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Quantitative and qualitative measurement of carbon compounds in dust emitted in the work environment for electrical insulators production factory

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Abstract: A quantitative and qualitative determination of the pollutants emitted within the work environment, including dust and its components of organic and inorganic carbon was conducted in one of the factories of electrical insulators production.

A dust sampler and 5 micron diameter filters were used and prepared for analysis in the carbon analyzer of organic and inorganic components.

The result of the analysis shows the dust emissions concentrations of organic carbon (OC) in the mechanical lathing unit for cutting Phenolic Carbon Insulators (PCI) is (244.0 µg.m^{-3}) and the lowest inorganic emissions (59.0 µg.m^{-3}). The emission of manual filings from inorganic carbon dust is the highest concentration (916.0 µg.m^{-3}) and the lowest organic carbon is (4.0 µg. m^{-3}).

The highest level for total inorganic carbon (TIC) in the manual unit fillings is (440.0 mg.m^{-3}. .8hr^{-1}) and the lowest TIC concentration is (2.8 mg.m^{-3}. .8hr-1) in the mechanical lathing unit for phenolic carbon. While the highest level for OC in the mechanical lathing unit is (117.0 mg.m^{-3}. .8hr^{-1}) and the lowest OC concentration is (2.0 mg.m^{-3}..8hr^{-1}) in manual and pressing units.

All concentrations of the dust and their components of organic and inorganic carbon are out of standards limitation of the International Standards Units (ISU).

Exposure to these emissions during an actual working time of 8 hours a day requires commitments to individual and group safety measures to maintain workers safety.

Keywords: Phenolic Carbon Insulators (PCI), Dust emission, Work environment, Organic carbon (OC), Inorganic carbon (IOC).

القياس الكمي والنوعي لمركبات الكربون في الغبار المنبعث في بيئة العمل لمصنع إنتاج العوازل الكهربائية

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الملخص: تم إجراء تحديد كمي ونوعي للملوثات المنبعثة في بيئة العمل، بما في ذلك الغبار ومكوناته من الكربون العضوي وغير العضوي في أحد مصانع إنتاج العوازل الكهربائية.

استخدمت مرشحات قطرها 5 ميكرون لتجميع الغبار المنبعث وتحضيرها في محلل الكربون للمكونات العضوية وغير العضوية.

نتائج التحليل أظهرت وجود نسبة عالية من انبعاث الغبار ومكوناته من انبعاثات الكربون العضوية وغير العضوية في وقت الذروة لجميع أماكن العمل في وحدات مختارة. حيث بلغت الإيداعات (244.0 مايكروغرام.م$^{-3}$) وأقل قراءة (59.0 مايكروغرام.م$^{-3}$).

الإيداعات اليدوية سجلت تراكيز عالية من الكربون العضوي حيث بلغت (916.0 مايكروغرام.م$^{-3}$) وأقل قيمة (4.0 مايكروغرام.م$^{-3}$).

كانت أعلى تراكيز للكاربون غير العضوي الكلي باستخدام الايداع اليدوي خلال يوم كامل للعمل /8 ساعات (440.0 ملي غرام.متر$^{-1}$ .8 ساعة$^{-1}$) وأقل تركيز (2.8 ملي غرام.متر$^{-1}$ .8 ساعة$^{-1}$) . وكان اعلى تركيز للكاربون العضوي (117.0 ملي غرام.متر$^{-1}$ .8 ساعة$^{-1}$) وأقل تركيز (2.0 ملي غرام.متر$^{-1}$ .8 ساعة$^{-1}$).خلال الإيداعات اليدوية والآلية.

جميع تركيزات الغبار ومكوناته من الكربون العضوي وغير العضوي هي خارج حدود المعايير القياسية الدولية.

التعرض لهذه الانبعاثات خلال وقت عمل فعلي قدره 8 ساعات في اليوم يتطلب التزامات بتدابير السلامة الفردية والجماعية للحفاظ على سلامة العاملين.

الكلمات المفتاحية: عوازل الكاربون الفينولية، انبعاث الغبار ، بيئة العمل ، الكاربون العضوي ، كاربون لا عضوي.

1- Introduction

For more than 200 years, chemists have divided carbon compounds into two groups. Those that were isolated from nature (plants or animals) were called organic carbon compounds, while those extracted from a biotic and minerals were inorganics. Compounds are those which contain carbon, although some carbon-containing compounds are traditionally regarded inorganic. Over the century ago, the accurate classification of inorganic and. organic compounds has become less important, primarily because the majority of known carbon compounds are synthetic and not of natural source. [1]

Air pollution is polluted of the indoor or outdoor environment by any chemical, physical or biological agents that modify the natural characteristics of the atmosphere. Household fuel combustion, motor vehicles, industrial facilities and forest fires are common sources of air pollution. Pollutants of major public health concern consist of particulate matter, carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) [2].

