



## Refinables Project Identification of parameters allowing a structural representation of the PM slags

### Background

The ECHA proposed methodology for sameness of UVCB substances sets priority to the structural representation followed by the reaction scheme and the process output. This hierarchy requires considerations on the description of the composition to be made first before any other additional depiction is applied to define the substance sameness criteria.

The methodology recognises the limits of identifying UVCB substances by their chemical composition. Accordingly, it does not require setting substance sameness criteria based on the structural representation only. It entails instead the identification of systematic structural characteristics which, if the substances were to be well-defined, would constitute substance sameness criteria. The structural depiction therefore relies on the "80% rules" established for well-defined substances.

The ECHA SID guidance states that the "≥ 80%" rule for mono-constituent substances (i.e. one main constituent present to at least 80%) as well as the "< 80%/≥ 10%" rule for multi-constituent substances (i.e. several main constituents present at concentrations ≥ 10% and < 80%) should be applied to check if substances are the same. Well-defined substances should contain the same main constituent(s). It is further noted that a multi-constituent substance of main constituents A, B and C shall not be regarded the same as a multi-constituent substance of main constituents A and B or as a reaction mass of A, B, C and D.

### Structural representation of the Slags, doré furnace

The current description of Slags, doré furnace in the registration dossier is 'Slags produced as by-products in the production (smelting, reduction, converting, and refining processes) of Slags, doré furnace. They generally contain copper and lead and small amounts of silver, antimony, tellurium and other metals. Depending on the fluxing agent used, slags in this group may contain metal oxides, phosphates, silicates, sulphides/sulphates and/or fused salts in varying concentrations.'

The oxide content of the slags was not reported but based on the elemental composition and speciation information reported by members, the oxide content of each slag was calculated. Main constituents were then identified both for the speciation and the elemental composition.

### Main constituents - species

Below table shows the constituents for which the maximum of the company typical concentrations ≥ 10% (i.e. constituents for which at least 1 company reported typical concentration ≥ 10%).

|                          | Ag   | BaO  | Cu2O | Fe3O4 | Na2O | PbO  | Sb2O3 | SiO2 | SnO2 | Sum  |
|--------------------------|------|------|------|-------|------|------|-------|------|------|------|
| Min typical conc (%)     | 1,4  | 0,0  | 1,1  | 0     | 0    | 0    | 0     | 0    | 0    |      |
| Max typical conc (%)     | 13,4 | 20,2 | 47,7 | 29,3  | 16,3 | 50,9 | 13,0  | 27,9 | 11,4 |      |
| Average typical conc (%) | 4,6  | 5,6  | 14,6 | 5,1   | 4,0  | 33,4 | 4,2   | 12,6 | 3,3  | 87,4 |

Question: can all members confirm the main constituents are (mainly) present in above assumed speciation? Some members reported presence of AgO but available Outotec reports show presence of metallic silver (mechanically entrapped in the slag); can members reporting AgO provide a ratio Ag/AgO? And is reported speciation based on available analysis or on expert knowledge?

Below table shows the sum of above constituents for all reported slags, doré furnace.

| Slag code | Sum main constituents - species (%) |
|-----------|-------------------------------------|
| 1         | 86,6                                |
| 2         | 89,0                                |
| 3         | 92,8                                |
| 4         | 91,1                                |
| 6         | 65,1                                |
| 7         | 92,5                                |
| 8         | 94,8                                |



It is noted that for the main constituents **Cu<sub>2</sub>O**, **PbO** and **SiO<sub>2</sub>**, the average of the company typical concentrations is  $\geq 10\%$ . If we were to define the Refinables as well-defined substances and we apply the “ $< 80\%/\geq 10\%$ ” rule of the ECHA SID guidance (i.e. for multi-constituent substances, the typical concentrations for main constituents should be  $\geq 10\%$ ), Cu<sub>2</sub>O, PbO and SiO<sub>2</sub> are thus identified as the main constituents of the Slags, doré furnace. However, these 3 constituents do not allow defining the substance up to 80% (sum average typical concentrations Cu<sub>2</sub>O, PbO and SiO<sub>2</sub> = 60,7%).

