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Introducing Environmental Technologies in Industrial Fuel Combustion Processes

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Abstract – **Atmosphere pollution is a complex and worldwide process carried out for a long period of time. Greenhouse effect, global warming and acid rain are only some examples generated by atmospheric pollution. Experts discovered a strong motivation on finding solutions for reducing pollutant emissions caused by atmospheric pollution. Transport activities and fossil fuels combustion are the main concern on environmental pollution, more than that, they are used in industrial processes, being the main cause of environmental pollution.**

We have to understand that global pollution is causing the main effect on economic and social challenges of each country, a fact that will be hard to change in the future, and every small step will help for a better and healthy environment. Sebes and Zlanta city, from Alba regions, were the areas that draw our attention for studying the level of atmospheric pollution for a period of 5 years. We made periodic determinations on emission level for SO2, CO, CO2, NOx and writing down periodic reports. The measurements were made in industrial areas for Zlatna and Sebes city and in urban areas in Alba-Iulia city. Traffic environment was the main issue discovered after this research. The concerning was on industrial pollution for the cities of Sebes and Zlatna. The final part is offering solutions on reducing gaseous emissions in particular for economic operators and for the industries as well. This research is particularly aimed at emissions reduction like SO2, CO, CO2 and also for volatile organic compounds. Directive 2008/50/CE concerning ambient air quality were the main sources where we started on our research targeting on reducing atmospheric pollution.

Keywords – environmental technologies, industrial polluting emissions.

1. ENVIRONMENTAL POLLUTION

In the last decade, researchers draw our attention in terms of environmental pollution, especially on the atmosphere. The major impact is global warming caused by greenhouse gas emissions. Scientists are offering information and alerts with conclusive evidence on air pollution hoping to attract interest for those responsible.

Responsible organizations must understand that air pollution is affecting human health in other to accelerate the attempts procedures for reducing environmental pollution.

Emission resulting from industrial processes must be measured for identification and assessment. The assessment must be done for pollutant emissions with major impact on surrounding environment for medium to long term. On this basis, we considered appropriate a further research for seeking a solution aimed to slow down the negative impact of air pollution on the planet.

Only the ones with financial strength and decision-making powers can implement a development plan to reduce pollution. This can be done only with an appropriate innovation study and a creative research. The overall conclusion is atmosphere pollution should be the main concern for mankind and ensuring Directive 2008/50/CE concerning ambient air quality is implemented worldwide.

2. ATMOSPHERE POLLUTION – MAIN CONCERNS

The sources of pollution are various, split between natural and human nature factors. To appreciate each contribution is almost impossible. Sources of pollution can are divided by different criteria. The common criteria divide them by the natural sources. Through this principle, we have two alternatives: natural sources and anthropic ones.

Key air pollutants and their natural sources:

a) Soil contamination with virus and particulates caused by erosion;
b) Seawater caused by aerosol loaded with salts (Sulphur and Chlorides);
c) Plants with pollen, organic and inorganic substances;
d) Humans and animals in their physiological process discharging CO_2, viruses;
e) Mass plants fire causing ash, Sulphur Oxides, Nitrogen and Carbon;
f) Volcanic eruptions through the hash, Carbon Oxides, Sulphur and Nitrogen;
g) Decomposition of organic, vegetable and animal matters;
h) Terrestrial or cosmic radioactivity;
i) Lightning;
j) Dust and sandstorms causing terrestrial particulates.

