THE THERMO-ELECTRIC POWER PLANTS AND THE ENVIRONMENT. THE IMPACT OF T.P.P. SUCEAVA ON THE ENVIRONMENT – CASE STUDY

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Key words: environment, environmental pollution, thermo-electric power plants.
Cuvinte cheie: mediu, poluarea mediului, centrale termoelectrice.

ABSTRACT:

The environment represents all of the natural and artificial factors created through human actions, which in tight interaction, they are influencing the biological equilibrium determining the life conditions for the human being and the society developing. The technical progress brings along, besides so many wonderful achievements, numerous drawbacks and a lot of polluting substances, which may destroy the environment.The environment polluting has became a contemporary, social-economic problem which has taken so big proportions, that required adopting some laws to reduce its harmful actions. The quantification of the human activity effects and the natural processes on the environment, the health and security of the human being, as well as goods of any kind are achieved by assessing the impact on the environment. The paper presents the way the thermo-electric centrals influence the environment by evacuating in the atmosphere the polluting substances resulted from the burning of fuel in the energetic boilers. There are analyzed the noxa emissions for the combined heat and power plant of Suceava.

The central was projected to work on solid fuel (lignite from the Rovinari basin) combined with fuel oil for stabilizing the burning. Between 1999-2001 people have been working on repairs at the energetic boilers by upgrading from the lignite operating to the pitcoal operating. The pitcoal is imported from Russia, Ukraine, Australia, South Africa.

The source of air polluting is the emission in atmosphere of the polluting contained in the burning gases resulted from burning the fuel in the focus of energetic boilers (SO_2, NO_x, CO_2, powders). The direct impact of the polluting (SO_2, NO_x, CO_2, powders), evacuated in the atmosphere by the burning installation, takes place in areas relatively close to the central, on distances from hundreds of meters to tens of kilometers (by affecting the air quality and solid, acid deposition on the soil), this depends of the evacuated polluting quantity and the climatic factors in the area.

The gas polluting emission effects can manifest on wide areas, at noticeable distances from the source (some hundreds of kilometers) by the acid rain apparition (because of the SO_2 emissions) and even at global scale through contribution to the sere effect (because of the CO_2 emissions).The thermal power plants in Romania were built during a period in which their impact on the environment was undervalued and constraints relating to environmental protection were relatively few. The location has been chosen most often by other criteria (sources of cooling water, fuel, energy consumers) and less after the environmental impact. Stack height was considered a means (only) effective to prevent air pollution in the neighboring area, the dispersion of the combustion gases over a large area around the plant. For the case the combined heat and power plant of Suceava is observed that exceeded the maximum permissible limits for the pollutants SO_2, NO_x, and particulates in the combustion gases discharged, compared with the limit imposed by GD 541/2003. Solution with high funnel is no longer sufficient and that the rules will be supplemented with measures to limit emissions into the atmosphere for each noxa separately.

1. Introduction

The environment represents all of the natural and artificial factors created through human actions, which in tight interaction, they are influencing the biological equilibrium determining the life conditions for the human being and the society developing. The technical progress brings along, besides so many wonderful achievements, numerous drawbacks and a lot of polluting substances, which may destroy the environment.The environment polluting has became a contemporary, social-economic problem which has taken so big proportions, that required adopting some laws to reduce its harmful actions. The quantification of the human activity effects and the natural processes on the environment, the health and security of the human being, as well as goods of any kind are achieved by assessing the impact on the environment.

2. The influence of the thermal plants on the environment

The burning of fossil fuels (coal, oil, natural gas) in energy boilers has resulted in the evacuation in the atmosphere of large quantities of harmful substances. The main pollutants resulting from fuel combustion in thermo plants are:

- carbon monoxide (CO);
- sulfur dioxide (SO_2);
- nitrogen oxides (NO_x);
- carbon dioxide (CO_2);
- particulate matter.

Carbon monoxide appears when the burning in the energetic boilers is incomplete due to errors of the combustion. Carbon monoxide gas is a colorless, odorless, very toxic, slightly more easily than air. The effect of carbon monoxide presence is poisoning. The first signs of carbon monoxide poisoning are headache, fatigue and dizziness.

Nitrogen oxides are formed from the combination of oxygen and nitrogen in the air at high temperatures resulting from burning fuel. Approximately 95% of total NO_x combustion is in the form of nitrogen monoxide (NO) and the rest only in the form of nitrogen dioxide (NO_2).

Disposed in the atmosphere, nitrogen monoxide in the presence of oxygen in the air and under the action of ultraviolet rays, turns quite quickly into NO_2, which is very toxic. Under certain conditions, NO_2 with water forms nitric acid. Through their aggression and toxicity nitrogen oxides and nitric acid are extremely hazardous to human biological mechanism.

