Dangerous waste incineration and its impact on air quality. Case study: the incinerator SC Mondeco SRL Suceava

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doi: 0.4316/GEOREVIEW.2015.25.1.197

GEOREVIEW

Article history
Received: November 2014
Received in revised form: February 2014
Accepted: February 2015
Available online: March 2015

ABSTRACT: Dangerous waste, such as oil residues, pesticides, lacquers, stains, glues, organic solvents, hospital and food industry residues represent a major risk for all components of the environment (water, air, earth, soil, flora, fauna, people as well). Consequently, their incineration with high-performance burning installations lessens the impact on the environment, especially on the air quality, and it gives the possibility to recuperate the warmth of the incineration. This research presents a representative technique of incineration of dangerous waste at S.C. Mondeco S.R.L. Suceava, which runs according to the European standards, located in the industrial zone of Suceava, on the Suceava river valley Suceava. Also it is analysed the impact of this unit on the quality of nearby air. Moreover, not only the concentrations of gases and powders during the action of the incineration process (paramaters that are continuously monitored by highly methods) are analysed, but also here are described the dispersions of those pollutants in the air, taking into account the characteristics of the source and the meteorological parametres that are in the riverbed.

KEY WORDS: emissions, atmospheric pollutants waste burning, Gaussian modelling

1. Introduction

In the national and European legislation, dangerous waste is defined as those substances that contain at least a property that makes them harmful to the environment: toxicity, corrosiveness, flammability, explosiveness, infectiousness and radioactivity.

The list containing the dangerous substances was presented at Basel Convention in 1989 with reference to the control of dangerous substances transportation abroad and their elimination, in the Law 91/689/EEC and 94/904/CE, transposed at a national level through HG 856/2002 and Law 211/2011 referring to waste regime.

Dangerous waste derives from a variety of human activities like: extractive industry (oil residues silts, liquid fuel waste), chemical industry (overused oil, pesticides, lacquers, stains, glues, adhesives, solvents etc.), food industry (food waste), hospitals etc.

Depending on their composition, dangerous waste can present major pollution risks on the environment; among them we can mention:

- the chemical pollution of the environment with pesticides, cyanides, organic solvents, heavy metals, etc. with negative effects on the water, air, soil, underground water, vegetation, fauna and human beings.
- the biological contamination with pathogens, viruses, parasites and spreading infections to humans and animals on a large area.
- the radioactive contamination, especially the waste resulted from nuclear power activities (nuclear power plants, sterile from mining exploitations of uranium ores etc.), which have special regimes.

Knowing how to handle the dangerous waste is a major global problem, and as a result, the application of strict rules is required, from the production to their elimination.

In order to manage the dangerous waste and to respect the rules, the operators have the following obligations (Cupşa et al., 2011):

- the temporary storage of the waste must be realised on concrete and covered platforms, in closed spaces which have alarm systems;
- finding appropriate methods for treating each part of dangerous waste, according to its composition and characteristics;
- turning to good account of the recyclable dangerous waste must be done only by authorised economic agents;
- eliminating unrecyclable dangerous waste, which must be carried out in authorised incineration spaces or in special deposits;
- organizing campaigns intended to make people aware of the importance of the correct management of dangerous waste, with the aim of protecting the environment and the human health.

2. Data and methods

The data employed for this study included:

- the ArcGIS software v 9.3, which has been used in order to create the map showing the territorial distribution of the incineration system location of S.C. Mondeco S.R.L Suceava. The raster data was brought to the rectangular coordinates of the zone and then the vector data system necessary to map making was identified and created. As a raster support, the ortophotoplans from 2006 and the satellite images from 2012 were used;
- data regarding the characteristics of the incineration system of S.C. Mondeco S.R.L. from Suceava;
- averaging out the results of the measurements of the pollutants concentrations (sulphur dioxide, nitric oxide, carbon monoxide, total organic carbon, hydrochloric acid, powders) that are emitted through the incineration gases evacuation chimneys, after cooling and treating them in 2013; they are continuously monitorised with high-performance methods by S.C. Mondeco S.R.L. Suceava;

- the pollutants quantities in the atmosphere, after incineration process from 2013, seasonally and annually; they were compared to the threshold values (VP) imposed through Law CE 166/2006, which establishes the threshold limits of the pollutants emitted and transferred to the environment;
- the hourly values of the meteorological parameters for 2013 (temperature, air, wind direction and speed, solar radiation intensity), for 4 seasons, for daily period (between 7 A.M.-9 P.M., when the incineration system was running);
- calculating the dispersion of the pollutants emitted in atmosphere in 2013, coming from the dangerous waste incineration, through the Gaussian modeling implementation, type ISC3 (Industrial Source Complex Model), in order to approximate the soil pollutant concentrations, for fixed sources.

3. Description of location and appliance for dangerous waste incineration SC Mondeco SRL

3.1. Location of the Incineration System

The incineration system of S.C. Mondeco S.R.L. Suceava is located in an industrial zone, on the left bank of Suceava River, on its flood-plain, at an approximate 1.5 km distance from the residential areas of Suceava, having the following coordinates: 26°16'43.272" eastern longitude and 47°39'26.659" northern latitude, at an altitude of 268 m.

