

## TO THE PROBLEM OF COMPLEX PROCESSION OF COPPER-, ARSENIC-CONTAINING MULTIMETALLIC MATERIALS

Zhaldobay E.E., Nurlan G.B., Dosmukhamedov N.K.

*Kazan national research-technical university of K.I. Satpayev, Almaty, e-mail: nurdos@bk.ru*

Involvement into procession of multimetallic sulphide ore and concentrates is limited by an increased arsenic content in them. Nevertheless, due to depletion of the initial deposits of materials, rich in basic metals, the mentioned metals are processed by force within the existing production chain ("linkage") with alteration of the production regime. A critical level of situation that requires urgent measures on creation of approbated technologies, aimed to solve the problem of complete and complex extraction of all valuable components from multimetallic materials, is achieved at certain enterprises. Solution of this problem obtains a special urgency in terms of extracting such valuable material as rhenium which is an additional metal of sulphide multimetallic copper concentrates. This work provides results of complex procession of copper-arsenic concentrates that contain rhenium. It demonstrated principal possibility of high extraction of rhenium into gas phase via carrying out preliminary oxidation glazing. It was established that a relatively high selective extraction of rhenium into dust up to 83 % is achieved in terms of oxidation of sulphide copper-arsenic concentrate within temperature range 400–500°C, and oxygen consumption blowing coefficient to fuel 1,0–1,5. In the described conditions sublimation of arsenic into gas phase is preserved at a low level of ~17%. Further extraction of rhenium from the received selective product with the low content of arsenic does not cause any difficulties. The received copper end can be processed after the burning according to the existing technologies with discharge of arsenic remains from the further operation via traditional means.

**Keywords:** copper-arsenic concentrate, extraction, rhenium, burning, blowing, oxygen

Growth in consumption of mineral-raw materials and energy sources has led to an increase in number of the opened and exploited mineral deposits. Multimetallic ores and concentrates, complex in their mineralogical and chemical composition, have been involved into procession. The existing technological schemes proved to be unable to process such type of raw materials, and it led to a serious complication of the former. Nowadays nature-users have no motivation to solve the problem of complex procession of multimetallic raw materials while they are receiving great income for selective procession of the rich part of deposit and realization of final product – strictly basic metals. However, clear economic advantage lies in realization of the fact that multimetallic resources can be used in production of import-replacing and export-directed products.

Such approach is basically significant and makes us to pay attention to the problems of extracting such valuable additional metals of copper as rhenium, osmium, ruthenium, and a number of other rare and rare-earth metals for which sulphide copper ores and concentrates are the basic sources of extraction.

In Republic of Kazakhstan production of rhenium has been established on two enterprises – LLC "Corporation Kazakhmys" and LLC "Industrial Corporation "Yuzhmultimetal"". Nowadays, due to the shutdown of LLC "Industrial Corporation "Yuzhmultimetal"" extraction of rhenium is carried out at Djezkazgan copper-melting plant of LLC "Corporation Kazakhmys" from lead converter dust. Let us underline that the existing technology of producing rhenium at Djezkazgan copper-melting plant has been complicated significantly due to an increase in

content of other additional elements in the initial material and is defined by low extraction of rhenium at the level of 35–40%.

It is known [1-3] that valuable additional rare and rare-earth elements of copper ores and concentrates can be divided into three groups depending on which product of melting can be extracted from them most easily and thus reasonably. As the same time the most complex and multisided remains management of behavior of admixture groups that should be extracted into gas phase or sublimes. The following elements, in addition to rhenium, osmium, and ruthenium, can be referred to this group: Zn, Cd, In, Pb, Ge, As, Sb, S, Se, Te, Ta and others. While organizing the process of processing multimetal copper materials one should consider legislations of distribution of the mentioned metals between products of melting.

In its time, a great attention to this problem was devoted by professor A.V. Vanyukov. In his opinion, none of the facilitated processes creates due conditions for distillation of all valuable components. He underlined the fact that behavior of additional elements of copper differs significantly: some of them (In, Pb, As, Sb, S, Se, Os, Re, Ru) require melting under oxidation conditions for extraction into gas phase or sublimes, others (Zn, Cd, Ge) need restoring conditions. Process KIVCET corresponds to conditions of complex sublimation of valuable components to the fullest extent. However, its significant disadvantage is an extremely slow pace of restoration process and sublimation in the electro-thermal area due to a low speed of mass exchange. Considering the change in composition of initial raw materials to the side of degradation, conclusion of A.V. Vanyukov

on that a critical necessity of creating principally new processes that will provide for a high degree of extraction for all valuable copper satellites from multimetal materials at a high speed of process [1] proves to be convincing.

Considering the above-mentioned reasons, we can claim that complex solution of the problem – simultaneous increase in extraction of all valuable elements of the mentioned group within one separate melting aggregate is very difficult to achieve. At refers especially to multimetal copper concentrates that contain arsenic and rhenium. In order to process such materials, in our opinion, it is preferable to carry out their preliminary burning to provide for relatively high extent of selective sublimation of rhenium into gas phase.