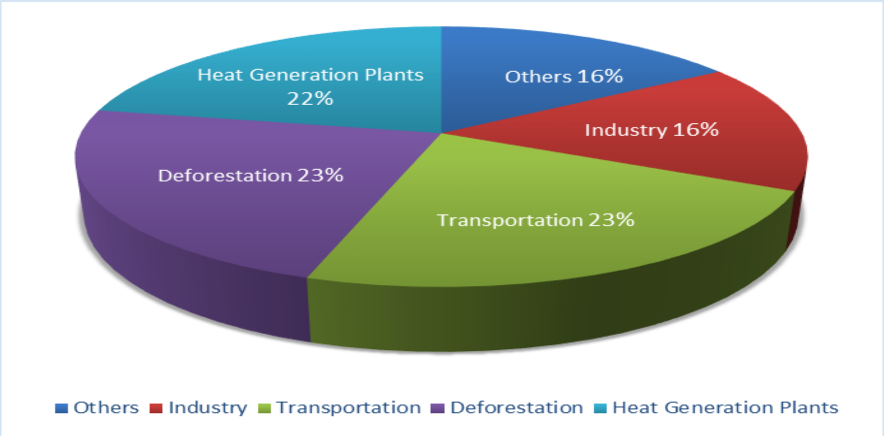

Fig.1 Distribution of pollutant source [1]

The sources used for human activities causing particulate matter evacuated into the atmosphere are classified by their branch:

a) Food processing industry;
b) Road traffic;
c) Metallurgical industry;
d) Energy industry;
e) Chemical industry;
f) Oil industry.

In terms of procedural conditions, anthropogenic emissions are consisted by particulate matter and gas emissions. COV, CO_2, NO_X, SO_X, N_2O and CO can be specified for gas emissions and Lead, Cadmium, Chromium, Copper, Arsenic, Zinc and their compound even non-metals for particulate matter and heavy metals powders.

Area pollution was the case study for us. Air pollution is identified in certain areas well defined and distinguished at different distances from urban centers. In this case, industrial activities and road traffic are the sources.

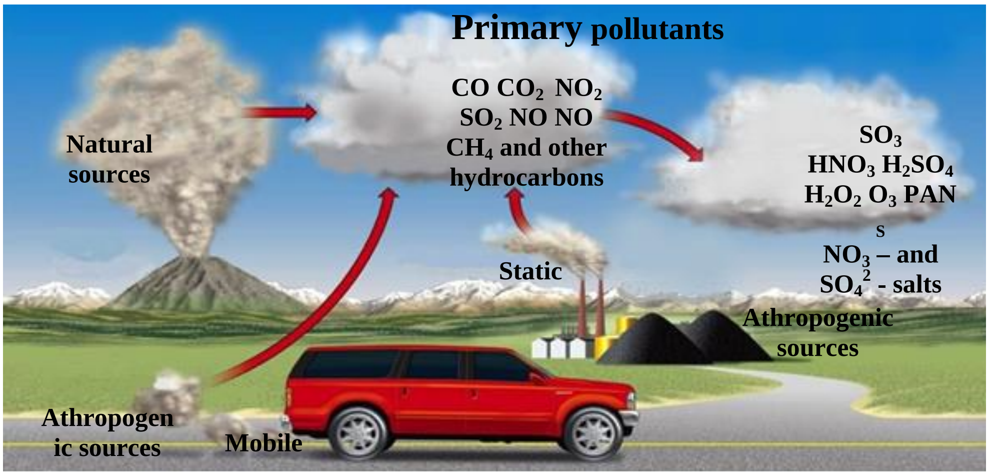

Fig.2 Atmospheric pollutants – sources [1]

If we are talking about anthropogenic sources, we have to exemplify combustion process for heat supply and heating and the industrial processes for processing materials. Vehicles are generating pollutant emissions close to the ground being concentrated at a low level. In the same time, the level of pollutant emissions generated by vehicles may be different according to the engine type, technical performances and last but not least by the quantitative ratio fuel-air. Gas emissions resulting from automotive sector contains as main pollutants: carbon monoxide (CO), nitrogen oxides (NOX) and unburnt hydrocarbons (HC). Through a chemical process of oxidation and reduction, the pollutants may become clean emissions. The overall conclusion is that artificial sources are the most numerous and harmful emissions due to technological development and their generating process.

3. Assessing the level of air pollution in urban areas

Urban pollution factors are in direct relation with urban centre territorial size related as well to: infrastructure, population density, industrial development and company's location through their manufacturing process are discharging particulate matter.