Figure 1 Location of S. C. Mondeco S. R. L. Suceava.

On the left side of Suceava valley, the landscape descends from the north-western even plateaus to the six terraces levels of Suceava and towards its minor bed. On the right side of the valley, in the same line with the described objective, the landscape is fragmented by Suceava's tributaries (Scheia brook, Cetatii brook), but the major morphometric and morphological characteristics are comparable with the characteristics from the left side of the river. The flood-plain bed of Suceava river is more than 3 km wide in the area of SC Mondeco SRL Suceava, increasing the good air circulation alongside the valley. Morphometrically speaking, the highest altitude from Suceava is Zamca Hill (385m) and the lowest altitudes of the city are found in the minor bed of Suceava river, 277m in Itcani and 258m in Lisaura (Cocerhan, 2012).

3.2. Description of the components of the Incineration System

S.C. Mondeco S.R.L. has a FM-6G500-type incinerator with the following characteristics:

- incineration capacity – 10 500 t per year;
- bicameral incinerator with 2 burners;
- burning temperature in the second room higher than 850°C;
- endowment with: system of warmth recuperation and energy utilization, filters and systems of gas purification; a system trat continuously monitors the emissions so that they are below the maximum admitted values in the regulatory document regarding waste and burning.

The appliance is composed of 3 distinct lines of incineration, each of them having a system of cleaning (filtering) the gases resulted from waste burning and a continuously emissions monitoring system, according to the current legislation.

The dangerous waste, received from generators, is discharged in the reception zone (Figure 2a), where the selection is made (solid, liquid etc. waste), according to the chemical composition, caloricity etc. After being weighed, the different types of waste are placed in containers (Figure 2a) and transferred to the incineration system.

The feeding with waste of the incineration system is done automatically, through a hydraulic system (Figure 2b), at certain time intervals.

a b c

Figure 2 Storage (a), automatic feeding of the incinerator with waste (b) and gas cooling system (c) *(Photo: Ana Humeniuc).*

Firstly, the incineration consists in carbonizing the waste in the initial burning room at a temperature of 750-800 C and an atmosphere with a low level of oxygen. Afterwards, the resulted gases get to the secondary burning room (post-combustion) where the temperature is between 850-1100°C.

Then, the gases are cooled (Fig. 2c) to a temperature under 300°C using a warmth changer in order to recuperate the primary energy of the waste as thermic energy.

The cooled burning gases are carried on to the cleaning system of gases, and after being cleaned, they are eliminated in the atmosphere through a chimney, having the diameter of 0.87m and the height of 15 cm.

4. The impact of SC MONDECO on the air quality

4.1. Types of pollutants emitted in the atmosphere and measures to protect the environment

After incinerating the dangerous waste, high amounts of gaseous and solid pollutants are generated, which, according to the waste nature, are seriously toxic for humans. That is why these gases which can contain powders, nitric oxides, sulphur dioxides, acids, dioxins and furans are cleaned using a special system of purifying the burning gases.

This is composed of a fluid bed filter that ensures not only the chemical treatment of the gases (a dry process named chemisorption using as absorbent the hydrated lime, that fixes the pollutants: HCl, HF, SO2, CO, NOx, after some chemical reactions) but also mechanically (by keeping the powders and the reaction products on filters with bags).

Figure 3 Cleaning System of the Burning Gases *(Photo: Ana Humeniuc).*

For limiting the dioxin and furan emissions, which are dangerous for human health, some special measures are taken, such as:

- burning takes place at a temperature higher than 850°C;
- inhibiting the catalytic activities of the cooper from the flying ashes by using lime, and rapid dedusting, made at a temperature of about 300°C;
- using some systems of low temperature with absorbents;
- automation of the process of burning and gases cleaning.

After complete burning of the waste, residual gas cleaning is the most important possibility of lowering the level of emissions from the incinerator.

4.2. Processing the data obtained through automatic monitoring of the gases emitted in the atmosphere

The monitoring of the evolution is done using an automatic system, S.C.A.D.A. type (Control and Data Acquiring System) with the following purposes:

- it gives information about the burning process;
- it reduces the peaks of the polluting evolving, when they appear by increasing the quantity of the absorbent material introduced in the system;
- it generates protocols of emissions that contain the quantitative values of the pollutants, as weighted average, at every 30 minutes and daily average values.

The facilities for the automatic monitoring of the emissions and the data circuit inside the S.C.A.D.A system are presented in Table 1, Figures 4 and 5.

