ELEMENTS OF IMPACT ON THE ENVIRONMENT AS A RESULT OF FIRE AT THE FUEL GROUND OF A THERMOELECTRIC POWER STATION

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The article below presents some consequences on the environment of a fire at the fuel ground of a thermoelectric power station and the fire prevention measures in order to avoid pollutant emissions involved.

Keywords: fuel, combustion gases, autopurification, fire, measures

1. Introduction

The research deals with the effects of the pollutants emitted by a fire at the fuel ground of a thermoelectric power station. It also analyses the difference between the impact of a controlable gas emission and combustion on the enviromment and the impact of an uncontrolable gas emission and combustion. A great emphasis is laid on the pollution avoidance by analysing the fire causes, dangers and prevention measures.

2. The main pollutants emitted by a thermoelectric power station and the fuels involved

The thermo-electrical power station has an energetic goal and it is defined as a complex equipment with a lot of assemblies and outfits that turn the thermic power caused by fuel burning into electric power. The fuels used by a thermo-electric power station are: coals, black oil and natural gases. After these fuels are burnt there can be obtained slag, ash and combustion gases [1].

In theory, a complete burning of a pure fuel should result only in carbon dioxide and water which are substances with a very small degree of noxiousness. In practice, however, the fuels are not pure and the burning process is incomplete. Therefore, the burning processes involve a quantity of by-products which belong to the smoke composition and are release into atmosphere. The by-product may be both some substances that do not be long to the normal air composition and some other substances that belong to the mentioned composition. The latter-depending on the concentration and/or action time- have a noxious effect on people and on

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the environment. They are called polluting agents and they can be found in the form of slurries or aerosols and of gases and noxious effluvia.

The main polluting agents are emitted by coal, which is considered the most frequently used fuel. Moreover, there are important coal supplies on a world scale. There is a great variety of types of used coals, the presence of pollutants depending on the purity degree. The resulting smoke contains both coal and ash slurries and gas. The slurries contain carbon, silicium, aluminum, ferum oxides, and slightly variable quantities of cadmium, vanadium, nickel and selenium. The gases contain watery vapors, but also nitrogen oxides, sulfur dioxide, carbon oxide, fluorhydric acid aldehydes and some other hydrocarbons. Among the main emitted polluting substances, the quantity of coal, carbon oxide and nitrogen oxides depends on the type and the quality of burning, whereas, the quantity of ash and sulfur dioxide depends first on the quality of the coal. It is necessary to be mentioned the fact that during the burning process there can be formed polycyclic hydrocarbons with a harmful effect, bezoapyrene in particular, which quickly condense on the slurring particles.

The main polluting substances released into atmosphere after the burning process of the black oil and the oil products are: the nitrogen oxides, the carbon oxide, the sulfur dioxide (dependent on the sulfur concentration on the black oil), hydrocarbons, polycyclic hydrocarbons, slurries of carbon and ash containing sulfates, and some other substances, such as selenium and vanadium.

The natural gases represent the fuel with the smallest polluting potential. Besides water and carbon dioxide, quantities of nitrogen oxides are constantly released into atmosphere but, according to the quality of burning, quantities of carbon oxide, hydrocarbons and sometimes slurring particles are also released. [2]

The most noxious gaseous pollutants caused by the fuel combustion in thermoelectric power stations are: carbon dioxide, carbon oxide, sulphur oxides and nitrogen oxides.

The **carbon dioxide** is a dangerous gas, in the sense that it can become a climatically disturbing element if its concentration in the air is doubled. Its concentration has recorded an important increase due to the massive deforestation on the one hand and to the fossil fuel consumption in industry used to produce electric power, on the other hand. It is well known that 12g of coal release 48g CO_2 by burning. So, 15.4-mil tone CO_2 can be released into atmosphere every year.

In addition, the human intervention and activities destroyed the dynamic balance between the quantity of the carbon dioxide absorbed by the photosynthesized organisms and the concentration and quantity of the carbon dioxide released into atmosphere by the organism breathing, volcanic eruptions and fermentations. The normal maximum concentration of carbon dioxide allowable into atmosphere is 0.3mg/cm of air. If the concentration increases by

more than 3%, the carbon dioxide turns into a toxic gas for human beings. For 10-20% increases, there could appear mortal effects on people.

The **carbon oxide** is the most widespread pollutant in the atmosphere, with a medium concentration of 0.1- 0.2 ppm. It represents the result of the incomplete combustion of the coals and the carbon compounds. In high concentrations it has mortal effect on people.

The **sulfur oxides** are the result of the oxidation of the sulphur from the coal composition. The sulphur dioxide is a stable gas, whereas the sulphur trioxide produces vapors at normal temperature, the smoking phenomenon being evident in the air. The sulphates from the slurry in the atmosphere belong to a large extent to the breathing fraction of the material particles, the sulphate particles being the cause of the strongest visibility reductions.

