IDENTIFICATION OF SOURCES AND NATURE OF POLLUTANTS SPECIFIC TO SIDERURGICAL PROCESSES GENERATING ENVIRONMENT IMPACT

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Abstract. The paper presents the principal sources of pollutants in siderurgic industry, nature of these pollutants and the effects they produce against environment. This analysis is made by steps of technological flux specific to each procedure of elaboration of siderurgic materials.

Keywords: polluting sources, nature of pollutants, effect against environment.

1. INTRODUCTION

Polluting sources of air, water and soil specific to integrating flux for obtaining of steel products are classified after the following criteria:

a) nature of processes

1. - sources that issue pollutants in consequence of burning processes:
- coals' coking (fuels: coke gas);
- agglomeration of ores (fuels: natural gas and bi-gas composed by natural gas and coke gas or furnace gas);
- elaboration of iron (fuels: methane gas and coke gas in cowpers);
- plastic deformation and thermal treatment of steel (fuels: natural gas and bi-gas composed by natural gas and coke gas or furnace gas).

2. - sources that issue pollutants (powders) from transport and processing (breaking, grinding, sifting, sorting) of raw materials and semi-finished materials in pulverulent shape resulting fine coal particles, coke, iron ore, lime, dolomite.

b) from distribution sources point of view

1. - concentrated sources having high flow, emissions being evacuated through dispersion chimneys for emissions in air (powders and/or burning gases), through collecting channels for wastewater and, also, through waste dumps.

2. - individual and random sources which are characterized by low flow, continuous or intermittent like transport flows with discharge points (intermittent emissions) gases' escapes and powders through leakiness.

c) particularities of fabrication processes of:

1 - coke; 2 - crowd; 3 - iron; 4 - liquid steel;
5 - steel semi-manufactured products.

1. COKE-CHEMICAL SECTOR

1.1 Emissions in air

Polluting sources of air in time of coke fabrication process are:
- discharging flow, flow of transport on conveyors and prepare of coals for coking;
- coals' coking process;
- technological phases for charging and discharging of coal and coke respectively;
- wet and dry extinction of coke.

In the chemical plant for processing of coke gas, for obtaining of byproducts, emissions of pollutions in air take place due to evaporation of wastewater and releases of gases through leakiness.

The specific pollutions of this sector are:
- coal powders;
- process gases (through leakiness) and burning gases which contain: CO, CO_2, NO_X, SO_X, NH_3, H_2SO_4, HCN, H_2S, CH_4, benzene, polycyclic aromatic hydrocarbons (HPA), organic volatile compounds (COV);
- coke powders.

1.2 Emissions in water

Polluting sources of water in technological process in chemical sectors and tar processing sectors are:
- coal's humidity;
- load's humidity;
- washing of coke gas in different purge steps;
- steam condensation from ammonia stripping;
- condense from coke gas pipes;
- washing of installations and equipments, leakages, purges and rainwater;
- installations of tar distillation, indirect cooling of equipments, accidental leakages.

Pollutions present in composition of this water are: suspensions, ammonium, cyanides, phenols, sulfates, nitrates, chlorides, iron ion, tars, oils.

1.3 Waste

The generating sources and types of waste are:
- coking batteries: powders;
- primary cooling installation and decantation: fuze;
- ammonium sulfate installation: tar, acid;
- tar tanks: tar mud;
- rectification and refinement of naphthalene: acid tar.

Because from total of generated waste only powders are recovered and capitalized, rest being deposited in dumps, there is the risk of contamination of soil and groundwater with dangerous substances from dumps by washing and training phenomenon (leaching) of them by meteoric water (pluvial).

2. ORES' AGGLOMERATION SECTOR

2.1 Emissions in air

Polluting sources in agglomeration process are:
- mixing and homogenization of raw materials;
- coke grinding;
- processes from agglomeration conveyor (discharging zone and cooling zone);
- dedusting of the evacuated gases.

The pollutions present in gaseous emissions resulted from agglomeration processes are:
- agglomeration dust;
- heavy metals (Cd, Cr, Cu, Hg, Mn, Ni, Pb, Ti, V, Zn);
- acids (HCl, HF);
- NO_X, SO_X, CO, CO_2, COV, HPA, polychlorinated organic compounds (PCB, PCDD/F).

2.2 Emissions in water

Usually, purge of gases resulted in agglomeration process is made by dry way by means of electrostatics, in this process wastewater is not generated.

2.3 Waste

Because agglomeration dust is recycled in proportion of 100%, ores' agglomeration process does not generate waste.

3. IRON'S ELABORATION SECTOR

3.1 Emissions in air

Polluting sources in elaboration process are:
- cowpers: burning of fuels;
- charging of furnace;
- iron drain-casting hall;
- slag processing.