Table1 Facilities and methods used for automatic monitoring of atmospheric emissions

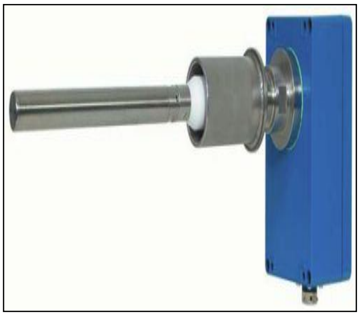
Pollutant	Facilities for automatic monitoring of emissions	Working principle	Method used
White Damp (CO) Nitric Oxide (NOx) Sulphur Dioxide (SO2)	Siemens ULTRAMAT Analyzer 6 (NDIR) with IR fluorescence	Measures the intensity of fluorescence radiation, which is proportional to the number of molecules of CO, NO_x and SO_x, from the volume of air analysed and therefore proportional to the concentration of the respective gaseous components	ISO 12039/2001 ISO 11564/98 ISO 11564/98
Total Organic Carbon (TOC)	ABB Multi-FID Sensor	Functions on the basis of the interaction between gas and an emitted light fascicle, and the absorption of the radiated energy is proportional with the concentration of the measured gas	EN 1484/1997
Fluorine and inorganic compounds of fluorine (HF)	Simens LDS 6 Analyser, laser diodes	Functions on the basis of light absorption, extinction being proportional with the concentration of the compounds from the gases to be measured	ISO 9096/2003
Chlorine and inorganic compounds of chlorine (HCl)	Simens LDS 6 Analyser, laser diodes		EN 1911-1-3/2003
Powders in suspension (PM10)	DURAG-FW 231 Powders Sensor	Measures the intensity of the electric charge of the dust particles, created after they collided.	ISO 9096/2003

In this work we averaged out the values of the daily average concentrations for gaseous pollutants (hydrofluoric acid HF, hydrochloric acid HCl, sulphur dioxide- SO_2 nitric oxide - NOx, total organic carbon - TOC) and powders, obtained by daily measurements, between 7.00 A.M. - 7.00 P.M. (facility's daily work schedule in 2013).

Also, there were estimated the total quantities of emitted pollutants, on seasons and for the whole year 2013 (Table 2, Figure 6 and Figure 7). The total quantity of the different types of dangerous waste incinerated in 2013 was 6386.396 tons.

a. LDS 6 Simens Analyser

b. ULTRAMAT 6 Simens Analyser



c. DURAG-FW 231 Powder Sensor

Figure 4 Analysers used for continuous monitoring of emitted pollutants *(Source: Technical books).*

Figure 5 S.C.A.D.A. Automatic System (Control System and Data Collection) (*Photo: Ana Humeniuc).*

When calculating the average flow of each pollutant per season, there were taken into consideration took into consideration the number of the daily hours when the system was running (with a total of 3243 hours in 2013) and the volume of pollutants emissions reported per hour (with a total of 28,871 m^3/year).

The pollutant amounts emitted in the atmosphere (kg/year) were compared to the threshold values (VP) imposed by EC Regulation 166/2006 which establishes the pollutant emitted and transferred to the environment at a European level (E-PRTR Regulation), and the concentrations of the pollutants emitted at the stack were compared to The limit values of the emissions (VLE) according to Direction 2010/75/EU regarding industrial emissions, transposed at a national level through Law 278/2013.

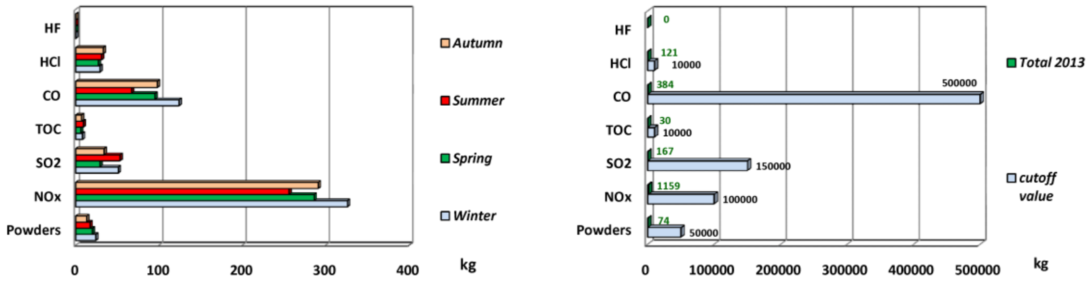
Table 2 Pollutant concentrations and quantities emitted in the atmosphere (seasonal and annual average values) in 2013

Indicator	**Powders**		**NOx**		**SO_2**		**TOC**		**CO**		**HCl**		**HF**	
Quantity	**mg/m^3**	**kg**	**mg/m^3**	**kg**	**mg/m^3**	**kg**	**mg/m^3**	**kg**	**mg/m^3**	**kg**	**mg/m^3**	**kg**	**mg/m^3**	**kg**
Winter	4.3	24	55.7	326	8.8	51	1.4	8	20.7	124	5.1	29	**0**	**0**
Spring	3.5	20	50.8	286	2.4	29	1.2	6	15.7	95	4.9	27	**0**	**0**
Summer	2.9	17	42.5	256	8.7	53	1.4	9	11.3	67	5.2	31	**0**	**0**
Autumn	2.0	13	85.6	291	5.9	34	1.1	7	16.5	98	5.7	33	**0**	**0**
Total 2013 Quantity	3.2	**74**	58	**1159**	6.5	**167**	1.3	**30**	16.1	**384**	5.2	**121**	**0**	**0**
VLE (mg/m^3) Law 278/2013	**10**		**200**	-	**50**	-	**10**	-	**50**	-	**10**	-	**1**	-
VP (kg/year) Regulation CE 166/2006	-	**5*** 10^3	-	**100*** 10^3	-	**150** *10^3	-	**10*** 10^3	-	**500** *10^3	-	**10*** 10^3	-	**5***10^3

