S. BIERNAT, A. W. BYDAŁEK, P. SCHLAFKA

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# ANALYSIS OF THE POSSIBILITY OF ESTIMATION ECOLOGICAL SLAG PROPRIETY WITH USE THE DATABASE

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This article contains information concerning of the analysis the possibility of defining refinery qualities of the slag based of the thermo-physical and thermodynamical data. The isues presented deals not only with refining copper and melting stages, but also of the idea building an optimization program. In its assumption the program is supposed to check and search specific data very quickly on the particular types of slag. There are possible and purposeful the construction optimization programme engaging all of the physics chemical influence the slag in processes of melting metals alloys. The proposed results, ranges of areas on graphs of phase equilibria's, demonstrative on the optimum values, will be verified in laboratory conditions and industrial. The initiation the new data the gathered base will be built in system of open base enabling.

*Key words:* slags propriety, analysis, refinery, computer programme, DTA

**Analiza vjerojatnosti procjene ekološke prikladnosti troske korištenjem baze podataka.** Rad sadrži informacije koje se odnose na analizu vjerojatnosti definiranja rafinacijske sposobnosti troske koja se temelji na termofizikalnim i termodinamičkim podacima. Prikazani rezultati ne odnose se samo na rafinaciju bakra i stupnjeve taljenja, već također i na ideju gradnje optimizacijskog programa. Pod tom pretpostavkom programom je predviđeno da se provjeri i istraži određeni podatak vrlo brzo za pojedinu vrstu troske. Moguća je i svrsishodna gradnja optimizacijskog programa koji uključuje sve fizikalne i kemijske utjecaje troske u procesu taljenja metalnih slitina. Predloženi rezultati, područja površina na grafovima faznih ravnoteža, izrazito na optimalnim vrijednostima, bit će verificirani u laboratorijskim i industrijskim uvjetima. Uvođenjem novih podataka sakupljene baze ugradit će se u sustav baze otvorene mogućnosti.

*Ključne riječi:* svojstva troske, analize, pročišćavanje, kompjutorski program, DTA

## INTRODUCTION

The work will especially concentrate upon the slag extraction processes, there is commonly used in the casting processes of melting copper alloys. According to W. Nernst principle of division in this type of configuration as in the metallurgical slag the process of refining the state of solution with the non-metallic inclusions beining extracted is quickly established. In casting processes fusions metals and melts to head refining slag counts:

- effacement from refined melt harmful admixtures and pollutions,
- protection mirror of liquid metal from influences of atmosphere,
- limitation of negative interactions with facing of stove.

Matching the specified tasks require regard of the chemical mechanisms of interactions slags with the whole environment. Important part we attribute to effect consequent from rules establish conditions of balance of fusion atmosphere of metal with slag coat [1,2]. Takes root, that in the earliest stadiums of refinement are changes in chemical constitution such sheath, that additionally deepen side factors as a result of influence of dirt surfaces of added materials and fire-proof erosion of facing stove. It the literature we can find publications relate to individual proprieties of slag refinement sheaths [3,4] and the descriptions of drawing ahead chemists effects [5-7].

In casting technological processes the fusion temperature, does not make up freely controllable parameter [8]. Necessary is to use fluxing factors or incrassative, to correct stickiness. About difficult to catch changes of superficial interfacial tension, mainly between liquid metal, drip slag and extracted non - metalic interpolations, we can conclude based at total energetic factors, concurrent the exchange the pulp, got on the ground analyses, method of differentiation of thermal effects and mass [9].

## THE DTA INVESTIGATION OF SLAG

On the basis of the thermo gravimetrical measurements an original methods, which modulates real condi-

S. Biernat, Jan Amos Komenski State School of Higher Vocational Education, Leszno,
A.W. Bydałek, West Pomeranian University of Technology, Szczecin,
P. Schlafka, University of Zielona Gora, Zielona Gora, Poland

tions of reacting, was elaborated [9,10] On the basis of this measurements system a method of interpretation the slag property was proposed. The method enables estimation of refining features of slag (S). In the experiments with derivatograph refined alloy is replaced with non-metallic inclusions (WN) in the melting pot. The inclusions are introduced into the slag in proportions, which respond with the melting losses of the alloy. $Al_2O_3$ standard is proposed to be replaced with S+R refining sample. This made it possible to achieve thermal and mass effects accompanying of the reduction reactions of WN which are is in the slag. The analysis of slag containing WN allowed establishing the possible combine EW and r values (Table 1) together with a proposed explanation [10]. On the basis of calculations it was also found that due to the differences in vaporisation or reaction with the atmosphere of compositions the simultaneous consideration of two values (r and EW) is necessary. It has been decided to consider the registered on TG-curves mass changes from an initial reduction phase vividly marked on DTA curves.