Pollutions specific to gaseous emissions from iron elaboration sector are represented by:
- furnace dust which contains heavy metals (Mn, Ni, Pb etc.);
- CO, CO_2, SO_X, NO_X, H_2, COV, HPA, polychlorinated organic compounds (PCB, PCDD/F).

3.2 Emissions in water

Polluting sources of industrial water which are used for iron elaboration are:
- indirect cooling of constructive elements of furnace;
- wet purge of furnace gas;
- slag processing.

Polluting agents resulted in wastewater from furnace are:
- Ca and Mg salts (carbides, chlorides, sulfates etc.);
- cyanides;
- heavy metals (Pb, Cr, Cu, Zn, Ni).

3.3 Waste

Generating sources as well as waste types are:
- casting of iron: fine dust;
- purge of furnace gas: dust and slam;
- transport and processing of slag: slag;
- metallurgical aggregates: debris.

4. SECTOR OF ELABORATION AND CASTING OF STEEL

4.1 Emissions in air

In this sector, polluting sources are divided by:
1. primary sources:
- pretreatment of liquid iron;
- elaboration of iron (oxygen blasting);
- burning of converter gas;
- treatment of steel in secondary metallurgy installations.

2. secondary sources:
- decanting of liquid iron and pulling of slag from cast iron pots;
- charging of steel elaboration aggregate;
- evacuation of liquid steel and slag from elaboration aggregate and from secondary metallurgy pots;
- manipulation of fillers;
- continuous casting.

Pollutions specific to gaseous emissions in steel elaboration sector are:
- fine powders which contain metals (Al, As, Cd, Cr, Cu, Fe, Hg, Mg, Mn, Pb, Zn, Ni etc.);
- Co, CO_2, SO_X, NO_X, HF, HPA, polychlorinated organic compounds (PCB, PCDD/F).

4.2 Emissions in water

Polluting sources of industrial water which are used in steel elaboration are:
- indirect cooling of constructive elements of elaboration aggregates, treating and casting of steel;
- wet purge of converter gas;
- direct cooling of semi-continuous casting products.

Polluting agents resulted in wastewater from steel elaboration are:
- metallic salts (carbides, chlorides, sulfates etc.);
- oils;
- metallic oxides (skims).

4.3 Waste

Generating sources and types of waste are:

- pretreatment of iron: desulphurization slag;
- elaboration of steel: dust, slag;
- purge of converter gas: dust, coarse and fine slurry;
- secondary metallurgy: dust, slag;
- continuous casting: slag, skims;
- metallurgic aggregates: debris.

5. SECTOR OF PLASTIC DEFORMATION AND THERMAL TREATMENTS

5.1 Emissions in air

Polluting sources in this sector are:
- heating furnaces;
- thermal treatment furnaces.

Pollutions specific to gaseous emissions in this sector are burning gases which contain low quantities of: CO, CO_2, SO_X, NO_X.

5.2 Emissions in water

Polluting sources of industrial water used to plastic deformation and thermal treatment of steels are:
- indirect cooling of constructive elements of deformation aggregates;
- direct cooling of constructive elements of deformation aggregates;
- direct cooling of semi-finished products;
- finishing processes: annealing, washing, pickling, electrolytic coating etc.

Pollution agents resulted in wastewater in this sector are:
- alkalis, acids, salts;
- solid suspensions;
- emulsions, fats, oils;
- phenols.

5.3 Waste

Generating sources and types of waste are:
- heating and thermal treatment of semi-finished products: skims;
- plastic deformation: skims and oil;
- purge of wastewater: skims and slurry;
- installation of emulsions' recirculation: oily sludge;
- adjustment of semi-finished products: discards;
- grinding of ingot slab: powders, waste rock;
- processing by splinting: shavings;
- galvanizing baths: zinc yeast;
- pickling baths: ferrous sulfate;
- neutralization of acid wastewater: chemical sludge;
- metallurgic aggregates: debris.

6. SOURCES AND LEVELS OF EMISSION OF GASES HAVING GREENHOUSE EFFECT IN SIDERURGY

Sources of emission of gases having greenhouse effect in siderurgy are: burning of fuels and ongoing of processes in different aggregates.

6.1 Sources associated to burning processes

Burning processes specific to siderurgic sectors are:
- burning of gaseous fuels in combustion rooms of coke oven batteries;
- burning of coke in small layer, in agglomeration process;
- burning of carbon in coke and in auxiliary fuels blown into furnace;
- burning of carbon in gaseous fuels, in cowpers;
- burning by open flame of CH_4 in sections of preparing of pots and in halls of iron and steel casting;
- burning of CH_4 in order to decompose the calcareous stone into calcination furnace;
- burning of fuels in rotary kilns, tunnel kilns and circular kilns for obtaining refractory materials;
- division of oxi-fuel burners for intensification of processes in electric furnace.