From the data obtained through summing the amounts of pollutants issued at stack for each season and on the whole 2013, presented in Table 1 and Figure 6, compared to the threshold values (TV) established by CE Regulation 166/2006 can be observed the following aspects:

- annual amounts of hydrochloric acid in the atmospheric air were 82 times lower than the threshold value of 10,000 kg/year;
- annual amounts of carbon monoxide (CO) were 1302 times lower than the TV, the sulphur dioxide ones (SO_2) 900 lower, and the organic substances, in gaseous or steam state, expressed in total organic carbon (TOC) were 330 times lower than TV;

- annual amounts of powders in atmosphere were 675 times lower than TV;
- from the data analysis on the pollutant amounts emitted at stack for each season, one can notice mismatches between indicators due to the big variety of the structure of various types of dangerous waste which are incinerated daily; so, the biggest amounts of powders, nitrogen oxides and monoxide carbon were emitted in the winter (24 kg powders, 326 kg NOx and 124 kg CO), and for sulphur dioxide and total original organic compounds the biggest amounts were emitted in the summer (53 kg SO_2 and 9 kg TOC).



a. **b.**

Figure 6 Seasonal quantities (a) and annual quantities (b) of emitted pollutants in the atmosphere by S.C. Mondeco S.R.L. in 2013.

After averaging out on seasons the daily average concentrations, automatically measured in the four seasons of 2013, compared to the **limit values of emission (LVE)**, according to Law 75/2010/EU about industrial emissions, at a national level transferred, the following aspects can be established (Figure 7):

- for hydrofluoric acid (HF), in 2013 all the schedule values were under the detection limit of the LDS 6 Simens, these being considered 0;
- comparing the *average value on seasons*, the values are under the Limit Values of Emission: the highest concentrations were registered in winter for powders (a maximum average of 4.3mg/m^3 as compared to 10mg/m^3 LVE) and for white damp (20.7mg/m^3 as compared to 50mg/m^3) and in autumn the highest average concentrations were registered for nitric oxides (85.6mg/m^3 to 200mg/m^3 LVE) and hydrochloric acid (5.7mg/m^3 as compared to 10mg/m^3 LVE);
- *annual average values* registered in 2013 did not cross LVE imposed by Law 75/2010/EU about industrial emissions, transposed at national level through Law 278/2013: the hydrochloric acid was twice smaller than LVE, the powders and nitric oxides were three times smaller than LVE, and NOx and TOC eight times smaller than LVE.

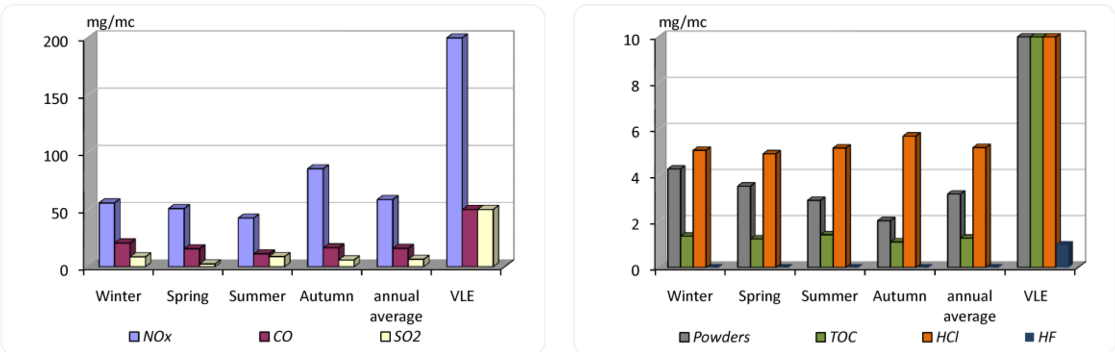


Figure 7 Stack pollutant emissions at S.C. Mondeco S.R.L. Suceava.

Therefore, after analyzing the data in figure number 7, the following can be noted:

- the total quantities of stack emitted pollutants from S.C. Mondeco S.R.L. Suceava by incinerating the dangerous waste in 2013 (HF, HCl, SO_2, NOx, TOC) and even for powders are under the threshold values (TV) imposed by Regulation CE 166/200, which establishes the emitted and transferred pollutants in the environment at the European level.
- all the average seasonal and annual values of the pollutants concentrations are much smaller than LVE imposed by Law 2010/75/UE concerning the industrial emissions, transposed at a national level by Law 278/2013.

4.3. Estimation of the dispersion of emitted gaseous pollutants in the atmosphere

For all seasons of 2013, when the incinerator worked daily between 7 A.M. and 7 P.M., the concentration of pollutants has been calculated in the atmosphere on distances of 3000 m from the source, using a Gaussian modelling software, taking into account the following parameters: the characteristics of the incinerator (incinerator diameter and height, temperature, the mass flow and the speed of the gases at the exit from the incinerator), the wind speed and frequency, air temperature, the classes of thermal stability) and the altitude.

Pasquill defined for daytime 6 classes of atmospheric thermal stability, depending on wind speed and the intensity of solar radiation, which are: A - very unstable, B - unstable, C - slightly unstable, D - neutral, E - stable, F - very stable (Pasquill, 1983).