They attack the airways, mucous membranes, transforms oxihemoglobina in metahemoglobina, which can lead to paralysis. A longer exposure to the oxides of nitrogen, even at very low concentrations, weakens the body, rendering him very much from bacterial infections. This influence is more conspicuous on the health of children.

The strong oxidant and nitrurant character of nitrogen oxides and nitric acid is the main cause of the plastics, lakes, paints destruction, materials used as protective equipment and construction industries. Also, the materials have corrosive

effects on copper, brass, aluminium, nickel and so on, destroying electrical and telephone networks.

Recently is given particular attention to N_2O compound (nitrogen protoxide). Although its harmful effects are well known, no legislation on emissions of N_2O was enacted yet in any country, to protect the environment. N2O is part of the tropospheric inert gas (area up to about 10 km above the earth), but harmful in the stratosphere due to its catalytic effect in the photochemical reactions which develop active radicals that attack the ozone blanket.

Sulfur dioxide results from combustion of sulfur content in fuels, particularly coal and oil. Sulfur dioxide is a toxic substance, which draws attention to the odor and irritant action on mucous membrane, causing muscle spasm and contraction of the upper airway. In high concentrations, SO2 causes the burning sensation and mucosal conjuctivale respiratory, cough, problems with breathing, sensation of choking, etc. The presence of sulfur oxides in the environment is manifested both by direct damage to plants and by altering the composition of water and soil.

Through the oxidation of sulfur fuel, over 95% is converted into SO2, the remainder in SO3 (sulfur). Converting SO2 to SO3 takes place in the flame, in case of a large excess of oxygen, but also on the gas route, in the presence of vanadium oxides and even iron, which plays role of catalyst, especially at temperatures over 800°C. Discharged into the atmosphere, sulfur dioxide, under the action of solar ultraviolet radiation, reacts with oxygen in the air giving rise to sulfur trioxide (SO3). This, in turn, combines with water vapor in the atmosphere and forms sulfuric acid.

Oxides of sulfur and sulfuric acid, which result by hydration, determine corrosion phenomena, discoloring colored materials, reduced elasticity and resistance to some organic compounds (amines, polymers, textiles, etc..), Some construction materials and some types of electric cables.

Oxides of sulfur, along with those of nitrogen, are now considered main causes of acid rain, causing destruction of forests, the area of high concern. Changes in water and soil composition have the following effects: disorders of plant development, a decrease in the production of timber and the production and fruit quality, with the concomitants of economic and other interests, manifested in the last chain-plant-animal humans.

Carbon dioxide is toxic in high concentrations (over 5000 ppm). CO2 influences climate through the greenhouse effect created on earth, its contribution is assessed to about 50%. The greenhouse effect is caused by so-called greenhouse gases of which are major carbon dioxide (CO2), nitrogen oxides (NOx), methane (CH4) and a class of organic compounds of carbon with fluorine and chlorine (CFCs).

Greenhouse gases allow the passage of solar radiation wave length, but retain the radiation emitted by the Earth in infrared, which would otherwise be dissipated into space, leading to disruption of thermal balance of Earth. If the greenhouse gas concentrations are higher, it retains more heat and increases the greenhouse effect. The greenhouse effect has always existed, with the formation of the atmosphere is an essential factor for the development of life as forfeited during the night, the heat on the Earth's surface and lower layers of the atmosphere, reducing the amplitude of thermal fluctuations.

Carbon dioxide, the main greenhouse gas, is produced to the greatest extent by human activities. So far there are no technical-economic solutions to combat CO2 emissions. The only feasible solution is increased efficiency in production, processing and use of electricity and heat or use of nuclear and other unconventional and renewable energy sources.

Fortunately, the process of photosynthesis uses carbon dioxide out of living beings or removed from the industry, giving rise to carbohydrates and oxygen (equation of life):

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyl}]{\text{light}} C_6H_{12}O_6 + 6O_2$$

The forest clearing has an important role in increasing concentrations of carbon dioxide. The clearing of a forest area has serious effects on increasing the concentration of CO2 in the atmosphere, estimated at 18% in 1990. Many developing countries contribute with much more carbon dioxide in the atmosphere through deforestation than through the combustion of fossil fuels.

The particulate matter consists of ash evacuated through the thermal plants' chimneys based on coal and the ash that comes from the slag and ash deposits. They also have harmful effects, they can irritate eyes and the airways mucous membranes, they make the environment dirty and degrade it, they are deposited on vegetation, buildings, streets and give an unpleasant appearance.

3. The combined heat and power plant impact of Suceava on the environment

The activity of the heat power (CHP) Suceava is producing electricity and heat.