Scientific literature knows works [4–6] which develop and suggest various methods of solving this problem. However, regardless of the achieved positive results, these works possess a number of mutual weak points. Particularly, work [4] draws our attention to studying behavior of arsenic while problems of rhenium behavior during the process of burning sulphide material in the boiling layer remain beyond the research. Among the disadvantages of work [5] we can outline complexity of implementing the suggested methods such as spreading rhenium among products of granulation and sulphatizing burning as well as concentration of arsenic in dust together with rhenium. Suggested in work [6] method of processing sulphide arsenic-containing multimetal material is defined by complexity of apparatus mounting and implementation of technological process: before dust collection it is necessary to carry out additional oxidation of arsenic-carrying gassy products. Besides, during the process rhenium sublimes together with arsenic and concentrates in dust. Further procession of dust aimed to extract rhenium leads to increase in material costs.

This work presents results of studying selective extraction of rhenium from sulphide copper-arsenic multimetal concentrate.

### Methods and materials of research

The essence of the research lies in definition of optimal technological parameters of oxidizing burning that will establish high extraction of rhenium into sublimes depending on temperature and various blowing regimes.

Experiments were carried out with usage of copper-arsenic concentrate of the following composition, %: Cu – 23; Fe – 34,2; As – up to 10; S – 33; Re – up to 40 g/t.

The initial addition of concentrate in all tests was constant and equaled 100 g. Blowing consumption was varied within limits 0,1 to 0,2 l/g of the concentrate. For blowing we used composition of gases that consisted of fumes of water, carbonic acid, nitrogen, and oxygen that corresponded to products of natural gas burning. Tests took place in aerial ( $\alpha = 1,0$ ) and oxygen-enriched blowing ( $\alpha = 1,3–1,7$ ) under different temperatures. Range of temperature alteration varied from 350 to 550°C. Duration of each test, carried out under certain temperature condition, equaled 30 minutes.

After the set period of burning the received end was exposed to chemical analysis for content of copper, arsenic, sulphur, and rhenium.

### Results of research and their discussion

According to the results of chemical analysis of arsenic, sulphur, and rhenium in the initial concentrate the received end, final technological indexes for each test were received – desulphurization degree, dearsenization degree, and extraction of rhenium into gas phase.

The below provided table shows selective massive of test results.

Initial analysis of the received results shows us that extraction of rhenium grows along with growth in temperature and coefficient of blowing enriching with oxygen. At the same time, in the temperature range 350–500°C desulphurization degree grows almost 3 times, while dearsenization degree increases almost 6 times

Dependence of rhenium extraction and sublimation degree of arsenic and sulphur on temperature and coefficient of oxygen consumption

Number	Temperature, °C	Coefficient of oxygen consumption	Rhenium extraction into gas phase, %	Dearsenization degree, %	Desulphurization degree, %
1	350	1,0	15,3	Сл.	Сл.
2	350	1,5	35,1	1,8	3,7
3	400	1,0	58,8	2,3	3,1
4	400	1,3	78,1	4,8	7,5
5	400	1,5	79,5	5,2	8,7
6	400	1,7	81,7	12,9	15,1
7	500	1,0	74,6	15,7	9,2
8	500	1,5	82,7	17,5	12,0
9	500	1,7	83,8	33,8	25,9
10	550	1,0	88,3	44,9	32,5
11	550	1,7	89,0	48,4	34,2

During further increase of temperature we observed a sharp growth in desulphurization and dearsenization degree which testifies for fairly equal high speeds of oxidation of arsenic, sulphur, and their sublimation into gas phase.

According to mathematical procession of total test result massive (43 tests) regressive equation was constructed, and it allows us to predict extraction of rhenium in dependence on various technological parameters of copper-arsenic concentrate oxidation burning. The received equation looks as follows:

$$y = 64,220 - 0,738x_1 + 2,107x_2 - 5,207x_3;$$

$$r = 0,69,$$

while  $y$  is extraction rhenium into gas phase, %;  $x_1$  is dersenization degree, %;  $x_2$  is desulphurization degree, %;  $x_3$  is coefficient of oxygen consumption;  $r$  is coefficient of correlation totality.

The received results show us that it is reasonable to carry out oxidation burning before melting in case of processing sulphide copper multimetal material that contains arsenic and rhenium. Under optimal technological parameters of burning process (temperature, oxygen content in blowing) maximal extraction of rhenium into gas phase can be achieved with minimal sublimation of sulphur and arsenic. After the burning the received copper end can be easily processed according to the existing technologies with extraction of arsenic remains from further operations via traditional means.

### Conclusion

1. The received results show us that rather high selective extraction of rhenium into dust up to 83 % can be achieved in terms of oxidizing sulphide copper-arsenic concentrate within temperature range 400–500°C and coeffi-

cient of blowing oxygen consumption to fuel 1,0–1,5. Under the set conditions extraction of arsenic into gas phase remains at low level of ~17%. Further extraction of rhenium into the received selective product does not cause any complications.

2. Process of processing sulphide multi-metal concentrates that contain rhenium and arsenic, developed according to the taken research shows us principal possibility of selective extraction of rhenium into targeted product via carrying out preliminary burning in stove of “boiling layer”.

3. Implementing the described method before melting allows us to increase through extraction of rhenium into merchandise due to decrease in losses of it during the process of melting and converting, defined by “spreading” rhenium between products of these processes.

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