Turner classified incident solar radiation in this way: "strong radiation" 600 W/m^2, "moderated radiation" ranging between 600-300 W/m^2 and "weak radiation" 300 W/m^2 (Turner, 1994). In the third table are presented the average values/seasons for the 2013 parameters, obtained by calculating the average out of hourly daily average values.

Table 3 Meteorological parameters – thermic stability classes (Source: Suceava Meteorological Station and EPA Suceava)

Season/ Day	Average temp/ day (^{0}C)	Solar radiation intensity (W/m^2)	Parameters	N	NE	E	SE	S	SV	V	NV	Calm
Winter	**- 0.15**	**69.39**	**Stability Class**	C	C	C	C	C	C	C	D	E / F
			H_{mixing} (m)	1038	712	949	1335	979	1038	1068	1542	-
Spring	**9.4**	**238.67**	**Stability Class**	C	C	C	D	C	C	C	D	E / F
			H_{mixing} (m)	1216	1186	949	1720	1186	1216	1097	1631	-
Summer	**21.31**	**331.47**	**Stability Class**	B	B	B	C	B	B	B	C	E / F
			H_{mixing} (m)	978	949	978	1334	1127	889	1008	1423	-
Autumn	**19.95**	**176.47**	**Stability Class**	C	C	C	C	C	C	C	C	E / F
			H_{mixing} (m)	1067	919	889	1304	949	1038	1156	1423	-

The meteorological data were obtained from Suceava weather station and from the SV2 automatic Station for monitoring air quality (located at a distance of approx. 1000 m from the location of the studied institution, equipped with automatic weather station) managed by the

Environment Protection Agency in Suceava. The heights related to the mix of toxic substances (H_{mixing}) were automatically calculated by implementing the modelling of ISC3 programme (Industrial Source Complex Model) in the long run.

The characteristics of evacuation stack at S.C. Mondeco S.R.L. Suceava are given in Table 4.

Table 4 Characteristics of evacuation stack of atmospheric pollutants (Source: A. R. P. M. Bacau)

System	Identified Emission Point	Depollution Equipment
Incinerator of dangerous waste	Dispersion chimney with 0.9m exterior diameter, 0.87 m interior diameter, H=15 m Debit of burning gases: 6000 N cubic meter/h Burning temperature : 850-1200 C Chimney gases temperature-200 C	Dry system of cleaning the burning gases formed of: -primary absorption reactor - textile filter separator Efficiency: 99%

Taking into account the characteristics of the pollution source and of the meteorological parameters in the four seasons of 2013, through implementing the actions proposed by ISC3 (Industrial Source Complex Model) in the long run, there have been obtained the soil concentrations of the pollutants (SO_2, NO_2,CO, HCl) that have been compared with the limit values (LV) as established by Law 2008/50/CE about evaluating the quality of environmental air, transposed at a national level through Law 104/2011 and the limit value (LV) imposed by STAS 12574/1987 regarding air quality.

- In **winter, during daytime**, when the solar intensity is of 69.39 W/m^2 and the average temperature of -0.15 C the following are observed:

- in situations of atmospheric calm, with a frequency of 27.5% there can be noticed maximum values for NO_2 of 24.1 µg/m^3 (while LV is 40 µg/m3) at 100m distance of source, for CO maximum values of 1.55 µg/m3 (while LV is 10µg/m3), for SO_2 of 6.37µg/m3 (while LV is 125µg/m3) and HCL of 3.59 µg/m3 (while LV is 100 µg/m3);

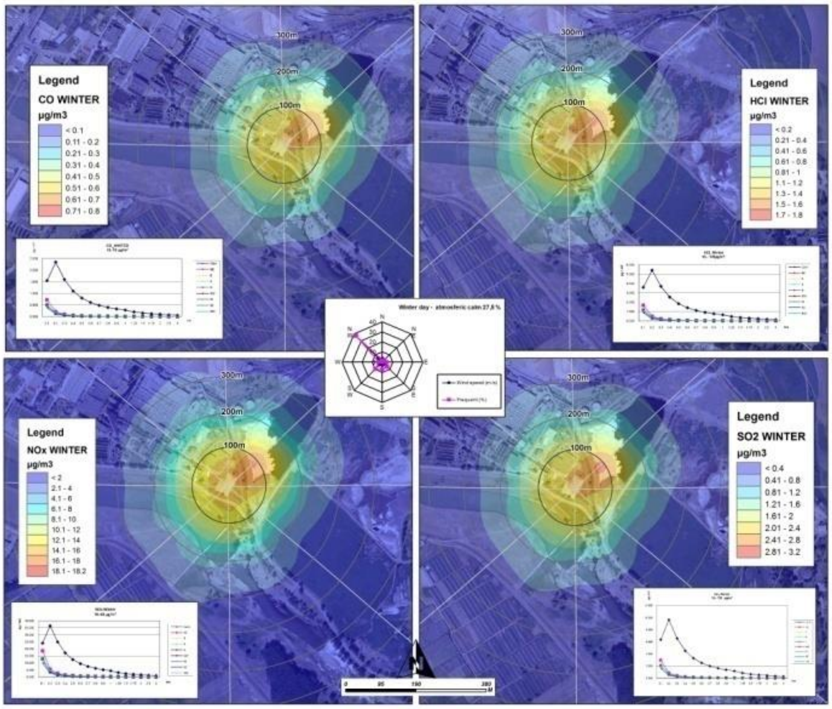


Figure 8 Dispersion and isoconcentrations of gaseous pollutants for daytime during winter.

