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CHARACTERISTICS OF DUST SOURCES AND DEDUSTING TECHNOLOGY IN COPPER INDUSTRY PLANTS

Main sources of emission of dust and mechanisms of its formation in the copper mine and mill have been characterized. The efficiency of the flue gas dedusting methods as well as that of the separate dedusting units and their disposability have been discussed.

1. INTRODUCTION

Dust emission is one of the more important factors contributing to the pollution of the atmosphere. This problem is of a particular importance in the Lubin-Głogów Copper Region, considering the fact that this area belongs to the most polluted regions in Poland. All the activities aimed to reduce the environment pollution should be preceded by a detailed examination of the situation existing in a given area.

Analysis of statistical data concerning the pollution emission shows that it is the copper industry which is responsible for the environment pollution in the region of our interest. That is why the recognition of sources and mechanism of dust emission in copper ore processing is of a particular significance.

Results of the respective investigations have been presented in this paper. All the sources of dust emission are given in fig. 1 [2]. A detailed characteristics has been presented only for organized emission sources, neglecting such sources as reservoirs of flotation wastes and dumping of gangue. Although they contribute markedly to the pollution of atmosphere, but abatement of this disadvantageous effect requires entirely different activities.

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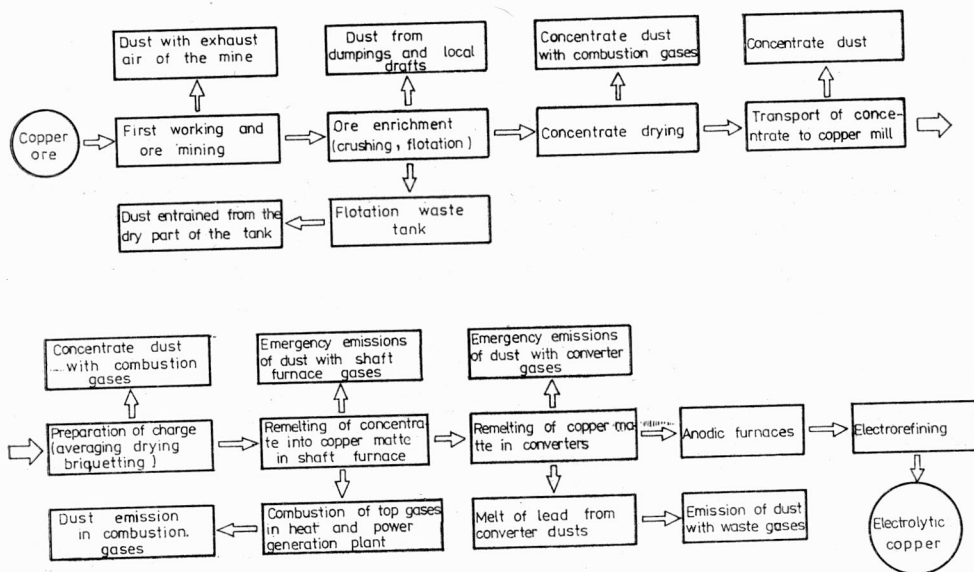


Fig. 1. Simplified block diagram of copper mining and metallurgy with dust emission marked
Rys. 1. Uproszczony schemat blokowy technologii górnictwa i hutnictwa miedzi z zaznaczeniem emisji pyłów

2. SOURCES OF DUST EMISSION IN MECHANICAL PROCESSING OF COPPER ORE

Copper ores are enriched by flotation method. They are subject to crushing and preliminary grinding processes together with classification and additional interstage grinding. Flotation process consists of two stages with the developed systems of concentrate refining and grinding of intermediate products. Ore concentrates are then transferred through mechanical thickeners to vacuum filters. The filter cake is sent to drying chamber. According to the requirements of metallurgical processes the dewatered water content in the concentrate supplied should not exceed 6–7%. Such a deep drying of the concentrate, being heat consuming, requires substantial amounts of fuel, thus contributing to the amounts of gases and dusts emitted from driers.

Dust content in gases after passing the driers ranges within 5–50 g/Nm³.

3. TECHNOLOGY OF DEDUSTING OF GASES EMITTED FROM MECHANICAL PROCESSING OF COPPER ORE

Gases, after leaving the driers, are directed to the dedusting system presented in fig. 2. The dust-containing gas flows tangentially through the inlet channels to the separate