$$r_1 = \frac{\Delta m - y \cdot \Delta\, m_1}{a_t} \cdot 100\ \%$$

where :

$\Delta m$ - mass decrement of slag with oxide calculated from the beginning of the reduction processes,

$y$ - slag participation in the slag-oxide system,

$\Delta m_1$ - mass decrement of slag without oxide,

$a_t$ - total initial amount of oxygen, resulting from stechiometrical calculations, referring to the sample mass.

$$r_2 = \frac{\Delta m - y \cdot \Delta\, m_1 - x \cdot \Delta\, m_2}{a_t} \cdot 100\ \%$$

where:

$\Delta m_2$ - mass decrement of the analysed oxide (WN)

x - WN participation in the total mass of the tested sample.

Table 1 **The explanation of results on the basis of indicators EW and r**

| N | Value of EW | Value of r | Explanation |
|---|---|---|---|
| 1 | EW << 0 | r << -10 | strong reductive interaction |
| 2 | EW << 0 | r (-5, -1) | weak reductive interaction |
| 3 | EW ≤ 0 | r (-1, 0) | no reductive interaction |
| 4 | EW > 0 | any r | oxidizing reaction |

Proposed numerical indexes of EW and r (Table 1 ) are regarded as a measure of refining abilities of the whole system atmosphere-slag-inclusion-activator (A-S-WN-R). It enabled optimisation of alternatives of WN interactions with carbides and carbide-originating metals in slag of various different chemical compounds. The recently elaborated method of observing effects of co-reaction between slag and oxide inclusions made possible to estimate the reduction capacity of the slag composition with addition metal, carbon and carbide reagent and stimulators (Table 2), in comparison to the CuSn5Zn5Pb5 alloys melting conditions. Carbon, carbide ($Al_4C_3$) and metal, as carbide-originating elements (in this work Al), are used to created condition lake as reducing [9], in real melting conduction (in the foundry) the CuSn5Zn5Pb alloys. In the experiments the refined alloys are replaced , according with the described methods with follow oxides: CuSn5Zn5Pb5 alloy with $Cu_2O$ 5 %, SnO 15 %, ZnO 50 %, PbO 30 %, which respond with the melting losses of it alloy in the real metallurgical condition.

Table 2 **Scheme of the investigation – kind of the used slag composition**

| No | Reagent % | Stimulators wt. % |
|---|---|---|
| 1.1 | 40 % $Al_4C_3$ 10 % C | ---------- |
| 1.2 | | 5 - $Na_2CO_3$ + NaCl (2:1), |
| 1.3 | | 5 - NaCl + $NaF_2$ (1:1) |
| 1.4 | | 5 - $Na_2B_4O_7$ + NaF (3:1). |

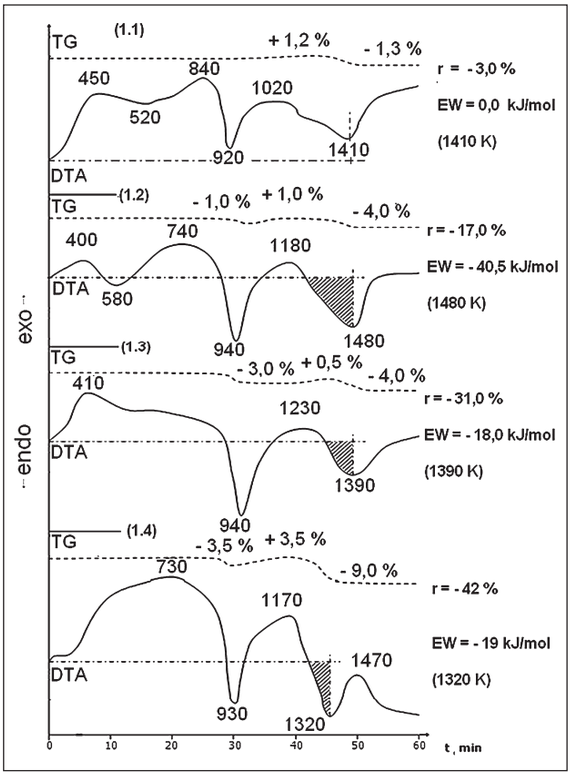



**Figure 1** The DTA/TG diagrams for the CuSn5Zn5Pb melting condition with the indicators EW and r (slag composition – Table 2)