- on the main wind direction NW, with a frequency of 37.3% average speed of 5.2 m/s, the solar radiation intensity of 69.39 W/ m2, stability class D (neutral) and the height of 1542 m (conditions that increase the good dispersion of pollutants not only horizontally, but also vertically), maximum concentrations are at 100 m distance from the source, so: for NO_2 values of 12.5 µg/m3 (three times smaller than LV), for CO values of only 0.48µg/m^3 (two times smaller than VL), for SO_2 values of 2 µg/m3 (sixty times smaller than VL) and HCL values of 1.12 µg/m^3 (approx. 100 times smaller than LV);
- on the other wind directions, for all the evaluated indicators, there have been recorded values of the maximum concentrations smaller than those from NW direction and much smaller than LV.

▪ For **spring, during daytime**, when the average solar intensity is of 238.67 W/m^2 and the average temperature is of 9.4°C, one notices maximum values smaller than those in the winter period and smaller than LV imposed by legal norms, so (Figure 9):

- in situations of atmospheric calm, with a frequency of 17.7%, the highest values being at 100 m distance from the source, one remarks that all average concentrations are less than VL. Thus, for the indicator nitrogen dioxide ($NO_{2)}$ we identified the maximum values of 21.82 µg/m^3, maximum values for CO of 6.08 µg/m^3 , for SO_2 3.68 µg/m^3 and HCl 3.47µg/m^3);
- on the predominant NW wind direction, with a frequency of 36.6% and a mixture height of 1631 m were recorded the following maximum values below VL: for NO_2 - 10.47 µg/m^3, 3.46 µg for CO, 1,06 µg/m^3 for SO_2, and 1.0 µg/m^3 for HCl;
- on the other wind directions for all indicators were recorded maximum concentration values much smaller than those from the NW direction.

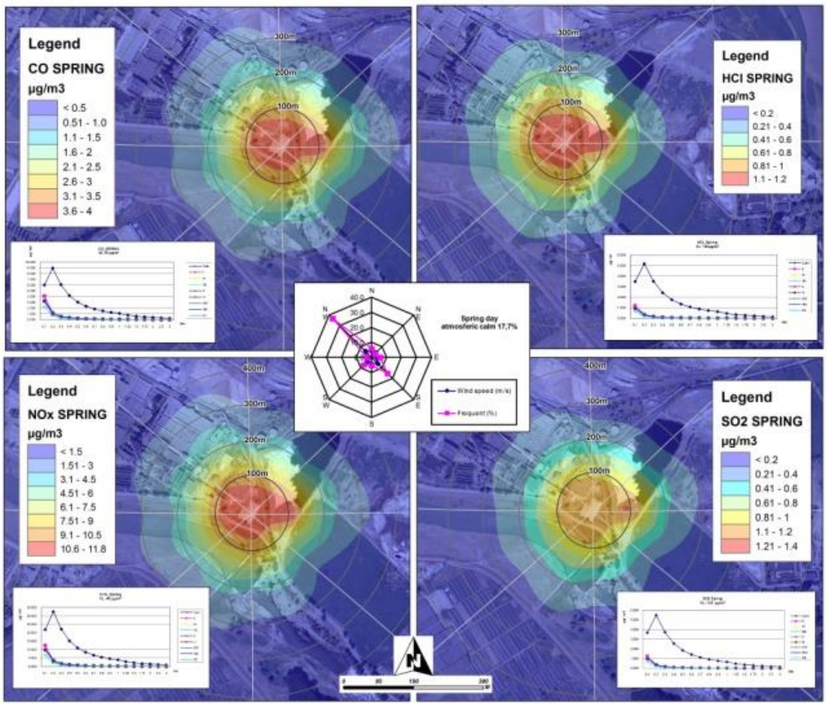


Figure 9 Dispersion and isoconcentrations of gaseous pollutants for daytime during spring.

▪ In **summer, during daytime**, the average intensity of solar radiation is the highest (331.47W / m2) and the average temperature is of 21.31°C.

Analysing the data from Figure 10, the following can be remarked:

- the atmospheric calm is 23.9%, the periods when the maximum values are within 100m distance from of the source, we have the following averages: 18.87 µg/m^3 for NO_2, 4.13µg / m^3 for CO, the 6.5µg/m^3 for SO_2 and 3.85 µg/m^3 for HCl, all of which being also much lower than LV;
- on the NW prevailing wind direction, with a frequency of 36.5%, with an average wind speed of 4.8 m/s, thermal stability class C (slightly unstable) and a mixture height of 1423 m that promotes good dispersion of the pollutants both horizontally and vertically, the maximum concentrations recorded were still at 100m from the source, but in VL, as follows: NO_2 - 9.78 µg/m^3, CO - 2.57 µg/ m^3 for SO_2, 2.02 µg/m^3 and HCl - 1.19 µg/m^3).