This indoor environment is often contaminated with differences air pollutants; the concentration of these pollutants may reach high peak levels due to the small spatial size. Indoor air in cities has been reported to be as much as 100 times more polluted than that outdoors [3] .Typical average concentration of organic carbon (OC) in the atmosphere are in the range of 1 $\mu g.m^{-3}$ in clean places to 10 $\mu g.m^{-3}$ in polluted areas, whereas peak concentrations might reach 50 $\mu g.m^{-3}$ during biomass burning accidences. Elemental carbon concentrations in clean areas are typically around of 1 $\mu g.m^{-3}$, in polluted areas they might exceed 5 $\mu g.m^{-3}$ [4]. Small dust particles remain stuck in the air for a long time by the viscosity or resistance of the air, which resists any force to settle the plankton and the particles. Minutes are separated from the air over time, and the techniques used reduce the time required to precipitate, so dust is defined as a diffuse spray with solid minutes [5]. A single spray is composed of many chemical compounds but

chemical analysis is difficult because of the amount of material to be analyzed. One of the successful methods of measurement is the metallic components of single minutes, which are accomplished by using a microelectronic sensor. There are equipment used to collect and analyze dust and gases, including total filter, and cascade impactor [6]. Maximum Desirable Levels (MDL) are those that provide maximum environmental protection and should not be crossed. The WHO includes the protection factor for sensitive plant and animal organisms as well as human health, so the small scale was based on two indicators, Particulate Matter 10 micron diameter (PM10), which is preferred according to the previous specifications is 50 $\mu g.m^{-3}$ for a period of 24 hours in ambient air and 20 $\mu g.m^{-3}$ annual mean. The maximum acceptable level of fine Particulate Matter 2.5 micron diameter (PM2.5) is 25 $\mu g.m^{-3}$ for 24 hours mean and 10 $\mu g.m^{-3}$ [7]. The size of particles is directly linked to their potential for causing health problems. Particles that are 10 µm in diameter or smaller generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. Coarse particles, such as those found near roadways and dusty industries, are larger than 2.5 µm and smaller than 10 µm in diameter [8].

The study aims at quantitative and qualitative determination of the components of dust particles emitted within the work environments due to mechanical activities such as lathing and pressing of organic carbon materials for the production of insulators through the collection and recovery of dust and then the determination of its carbon components.

2- Material and Methods

Source of samples: Four dust samples were withdrawn during the employs working in selective units of the electrical and Phenolic Carbon insulator (PCI) production factory / Baghdad-Iraq .September 2019. Using mechanical lathing, manual filings and pressing methods [6]. Four replicates of samples were collected, weekly intervals for one month at peak time around 10 am. Another four samples were withdrawn for 8 hour work.

Samples analysis: Dust sampler (Air chek, 2000) with air intake at flow rate of 2 L/min for one minute and a 5 micron diameter filter Particulate Matter 5 micron diameter (PM_5) was used for collection the air samples from work environment of the units (Diagram 1). The filter was weighed before and after air collected for each sample using a sensitive analytical balance. Four samples were collected from the same location and the mean weights are taken. The dust loaded filter paper was analyzed for Total Organic Carbon (TOC), Total Inorganic Carbon (TIC) analyzer after the furnace was set at 680 ° C. The mean concentrations ($\mu g.m^{-3}$) of TOC and TIC were calculated for 4 replicates samples per week for one month.

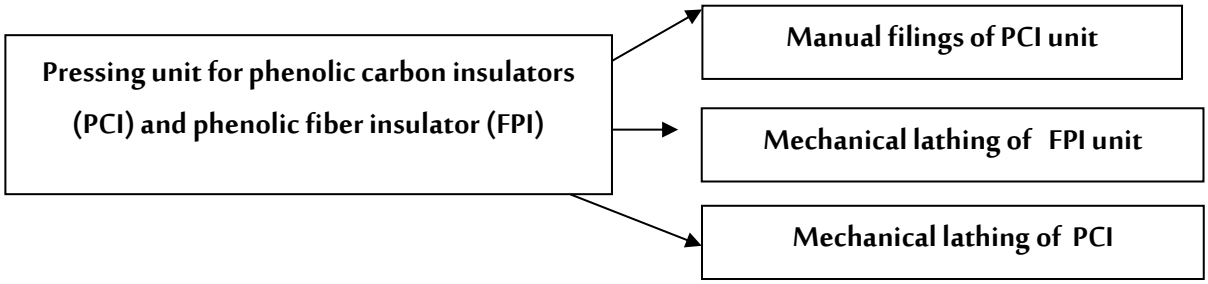

Diagram (1) Units of electrical insulators production factory

3- Results and discussion

Table 1 shows the results of the analysis of Total Inorganic Carbon (TIC) and Organic Carbon (OC) in the dust emissions from the work environment of the lathing and pressing units for the production the electrical insulators factory.