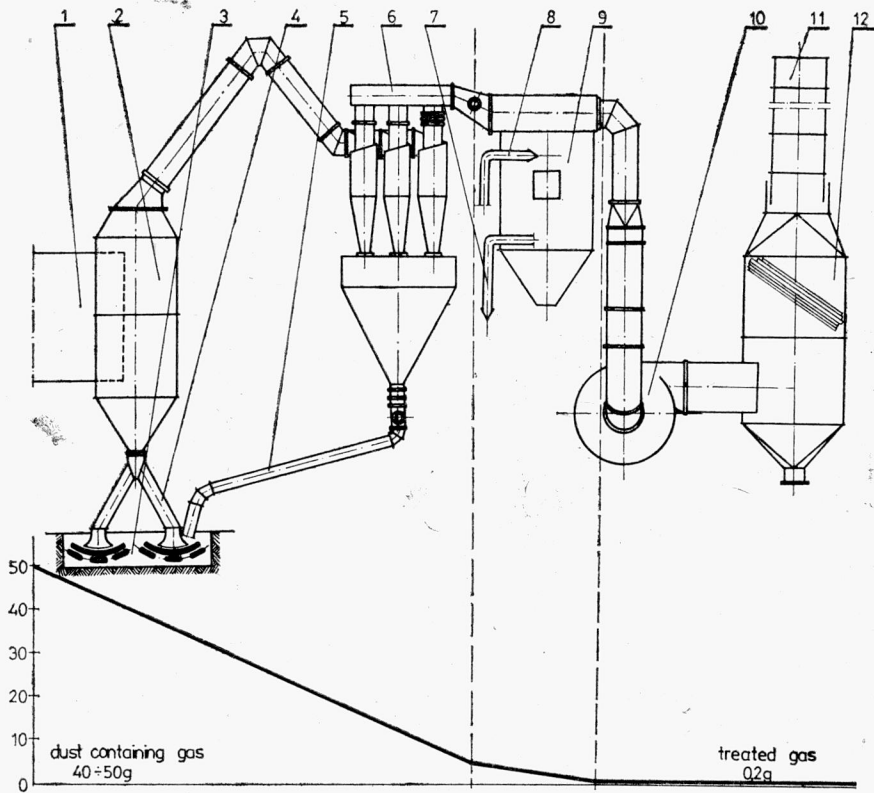


Fig. 2. Dedusting system for waste gases from the chamber for copper concentrate drying in mining plants

1 - rotary drier; 2 - reception chamber; 3 - belt conveyer; 4 - bipartite charging-car; 5 - transport of dust caught, 6 - battery of dust extractors $\tau = 6$ pieces, type - CN-15 (NIOGAZ), internal diameter $\varnothing = 750$ mm, pressure drop $\Delta p = 280$ mm H_2O , efficiency $\eta = 53\%$; 7 - slime discharge; 8 - water supply; 9 - striking washer: water consumption 0.5 dm^3/Nm^3 , efficiency $Q = 25000$ m^3/h , pressure drop $\Delta p = 108$ mm H_2O , water demand 12.55 m^3/h ; 10 - ventilator, type WpWs-60/1817, pressure $\Delta p = 480$ kG/m^2 , number of revolutions $n = 1417$ /min, temperature of combustion gases $t = 328$ K; 11 - chimney; 12 - decondenser

Rys. 2. Układ odpylający gazy odlotowe z suszarni koncentratu miedzi w zakładach górniczych

1 - suszarka obrotowa; 2 - komora odbioru suszarki; 3 - przenośnik taśmowy, 4 - zasypnica dwudzielna; 5 - transport uchwyconych pyłów; 6 - bateria cyklonów $\tau = 6$ sztuk, typ: CN-15 (NIOGAZ), średnica wew. $\varnothing = 750$ mm, spadek ciśnienia $\Delta p = 280$ mm H_2O , sprawność $\eta = 53\%$, 7 - odprowadzenie szlamów; 8 - doprowadzenie wody; 9 - płuczka uderzeniowa: zużycie wody $0,5$ dm^3/Nm^3 , wydajność $Q = 25000$ m^3/h , spadek ciśnienia $\Delta p = 108$ mm H_2O , sprawność $\eta = 99\%$, zapotrzebowanie wody $12,55$ m^3/h ; 10 - wentylator typ: WpWs - 60/1817, spręż. $\Delta p = 480$ kG/m^2 , ilość obrotów $n = 1470$ obr./min, wydajność $Q = 28000$ m^3/h , temp. spalin $t = 328$ K; 11 - komin; 12 - odkraplacz

cyclons, whence — after preliminary dedusting — it is transferred through outlet channel¹ to a washer. Its basal part is a striking chamber filled partially with water.

The stream of polluted gas strikes the water surface at a high velocity which results in dust precipitation. Thereupon the gas is conveyed to a drop drap, whence, devoid of drops, it leaves the dedusting unit. Dust content after the washer varies from 0.1 to 0.2 g/Nm^3 and dedusting efficiency amounts to about 99.6%.

4. CHARACTERISTICS OF THE SOURCES OF DUST EMITTED FROM SHAFT FURNACE CHARGE CONDITIONING

The process of copper melt applied in "Legnica" and "Głogów I" copper mills is based on the technology of shaft furnace which requires lumpy charges [5].

In the case when the copper ore is processed by flotation method, the obtained concentrate should be first subject to briquetting. This process, which requires a number of equipments and extra technological operations, is an additional source of dust emission. In order to reduce the emissions of such dusts to the atmosphere, a dedusting system consisting of a battery of cyclons CN-15 and dry electrofilters has been used. The efficiency of this system ranges within 80–95%, and the gas dusting efficiency determined at the system's outlet varies from 0.2 to 1.0 g/Nm³.

Loading devices and chutters of the shaft furnace are also a substantial source of dust emission. At the outlet of ventilation gases from these devices a special dedusting system has been applied. It consists of a battery of cyclons CN-15, of the diameter of 750 mm. The dedusting efficiency of this system being not high (about 80%), the dust content in waste gases ranges within 0.3–0.6 g/Nm³.