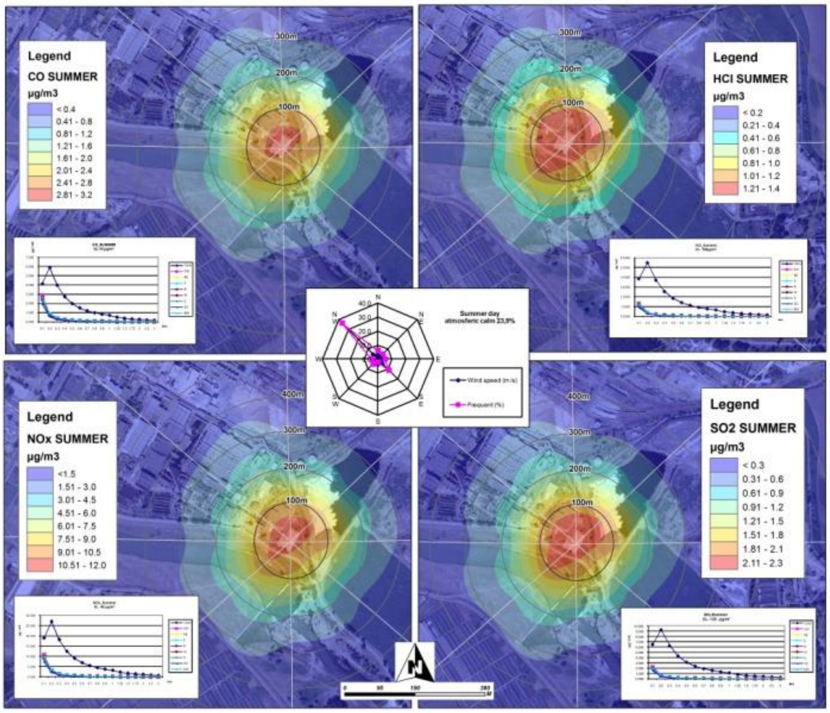


Figure 10 Dispersion and isoconcentrations of gaseous pollutants for daytime during summer.

▪ From the resulting data for the autumn season during daytime when the average solar intensity is 176.47.47 W/m^2 and the mean temperature is 19.25 ° C, there were found (Fig. 11):

- the atmospheric calm represents 31.1%, situation in which the maximum concentrations are 100m from the source: the maximum values of NO_2 are 21.55 µg/m^3 (VL is 40 µg/m^3) for CO the maximum values are 1,2 µg/m^3 (VL is 10 µg/m^3), for SO_2 they are of 4,27 µg/m^3 (VL is 125 µg/m^3) and for HCl they are of 4,13 µg/m^3 (VL is 100 mcg/m^3).
- on the prevailing NW wind direction, with a frequency of 34.5%, with an average wind speed of 4.8 m/s, C class thermal (slightly unstable) and 1536 m mixing height, where there is a good dispersion of the pollutants all concentrations are below VL, the maximum concentrations at 100 m from the source are NO_2 - 11.32 µg/m^3, CO - 0.38 µg/m^3, SO_2 - 1.35 µg/m^3 and HCl - 1.3 µg/m^3.

In conclusion, from the analysis of the data obtained by modeling the dispersion of gaseous pollutants in the atmosphere, coming from SC Mondeco SRL Suceava by incineration of dangerous waste, it is found that for the four seasons of the year 2013, the maximum concentrations at the ground for the analysed gaseous pollutants (NO_2, SO_2, CO and HCl) are much lower than the limit value (LV) required by the regulations in force in the European Community and implemented at the national level.

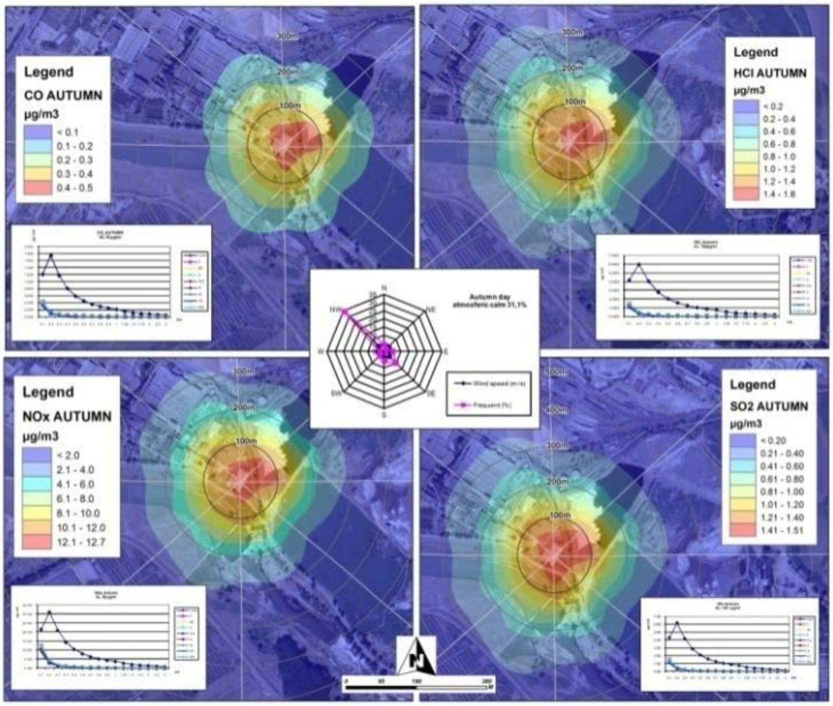


Figure 11 Dispersion and isoconcentrations of gaseous pollutants for daytime during autumn.

