exposure Limit), one of the best methods for sampling of organic compounds is the use of absorbents. In order to sample the benzene concentration as one of VOCs, 226-01 activated carbon absorbent was used. Sampling was done in different steps. Air passing through SIBATA mini sampler was set on 200 mL/min. The end sides of absorbent tube were broken so that the air enter and exit easily and were connected to pomp. In order to have regular air flow, electricity was used in place of battery. Once the sampling was over the end sides of absorbent tube were closed using a plastic cap. Absorbent tube was kept in the refrigerator for later tests. CS2 dissolver was used to separate aromatic compounds from the surface of active carbon, and then was injected to gas chromatograph instrument. The data used in this research were obtained from Tehran Air Quality Control Company.

RESULTS & DISCUSSIONS

Average benzene concentration was 0.1 mg/m^3 in ambient air at some stations of Tehran, which is high comparing to the United States Environmental Protection Agency (U.S.EPA) standard. EPA has documented Reference Concentration for Chronic Inhalation Exposure (RFCs) and Reference Dose for Chronic Oral

Exposures (RFDs) at Integrated Risk Information System (IRIS). Since this research was done on adverse effect of benzene inhalation, so RFD was not applicable. Last revised in 2003 the Inhalation Reference Concentration of benzene is 0.03 mg/m^3 (U.S. EPA, 2003). A review of the relevant literature suggests absorption efficiencies of 50% and 100% for inhalation and oral routes of exposure, respectively. Adverse effects of benzene on human's health depend on its concentration and exposure time. In order to determine adverse effects of benzene, cancer induced risk of benzene inhalation were determined for some stations habitant and compared to U.S EPA RFC standard. Benzene is classified as a "known" human carcinogen (Category A) under the Risk Assessment Guidelines of 1986. Under the proposed revised Carcinogen Risk Assessment Guidelines (U.S. EPA, 1992), it is characterized as a known human carcinogen for all routes of exposure based upon convincing human evidences as well as supporting evidence from animal studies (U.S. EPA, 1998; ATSDR, 1997) which indicates there are adequate epidemiologic evidence to prove the relation of exposure to benzene and cause cancer both on human health studies and laboratory animals. In this paper, average life time of a male adult was considered as 70 years. Also Potency Factor of benzene for inhalation is 0.029. The formula of calculation for lifetime risk is:

Table1: Benzene Concentration in the Air of some stations (mg/m^3)

Stations	Concentration
1	0.143
2	0.536
3	0.104
4	0.035
5	0.084
6	0.051
7	0.016
8	0.018
9	0.018
10	0.011

Figure 1 illustrates the difference among benzene concentration measurements at Various stations.

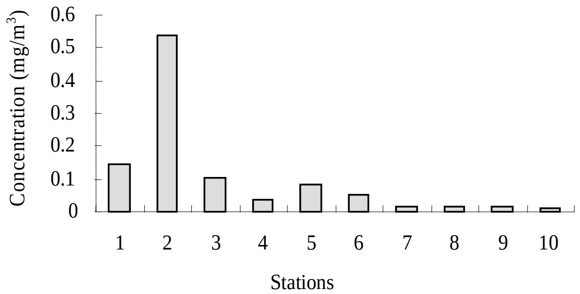

Fig.1. Air Benzene Concentration at various Stations (mg/m^3)

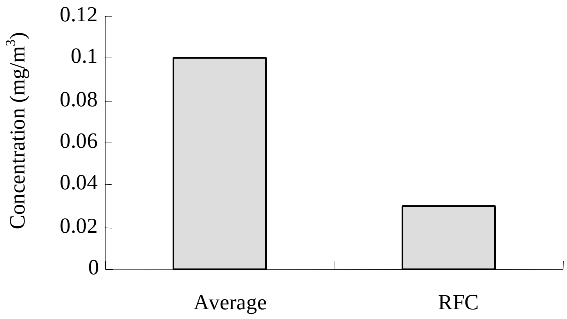

Fig.2. Average Air Benzene concentration compared with RFC

Life time Risk = Average daily Dose × Potency Factor

Then, in order to determine Chronic Daily Intake (CDI) following formula was used:

CDI (mg/kg/day) = Total dose (mg) / [(Body weigh (kg) × Lifetime (days)]
Total dose=Pollutant concentration×Intake rate Exposure time×Absorbent rate of toxic substance

According to measurements at some stations, benzene concentrations of the air were determined and are summarized in Table 1.

Average benzene concentration in the air at stations was 0.1mg/m^3 that shows considerable difference to United States Environmental Protection Agency RFC and is shown in Fig. 2.

In order to calculate the risk of benzene inhalation by station habitants and workers around the stations, whom work some part of a day and breathe polluted air, following conditions were considered:
Body Weigh (of a male adult worker): 70 kg
Exposure time: 5 days per week, 50 weeks per year for 20 years
The worker breaths deep 2 hours (1.5 m^3 air per hour) and in other 6 hours (1m^3 air per hour)
Potency Factor of Benzene (inhalation): 0.029 $(mg/kg/day)^{-1}$
Benzene Absorption Rate (of inhalation): 50%
Average Benzene Concentration rate of stations: 0.1mg/m^3
Risk Calculation:

Daily Intake Rate:
$1.5\ m^3/hr \times 2\ hr \times 1\ m^3/hr \times 6\ hr = 9\ m^3/hr$
Total Dose:
$9\ m^3/day \times 5\ day/week \times 50\ week/year \times 20\ year \times 0.1 mg/m^3 \times 0.5 = 2250\ mg$
Chronic Daily Intake (CDI):
$2250\ mg / (70kg \times 70year \times 365day/year) = 0.001258\ mg/kg/day$
Risk = CDI × PF
$Risk = 0.001258\ mg/kg/day \times 0.029\ (mg/kg/day)^{-1} = 0.000036482 = 3.6 \times 10^{-5}$
Thus, risk for the workers is 3.6 people per 100000 people.
And RFC calculations:
Total Dose: 675 mg
Chronic daily Intake: 0.000377 mg/kg/day
Risk = 0.000011
In other word, risk for the workers must not exceed 1.1 people per 100000 people.

As the Figures illustrate, it can be concluded that EPA standards is not adequate for the condition of Tehran air quality; so we suggest to modify the standards for air quality of Tehran and beside carry out more precise researches to over come the deficiencies of present work. Emissions of air pollutants especially from vehicles are still to be acknowledged as a serious economic concern primarily because data of sufficient quantity and quality are not available. The limited development of effective air quality policy is not surprising, since policy formulation and implementation always lags behind problem recognition. As is the case with environmental problems that result from incremental change and require specific and costly technologies to measure, developing policy to address their impacts is usually constrained by a lack of political attention, support and consensus, until the problem is well advanced and well defined. In the first instance this relies on the generation and distribution of trusted environmental information. In many places, policymakers are demanding access to better quality information resources, better integrative policy processes and assistance from information systems managers (Ballantyne, 1995; Fisher, 2002; Sliggers, 2004).

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