5. MECHANISM OF POLLUTANTS' GENERATION IN A SHAFT FURNACE

The charge to a shaft furnace, composed of briquettes, converter slag and coke in the ratio 1:0.25:0.20, respectively, is batched from its top and gradually falls down due to the melting of lower layers [1]. The air blast to the furnace for coke combustion as a stream of hot gases raises up heating newly batched charge. Thus, due to the conditions advantageous for heat exchange between the charge and gases existing in a shaft furnace, a high degree of heat utilization can be achieved.

Ores taken from the local copper beds contain chiefly:

copper glance — Cu_2S ,

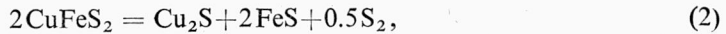
bornite — Cu_5FeS_4 ,

copper pyrite — CuFeS_2 .

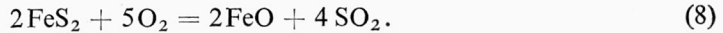
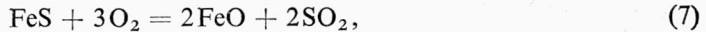
Apart from Cu, Zn, Pb, Ag, Ni, Sb, Fe, As, and Co, the copper bed contains also small quantities of Mo, V, Re and spectrally detectable Ga, Bi, Sb, In, Te, Ge, Tl, Sn, Au, Sr, Be, Ba, Hg, and Cd.

From the viewpoint of pyrrrometallurgical processes occurring in a shaft furnace, small contents of pyrite in the local ores are disadvantageous, since having a univocal influence on the choice of technology and excluding the pyrite method [1]. Thus, in order to have the necessary amount of heat during the ore processing, small quantities of coke (up to 10% of the charge weight) as well as iron are added. This mixture, which is burnt close to the nozzles, produces the lacking heat. During melting process the working space of the furnace can be divided into three zones [1]:

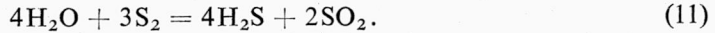
1. Upper zone, where drying, heating and decomposition reactions take place:



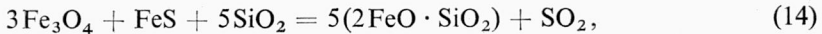
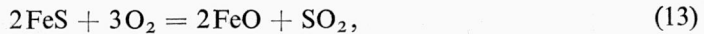
It should be noted that oxidation reaction of FeS may also occur without the preceding decomposition:



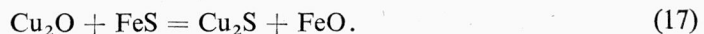
In this zone some other reactions may also take place yielding noxious gas products:



2. In the central reduction zone coke combustion proceeds, the oxidation of sulphides is completed and the slug is formed:



3. In the third — lower (oxidation) — zone the reactions between sulphides and oxides are terminated and the basic reaction occurs:



The mechanism of metal oxides formation proceeds according to the reactions (7) and (8). The oxides formed in the reduction zone are then deoxidized according to the general equation



Reactive sulphur which results from the reactions (1), (2), (4), and (5) occurring in the upper zone of the furnace comes into contact with metals giving sulphides which are the components of waste gases



This is, obviously, a side reaction, but very important one, as it decides about the composition of the dust emitted. It is also important to establish which kinds of sulphides will result. Volatility of a liquid metal depends on its vapour pressure [1] at the given temperature which is expressed by the equation

$$P_m = p_m^0 \cdot a_m = p_m^0 \cdot x_m \cdot \gamma_m^0 \quad (20)$$

where:

P_m — vapour pressure over the solution,

p_m^0 — vapour pressure of the component m ,

a_m — activity of the component m ,

γ_m^0 — coefficient of activity of the component m ,

x_m — molar fraction of the component m .

Under the assumption that the molar fractions x_m are equal, the metals form the following series according to the increasing values $p_m^0 \gamma_m^0$: Pt, Si, Ge, Al, Pd, Ni, Au, Co, Sn, Fe(Cu), Ga, Cr, Ca, In, Mn, Sb, Ag, Mg, Pb, Bi, Se, Te, As, Tl, Zn, and Cd.

It follows from theoretical considerations that the most probable components of gaseous phase are Pb and Zn: Zn — because of a high value of $p_m^0 \gamma_m^0$, and Pb — because of high value of x_m and also of $p_m^0 \gamma_m^0$. Thus, PbS and ZnS are the sulphides that may be primarily expected in the dusts from a shaft furnace.

In result of the charge melting and reduction we obtain copper matte that consists mainly of copper sulphides (50–60%), iron (20–25%), sulphur (20–23%), and shaft slug which is a silicate alloy composed of ferrous oxide, calcium oxide and silicon dioxide.