The leading causes causing pollution in urban center are:

- The explosive sharp demographic increases together with massive migration from rural areas to urban setting;
- Industrialisation not according to sustainable development policies;
- Dangerous increasing of road traffic;
- Missing green areas in places where pollution reaches its maximum.

Industrial processes, road traffic and buildings heating process are causing atmospheric pollution in urban agglomerations. Main chemicals found are Nitrogen, Sulphur and Carbon.

3.1. Monitoring of air quality on Alba country

In the following table are presented separately air quality monitoring stations for Alba country. They are part of National Network for Air Quality Monitoring (RNMCA).

Table 1. Pollutant elements and indicators [5]

Station codification /Station Type	Location	Measured indicators
AB1 urban background	ALBA IULIA 7B Lalelelor Street	SO_2, NO_X, CO, O_3, PM_{10}, Lead, Cadmium, Nickel, Arsenic, COV
AB2 Industrial 1	SEBEŞ M.Kogălniceanu Street (4 Primary school)	SO_2, NO_X, CO, O_3, PM10, COV
AB3 Industrial 1	ZLATNA 14 T.Vladimirescu Street (Avram Iancu Industrial High School)	SO_2, NO_X, CO, O_3, PM_{10}, Lead, Cadmium, Nickel, Arsenic

Correlation between pollution sources and their level is done using meteorological information from meteorological stations such as wind speed, pressure, temperature, humidity and solar radiation intensity.

Nitrogen oxides as pollution factors derive from solid, liquid and gas fuel combustion, several industrial installations, road traffic, commercial, institutional and residential areas heating plans.

Table 2. Monitoring nitrogen oxides values from monitoring stations [5]

AB1 Station	Total data Validated hours	% Available data	Evidence with concentration 200 µg/mc	% Exceeding frequency	Average values µg /mc
2013(year)	**8010**	**91**	**0**	**0**	**21.31**
2014(year)	**6929**	**79**	**0**	**0**	**21.15**
2015(year)	**7716**	**88**	**0**	**0**	**21.41**
2016(year)	**8120**	**92.4**	**0**	**0**	**24.70**
2017(year)	**7872**	**89.6**	**0**	**0**	**23.81**

AB2 Station	Total data Validated hours	% Available data	Evidence with concentration 200 µg/mc	% Exceeding frequency	Average values µg /mc
2013(year)	**No**	**No**	**0**	**0**	**No**
2014(year)	**No**	**No**	**0**	**0**	**No**
2015(year)	**6197**	**78.9**	**0**	**0**	**18.68**
2016(year)	**7892**	**89.8**	**0**	**0**	**24.22**
2017(year)	**7335**	**83.73**	**0**	**0**	**27.66**

AB3 Station	Total data Validated hours	% Available data	Evidence with concentration 200 µg/mc	% Exceeding frequency	Average values µg /mc
2013(year)	**7427**	**84**	**0**	**0**	**19.97**
2014(year)	**6497**	**74**	**0**	**0**	**12.14**
2015(year)	**5709**	**65.1**	**0**	**0**	**10.47**
2016(year)	**8116**	**92.3**	**0**	**0**	**11.42**
2017(year)	**7698**	**87.8**	**0**	**0**	**18.40**

Sulphur dioxide is a strong reagent gas, coming mostly from sulphurous fossil (coal, fuel oil) used for fuel combustion. The fuel combustion is used for generating electrical and thermal power due to industrial processes and the liquid fuel is used for engines internal combustion for vehicles. Sulphur dioxide is the main element of acid rains.

Table 3 is offering information for Sulphur dioxide with values that not exceeded the hourly limited value of 350 µg/m^3. Data capture was found between a range of 91,8% for AB1 Station and 55,6% for AB3 Station.