Processes of burning are sources of emission of CO_2, CO, N_2O, NO_X and COV of type of aliphatic, aromatic and polycyclic aromatic hydrocarbons and oxygenized compounds. Formation of these pollutions is closely related to burning conditions, specially to air and temperature excess. Generally, burning processes in siderurgic aggregates generate thermal NO_X but, in agglomeration process there are conditions for formation of fuel NO_X and even prompt NO_X which, eventually, are transforming in secondary fuel NO_X.

6.2 Sources of emission of gases having greenhouse effect and associated to proper siderurgic processes

Sources of emission of gases having greenhouse effect and associated to proper siderurgic processes are:
- pyrolysis of coals in coking rooms that generate emissions of CO_2, CO, COV including CH_4, HAP, etc. in decomposing of coal's mass process;
- losses in transport and captation systems and in installations of treatment of coking gas and in CH_4 distribution pipes or distribution pipes of other technological gases, respectively;
- dissociation of carbonates and local reductions in layer, in the neighbourhood of coke particles, in ores' agglomeration which constitute CO_2 emission sources;
- elaboration of iron into the furnace that generates CO_2, CO and reduced quantities of COV from which a small part (max. 5%) arrives in atmosphere and the rest are directed into diverse burning installations in the plant, that thus become CO_2 sources.

Sources of CO_2 in furnace: indirect reduction by CO of iron and manganese oxides in the vat, carburization of iron by CO, formation of soot in the vat, disengagement of coke's volatiles and reaction between water vapors and CO, C respectively.

Sources of CO in furnace: reaction of regeneration of CO (Bell-Boudouard's reaction), decomposing of water vapors from air in contact with incandescent coke, direct reduction of FeO, MnO, SiO_2, P_2O_5 in the inferior zone

of the furnace, disengagement of volatile matters from coke and coal dust.
Sources of COV in furnace: emissions of COV from furnace gas are due volatile matters of fuels and they are quantitatively reduced because a major part is destroyed in furnace.
- elaboration of steel in converter: burning of carbon from charge is a source of CO and CO_2, in oxygene blowing process. Converter gas mainly formed by CO is burned afterwards in the hood, on the rooting path of gases toward installation of purge or toward the coke, thus, constituting an important source of CO_2 emissions, either in converter either in other sectors in the enterprise. In the converter there are conditions of formation of thermic NO_X, by nitrogen oxidation from oxygene impurities, but the quantities are extremely reduced.
- elaboration of steel in electric arc furnace generates CO_2, CO, N_2O, thermic NO_X and COV. CO and CO_2 oxides are passing into gaseous phase in melting and purification periods. A part of CO is burning as well in the furnace as in the afterburner room so that in chimney zone, CO is found in small quantities.
More important quantities of COV may appear in situation of recycling of contaminated scrap by diverse organic substances, although, in chimney, COV are found in relatively low concentrations as consequence of destroying of these in afterburner process.
- cracking and vaporization of oil mills is a source of COV;
- pickling of metallic surfaces is a potential source of COV, or CFC;
- decomposing of calcareous stone at fabrication of metallurgic lime is a source of CO_2.
So, pollutions involved in greenhouse effect, specific to siderurgic processes are: CO_2, CO, CH_4, N_2O, NO_X, COV and aerosol.
As it concerns the share of gases having greenhouse effect, it is found that on both feeds, integrated and only by electric arc furnace, emissions of CO_2 are most important, they hold over 90%. Analyzing CO_2 emission levels in siderurgic processes, it results that the major share is held by agglomeration (60%, 175,5kg laminated CO_2/t respectively), followed by rolling (27%, 80kg laminated CO_2/t respectively).
It results that the main sources of emission of gases having greenhouse effect in siderurgic field are burning of fuels and ongoing processes in diverse aggregates and it includes the following pollutions: CO_2, CO, CH_4, N_2O, NO_X, COV and aerosol.
Analysis of data regarding emission levels of gases having greenhouse effect nationwide and international has revealed the fact that agglomeration process holds the highest share.
Comparison of emission levels of gases having greenhouse effect on the integrated feed and on that only with electric furnace has illustrated emissions over 3 times higher on the integrated feed from that with electric arc furnace.
Reduction of emissions of gases having greenhouse effect in siderurgic field is based on energetic efficiency of installations, by measures that include improvement of installations and processes and also, reduction of consumption and energy recovery.
In nationwide, emission level of gases having greenhouse effect in siderurgic field will significantly decrease in year 2012, in comparison to year 1990, due to contribution of energetic efficiency measures.

7. REFERENCES

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