Figure 1 shows the results of the DTA analysis for the slag composition with different stimulators (Table 3). On this figure there are indicators EW and r showed. Each of this DTA and TG curves are make from 3 analysed cycles. There are the temperature of endo- and exoeffects and "zero" DTA line showed. Results of the DTA/TG analysis of the slag to CuSn5Zn5Pb5 alloys refining (Figure 1) permitted on indication of arrangement mixture 1,2, 1,3 or 1,4 as most profitable in respect of abilities in thus condition. From other DTA analysis can be say that best should be the slag 1,2. However it is now from labour and industrial investiga-

tion that $Na_2CO_3$ after dissociation can give substance about oxidising characteristics. The stimulator composition 1,3 contain only fluoride and chloride there are not indifferent for health the worker at the furnace. Therefore authors suggest slag composition with $Na_2B_4O_7$ + NaF (3:1) as stimulator (in the Table 2 singed as 1,4).

## CONCEPTION OF BUILDING THE PROGRAMME

The study of computer programme including the satisfactory number of data, both thermodynamical how and experimental - gathered with literature and own investigation, the simpler qualification of optimum proprieties of slags would make possible. Settled by programme of areas the verification it is possible to the end to conduct in the support about proposed by method of the modelling processes of refinement [9] from it utilization the derivatograph or directly in conditions industrial. User starting programme should have the possibility of choice kind of the information, he would like to get which [10]

## WORKING COMPUTER PROGRAMME

After actuation programme and introduced threephase user Gibbs arrangement becomes the recess the suitable kind of material. It is then equilateral triangle which tops answer the concrete entering in composition of studied material substance. Every point in arrangement answers the not only different quantitative composition of substance, but it be characterizes different proprieties physics chemical also.

Arrangement was partite on 400 areas, which answers changes composition of material, what 5 % on every component. Restricting area and division him what 5 % makes possible the comparatively precise qualification of propriety studied material regard of his molar composition.

User it after recess any area, clicking on him, gets information about the most important proprieties him characterizing. Additionally following drawing represents the principle of procurance of information the regard of passed area (Figure 2).

User has the possibility of filtration of database physics chemical also, thanks what it gets information about occurrence in arrangement of areas fulfilling passed by him criterions. After he recess kind it writes down he the limits the value of definite proprieties. The sended suitable form thereon becomes the basis from data to database. After correct realization question user gets in tabular figure information about possible occurrence about set proprieties areas. The result of question was it been possible additionally to broaden about information about remaining proprieties physic-chemical. Besides, in aim the image of location about set properties the area on graph Gibbs, the special navigator was

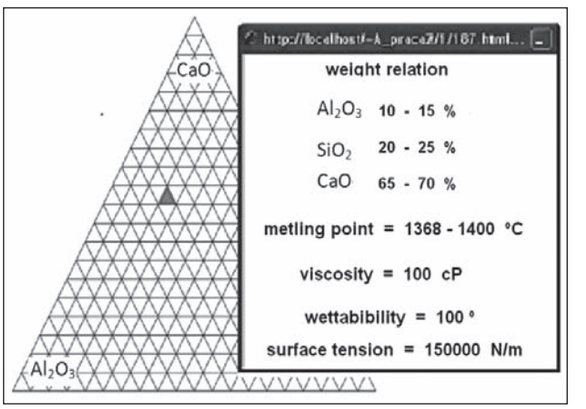
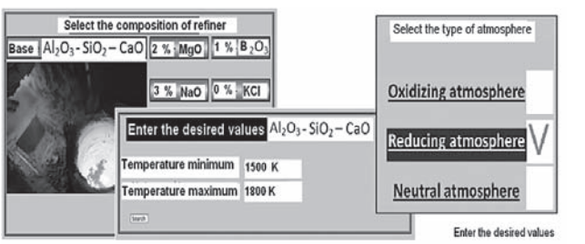



