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The Flying Ash Taken by Wet Process from C.E.T. Holboca Iassy – Major Pollution Source

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Abstract

The study is underlining the negative effects and is proposing some solutions of reintroduction into the economic circuit of this type of material aiming to reduce the depositing dumps volume. In the study were analyzed that some affections that are observed on children and adults due to the presence in the inhaled air of the power plants ashes from dumps. Also ashes chemical and mineralogical composition and some specific properties of dusty materials were presented.

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1. Introduction

The power plants that are using solid combustible are leading to a material that is resulting from combustion generally called power plant flying ash. To realize the combustion in stokers it is grinded in ball mills to an advanced finesse, the powdery material is transported in air flow in the stokers, and then a fine granular material is obtained.

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The collecting and transport of the ash from combustion can be performed by dry procedure (flying ash) in small proportions and in water flow (wet procedure). The collected ash by wet procedure is drained in tanks and then is stored in opened dumps. The air flows are entraining the fine particles on very large surfaces.

The dump ash represents a pollution source with unfavourable effects on the ambient environment and important consequences on human health.

The great amount of dump ash is recycled in small percents, so in any utilization field is favourable.

The released ash particles from the power plants have as injurious effect on the human health, so the utilization of the collecting by wet procedure method is decreasing their releasing in the atmosphere.

Concerning the decrease of the high pollution degree in city of Iassy area would be involved the specialists in civil and environmental engineering and the medical personnel to highlight the increasing incidence of the respiratory diseases and the utilization necessity of some collecting methods as less injurious.

2. Implications of the power plant ash on human health

Pollutants released into the atmosphere from the thermocentrals have a major impact on the health of the general population. WHO and European Environment Agency emphasizes, year over year, the harmful effects on the entire human body: ocular, skin, lung allergic diseases, increase risk of developing certain malignancies or neurological diseases, the occurrence of cerebral or cardiac infarction, and last, but not least, harmful effects in children normal lung development. Also, the pollutants involved in allergic disease at the paediatrics ages, act on immature lungs and immune system, respiratory epithelium being more vulnerable and unable to repair properly.

The prevalence of allergic disorders has considerably increased over past decades and in attempt to explain this trend have been issued several hypotheses, the most important of them being the appearance of new risk factors, no concern in the past, nutritional or environmental (air pollution) [1]. Romania is considered to be the sixth industrial polluter of the EU, the energy sector contributing to major degradation of the environment, generating approximately 90% of polluting emissions: significant amounts of particulate substances, sulphur, nitrogen, silica oxides, ozone and high volumes of waste water discharged to ground level.

Pollutants destroy the physical barrier function of the bronchial respiratory epithelium, facilitating the allergens penetration, the interaction between air pollutants and the epithelium being a complex phenomenon, mostly genetically conditioned. Increased pollen allergies, especially in the urban areas it seems to be based also on the exposure to atmosphere dispersed particles, attaching of pollutants on the pollen particles modifying the allergic potential [2].

Air pollutants are substances with harmful effects on living organism with implication from intrauterine life. Exposure of pregnant women has different consequences depending on the stage of development of the fetus and can lead to spontaneous abortion, delay in intrauterine growth, premature birth and low birth weight, congenital malformation or certain injuries of the central nervous system responsible for cognitive and physical impairments. After birth, all types of pollutants may affect the respiratory tract health, especially if the exposure occurs in infancy when the growth processes are at the maximal level [3].

Pollutants are generally non allergenic inside them, but may facilitate the entry of air allergens by destructions at the respiratory mucosa and through modifications of mucociliary clearance and may trigger or amplify chemical mediators synthesis, promoting a Th2 inflammatory conditions or may be risk factors for epigenetic reset.

WHO recently stated that the effects of particulates matters on human health occurs at levels with which is currently facing the largest part of urban and rural population, the inhalation of this matters being responsible for more than 50000 death annually, principally through pulmonary or cardiovascular diseases, contributing as a risk factor in lung cancers. In the occurrence of toxic and allergic phenomena in which these substances are incriminated, an essential role is the dimension of the particles: those between 5-10 μm are eliminated by the mucociliary clearance, but those with a diameter less than 2.5 μm can absorb toxic products of combustion, metals, allergens and are retained on the lung parenchyma and may determine alveolar inflammation, coagulability modification and release of free radicals. (4) In general the ashes granular of Holboca thermocentral is characterised by a advanced degree of fineness, 12% of particles having a diameter below 12 μm .

From the point of view of chemical composition, at the level of this ash, predominant is the silica, aluminium oxides and less sulphur, calcium or ferrous oxides.

Exposure to sulphur oxide can cause an immediate bronchoconstrictor response as well in healthy subjects, as well in asthmatic patients, the response being concentration dependent, appearing at lower concentration in asthmatic patients comparative to non asthmatics and being amplified by concomitant exposure to cold air or ozone [3].