5. Conclusions

The measure of incinerating dangerous waste aims to protect the environment and preserve natural resources by recovering heat from burning.

❑ The *advantages* of burning the dangerous waste are:

- burning the waste through incineration reduces its volume by over 95-98%;
- incineration destroys biological pollutants which may spread epidemics;
- it allows the treatment of the chemical pollutants from the waste, using a high-performance system of cleaning the gaseous and solid pollutants;
- the energy released by the incineration of waste is converted into heat, thus reducing the use of non-renewable resources, especially fossil fuels;
- a part of non-toxic solid waste, resulted from incineration, can be reused.

❑ The *disadvantages* of dangerous waste incineration: in the this process, due to their chemical composition, extremely toxic gaseous and powder pollutants might be generated, such as hydrochloric acid and hydrofluoric acid, nitric and sulphur oxides, dioxin, furan, powders with heavy metals, and because of this it is necessary to introduce a series of expensive measures for environment protection.

❑ *Emissions monitoring*, made through automated SCADA system has the following purposes:

- provides information about the process;
- works to reduce pollutant emission peaks by increasing the amount of adsorbent material in the system;
- generates protocols emissions of pollutants containing quantitative values as a weighted average, every half-hour and daily average.

- By comparing the total annual quantity of each pollutant issued at the chimney: HF, HCl, SO2, NOx, total organic carbon (TOC) and the powders, with threshold values (PV) required by EC Regulation 166/2006 we found that, for 2013, they were between 85-1302 times less than VP.
- After calculating the average daily concentrations measured automatically in all the seasons of 2013, compared with emission limit values (ELVs) in accordance with the Directive 2010/75 / EU regarding the industrial emissions, nationally transposed through Law 278 / 2013, we found that the highest values were recorded in the atmospheric calm situations, but all of them are below the emission limit (ELVs).
- After modelling the dispersion in the atmosphere of gaseous pollutants emitted at the chimney by SC Mondeco SRL Suceava, with a maximum operating capacity 10,500 t / year (in 2013 an amount of 6,386.396 tons was incinerated), we remarked that they decreased below the limit (VL) imposed by law 104/2011 on the quality of the atmosphere, for NO_2, SO_2 and CO and at the limit of STAS 12574/1987 for HCl.

  The highest values are recorded in situations of atmospheric calm: in winter for nitrogen oxides (measured as NO_2), in summer for sulfur dioxide (SO_2), in spring for carbon monoxide (CO) and in autumn for hydrochloric acid (HCl). This behavior can be explained due to the wide variety of composition of the various types of dangerous waste that is incinerated every day. Due to the high standards of safety and environmental protection that must be met and because of the energy recovery, the incinerators have become a viable future for the management of dangerous waste.

Acknowledgements

The author Bistricean Petrut-Ionel would like to specify that this paper has been financially supported within the project entitled „SOCERT. Knowledge society, dynamism through research”, contract number POSDRU/159/1.5/S/132406. This project is co-financed by the European Social Fund through the Sectoral Operational Programme for Human Resources Development 2007-2013. Investing in people!”

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****Directive 2008/98/CE regarding waste*

****Directive 2010/75/UE regarding industrial emissions*

****Directive 2008/50/CE regarding the evaluation of environmental air quality and some clean air for Europe*

****Directive 2001/77/CE - RES directive regarding the promotion of electricity produced using renewable energy sources*

****ISC 3 (Industrial Source Complex Model) - User´s Guide*

****Law 278/2013 regarding industrial emissions.* Part 3 Limit values for the emissions in the air coming from waste incineration installations

****Law 104 /2011 regarding environmental air quality*

****STAS 12574/1987 regarding air quality*

****Government Resolution 856/2002 regarding waste*

****Ministry of Environment and Climate Changes Romania, National Strategy for Waste Management 2014-2020*

****Standard ISO 12039:2001: Stationary source emissions - Determination of carbon monoxide, carbon dioxide and oxygen*

****Standard ISO 10849:1996: Stationary source emissions - Determination of the mass concentration of nitrogen oxides*

****Standard EN 14791:2005: Stationary source emissions - Determination of mass concentration of sulphur dioxide*

****Standard ISO 9096/2003: Stationary source emissions - Determination of mass concentration of sulphur dioxide*

****Standard ISO 1484/1997: Stationary source emissions - Determination of mass concentration of total organic carbon*

****Standard ISO 9096/2003: Stationary source emissions - Determination of mass concentration of particulate matter (PM10)*

****Regional Agency of Environment Protection Bacau, Incorporate Environmental Authorization no. 14/2007*

****Hourly statistical data taken from SC Mondeco SRL Suceava for the year 2013*

****Hourly statistical data taken from the Agency for Environment Protection Suceava for the year 2013*

****Hourly statistical data collected from Weather Station Suceava for the year 2013.*