The processes occurring in the furnace produce an intense flux of gases directed upwards and carrying substantial amounts of fine particle charge. Totally, the content of those particles and condensation dusts (vaporous of inorganic compounds and bituminous tars) in a shaft gas leaving the furnace ranges within 40–100 g/Nm³. The quantity of shaft gases is substantial and for the furnace it amounts to about 100 000 Nm³/h or 4–10 Mg per one furnace during one day. Chemical composition of gases leaving the shaft furnace at the temperature of 620–870 K is given in tab. 1.

6. DEDUSTING TECHNOLOGY OF SHAFT FURNACE GASES

Gases, after having left shaft furnaces, flow to a dedusting system. The system employed in copper mill "Głogów" is presented in fig. 3. The dedusting system based on Venturii scrubber produced by "MICROPUL" deserves a special interest. This system is composed of two main dedusting units (fig. 4):

Table 1

Chemical composition of gases emitted by shaft furnace
 Skład chemiczny gazów wychodzących z pieca szybowego

Chemical compound	Concentration Percent by volume
CO ₂	10.0-12.0
CO	16.0-19.0
C _n H _m	1.0-2.0
H ₂	0.5-4.0
O ₂	0.2-0.5
SO ₂	0.2-0.3
COS + H ₂ S + CS ₂	0.3-0.5
CH ₄	0.2-0.4
H ₂ O	10
N ₂	residue

Table 2

Chemical composition of gases emitted from converter
 Skład chemiczny gazów wychodzących z konwertora

Chemical compound	Concentration Percent by volume
SO ₂	2.0-12.0
CO ₂	12.0
CO	5.0
SO ₃	0.2-1.4
O ₂	0.2
COS + H ₂ S	0.2
NO ₂ + NO + N	residue

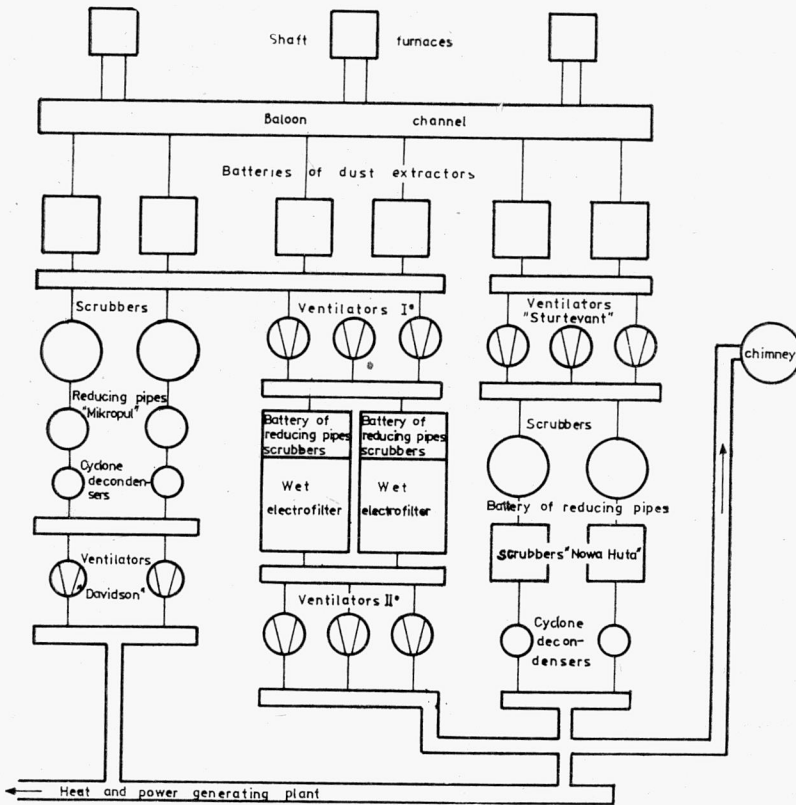


Fig. 3. Block diagram of dedusting systems for top gases in copper mill "Głogów I"

Rys. 3. Schemat blokowy układów odpylania gazów gardzielowych w hucie miedzi „Głogów I”