Table 3. Sulphur dioxide – Statistic data (average hourly values) [5]

AB1 Station	Total data Validated hours	% Available data	Evidence with concentration 200 µg/mc	% Exceeding frequency	Average values µg /mc
2013(year)	**8268**	**94.3**	**0**	**0**	**5.5**
2014(year)	**6913**	**78.9**	**0**	**0**	**5.1**
2015(year)	**8048**	**91.8**	**0**	**0**	**9.84**
2016(year)	**8096**	**92.1**	**0**	**0**	**7.89**
2017(year)	**8018**	**98.9**	**0**	**0**	**7.48**

AB2 Station	Total data Validated hours	% Available data	Evidence with concentration 200 µg/mc	% Exceeding frequency	Average values µg /mc
2013(year)	**4435**	**50.6**	**0**	**0**	**7.2**
2014(year)	**7757**	**88.5**	**0**	**0**	**3.3**
2015(year)	**7910**	**90.2**	**0**	**0**	**6.76**
2016(year)	**7818**	**89.0**	**0**	**0**	**8.06**
2017(year)	**7829**	**96.4**	**0**	**0**	**8.81**

AB3 Station	Total data Validated hours	% Available data	Evidence with concentration 200 µg/mc	% Exceeding frequency	Average values µg /mc
2013(year)	**0**	**0**	**0**	**0**	**0**
2014(year)	**0**	**0**	**0**	**0**	**0**
2015(year)	**4876**	**55.6**	**0**	**0**	**8.54**
2016(year)	**4698**	**76.2**	**0**	**0**	**3.28**
2017(year)	**4659**	**75.2**	**0**	**0**	**7.76**

Particulate matter - PM 10 are pollutants in suspension, situated in the atmosphere. They are transported on long distances by de wind or by the volcanic eruptions. Furthermore, they arise from anthropogenic sources such as fuel combustion from the energetic sector, production processes (metallurgical industry, chemical industry), building sites, road traffic, waste dump industrial and municipal areas, district heating plants especially the one using solid fuel. The minimum value accepted is 50 g/mc for a day. Annually, the minimum accepted value is 40 µg / mc. Is not recommended to exceed more than 35 times per year this value.

Table 4 Statistical data for PM10 [5]

AB1 Station	Total data Validated hours	% Available data	Evidence with concentration ≥50 g/mc for a day	% Exceeding frequency	Average values µg /mc
2013(year)	**285**	**78**	**0**	**0**	**16.43**
2014(year)	**340**	**93.1**	**8**	**2.35**	**10.19**
2015(year)	**358**	**98**	**1**	**0.27**	**10.55**
2016(year)	**360**	**98.3**	**5**	**1.39**	**12.94**
2017(year)	**353**	**96.7**	**26**	**7.36**	**19.76**

AB2 Station	Total data Validated hours	% Available data	Evidence with concentration ≥50 g/mc for a day	% Exceeding frequency	Average values µg /mc
2013(year)	**210**	**57.5**	**2**	**0.95**	**13.19**
2014(year)	**344**	**94.2**	**10**	**2.91**	**16.34**
2015(year)	**357**	**97.8**	**5**	**1.37**	**14.60**
2016(year)	**363**	**99.1**	**2**	**0.55**	**12.39**
2017(year)	**331**	**90.68**	**16**	**4.83**	**14.39**

AB3 Station	Total data Validated hours	% Available data	Evidence with concentration ≥50 g/mc for a day	% Exceeding frequency	Average values µg /mc
2013(year)	**87**	**48**	**1**	**1.15**	**23.46**
2014(year)	**341**	**93.41**	**3**	**0.88**	**11.55**
2015(year)	**340**	**93.1**	**0**	**0**	**15.25**
2016(year)	**356**	**97.2**	**5**	**1.40**	**13.48**
2017(year)	**345**	**94.5**	**16**	**4.63**	**13.21**

It can be seen from the statistical data presented that in 2015 the daily limit value of 50 µg / mc was exceeded once at the AB1 station and 5 times at the station AB2, compared to the 35, in 2016 the daily limit value of 50 µg / mc was exceeded 5 times at AB1 station and 2 times at AB2 station, and 5 times at station AB3 and in 2017 the daily limit value of 50 µg / mc was exceeded 26 times at AB1 station and 16 times at AB2 station, and 16 times at AB3 station compared to 35 times admitted by Law no. 104/2011 - on ambient air quality.