**Figure 2** Principle of procurance of information the regard of indicated area: user clique opens on passed area, then mouse representative window his physics chemical propriety.

created. After recess area and his click, displayed arrangement 3 becomes user - phase from noted on him at present under examination area. The principle of filtration of database under regard of concrete properties on drawing 2 was introduced phisics chemical (Figure 3). It the patern of conduct in the work was presented the permissive on calculation for arrangement of oxides $Al_2O_3$-$SiO_2$-CaO- $B_2O_3$ optimal co-ordinates areas in reference to conditions of fusion silicon bronzes. Moved analysis was provided to carry to traditionally appointive in metallurgy of data in basing about measurements of stickiness and melting-point. It was showed on the Figure 4a and they allow on the determining range favourable compositions - appointed with letters polygons. Optimization with proposed programme shown on appointed with triangle area (Figure 4b). However the investigation DTA, from utilization the method of differentiation of thermal effects and mass, shew on appointed with wheel area (the Figure 4 c).




| Minimal temparature K | Maximal temperature K | Minimal value $Al_2O_3$ % | Maximal value $Al_2O_3$ % | Minimal value CaO % | Maxima value CaO % | Minimal value $SiO_2$ % | Maximal value $SiO_2$ % | Surface tension limits N/m |
|---|---|---|---|---|---|---|---|---|
| 1500 | 1700 | 0 | 5 | 20 | 25 | 70 | 75 | 305 |
| 1500 | 1700 | 15 | 20 | 0 | 5 | 65 | 80 | 390 |
| 1500 | 1549 | 20 | 25 | 45 | 50 | 25 | 30 | 305 |
| 1500 | 1596 | 25 | 30 | 40 | 45 | 25 | 30 | 304 |
| 1500 | 1596 | 25 | 30 | 5 | 10 | 65 | 70 | 100 |
| 1500 | 1700 | 25 | 30 | 5 | 10 | 65 | 70 | 184 |
| 1530 | 1680 | 20 | 25 | 10 | 15 | 60 | 65 | 250 |

**Figure 3** Presentation of the results filtration database the regard the limits the value the chosen physics and chemical proprieties.

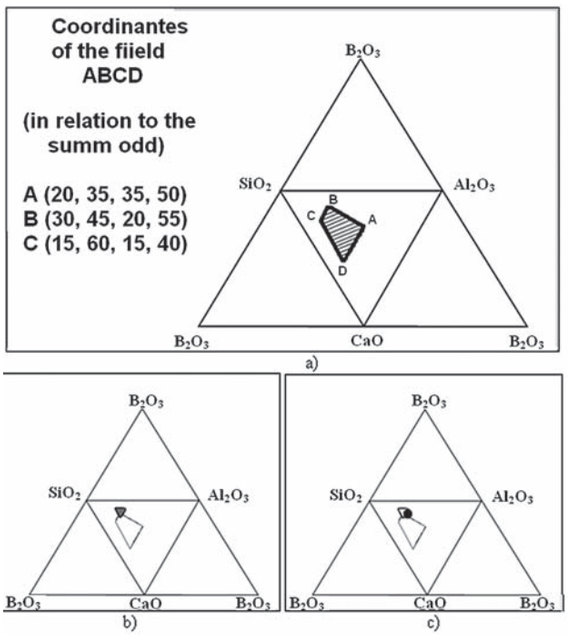



**Figure 4** Ranges of optimum concentrations with analysis the graphs of system $Al_2O_3$-$SiO_2$-CaO- $B_2O_3$ in basing about measurements: a) of stickiness and melting-point, b) with proposed programme, c) after the DTA investigation

## SUMMARY

Worked out programme need finishing up yet. Necessary DTA is introduction of peck of data and their verification method. The database, in system SQL, it will be accessible in aim fuel make-ups by different users. It was it been possible was already now however to move following:

- there are possible and purposeful the construction optimization programme engaging all of the physics chemical influence the slag in processes of melting metals alloys,
- the proposed results, ranges of areas on graphs of phase equilibria's, demonstrative on the optimum values, will be verified in laboratory conditions and industrial,
- the initiation of the new data the gathered base will be built in system of open base enabling.

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**Note:** The responsible for English language is the lecturer from University of Zielena Gora, Zielena Gora, Poland