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Polynuclear Aromatic Hydrocarbons (PAHS) and Hazardous Air Pollutants (Hap) Emissions from Open Burning of Used (Scrap) Tires as Fuel for Dressing of Meat in Benue State Nigeria:A Serious Threat to Human Health

BEETSEH C. I. AND ONUM D. E.
Department of Chemistry University of Agriculture Makurdi

Abstract
Emissions from combustion of scrap tires used as fuel for meat dressing were detected with the use of hand held gas detector meter, the RI VOC Meter extremely sensitive and capable of detecting contamination at 0.1ppm levels..The substances detected at weekly intervals for 3 weeks were carbon monoxide 15 minutes short term exposure limits STEL was a maximum of 100 ppm sulfur dioxide15 minutes STEL 7 ppm styrene STEL exposure 130 ppm butadiene 15 minutes STEL exposure 12 ppm furans 15 minutes l STEL exposure 8.1 ppm and other waste materials that could not be detected and those usually often left on site. These can cause contamination directly and indirectly to the meat source, to the river waters nearby as well as the land on which the tires are combusted . This scenario of cleaning of animals skins by roasting preparatory for sales in abattoirs is what is prevalent in Benue State Nigeria and its environs Emissions from an open tire fire can represent significant acute (short-term) and chronic (long-term) health hazard to those living nearby depending on the length and degree of exposure, these health effects could include irritation of the skin, eyes, and mucous membranes, respiratory effects, central nervous system depression, and even cancer..
Keywords: Durability, flexible , Bi-products ,Short-term , Emissions.

Introduction

According to U.S. EPA (October 1997) emissions from open burning of used (scrap) tires is a serious threat to human health , contains significant amounts of the following known human carcinogens: benzene, 1,3-butadiene, . "criteria" pollutants, such as particulates, carbon monoxide (CO), sulfur oxides (SO2), oxides of nitrogen , and volatile organic compounds (VOCs). They also include "non-criteria" hazardous air pollutants (HAPs), polynuclear aromatic hydrocarbons (PAHs), dioxins, furans, hydrogen chloride, benzene, polychlorinated biphenyls (PCBs); and metals such as arsenic, cadmium, nickel, zinc, mercury, chromium, and vanadium. This can also cause groundwater contamination.

British Britannica encyclopedia [2010] defines a tire as a strong flexibility rubber casting attached to the rim of a wheel providing a gripping surface for traction and serving as a cushion for the wheel of a moving vehicle. Pneumatic tires are now used for almost all free-moving vehicles because of their greater cushioning ability they are reinforced by layers of relatively inextensible cords that hold the air pressure and restrict deformation and growth of the tire during use. Cord materials have high stiffness, resistance to repeated flexing, high strength-to-weight ratio, and good adhesion to rubber also made of cotton, rayon, nylon, polyester, glass, hard and stiff synthetic fibre . The liner, which is intended to minimize the loss of air, is usually made of butyl rubber because that material has a low permeability to gas. Sidewalls, on the other hand, must resist scraping, flexing, and attack by ozone in the air. A typical formulation for sidewalls (measured in parts by weight of each ingredient) would be 50 parts natural rubber (for resistance to heat buildup), 50 parts butadiene rubber (for abrasion resistance), and 50 parts carbon black (for reinforcement which can be burned directly to produce power or condensed into an oily type liquid, generally used as a fuel.

Tires are typically not prone to self-ignition as a tire must be heated to at least 400 °C for a period of several minutes prior to ignition. Therefore, tire fires are normally the result of arson or improper manipulation with open fire. However, it is possible for tires to spontaneously combust, especially in the case of shredded tires or tire "crumbs". Extinguishing tire fires is difficult. The fire releases a dark, thick smoke that contains carbon monoxide, sulfur dioxide, and products of butadiene and styrene. A specific danger is posed by dripping hot fluids (which may cause burns) they have a low thermal conductivity, and are difficult to cool down. Moreover, they frequently burn inside even if they are extinguished from outside, and easily reignite when hot. One possibility is to cover the fire with soil, reducing the supply of oxygen and exhaust of the thick dark toxic smoke. After extinguishing and cooling down (which may last several days), the site must be surveyed and toxic chemicals neutralized. The biproducts of tyre burning are butadiene , styrene, chlorine ,dioxins , furans (extremely toxic chemicals) and ‘’none-criteria” hazardous air pollutants HAP such as heavy metals . These are very small particulate matters that can easily enter the circulatory system of our body to cause various kinds of health hazards. Dioxins and furans released during the process of burning are very potent carcinogens and