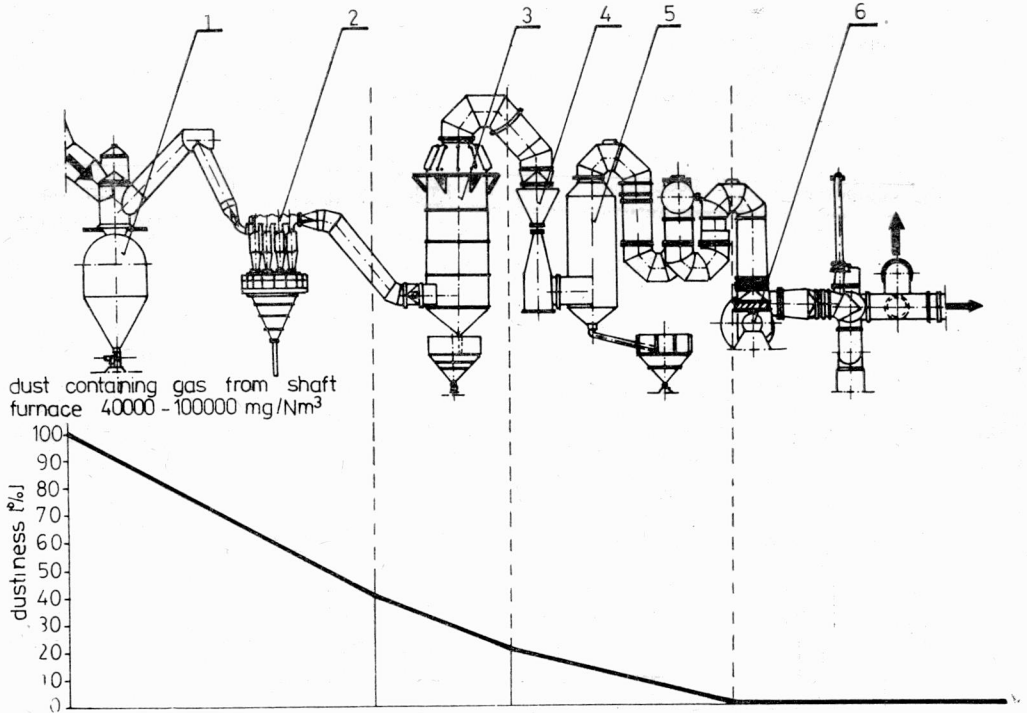


Fig. 4. Equipment for dedusting of top gases "MICROPUL" in copper mill "Głogów I"

1 - settling tank: $\varnothing = 4500$ mm, $l = 31000$ mm, gas temperature 673–873 K, dusting 30000–40000 mg/Nm³; 2 - battery of dust extractors (cyclones): $\varnothing = 8000$ mm, number = 8×4, $\eta = 60$ –90%; 3 - countercurrent scrubber: $\varnothing = 4500$ mm, $h = 15000$ mm, 27 nozzles, $\varnothing = 13$ mm, $\eta = 40$ –50%; 4 - reducing pipe: $\Delta p = \text{const} = 1100$ –1250 mm H₂O, $v = 90$ –120 m/s; 5 - decondenser - cyclonic type: $\varnothing = 3800$ mm, $h = 10000$ mm, $v = \text{const} = 20$ m/s; 6 - fan: $Q = 180000$ Nm³/h, pressure = 1870 kG/m², $n = 1470$ rev/min, $M = 1.2 \times 10^6$ W

Rys. 4. Instalacja odpylania gazów gardzielowych „MICROPUL” w hucie miedzi „Głogów I”

1 - komora osadacza: $\varnothing = 4500$ mm, $l = 31000$ mm, temp. gazu = 673–873 K, zapylenie = 30000–40000 mg/Nm³; 2 - bateria cyklonów: $\varnothing = 8000$ mm, szt. = 8×4, $\eta = 60$ –90%, 3 - skrubler przeciwprądowy: $\varnothing = 4500$ mm, $h = 15000$ mm, dysze - $\varnothing = 13$ mm × 27 szt., $\eta = 40$ –50%; 4 - zwężka: $\Delta p = \text{const} = 1100$ –1250 mm H₂O, $v = 90$ –120 m/s; 5 - odkraplacz, typ cyklonowy: $\varnothing = 3800$ mm, $h = 10000$ mm, $v = \text{const} = 20$ m/s; 6 - wentylator: $Q = 180000$ Nm³/h, spręż. = 1870 kG/m², $n = 1470$ obr./min., $M = 1,2 \times 10^6$ W

- 1) the unit of preliminary (dry) dedusting,
- 2) the unit of final (wet) dedusting.

The first unit comprises settling chamber and the battery of cyclons, whereas the wet dedusting unit consists of counter-current scrubber, reducing pipe and cyclone drop separator. The reducing pipe applied in this case has a square cross-section adjusted automatically with mechanically cleaned nozzles supplying the reducing pipe with water. Confuser and the reducing pipe mouth are lined with carborundum attrition-resistant lining. The mouth cross-section adjustment is based on a constant pressure drop in the reducing pipe mouth, since practically it corresponds to a constant gas velocity. In practical operation the pressure drop in the mouth is kept within 1100–1250 mm of water.

Dust content in the outlet gases from the dedusting system ranges within 20-60 mg/Nm³. The dedusting efficiency of this system is very high and reaches 99.9%.

The purified gas may be burnt in thermal-electric power station or emitted to the atmosphere. The effective working time of the dedusting system is also an important problem. For the system with the reducing pipe "MICROPUL" it amounts to 99.9%. For comparative reasons, the analogous parameter for the dedusting unit with the so-called battery of "NOWA HUTA" reducing pipes (fig. 3) amounts to 42%. During the remaining 58% of the operation time not purified shaft gases are discharged directly to the atmosphere through the so-called emergency chimneys [5].