Electricity is delivered to the National Energy System and the heat is delivered to urban consumers (for cooking and heating of domestic hot water) and industrial consumers in the area. The installed electrical power is 100 MW (2 groups of 50 MW). The first group came into service in 1987 and the second in 1988.

The combined heat and power plant of Suceava is located in the southwest of the Suceava city at about 8 km from the Bucharest-Suceava railway and the Suceava River, outside inhabited areas. Access to the area is through the urban artery Calea Unirii near the bridge of Suceava River. The site size is 1,553,054 m2 of which 44,829 m2 area is built.

The lands located near the site are occupied by the following companies:

- S.C. AMBRO S.A. located in the northwest, produces pulp and paper;
- Julius Mall company located in the southwest;
- The Suceava – Bucharest railway located in the north;
- S.C. ERRY S.R.L. and S.C. SAEM S.A. located in the south, which do construction works;
- S.C. ACET S.A. (the combing plant) located in the west.

The area where combined heat and power plant of is located and manifests its influence is part of Podişul Sucevei. Soils in the central part are of the following types: mollisols, claysols, cambisols, hidromorfe soils and soils inevoluated or

truncated. In areas near the combined heat and power plant of Suceava site have not been declared areas of species or protected habitats or sensitive areas.

The thermal plant was designed to operate on solid fuel (lignite from the Rovinari basin) mixed with fuel oil to stabilize combustion. Between 1999-2001 people have been working on repairs at the energetic boilers by upgrading from the lignite operating to the pitcoal operating. The pitcoal is imported from Russia, Ukraine, Australia, South Africa.

The source of air pollutants is the emission in atmosphere of the pollutants contained in the burning gases resulted from burning the fuel in the focus of energetic boilers (SO_2, NO_x, CO_2, powders).

The direct impact of pollutants (SO2, NOx, CO2, powders), evacuated in the atmosphere by the burning installation, takes place in areas relatively close to the plant, on distances from hundreds of meters to tens of kilometers (by affecting the air quality and solid, acid deposition on the soil), this depends of the evacuated polluting quantity and the climatic factors in the area.

The effects of emissions of gaseous pollutants can manifest on wide areas, at noticeable distances from the source (some hundreds of kilometers) by the acid rain apparition (because of the SO_2 emissions) and even at global scale through contribution to the sere effect (because of the CO_2 emissions).

The combined heat and power plant of Suceava has implemented in November 2004, a system of continuous monitoring of SO2, NOx emissions and particulates from stack emissions.

Annual average concentrations of pollutants in waste gases discharged into the atmosphere by the combined heat and power plant of Suceava in 2005 is presented in Table 1 and concentrations of noxa pollutants in the air from around the combined heat and power plant of Suceava site in Table 2.

Table 1. Annual average concentrarions of pollutants in waste gases discharged into the atmosphere by the combined heat and power plant of Suceava in 2005.

Pollutant	Annual average concentrations [mg/Nm^3 waste gases]	The maximum admissible value [mg/Nm^3 waste gases]
SO_2	919	400
NO_x	838	500
Particulates	125	50

Source: Report on environmental status of Suceava in 2005 (www.apmsv.ro)

Table 2. Concentrations of noxa pollutants in the air from around the the combined heat and power plant of Suceava site.

Polltuant	Measured value [mg/m^3]	The maximum admissible value [mg/m^3]
SO_2	0,29	0,75
NO_x	0,20	0,30
Particulates	7	50

Source: Draft integrated environmental authorization for SC TERMICA SA (www.apmsv.ro)

It is noted that the values obtained for concentrations in the discharged combustion gases exceed the maximum values permitted in GD 541/2003, but do not exceed the maximum values allowable in the air around the plant. This is due to a large height of the exhaust combustion gas chimney (180 m) intended to disperse the combustion gases over a large area around the plant.

The annual quantities of pollutants discharged into the atmosphere by the combined heat and power plant of Suceava between 1995-2005 is presented in Table 3.

Table 3. The annual quantities of pollutants discharged into the atmosphere by the combined heat and power plant of Suceava between 1995-2005.

Year	Discharged pollutants [tons/yr]		
	SO_2	NO_x	Particulates
1995	9.520	2.716	1.234
1996	8.580	2.030	1.135
1997	10.777	2.213	1.008
1998	7.872	1.805	765
1999	6.164	1.359	502
2000	2.169	526	153
2001	1.118	344	90
2002	718	415	127
2003	496	350	92
2004	644	381	103
2005	927	789	112

Source: Draft integrated environmental authorization for SC TERMICA SA (www.apmsv.ro)

The explanation for the reduction of SO2 emissions, NOx and particulate matter in the reviewed period is that the combined heat and power plant of Suceava modernizated boilers by energy conversion from the operation of the lignite (coal below) on the operation of coal (hard coal), work carried out during 1999-2001.