one of the most harmful gases in the world. Carbon monoxide is a colorless, odorless, tasteless and toxic gas produced also as by-products of combustion. It inhibits the blood's ability to carry oxygen to body tissues including vital organs such as the heart and brain. When inhaled, it combines with the oxygen carrying hemoglobin, which is no longer available for transporting oxygen.(Buckly N A, Isbister G K, Stokes B, 2005**).**

1. Byproducts of tire burning.

The following are detectable in the smoke of burning tires among others and are substances of public health concern J. Levy (2007)

1.1 Carbon monoxide.

Carbon monoxide is a gas that comes from the burning of tires or fossil fuels, cannot be seen or smelled , emissions are higher when engines are not tuned properly, and when fuel is not completely burned. Carbon monoxide makes it hard for body parts to get the oxygen they need to run correctly.

When the air or oxygen supply is restricted, incomplete combustion to carbon monoxide, CO, occurs.

$2C(s) + O_2(g) \text{---------- } \rightarrow 2CO(g)$

This reaction is important. In industry, air is blown through hot coke. The resulting gas is called producer gas and is a mixture of carbon monoxide (25%), carbon dioxide (4%), nitrogen (70%), and traces of hydrogen (H_2), methane (CH_4), and oxygen (O_2)

Exposure to carbon monoxide makes people feel dizzy and tired and gives them headaches. In high concentrations it is fatal. Elderly people with heart disease are hospitalized more often when they are exposed to higher amounts of carbon monoxide. On average, exposures at 100 ppm or greater is dangerous to human health. Prockop LD, Chichkova RI (Nov 2007 .)

1.2 Nitrogen dioxide.

A reddish-brown gas that comes from the burning of fossil fuels , general bush, logs and old tyres. It has a strong smell at high levels. Nitrogen dioxide mostly comes from power (electricity) plants and car exhausts. It is formed in two ways—when nitrogen in the fuel is burned, or when nitrogen in the air reacts with oxygen at very high temperatures.

NO2 exists in equilibrium with the colourless gas dinitrogen tetroxide

(N2O4):2 NO2========== N2O4

Hydrolysis

It hydrolyses to give nitric acid and nitrous acid:

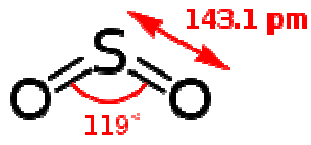
2 NO2/N2O4 + H2O---------- →HNO2 + HNO3

This reaction is one step in the Ostwald process for the industrial production of nitric acid from ammonia. Nitric acid decomposes slowly to nitrogen dioxide, which confers the characteristic yellow color of most samples of this acid:

4 HNO3 ---------- → 4 NO2 + 2 H2O + O2

.Nitrogen dioxide is also produced by atmospheric nuclear tests, and is responsible for the reddish colour of mushroom clouds.