7. MECHANISM OF POLLUTANTS' GENERATION IN CONVERTERS

The second important source of dusts in copper mill "Głogów" is the copper matte refining, the purpose of which is the removal of iron and sulphur. During this process other components, mainly metals, the vapours of which are easily volatile, are also burnt. The process of copper matte refining can be divided into two stages [1]:

1. During the first stage the following reaction occurs



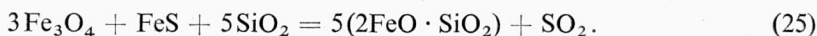
as well as a small part of copper sulphide is oxidized to copper oxide:



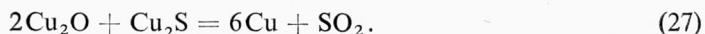
which, however, immediately combines with ferrous sulphide yielding



and



2. During the second stage the following reactions take place:



The product of reactions occurring in the converter is blister copper containing 98.5-98.7% of pure metal, slag, flue gases, and dusts. The composition of gas leaving the converter is shown in tab. 2. The gases leaving the converter catch tiny particles of silica, cold admixtures and droplets of copper matte, slag and metallic copper. Escaping gases include also the vapours of some volatile metals and their oxides (Zn, Pb, As, Bi, and Sb). In gas-ducts the metal vapours are oxidized and their oxides are next deposited in dedusting devices or are emitted to the atmosphere.

8. TECHNOLOGY OF TREATMENT OF GASES EMITTED FROM CONVERTERS

Waste gases from converters, under normal operation conditions, are directed to the dedusting system. As may be shown from the brief characteristics of the refining process, gas dedusting proceeding in cycles is rather a complicated process. SO_3 content, thereby high temperature point of gas condensation, requires that the dedusting process be conducted at appropriately high temperature (of order of 573 K). This temperature must be achieved by all the elements of dedusting system being in a direct contact with gases, since otherwise they will be liquified forming acid solutions.

Moreover, as mentioned earlier, because of periodic character of the process the amount of heat carried by gas in the intervals between the separate stages of convertering is too small to keep the required temperature inside the device. In order to keep it at a constant level, heat insulation or even heating of walls of electrofilters (employed commonly as a final deduster) should be applied. Schematic diagram of the set-up for dedusting of converter gases is shown in fig. 5.

First dedusting degree is achieved in settling tank with an emergency chimney which emits the gases to the atmosphere: in the first phase of start, in case of abnormal operation of converter, after stopping the converter's blast, or for air sucking into the system.

At a normal operation of the converter the emergency chimney is closed, whereas two throttles on pipes connecting settling tank with cooler are opened and enable the gas flow toward coolers. Pipe coolers are equipped with the sets of throttles. Their task is to regulate the temperature of gases after the coolers by swithing off parts of cooling pipes. The above system allows to keep the temperature about 650 K. Then, the gas passes the fan I° and the collector to reach the electrofilter. The latter is equipped with a natural gas heating system in order to keep inside it the temperature above 570 K. The walls and funnel (hopper) of electrofilter are, moreover, heated by means of steam heating coils. Heating coils are each time switched on before electrofilter is started to prevent condensation of acid solutions when the gases come in contact with cold parts of electrofilters.

Gases, after being treated, are transferred — through the collector and fan II° to the factory of sulphuric acid. Dust content of gases after leaving the dedusting system ranges within 150–200 mg/Nm³. Further, deep dedusting of gases supplied to the factory of sulphuric acid is performed in cooling and washing towers and wet electro-filters. Due to wrong operation of those systems the dusts may penetrate into further technological processes, decreasing their efficiency and poisoning the catalyst which exerts an inhibitory effect on conversion process.

9. CHARACTERISTICS OF OTHER DUST SOURCES IN COPPER MILL

An important source of dust in copper mills are heat-and-power generating plants. In the copper mill "Głogów" this plant is equipped with boilers ORG-32 and WML-25. The flue gas exhalation system includes a battery of cyclons of the type B-6-C-42-1050

