# EXPERIMENTAL RESEARCH REGARDING POLLUTION REDUCTION AT ARCELORMITTAL GALAȚI IN THE LOAD AND STEEL CASTING PREPARATION SECTORS

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*The paper includes the research and own experimentation results on reducing the gasous and solid pollution content in the elaboration of ferrous materials in the oxygen converter, reffering to the load and steel casting preparation sectors. Presented therefore are the results of the 10 experimentations carried out by the new technology, which led to a 20% decrease of pollutant emissions in these sectors.*

**Keywords:** phase flow , pollutants, pollution emissions, pollution technologies, pollution study, pollution reduction measures

## 1. Introduction

The oxygen steelmaking converters method is applicable to a wide range of steels. Technological development process proceeds in several stages. At each stage of development follows a significant amount of pollutant emissions and dust. In order to establish technological methods to decrease these amounts, the experiments should be carried out on each sector and determine the level of pollution [1,2,3].

## 2. Experimental Researches

### 2.1. Experimental Researches on determining pollution in the feeroalloy and scrap metal preparation and weighing sectors.

In order to perform these experiments, 10 charges were elaborated in the oxygen converter, having various load components. The pollution emission measurements followed in this case only the ferroalloy and scrap metal preparation sectors. For an accurate assessment of the pollutant emissions, a

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detailed study is required taking into account all the necesary equipment, as well as the used technologies.

Thus, the ferroalloy preparation sector_is provided with facilities for handling, weighing and drying ferroalloys.

The existing and used equipment in this sector are:

- a crane which serves the preparation of ferroalloy zone, with a power of 16 tf and electric operation, not being a polluting source.
- an electronic scale set in the weighing zone, with a maximum capacity of 5 tons, the weighing being done automatically and its value displayed on a screen visible from both the work platform and the control cabin. The machine itself, as well as the carried out operations do not pose as a pollution source.
- two marsh gas and compressed air combined injection burners are located in the drying and calcination area, designed to eliminate moisture (water) from the ferroalloys. The plant in question is not a pollution source, the resulting reaction compounds from the drying and calcination of the ferroalloys process being water vapors.

The scrap preparation sector receives the scrap metal batch from the scrap metal preparation section, in a covered hall, the metal being brought by domestic rail wagons.

The wagons that arrive in this section are unloaded by overhead cranes equipped with magnets. The scrapping batch is fed into barters with a (10-12) ton capacity and transported with the charging machines in the elaboration section.

The two charging machines serve the elaboration section, transporting the scrap metal bins for loading the converters.

The machines run on rails and are electrically operated, thus not polluting, providing the transportation of two barters simultaneously on each machine.

The five gantries serve the station. Two of them are equipped with hooks and can lift loads up to 52 tf each. These bridges secure the barter handling.The other three gantries of 16 tf capacity each are provided with magnets and ensure the barters being loaded with scrap metal. The bridge movement is done on rails and is powered electrically, thus not polluting [4,5].

The weighing scale holds two 50 ton each capacity scales. The weighing is done automatically, the command posts being equipped with electronic weighing and display systems.

Overall, the scrap metal preparation section does not present a pollution source, the technological activities carried out here not causing polluting emissions.

## 2.2. Determining pollution in the ingot steel casting sector

This sector includes:

**a)**-Fixed casting stands. Three stands served by casting trains exist in the section. The trains are moved using internal line locomotives. The casting machine is located on the train consisting of bridges, ingot molds and casting funnels. In the casting flow there are used as a rule four types of ingot molds according to the manufacturing requirements. Gas and dust emissions occur in this sector as there are no intake and filtering systems.

**b)**-Casting bridges. The sector is served by two casting cranes, 250 tf each. Movement is done on rails, at +18.000 mm and +21.000 mm altitudes, the equipment being electrically operated, thus not polluting.

**c)**-Fixed stands and pot dumps are devices on which the casting pots are placed, on hold or for assembly. They are electrically operated (the dumps) and not pose a polluting threat.

**d)**-Pot drying equipment. These are a fixed stand provided with a swivel lid in the middle of which $CH_4$ and air pressure can be injected, the resulting flame being directed to the pot's interior for masonry drying. Usually resulted from this sector are water vapors originated from the evaporation of the constitution water in the built material.

### 2.2.1. Pollution nature, quantity and source determination.

The gaseous pollutant emissions come from the poured steel and have the following components (CO, $CO_2$, FeO, $SO_x$).

The resulting dust comes from the coating and lubrication powders used in the technological process. The coating powders generate – alumina, silica, graphite, and the lubrication powders generate - calcium powders, silica, alumina, graphitized alumina. The pollutant emissions determinations performed in the casting sectors, for the 10 experiments, have the average values presented in table 1 and figures 1 and 2.