**Commented [k1]:** Typical concentration defined in Registration Dossiers as the average of the company typical concentrations.

Below table shows presence of the main constituents for all reported slags, doré furnace.

| Slag code | Cu <sub>2</sub> O | PbO  | SiO <sub>2</sub> | Sum  |
|-----------|-------------------|------|------------------|------|
| 1         | 2,5               | 39,1 | 12,6             | 54,1 |
| 2         | 4,9               | 37,9 | 23,8             | 66,6 |
| 3         | 17,1              | 50,3 | 16,7             | 84,1 |
| 4         | 25,4              | 50,9 | 7,5              | 83,8 |
| 6         | 3,7               | 15,9 | 0,0              | 19,6 |
| 7         | 47,7              | 0,0  | 0,0              | 47,7 |
| 8         | 1,1               | 39,7 | 27,9             | 68,7 |

**Commented [k2]:** Based on structural representation of species, these 2 slags would not be considered the same as the others, as one or more of the main constituents is not present. Composition will be double-checked with registrants.

#### Main constituents - elements

Below table shows the elemental constituents for which the maximum of the company typical concentrations  $\geq 10\%$  (i.e. constituents for which at least 1 company reported typical concentration  $\geq 10\%$ ).

|                          | Ag   | Ba   | Cu   | Fe   | Na   | O    | Pb   | Sb   | Si   | Sum  |
|--------------------------|------|------|------|------|------|------|------|------|------|------|
| Min typical conc (%)     | 1,4  | 0    | 1,0  | 0    | 0    | 13,2 | 0    | 0    | 0    |      |
| Max typical conc (%)     | 13,4 | 18,0 | 42,4 | 21,2 | 12,0 | 34,0 | 47,3 | 10,0 | 12,9 |      |
| Average typical conc (%) | 4,6  | 5,0  | 13,0 | 3,7  | 3,0  | 21,6 | 31,0 | 3,3  | 5,9  | 91,0 |

**Commented [k3]:** This approach is most in line with how the composition was reported in IUCLID. Also, if we base sameness on the elemental concentrations, this allows some differences in speciation across registrants. On the other hand, if we group different speciations under the same substance, this will be difficult to defend to ECHA. Ideally, we should have the same speciation across registrants at least for the main constituents. If not, we have to think of a justification on the speciation differences.

Below table shows the sum of above constituents for all reported slags, doré furnace.

| Slag code | Sum main constituents - elements (%) |
|-----------|--------------------------------------|
| 1         | 83,0                                 |
| 2         | 91,1                                 |
| 3         | 91,5                                 |
| 4         | 92,7                                 |
| 6         | 89,3                                 |
| 7         | 93,6                                 |
| 8         | 95,5                                 |

It is noted that for the main constituents **Cu**, **O** and **Pb**, the average of the company typical concentrations is  $\geq 10\%$ . If we were to define the Refinables as well-defined substances and we apply the “ $< 80\%/\geq 10\%$ ” rule of the ECHA SID guidance (i.e. for multi-constituent substances, the typical concentrations for main constituents should be  $\geq 10\%$ ), Cu, O and Pb are thus identified as the main constituents of the Slags, doré furnace. However, these 3 constituents do not allow defining the substance up to 80% (sum average typical concentrations Cu, O and Pb = 65,5%).

**Commented [k4]:** Typical concentration defined in Registration Dossiers as the average of the company typical concentrations.