The greatest part of the sulphur from the fuel used by thermo power stations turns into sulphur dioxide and rest of it turns into sulphur trioxide. The sulphur dioxide released into atmosphere reacts with the oxygen to form the sulphurous anhydride (SO_3) under the action of the solar ultraviolet radiation, according to the reaction: $2SO_2 + O_2 \rightarrow 2SO_3$.

Due to the watery vapours in the atmosphere, on foggy and highly wet days in particular, the sulphur trioxide turns into sulphuric acid, according to the reaction: $SO_3 + H_2O \rightarrow H_2SO_4$.

The sulphur dioxide is a toxic substance with negative effects both on the human beings and the animals. For example, in a concentration of 5-10 ppm, it causes irritations at the breathing system of the mucous membranes associated with bronchial spasm. The combination with other pollutants in the atmosphere emphasizes the toxic effects of the sulphur dioxide, in the sense that it has a harmful effect on the plants, destroying their leaf chlorophyll.

Moreover, the sulphur oxides attack different materials especially when, under the humidity effect it turns into sulphurous acid and then into sulphuric acid with a greater capacity of destruction. Thus different phenomena may appear: the corrosion, the discoloration of the colored materials, the marble rotting, the reduction of the elasticity and resistance for some organic compounds, such as textile pollution, etc.

The **nitrogen oxides** represent major pollutants of the atmosphere, not only by their toxic action, but also by their capacity to form by-pollutants in reaction with other usual air constituents, or with other main pollutants in the atmosphere.

From the total quantity of nitrogen oxides (NO_X) caused by the fuel combustion in thermo power stations, the greatest part represents nitrogen monoxide (NO), while the rest is nitrogen dioxide (NO_2). The nitrogen monoxide reacts with the oxygen in the air to form the nitrogen dioxide under the action of the ultraviolet radiation, according to the reaction: $2NO_2 + O_2 \rightarrow 2NO_2$.

The nitrogen dioxide is an extremely toxic gas, which forms the nitric acid under the watery vapors action in the atmosphere, according to the reaction:

$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$.

Both the nitrogen dioxide and the nitric acid are very dangerous for the human body. The nitrogen oxides attack the respiratory ducts, the mucous membranes and cause paralyses. On the other hand, the nitrogen oxides have some noxious effect on the plants, too, causing the fall of their leaves. The toxicity of the nitrogen oxides increases a lot by synergism with other toxic substances.

The nitric acid, resulted from the reaction between the nitrogen dioxide and water, leads to the appearance of the corrosion phenomenon of the metallic buildings, causing their destruction in the end. The nitric acid associated with different cations in the atmosphere form nitrates that have corrosive action on the copper, the brass, the aluminum, the nickel, etc, destroying the electric and telephone networks, too.

The strongly oxidant nature of the nitrogen oxides and the nitric acid leads to the destruction of the plastic mass, the lacquer and the dyes used as protection materials for the industrial equipments and buildings. The action of NO_X on some building materials in the carbonate group (such as the marble) can be proved. These oxides of the nitrogen penetrate through the micro fissures of the building materials, thus causing the building destruction. [3,4]

3. The influence of the fire on the atmospheric autopurification capacity

The noxious effects on the environment and the emissions of polluting agents may be reduced by different constructive methods. In the case of a controlled burning within normal parameters, the noxa emissions can be reduced and the impact on the environment is much smaller, if we take into consideration the latest technical solutions for reducing the quantity of noxa and gases released into atmosphere through the chimneys of the thermo power stations.

The atmosphere has the capacity of autopurification [2]. The fire may influence the pollution and autopurification processes by the nature and the great volume of the polluting emissions which can exceed the autopurification capacity of the airy basin. The autopurification process can be influenced by the velocity and the temperature of the emitted polluting substances in a fire.

The way of releasing into atmosphere plays an important role, too. Taking the stationary sources into account, the organised system (chimneys, vent holes, etc.) implies a localisation of the emissions. Thus the highest polluted area is limited and it is situated to some distance. On the other hand, the unorganised emissions are diffused and lead to a severely polluted area around the place of

emission. In the case of a fire, the burning of the fuel do not follow the stages for the reduction of the polluting agent emissions, the burning taking place before the beginning of technological procesess for the electric power production .

Therefore, in the case of uncontrolled noxa emissions and burnings, such as a fire, the impact on the environment is much greater because the autopurification capacity of the airy basin is exceeded and because the strong air pollution with sulphur dioxide and nitrogen oxides is generated.

Under humidity conditions, these oxides are turned into sulphuric and nitric acids. Being taken by the water drops in clouds, these acids either travel to great distances (transfrontarian pollution) or fall on the earth together with the raindrops. The less the rainfall is the higher the acid concentration becomes. The harmful acid causes severe burns to the earth vegetation. The acid rain can destroy large surfaces of forests, vegetation, fauna around and threaten people's lives. It causes serious lacks of balance among human beings. A great part of the gases released into atmosphere will reach waters and soils, either in a direct way due to the surface tensions or together with the rainfall that dissolve the majority of the gases, transporting them towards waters and soils.

The synergetic effects are also produced due to the emissions of the polluting agents on a wide scale. These agents are released from the burning of different parts of a building in the fuel stock of the thermo power station or even from various parts of the equipment of fuel circulation and supply.