Results reviled the dust emissions concentrations of organic carbon in the mechanical lathing unit for cutting Phenolic Carbon Insulators (PCI) were (244.0 $\mu g.m^{-3)}$ and this result is higher than the International Standards Units (ISU) [9] and the lowest inorganic emissions (59.0 $\mu g.m^{-3}$). The emission of manual filings from inorganic carbon dust is the highest concentration (916.0 $\mu g.m^{-3}$) and the lowest organic carbon is (4.0 $\mu g.m^{-3}$).

The reason for the presence of organic and inorganic dust in all the units is due to the movement of air currents loaded with these pollutants, as well as the inefficiency of dust capture systems in the units, as well as the use of air drafters in the unit of manual filings.

Table (1) Dust emissions analysis (One minute sample) in work environment of insulators production factory.

Sample source (Unit)	Dust (μg/2 L air)*	Total dust ($\mu g.m^{-3}$) **	Dust components ($\mu g.m^{-3}$) **	
			TIC	OC
Mechanical lathing (PCI)***	0.61	363.0	59.0	244.0
Manual filings	1.82	990.0	916.0	4.0
Mechanical lathing (FPI)***	0.5	266.0	166.0	80.0
Pressing	0.21	112.0	88.3	13.7

*Mean concentrations of dust collected by dust sampler for one minute.

**Mean concentrations of 4 replicates for 4 weeks.

***PCI: Phenolic carbon .insulator; FPI: Fiber phenol insulator

Table 2 shows the average concentration of dust ($mg.m^{-3}$) and its components in units within 8 hours. The highest level for TIC in the manual unit fillings is (440.0 $mg.m^{-3.}$ $.8hr^{-1}$) and the lowest TIC

concentration is (2.8 $mg.m^{-3.}.8hr^{-1}$) in the mechanical lathing unit for phenolic carbon. While the highest level for OC in the mechanical lathing unit is (117.0 $mg.m^{-3.}.8hr^{-1}$) and the lowest OC concentration is (2.0 $mg.m^{-3.}.8hr^{-1}$) in manual and pressing units.

The exposure of workers to these vapors is few where there are individual and collective safety equipment. Low concentrations of non-carbon dust were observed in most units ranging from (10 to 33 $\mu g.m^{-3.}.8hr^{-1}$) depending on sampling time and frequency. This result is higher than the International Standards Units (ISU) [2, 9, 10].

There is no Iraqi standard specifying permissible limits for organic and inorganic carbon emissions for industrial environment, and so application of international safety measures. [11, 12]

Table (2) Dust concentrations and their components during working hours (8 hour sample) in the electrical insulation production units.

Sample source*	Dust concentration ($mg.m^{-3}.8hr^{-1}$)* (Total)	Dust components ($mg.m^{-3}.8hr^{-1}$)		Non-Carbon Dust*** ($mg.m^{-3}.8hr^{-1}$)
		TIC	OC	
Mechanical lathing unit (PCI)**	147.0	2.8	117.0	27.2
Manual unit filings	475.0	440.0	2.0	33.0
Mechanical lathing unit (FPI)**	128.0	80.0	38.0	10.0
Pressing unit	54.0	42.0	2.0	10.0

*Mean concentrations of 4 replicates for 4 weeks.

**PCI: Phenolic carbon .insulator; FPI: Fiber phenol insulator

***Non Carbon Dust=Total-(TIC+OC)

4- Conclusion

The concentrations of dust emitted from the production machines of carbonic phenolic insulation and carbon fiber were very high and far exceeded the international standards. Phenolic carbon concentrations varied between dielectric production units as well as inorganic carbon concentrations. Individual and collective safety measures have been taken, but need to be improved.

5- Recommendation

Workers are exposed to many hazards that can adversely affect their health and well-being. Short hours, changing shifts, and reduce direct exposures to harmful chemicals through using individual and collective safety measures so reducing the risk of carbon dust exposure and risk for pollutions harm.

Application of Biological safety tools, like dust mask with filter and eye and face protection tool. Ensuring the presence of air conditioning system is a must for safety of the workers.

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