1.3 Sulfur dioxide.

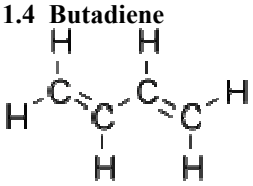


A corrosive gas that cannot be seen or smelled at low levels but can have a "rotten egg" smell at high levels. Sulfur dioxide mostly comes from the burning of coal , logs , bush , old tyres or oil in power plants. It also comes from factories that make chemicals, paper, or fuel. Like nitrogen dioxide, sulfur dioxide reacts in the atmosphere to form acid rain and particles. It is one of the few common acidic yet reducing gases. It turns moist litmus pink (being acidic), then white (due to its bleaching effect). It may be identified by bubbling it through a dichromate solution, turning the solution from orange to green (Cr^{3+} (aq)). It can also reduce ferric ions to ferrous:

$2Fe^{3+} + SO_2 + 2H_2O \text{ ----------} \rightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$

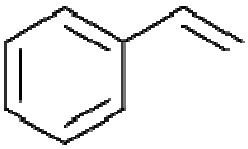
Sulfur dioxide exposure can affect people who have asthma or emphysema by making it more difficult for them to breathe. It can also irritate people's eyes, noses, and throats. Sulfur dioxide can harm trees and crops, damage buildings, and make it harder for people to see long distances.

1.4 Butadiene



Butadiene is a chemical made from the processing of petroleum. It is a colorless gas with a mild gasoline-like ordor. About 75% of the manufactured butadiene is used to make synthetic rubber. While polybutadiene itself is a very soft, almost liquid material, copolymers prepared from mixtures of butadiene with styrene and/or acrylonitrile, such as acrylonitrile butadiene styrene (ABS), acrylonitrile butadiene (NBR) and styrene-butadiene (SBR) are tough and/or elastic. SBR is the material most commonly used for the production of automobile tires Most of the health effects of butadiene come from breathing very high levels for a short-term , it can cause central nervous system damage, blurred vision, nausea, fatigue, headache, increased blood pressure and pulse rate and unconsciousness. Breathing lower levels have shown an increase in heart and lung damage. Animal studies show that breathing butadiene during pregnancy can increase the number of birth defects Landrigan, PJ (1990).

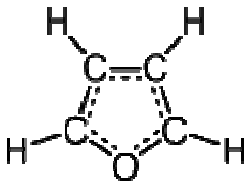
1. 5 Styrene



Styrene is primarily used in the production of polystyrene plastic andresin. Acute (short-term) exposure to styrene in humans results in mucous membrane and eye irritation and gastrointestinal effects. Chronic (long-term) exposure to styrene inhuman result in effects on the central nervous system [CNC),such as headache, fatigue, weakness and depression, CSN dysfunction, hearing loss and peripheral neuropathy. Animal studies have reported effect on the CNS, liver, kidney and eye's and nasal irritation from inhalation exposure to styrene. Liver, blood, kidney and stomach effect have been observed in animals following chronic oral exposure.

Table 1 U.S. Environmental Protection Agency (EPA) Hazard Summary - Styrene: exposure Limits

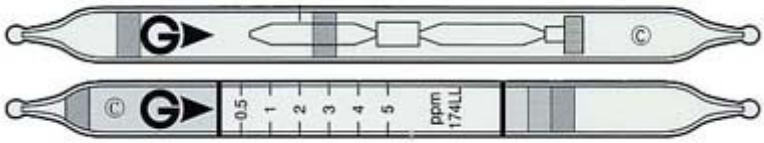
Exposure Limit	Limit Values
OSHA Permissible Exposure Limit (PEL) – General Industry	**100 ppm TWA 200 ppm Ceiling**
OSHA PEL – Construction Industry	**100 ppm (420 mg/m^3) Ceiling**
OSHA PEL – Shipyard	**100 ppm (420 mg/m^3) TWA**
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)	**50 ppm (215 mg/m^3) TWA 100 ppm (425 mg/m^3) STEL**
American Conference of Governmental Industrial Hygienists (ACGIH	**20 ppm TWA 40 ppm STEL**
CAL/OSHA PELs	**50 ppm (215 mg/m^3) TWA 500 ppm Ceiling 100 ppm (425 mg/m^3) STEL**



1.6 Furans 5-oxacyclopenta-1,3-diene)
are toxic substances produced as by-products of various industrial process, including the combustion of waste containing polyvinyl chloride (e.g. plastics). This happens particularly when waste is incinerated at temperatures lower than 800 degree Celsius or when the waste is not completely incinerated. Long-term, low level exposure of humans to furans may lead to the impairment of the development of the nervous system, the endocrine system and the reproductive function. Short-term, high level exposure of animals to furans has resulted in several types of cancer.
Katritzky, Alan R. (2003). . *Arkivoc* 2004

2 . 0 Emmisions Monitoring

The RI VOC meter was used for detection of emissions by a technology called Photo-Ionization Detection (PID).