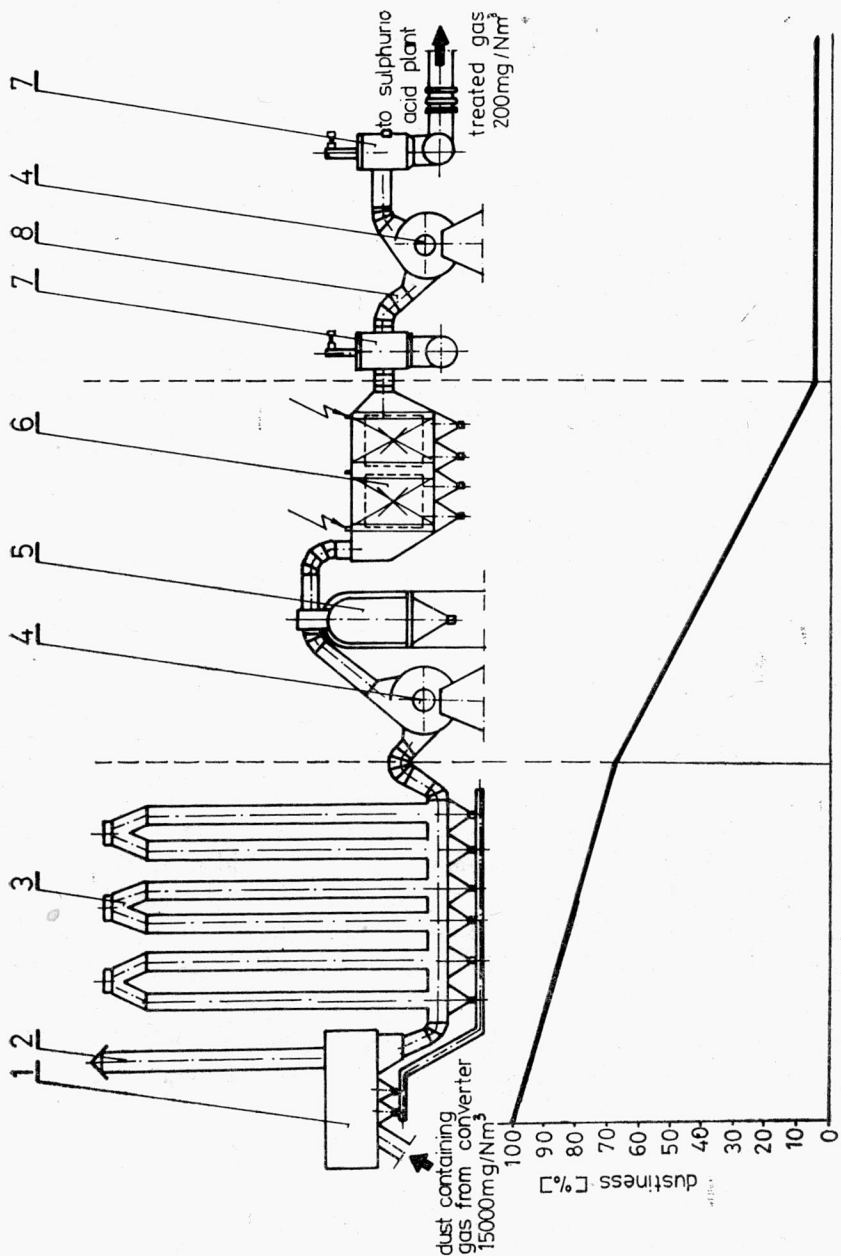


Fig. 5. Scheme of dedusting equipment for converter gases in copper mill "Głogów I"

1 - settling tank: gas temperature = 1173 K, $V = 22000 \text{ Nm}^3/\text{h}$, hydraulic pressure = 10 mm H_2O , 2 - emergency chimney: $h = 25000 \text{ mm}$; 3 - pipe cooler: $t_p = 1153 \text{ K}$, $t_k = 653 \text{ K}$, $\eta = 33\%$, hydraulic resistance = 60 mm H_2O , $V = 20000 \text{ Nm}^3/\text{h}$; 4 - fan: $\dot{Q} = 135000 \text{ Nm}^3/\text{h}$, pressure = 480 mm H_2O , $n = 0-1000$ revolutions/min.; 5 - collector of dirty gas: $\text{Ø} = 3500 \text{ mm}$, $t = 650 \text{ K}$, $V = 72000 \text{ Nm}^3/\text{h}$, hydraulic resistance = 10 mm H_2O ; 6 - dry electrofilter: electrodes - collecting - 17 rows, - 16 rows, $t_p = 643 \text{ K}$, $t_k = 613 \text{ K}$, $\eta = 96\%$, $V = 20000 \text{ Nm}^3/\text{h}$, $U = 50 \text{ KW}$, $A = 50-300 \text{ mA}$, 7 - bell valve: $\text{Ø} = 1400 \text{ mm}$; 8 - collector of cleaned gas: $\text{Ø} = 1800 \text{ mm}$, $l = 56000 \text{ mm}$, $t = 573 \text{ K}$, $V = 75000 \text{ Nm}^3/\text{h}$

Rys. 5. Schemat instalacji odpylania gazów konwertorowych w hucie miedzi „Głogów I”

1 - komora osadacza: temp. gazu = 1173 K, $V = 22000 \text{ Nm}^3/\text{h}$, odpór hydr. - 10 mm H_2O ; 2 - kominiek awaryjny: $h = 25000 \text{ mm}$; 3 - chłodnica rurowa: $t_p = 1153 \text{ K}$, $t_k = 653 \text{ K}$, $\eta = 33\%$, opór hydr. = 60 mm H_2O , $V = 20000 \text{ Nm}^3/\text{h}$; 4 - wentylator: $\dot{Q} = 135000 \text{ Nm}^3/\text{h}$, spręż. = 480 mm H_2O , $n = 0-1000$ obr./min.; 5 - kolektor gazu brudnego: $\text{Ø} = 3500 \text{ mm}$, $t = 650 \text{ K}$, $V = 72000 \text{ Nm}^3/\text{h}$, opór hydr. = 10 mm H_2O ; 6 - elektrolit suchy: elektrody - zbiorcze = 17 rzędów, ulotowe = 16 rzędów; $t_p = 643 \text{ K}$, $t_k = 613 \text{ K}$, $\eta = 96\%$, $V = 20000 \text{ Nm}^3/\text{h}$, $U = 50 \text{ KV}$, $A = 50-300 \text{ mA}$; 7 - zawór dzwonowy $\text{Ø} = 1400 \text{ mm}$, 8 - kolektor gazu czystego: $\text{Ø} = 1800 \text{ mm}$, $l = 56000 \text{ mm}$, $t = 573 \text{ K}$, $V = 75000 \text{ Nm}^3/\text{h}$

the efficiency of which is about 90% and final dusting of gases ranging from 0.18 to 0.50 g/Nm³. Combustion of top-gas contributes substantially to the reduction of dust emitted from heat and power generating plant. The gas thoroughly purified is transferred to the heat-and-power generating plant and burned under the boiler ORG-32 (capacity about 30,000 Nm³/h of gas per one boiler). In order the combustion process run properly the gas humidity should not exceed 110 g/Nm³.