Pneumoconiosis, chronic pulmonary restrictive interstitial disease, frequently with professional character are determined by prolonged exposure and the aspiration in the respiratory tract of various material particles, the importance of the lesions depending on the duration of the exposure, the concentration and the size, and the association with other irritants factors. Silicosis may be determined by alveolar aspiration of silica dioxide with size between 3 to 5 μm , but usually are affected persons working in stone quarries, cement industry or glass industry [5].

Certain particulates substances can interact with immune responses, in exposed persons, the particles based on aluminium can stimulate selectively the Th2 type immune response, which is characterized by IL4, IL5 production and IgE and IgG1 production, with implication in the occurrence of the allergic phenomena. Also, the silica particles may promote the Th2 immune response and the releases of IgE and IgG [4].

In addition to harmful effects on aquatic ecosystem, the sulphur oxides may affect the respiratory tract, causing, at increased concentration, bronchial inflammation and the aggravation of chronic phenomena already installed, such those from bronchial asthma or chronic obstructive diseases, with important implication in therapeutically management of these diseases. Exposure to sulphur particles may cause minimal ocular local effects, but can also increase the sensitivity to respiratory tract infections [5].

Lung cancer became in the end of the XX century one of the main causes of death in the world, some of the involved risk factor can be however prevent. Although the genetic basis is very important in the occurrence of pulmonary tumours and the fact that smoke and the tobacco exposure is the leading risk factors of these disease, mixed complexes between particulates matters and other air pollutants can be consider to have a real carcinogenetic effect [6]. Air pollution is not only involved in lung cancer, international studies underlining the involvement in bladder and digestive tract tumours.

Recently published metaanalyses shows that, at the international level, are an important increase of lung tumours incidence and heart failure correlated with air pollution, exposure to small material particles can be involved in the appearance of any type of lung cancer, but more frequently in the occurrence of adenocarcinomas [7]. Should be taken into account of the fact that the measurement level of one single pollutant does not bring enough data on the combined action, all the released particles from power plants or the action with some other environmental factors from the geographical area.

3. Characteristics of the ashes cropped by wet procedure from Holboca Iassy power plant

In the Building Materials Laboratory, Department of Concrete, Materials, Technology and Management from the Faculty of Civil Engineering and Building Services some studies on the power plant ashes were performed and on the recycling possibilities in construction.

3.1. General characteristics

The material is presenting as a powdery form having a light grey colour and a variable humidity that is decreasing from the surface to the deposit.

3.2. Chemical composition

By coals burning in the ash an elements series is concentrating that enters into different combinations or oxides mixtures.

For the ashes obtained from tar the composition the compositions are presenting a significant difference of the oxides containing excepting the calcium oxide that exists in great amount in the lignite.

Can be observe that near the main components SiO_2 , Fe_2O_3 , CaO and SO_3 the ashes contain secondary components Na_2O , K_2O , Fe_3O , TiO_2 , P_2O_5 and rare elements in relative small amounts called “trace elements”.

The ashes can have variable oxidic composition. Function of the SiO_2 and Al_2O_3 ratio and the CaO and SO_3 amounts the ashes can be classified in four classes:

- Alumino-siliceous ashes
- Sulpho-calcic ashes
- Silico-aluminous ashes
- Calcic ashes

Generally, the alumina-siliceous ashes and silico-aluminous ashes are formed from the tar's combustion and the sulpho-calcic ashes from the lignite's combustion.

Table 1. Chemical composition

No.	Chemical component	Determination method	Obtained values (%)			
			1	2	3	Average
1.	Total silicon dioxide (SiO_2)	g. 3832/2-85	37.0040	36.6900	37.0705	36.9215
2.	Iron trioxide (Fe_2O_3)	Volumetric, 3832/3-85	4.9622	4.9820	5.0104	4.9848
3.	Aluminium trioxide (Al_2O_3)	Volumetric, 3832/3-85	37.7650	37.8005	37.6985	37.7546
4.	Calcium oxide (CaO)	Volumetric, 3832/3-85	2.9380	2.8940	2.8440	2.9203
5.	Magnesium oxide (MgO)	Volumetric, 3832/3-85	0.1880	0.1805	0.1844	0.1845
6.	Sulphur trioxide (S_2O_3)	Gravitational, 3832/5-85	1.4406	1.4366		1.4386
7.	Total sulphur (St)	Gravitational, 3832/5-85	1.4418	1.4382		1.4400
8.	Sulphur in sulphides (S^{2-})	Flam-photometric, 3832/6-85	0.0012	0.0016		0.0014
9.	Sodium oxide (Na_2O)		0.2210	0.2170	0.2174	0.2181
10.	Potassium oxide (K_2O)	Flam-photometric, 3832/6-85	0.5465	0.5398	0.5460	0.5431
11.	Combustible substances (C)	g. 3832/7-85	9.8800	10.0020	9.8032	9.8950
12.	Substances soluble in cool HCl	g. 3832/8-85 dried at 110°C	7.0532	7.2145		7.1388
13.	Insoluble residuals in cool HCl	Calcination at 1050°C	87.2170	87.1570		87.1870
14.	Calcination losses (Pc)	g. $(1050 \pm 10)^\circ\text{C}$	77.6480	77.6720		77.6600
15.	Solubility in water at 20°C		9.9420	9.8111	10.0261	9.9264
						1.2900