*Table 1*

**Determined results**

| Determination number | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gaseous emissions concentrations, [%] | CO | 7,15 | 7.25 | 7,25 | 7,20 | 7,35 | 7,30 | 7.25 | 7,20 | 7,30 | 7,25 | 7,25 |
| | $CO_2$ | 1,60 | 1,62 | 1,64 | 1,62 | 1,63 | 1,64 | 1,61 | 1,62 | 1,60 | 1,62 | 1,62 |
| | $SO_x$,$FeO_x$ | 0,98 | 0,97 | 0,96 | 0,99 | 0,96 | 0,98 | 0,99 | 0,98 | 0,99 | 0,99 | <1 |
| Dust concentrations, [%] | alumina | 0,60 | 0,60 | 0,63 | 0,60 | 0,58 | 0,57 | 0,60 | 0,59 | 0,62 | 0,60 | 0,6 |
| | graphites | 0,65 | 0,64 | 0,67 | 0,62 | 0,68 | 0,65 | 0,66 | 0,65 | 0,63 | 0,65 | 0,65 |
| | silicates | 3,20 | 3,15 | 3,25 | 3,20 | 3,15 | 3,20 | 3,25 | 3,20 | 3,20 | 3,20 | 3,2 |
| | Ca powders | 3,55 | 3,50 | 3,60 | 3,50 | 3,50 | 3,55 | 3,45 | 3,45 | 3,45 | 3,45 | 3,5 |

Determined gaseous concentrations (Fig. 1) have the following average values:

There are schematically shown in Fig. 2 the average values of the revealed dust.

Usually these powders are trained by the resulting gases, as well as by the ascending heat effect of the molten steel.

In the respective area there are no intake and filtration systems, the ventilation of the area being made naturally.

About (10-15)% of the polluting emissions discharge into the air, the rest being deposited on the ground.

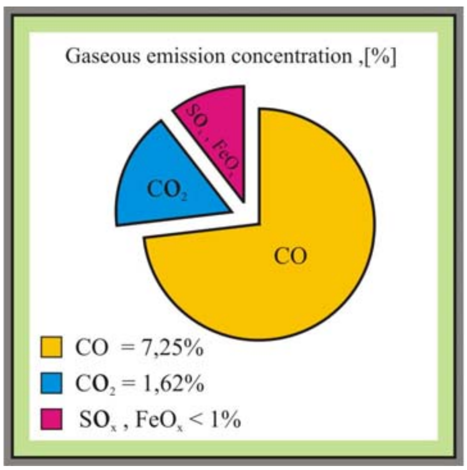


Fig. 1. Dust quantity distribution in the exhaust and ground areas

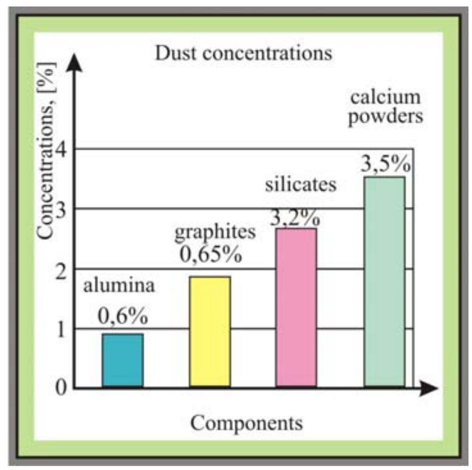


Fig.2. Schematic representation of dust components concentration

Given that OLD 1 steel production is directed to continuous casting, ingot casting is only done accidentally when for various reasons the steel cannot be cast continuously. Typically, ingot casting cases are about (2-5)% of the OLD 1 total steel production.

We can conclude that the participation of this sector in removing dust and gases is very low.

### 2.3 Determining pollution in the demolition ladle section

This sector was designed as an extension to the West side of the OLD 1 hall. Thus a suitable space for debating casting ladles has been created. The area is covered, and the West, North and South parts are open (no walls), permitting natural ventilation.

The respective sector acts for debating the pots emerged from the technological flux.

The sector is equipped with:

**a)**- a 250 tf capacity slide bridge that handles the pots and with which the proper debate is made. The crane is electrically operated, it travels on rails at +21.000 mm elevation, and does not pollute.

**b)**- a pot transfer carriage that moves the pots. It connects the elaboration - casting hall and the debate sector. The transfer carriage is electrically operated and runs on rails at ground level, not being a polluting equipment.

**c)**- a rail line that draws KB and IAS wagon types or the platforms on which the resulting demolition materials are loaded on.

The rubble and bricks are loaded onto the KB type wagons and are routed toward the slag dump and in the IAS type wagons metal carpets resulted from the debate are being loaded. The platforms are loaded with steel lenses remained on the bottom of the pot.

### 2.3.1. Pollutant nature and source determination

The sector itself is a polluting source, particle emissions being generated at the time of the debate. Dust particles usually come from the decomposed masonry material and from the material used as mortar for the wall execution. In particular, magnesite powder, chromium, calcium and dolomite powders were identified.

Being placed in an open area crossed by air currents, the vast majority of the emissions are carried to other areas, making the trained emissions measuring operation more difficult in this sector.

The remaining dust is deposited on the ground, where identified as participant in means of percentage and composition.

Typically, particles trained by the air currents to other areas are about (10-15)% of the total quantity, the rest being deposited on the ground.