The combined heat and power plant of Suceava has the obligation of the sulfur dioxide emissions progressive reduction up to 31.12.2013, and nitrogen oxides and dust up to 31.12.2010, under a reduction program approved by the Regional Environment Bacău. Until compliance it is allowed the operation of combustion but only respecting the negotiated emission ceilings (Table 4).

Table 4. Negotiated emission ceilings for the combined heat and power plant of Suceava between 2007-2013.

Pollutant	Measure Unit	2007	2008	2009	2010	2011	2012	2013
SO_2	[tons/yr]	5600	5600	5600	5600	4480	3360	3360
NO_x	[tons/yr]	1625	1625	1244	758	625	418	418
Particulates	[tons/yr]	420	420	420	175	175	175	175

Source: Draft integrated environmental authorization for SC TERMICA SA (www.apmsv.ro)

Non-conformity to the above deadlines may result in suspension of authorization to work environment and facilities.

Annual emissions of SO2 and NOx from stationary sources in Suceava during 2000-2005 are presented in Figures 1 and 2. Compared to the noxious emissions by the combined heat and power plant of Suceava and by county, it results that the combined heat and power plant of Suceava is a significant contributor to total emissions stationary sources in the Suceava county in 2005 to 72.8% for SO2 and 67% for NOx.

Contribution is mostly done by the combined heat and power plant of Suceava, the trend in the county follows the trend of decreasing pollutants due to the combined heat and power plant of Suceava measures listed above.

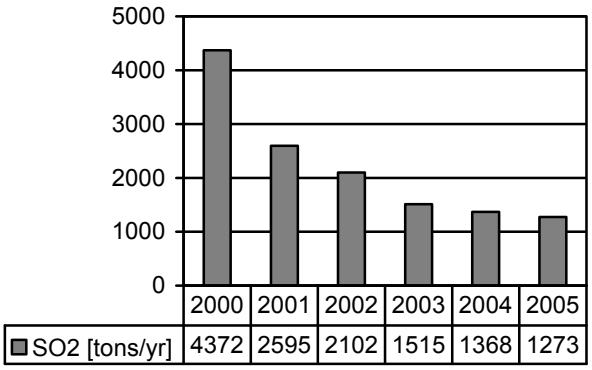

Fig.1. Annual SO2 emissions from stationary sources by the Suceava county between 2000-2005.

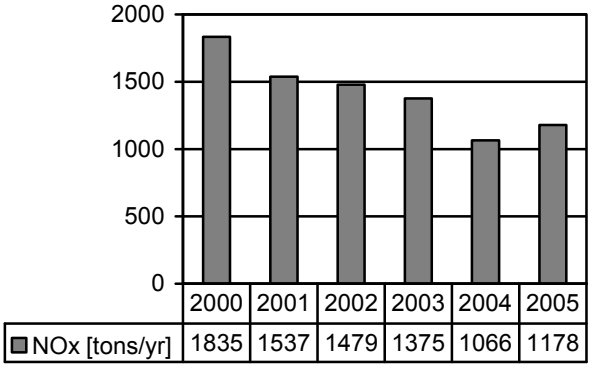

Fig.2. Annual NO_x emissions from stationary sources by the Suceava county between 2000-2005.

The deposit of slag and ash of the combined heat and power plant of Suceava is located on the left bank of the Suceava River, approx. 4 km downstream of the central and occupies an area of 49 ha, the active area being of 35.25 hectares. Dam base of the deposit has a length of 2700 m, the width of the canopy has 5 m and the

average height is of 4.5 m. In the warehouse of cinders and ash takes place the cinder sedimentation and ash hydra mixture of water being drained into the recirculated central. To prevent any ash sweeping a splash of the ash from the warehouse.

The population of the area may be affected by noise from steam discharges into the atmosphere when passions and power boilers that have a reduced time for action. Steam boilers are equipped with the muffler to reduce noise below 90 dB. Values measured in 2005 to limit the site were between 56 and 63 dB (the maximum allowed limit of the site being 65 dB).

4. Conclusions

The thermal power plants in Romania were built during a period in which their impact on the environment was undervalued and constraints relating to environmental protection were relatively few.

The location has been chosen most often by other criteria (sources of cooling water, fuel, energy consumers) and less after the environmental impact. The chimney height was considered a unique effective way to prevent air pollution in the neighboring area, through the dispersion of the combustion gases over a large area around the plant.

For the combined heat and power plant of Suceava case it is noticeable that there are exceedings from the maximum permissible limits for the SO2, NOx pollutants and particulates in the combustion gases discharged, compared with the limit imposed by GD 541/2003. Solution with high funnel is no longer sufficient and the rules will be supplemented measures to limit emissions into the atmosphere for each noxa separately.

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