The last source of dusts in copper mill "Głogów" is the so-called department of accompanying metals, whose task is to obtain lead from waste materials with a high (50%) content of lead, in the so-called Dörschel furnaces. These waste materials comprise chiefly lead-bearing slimes (retained in the deduster of top-gases) and dusts (from the deduster of converter gases). The unit for extraction of combustion gases is equipped with 10-chamber bag filter of the type 10/96 and the efficiency of about 86%. It should be, however, added that the effective working time of this deduster is very short. Failure frequency of this deduster is connected with the fact that often the temperatures of waste gases increase, damaging the filtration material in dedusting unit. In order to improve the dedusting effect, instead of dry dedusting, a wet process is to be applied on the extractor of combustion gases in the department of accompanying metals. The reliability of wet dedusting unit is very high.

In the copper mill "Legnica" the basic technological processes are similar to those in copper mill "Głogów", therefore their descriptions are omitted.

Dynamic development of copper basin required the construction of many plants which would perform auxiliary functions and services for mining and copper mills. The greatest plant of this type located in mining and copper mill industrial group is plant "Legmet" producing the self-propelled machines and non-typical machines and equipments. The most important source of the dust emitted takes its origin in cupolas, induction furnaces and arc furnaces installed in the foundry, the basic department of "Legmet". An additional dust emission comes from the plastic forming shop and pattern shop and woodworking shop. Considering, however, a small emission of gas by these sources only that from foundry is of essential importance. The remaining shops of "Legmet" emit various contaminants, but not in a dust form.

10. SUMMARY

Based on the review of dust emission sources in the separate stages of electrolytic copper production, it may be stated that copper mills are the chief source of dusts. This is due to the employed technologies based on shaft furnaces. The technology of fluidized-bed oven applied in copper mill "Głogów II" is by assumption less noxious. At present because of investment limitation the technology of melting in shaft furnace cannot be replaced by the fluidized-bed oven. It should be added, moreover, that the method of copper matte melt in such a furnace must be developed in details.

It is of a particular importance however, to reduce the duration of emergency emission from shaft furnaces and converters. To this end the efficiency of actually operating refining shops must be improved. Sometimes, however, the contaminated gases must be emitted directly to the atmosphere without being previously subject to dedusting process due to technological reasons. In order to reduce the noxiousness of pollutants discharged in this way, some systems limiting the amounts of gases emitted should be designed and constructed. These systems should have the following technical parameters: dedusting efficiency not higher than 40–60% and real working time — 100%. The latter parameter is of a particular importance, since by achieving 100% effective working time it would be possible to reduce substantially the noxiousness of the most important pollution source (the emergency chimneys). Dedusting systems employed in other pollution sources permit a satisfactory treatment of waste gases, provided, however, that these systems are in a continuous operation.

11. FINAL CONCLUSIONS

1. The basic amounts of dust in copper industry come from pyrometallurgic processes occurring in shaft furnaces and converters of copper mills.

2. Pollution of atmosphere with dusts in the environment affected by copper industry depends on emergency emissions.

3. Dedusting systems applied in copper industry ensure a sufficient purification degree of waste gases.

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CHARAKTERYSTYKA ŹRÓDEŁ PYŁU I TECHNOLOGII ODPYLANIA W ZAKŁADACH PRZEMYSŁU MIEDZIOWEGO

Scharakteryzowano główne źródła emisji pyłu i mechanizmy jego powstawania w zakładach kombinatu górniczo-hutniczego miedzi. Omówiono skuteczność stosowanych metod odpylania gazów odlotowych oraz efektywność i dyspozycyjność poszczególnych urządzeń odpylających.

DIE CHARAKTERISTIK DER STAUBQUELLEN SOWIE DER ENTSTAUBUNGSTECHNOLOGIEN IN BETRIEBEN DER KUPFERINDUSTRIE

Es wurden die Hauptquellen der Staubemission gekennzeichnet sowie die Mechanismen der Staubentstehung in den Betrieben des Kupfer Bergbau-Metallurgie Kombinars. Es wurde die Wirksamkeit von angewandten Abgasenentstaubungsmethoden besprochen sowie Effektivität und die Anordnung der einzelnen Entstaubungsanlagen.

ХАРАКТЕРИСТИКА ИСТОЧНИКОВ ПЫЛИ И ТЕХНОЛОГИИ ОБЕСПЕЧИВАНИЯ НА ПРЕДПРИЯТИЯХ МЕДНООБРАБАТЫВАЮЩЕЙ ПРОМЫШЛЕННОСТИ

Дана характеристика главных источников пылевой эмиссии и механизмов её образования в Медном горно-металлургическом комбинате. Обсуждена эффективность применяемых методов обеспыливания отходящих газов, а также эффективность и располагаемость отдельных обеспыливающих устройств.