For the dust deposited on the ground the following quantities and qualities of powders were highlighted. The pollutant emission determinations performed in the ladle demolition sectors, for the 10 experiments, have the average values shown in table 2 figure 3 schematically shows the distribution of the dust deposited on the ground.

*Table 2*

**Determined results**

| Det. No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dust concentrations, [%] | Chromite | 10,1 | 10,1 | 9,9 | 9,9 | 10 | 10,1 | 10 | 10,1 | 9,9 | 9,9 | 10 |
| | calcium | 20,1 | 20,2 | 20 | 20 | 20 | 19,9 | 20 | 19,9 | 20 | 19,9 | 20 |
| | dolomite | 30,2 | 29,9 | 30 | 30 | 30 | 29,9 | 30 | 29,9 | 30 | 30,1 | 30 |
| | magnesite | 39,6 | 39,8 | 40,1 | 40,1 | 40 | 40,1 | 40 | 40,1 | 40,1 | 40,1 | 40 |

The area is not equipped with intake and filtering systems, and being the only section in which these operations take place, is poses as a pollution source of the concerned area as well as for the surrounding area.

As a solution to reduce these dust emissions, the construction of walls on the South, West and North sides are required, as well as providing an exhaust system to reduce spreading dust emissions into the atmosphere.

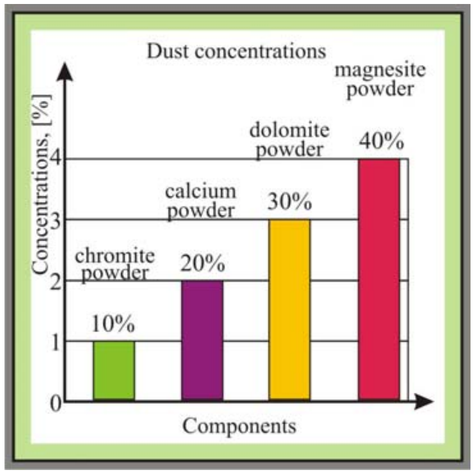


Fig.3. Schematic representation of the dust distributed on the ground

**2.4. Determining pollution in the ladle drying section**

The ladle drying section is located in a covered hall equipped with all the necessary amenities required for the drying operation.

This sector is located outside the main hall and is linked to the elaboration and casting work area through a railroad that moves a pot transfer carriage.

The machines that are fitted to the sector are:

**a)-** a crane that serves the entire area with a capacity of 80 tf being electrically operated, thus not pollutant.

**b)-** four burners for pot drying that can operate simultaneously, swiveling capable and that use $CH_4$ and air pressure as fuel.

The drying itself refers to the elimination of the constituent water used to prepare the mortar and bricks heated until red. The water vapors resulted from this technological operation are eliminated into the atmosphere and do not pose as a pollution source.

Not being a pollution source, the sector is not equipped with intake and filtering systems, no need such equipment, the existing ventilation is ensured naturally.

## 3. Results and discussions

The values of the performed emission measurements and the structure of these emissions for two big converter elaborated steel groups (mild steels and alloy steels), globally analyzed, are presented in table 3.

*Table 3*

**Pollution emissions values, [%]**

| COMPONENTS | MILD STEEL | ALLOY STEEL |
|---|---|---|
| $Fe_{all}$ | 25 – 50 | 30 – 40 |
| $SiO_2$ | 1,5 – 5 | 7 – 10 |
| CaO | 4 – 15 | 5 – 17 |
| $Al_2O_3$ | 0,3 – 0,7 | 1 – 4 |
| MgO | 1 – 5 | 2 – 5 |
| $P_2O_5$ | 0,2 – 0,6 | 0,01 – 0,1 |
| MnO | 2,5 – 5,5 | 3 – 6 |
| $Cr_2O_3$ | 0,2 – 1 | 10 – 20 |
| $Na_2O$ | 1,5 – 1,9 | 0 |
| $K_2O$ | 1,2 - 1,5 | 0 |
| Cu | 0,15 – 0,4 | 0,01 – 0,03 |
| Ni | 0,02 – 0,04 | 2 – 4 |
| V | 0,02 – 0,05 | 0,1 – 0,3 |
| As | 0,003 - 0,08 | 0 |
| CI | 1,5 – 4 | 0 |
| S | 0,5 – 1 | 0,1 – 0,3 |
| C | 0,5 – 2 | 0,5 – 1 |
| Basicity | 2 – 6 | 0 |
| Humidity | 6– 16 | 0 |

## 4. Conclusions

Research conducted over the entire flow of OLD 1 highlighted the major flow sequences and major emissions sources. All these researches were done on various types of technologies and equipment. In setting technologies and preparing the material balance sheets, calculating consumption norms according to the steel grades and deviation coefficients enrolled in admissible limits were taken into account.

Overall, conducted polluting emission measurements took into account two main groups of steel (low alloy steels and alloy steels).

The experiments showed that a significant weight over pollution is determined by the steel ingots casting sector, other sectors contributing to a very limited extent to increased emissions.

## R E F E R E N C E S

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