For heavy metals sampling considering different levels of toxicity, the limits are different, for Lead annual limit value is 0,5 μg/mc. This value needs to be respected in the immediate proximity of industrial sources.

The maximum value admitted for Arsenic is 6 μg/mc, Cadmium 5 μg/mc , and for Nickel 20 μg/mc.

Annual average		Lead (g/mc)	Cadmium (ng/mc)	Nickel (ng/mc)	Arsenic (ng/mc)
2014	**AB1**	**0.008**	**0.090**	**3.464**	**0.693**
	AB3	**0.015**	**0.082**	**2.684**	**0.606**

Annual average		Lead (g/mc)	Cadmium (ng/mc)	Nickel (ng/mc)	Arsenic (ng/mc)
2015	**AB1**	**0.011**	**0.564**	**2.447**	**0.665**
	AB3	**0.011**	**0.508**	**2.779**	**0.598**

4. METHODS FOR REDUCING ATMOSPHERIC POLLUTION IN INDUSTRIAL AREAS

For reducing the level of pollutant emissions from the industrial environment we have to start on reducing the pollutant from its origin. Since each industrial processes are specific will study ways to reduce polluting emission, control the source in order to propose a solution for retention or reducing the pollution.

By lowering air excess and flame temperature we decrease the number of nitrogen oxides during the processes of combustion.

When implementing these measures is not applicable we need to impose selective reduction. Due is catalytic and non-catalytic a chemical may be injected for releasing NH_2 who attacks the molecules of NO and NO_2.

As common reducing agents are used: ammonia, NH_3, urea, $CO(NH_2)_2$, isocyanuric acid, $(HOCN)_3$.

These molecules are very reactive and paired with NO and NO_2 molecules through oxygen, are capable of reducing nitrogen oxide (NO) and nitrogen dioxide (NO_2). In that way, we are able to reach nitrogen gas (N_2) and water vapors.

Sulphur dioxide retention is possible in all the phases of fuels usage. This is possible before, during and after burning (through actions on waste gases).

The process of phasing-out Sulphur and Nitrogen has the effect of destruction for the largest possible number of heavy molecules obtaining the increase ratio of light products.

Improving the retain ratio of sulphur to 65% is possible by introducing hydrogen in all the stages of processing petroleum.

The action on desulphurization of gaseous fuel consists in extracting, concentrating and retaining the hydrogen sulfide H_2S, who through special processes will be treated. Restricting the emission but only till 50% of the natural one is possible by enhancing additives on the outbreak during combustion such as emulsions particles for hydrocarbons or dolomite powder injected together with coal powder. Calcined limestone powder injected in the outbreak (CaO) reacts with Sulphur dioxide resulting $CaSO_4$.

The additives and desulphurization products that not reacted are collected into a precipitator together with combustion air. This method has shown maximum efficiency due to favorable temperature and sufficient pressure of injected limestone and air generated on the upper part of the burner.

Volatile organic compounds are commonly used in industry due to their capacity of evaporation after use.

By using volatile organic compounds appropriate precautions shall be taken due to the risk concerned for surrounding environment on-air treatment where they are kept.

COV is defined as organic substances (excluding methane) containing carbon and hydrogen who substituted partially or totally by other atoms in gaseous or vapor form in normal technical conditions

5. Conclusions and recommendations

With these technical tools, we can come support reducing the level of pollutant emissions from industry, we can establish adequate strategies for promoting environmental protection then integrate them in industrial manufacturing and energy sector. Based on this premise we are able to reduce the concentration of fine particles (PM2,5) up to 75%, ground-level ozone (O_3) up to 60%, risk to the natural environment caused by acidifying and eutrophying till 2020, taking into account 2000 level as basis.

Directive 2008/50/CE on ambient air quality must be considered if we want to reduce atmospheric pollution to minimize harmful effects on human and surrounding environment health.

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