(detector tubes are thin glass tubes with calibration scales printed on them which allows you to directly read concentrations of the substance gases or vapors to be measured. The tubes are hermetically sealed. All detector tubes undergo stringent quality control with each substance independently tested and calibrated. The air is drawn into the detection chamber by a pump. UV light is used to ionize the molecule bonds of all the substances present. These ions are electrically conductive and the meter detects the current that flows. The concentration of various substances present will be registered on the screen calibrated in ppm) . The meter was read continuously for 8 hours as stipulated by U.S Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) per 8-hour time-weighted average (TWA) , as well as the American Conference of Governmental Industrial Hygienist (ACGIH) Threshold Limit Values (TLVs and STEL.

3.0 Results

CARBON MONOXIDE CO

WEEKLY INTERVALS	15 MIN EXPOSURE PPM STEL	8 HOUR EXPOSURE PPM TLVs	8 HOUR EXPOSURE PPM TWA
1	90	50	20
2	100	60	30
3	90	40	30

SULFUR DIOXIDE

WEEKLY INTERVALS	15 MIN EXPOSURE PPM STEL	8 HOUR EXPOSURE PPM TLVs	8 HOUR EXPOSURE PPM TWA
1	5	3	2
2	7	5	3
3	6	4	3

STYRENE

WEEKLY INTERVALS	15 MIN EXPOSURE PPM STEL	8 HOUR EXPOSURE PPM TLVs	8 HOUR EXPOSURE PPM TWA
1	120	100	30
2	110	90	20
3	130	110	20

BUTADIENE

WEEKLY INTERVALS	15 MIN EXPOSURE PPM STEL	8 HOUR EXPOSURE PPM TLVs	8 HOUR EXPOSURE PPM TWA
1	10	4	2
2	12	6	2
3	10	5	3

FURANS

WEEKLY INTERVALS	15 MIN EXPOSURE PPM STEL	8 HOUR EXPOSURE PPM TLVs	8 HOUR EXPOSURE PPM TWA
1	7.5	2.5	1.7
2	8.7	3.2	2.1
3	9.1	3.1	1.9

4 .0 Observation and Discussion

Many of these compounds are at relatively low levels despite their measurement in open tire fires , these are furans , butadiene and sulfur dioxide . Carbon monoxide and styrene have shown significant emissions compared to the others . Individually they exhibit similar toxic characteristics , can represent significant acute (short-term) and chronic (long-term) health hazards to the tire fire users and nearby residents. Depending on the length and degree of exposure, these health effects could include irritation of the skin, eyes, and mucous membranes, respiratory effects, central nervous system depression, and cancer.

5 .0 Conclusion

The dangers of burning old tires as fuel allows substances like furans, sulfur dioxide SO_2 , Carbon Monoxide CO butadiene and styrene and many others which are either polynuclear aromatic hydrocarbons (PAHs) or hazardous air pollutants (HAPs) to get to the atmosphere exposing the meat products to various levels of toxicity as shown above.

Tire fires have severe impacts on air, water and soil. When burned in the open, they combusts incompletely and emit air pollutants including particulates, carbon monoxide, sulphur oxides, furans and others . These fires pollutants can cause short and long term health problems like skin and eye irritation, cancer, depression and nervous system ailments.

6 . Recommendations

Exposure limits for hazardous substances are set to limit exposure to people, the environment and to control exposure in places of work. Exposure limits are enforceable controls applied to approved substances. These must be displayed in open places in order to alert the public about the consequences . Firefighters and others working near a large tire fire should be equipped with respirators and dermal protection. Unprotected exposure to the visible smoke plume should be avoided.

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