3.3. Mineralogical composition

The main crystalline compounds of the ashes are:

- mulite (10-16)%
- quartz (6-10)%
- hematite (2-3)%
- magnetite (2-4)%

Based on the average composition was assessed the place of the ashes in the $\text{CaO-Al}_2\text{O}_3\text{-SiO}_3$ ternary system comparing to the Portland aluminous cement and the furnace slags.

The more reduced basic character of the ashes and their reduced hydraulic ability, as well were highlighted.

3.4. Radioactivity of the dump ash

The present radionuclides in the ashes are found in the following concentrations:

C (^{40}K) = 158...472; C (^{226}Ra) = 52...187; C (^{232}Th) = 212 [8], [9]

The ashes radioactivity does not exceed the values of the natural stock.

3.5. Physical characteristics

Bulk volumic mass in aerated state

The variation of the bulk volumic mass in aerated state function of the humidity is presented in the graph bellow [10]:

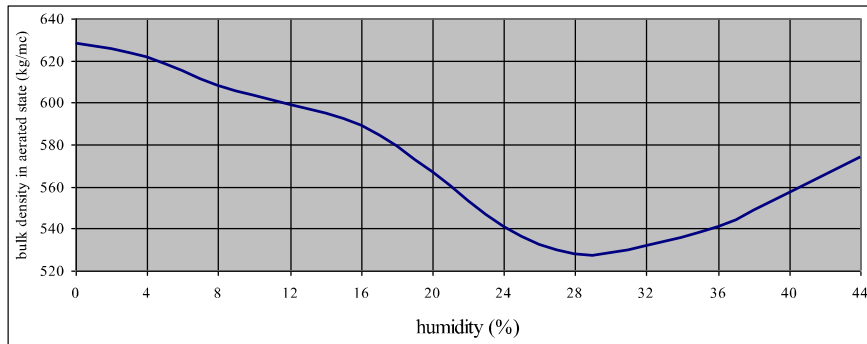


Fig.1. Variation of the bulk volumic mass in aerated state function of the humidity

Granularity

Table 2

Passing through the sieves and the dimensions of the sieves (mm):				
0.09	0.2	0.4	0.65	1
6.9	12.4	88	99.5	100

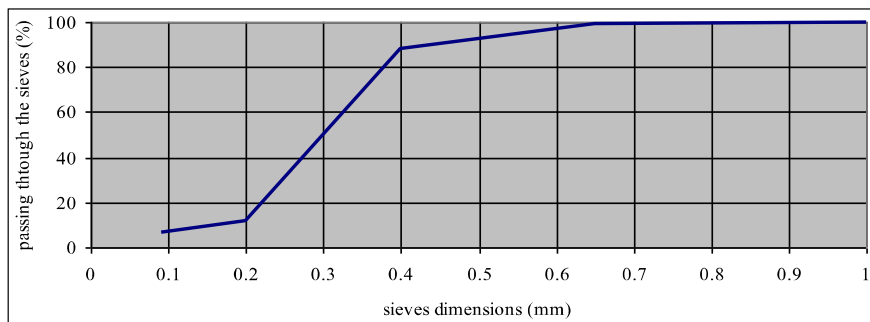


Fig.2. Granularity curve

Specific surface (Blaine method)

$S=4321\text{cm}^2/\text{g}$ [10]

The great specific surface is due to the irregular shape of the granules that are presenting many cracks observable by the optic microscope.

4. Utilization fields in construction [11]

Field	Utilization
Construction materials industry	Cement admixture
	Cellular concretes structure obtained by foaming with gas generators
	Agloporite (granular products for concretes and thermal isolations)
	Degresants for ceramics industry
	Active admixtures for mortars and concretes
Civil Engineering	Waterproof admixture for mortars
	Admixtures for concretes exploited in chemical aggressive terrains
	Clays stabilizers
	Masonry blocks (in combination with other materials - sawdust, slaggs)
	Self compacting blanket
Construction of terrestrial communication ways	Soil stabilizers in combination with calcium donator materials
	Filer replacing for asphaltic mixtures

5. Conclusions

- The thermocentral ashes collected by wet procedures represent a risk factor for health.
- The chemical activity that is consumed in the collecting and hydraulic transporting process is partial reducing the hydraulic character.
- The main utilization fields represent the construction.

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