Thus, it is important to analyse both the danger of fire in the thermo-electric power stations and the main causes which may provoke a fire burst.

4. Fire causes and dangers. Measures of fire prevention at the fuel ground of a thermoelectric power station

A number of damages may occur both to the old thermoelectric power stations and to those new or into service. These damages are caused by some deficiencies in designed and exploitation, by the personnel's carelessness, or by some technical defaults. They result in fires or explosions that finally turn into fires.

The fires burst at the fuel supply equipment and implicitly at the fuel stock of a thermo-electric power station are due to the following causes: electric arcs, short circuits, electric sparks, open flame (oil lamp, welding), incandescent bodies, mechanical sparks (frictions, piece breaks), sparks produced by welding or by open fires, friction heat (the overheat of the bearings or of the elements of the moving cars), the heat of the heating bodies (steam pipes), the heat radiated in highly heated rooms (drying equipments), spontaneous combustion.

Mechanical sparks can be produced in the equipments used to obtain coal powder after the metallic bodies (pieces of wire, nails, etc) get into crushers and

mills. These metallic bodies come either from the outside or from the breaks of some pieces of equipments, especially when the equipments of transport, of storing, of crushing and of grinding are overused. The most frequent frictions are produced at the moving devices and the conveyer-belts.

In the areas with combustible materials and substances, the danger of fire is due to the existence at the same time and in the same place, of the carburant (the oxygen in the air, which keeps a fire burning) and of a kindling source with some great enough energy to initiate burning.

The product between the danger factors brings the danger of the potential fire, while the product of the proportions which reduce this danger expresses the real value of protection. Therefore, we can say that the danger of fire represents the ratio between the potential danger and the protection measures. Some examples of protection measures could be: usual measures (general and specific rules for fire prevention) and special measures (signal devices, means of communication with the intervention brigades, automatic fire extinguishers,etc).

The pollution risk reduction may be realised by taking some measures for fire prevention in the thermo-electric power stations which use solid fuels. The coals are crushed, stored in bunkers, ground in coal mills and finally, the pulverized coals are introduced in furnaces through burners. Consequently, there should be taken some adequate fire prevention measures, such as: the removal of the possibilities of the explosive mixture formations and of the coal powder depositions on equipments and heated surfaces. It is necessary that the preparation, the transport and the deposition of the coal powder should be made, as far as possible, in the well-tight equipments in order not to allow it to get out in the air. In order to avoid the producing of the mechanical sparks, some electromagnetic separators are provided along the conveyer-belts. In order to remove the dust laying downs and to avoid the untightness, the devices of coal profile spraying need to be checked.

The coal mills have to be equipped with automatic turning off systems to prevent kindling of the coal profile. On the other hand, the mill devices of grinding, turning on/off and exploitation need to be well kept in order assure their good working. The mechanical and natural ventilation has to be adequately designed and exploited in order not to produce coal powder-air-mixtures in explosive concentrations.

In the thermo-electric power stations that use liquid fuel, the black oil supply device of the furnaces from the boilers is made up of the following: the large tank for the combustible reserve, the distribution tank for the daily consumption, the preheater that assures the preheating of the black oil in order to be transported through pipes, the filter, the black oil pumps, the pipes and the burner.

As far as the fire prevention measures are concerned, we could mention here some of them. So, for the liquid fuel supply devices, the temperature of the black oil heating does not have to surpass the temperature which can favour the appearance of the fire and explosion danger. The liquid fuel supply pipes will be placed in specially designed drains, to avoid their being damaged. In addition, the tanks, the transport pipes and the pumps have to be well tight.

As for the underground fuel tanks, there could be assured a good tightness of the tank walls in the connection places with the fuel aspiration pipes. The fuel tanks will be earthed and protected against the direct thunderbolt. Then, some great attention has to be paid to the cleaning of the fuel tanks and to the measures of fire and explosion prevention, such as: continuous ventilation, illumination at 12 V tension using an antiexplosive pattern, the use of tools made up of non-ferrous metal or wood, in order to avoid the spark producing.

The thermo power stations with gaseous fuel are equipped with a fuel distribution station. As far as the fire prevention measures are concerned, we could mention the following: the building of the fuel distribution station has to be made of incombustible materials. Moreover, it has to be provided with doors and windows opening outside. In order to evacuate the potential gas casualties, the distribution station will be equipped with natural ventilation assured by some openings. There will be also assured a good tightness of the gas pipes, for connections in particular. The existence of gases can be checked by the help of the gas detectors. In the gap pipes the exceeding of the admissible pressure is forbidden, otherwise, some damages and explosions can be produced [5].

5. Conclusions

The production of the electric power throughout the termoelectric power stations involves a major risk regarding with the pollution and the impact on the environment, especially if we take into account a fire at the fuel ground. By obeying the fire prevention measures, there can be reduced the risk of the environment pollution caused by the polluting agents released from a potential fire in the fuel stock of the thermo-electric power stations.

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