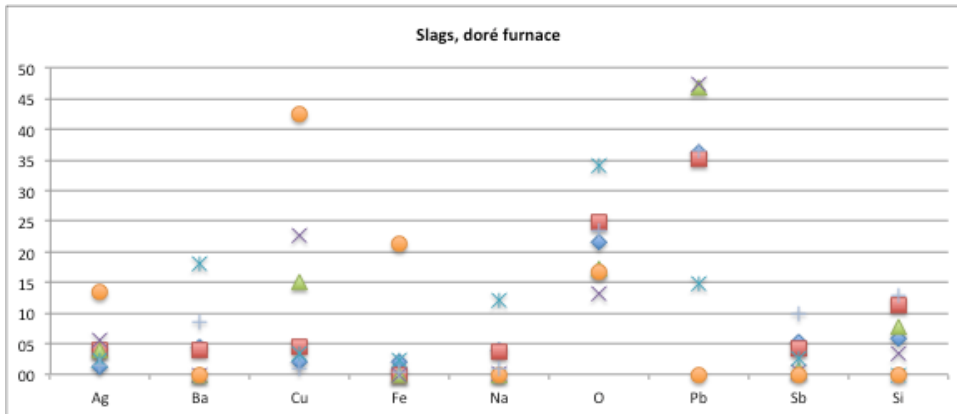
Below table shows presence of the main constituents for all reported slags, doré furnace.

| Slag code | Cu   | O    | Pb   | Sum  |
|-----------|------|------|------|------|
| 1         | 2,2  | 21,6 | 36,3 | 60,0 |
| 2         | 4,4  | 24,8 | 35,1 | 64,3 |
| 3         | 15,2 | 17,3 | 46,7 | 79,2 |
| 4         | 22,6 | 13,2 | 47,3 | 83,0 |
| 6         | 3,3  | 34,0 | 14,7 | 52,0 |
| 7         | 42,4 | 16,7 | 0,0  | 59,1 |
| 8         | 1,0  | 23,5 | 36,6 | 61,1 |

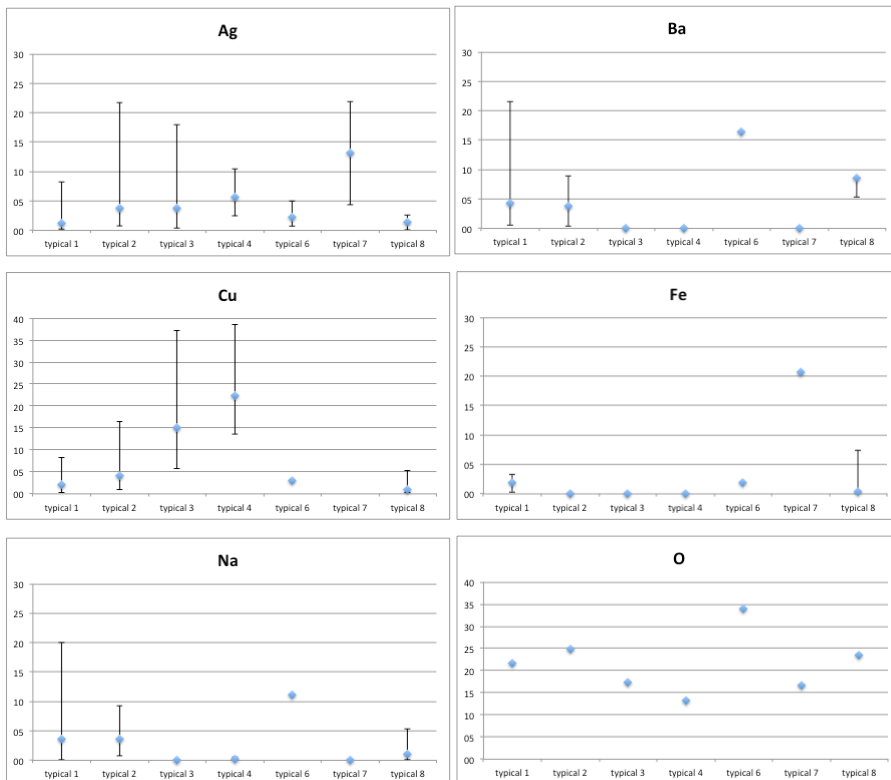
**Commented [k5]:** Based on structural representation of elements, this slag would not be considered the same as the others, as one of the main constituents is not present. Composition will be double-checked with registrants.



Below figure shows the variation of each (main) elemental constituent across the reported slags, doré furnace.



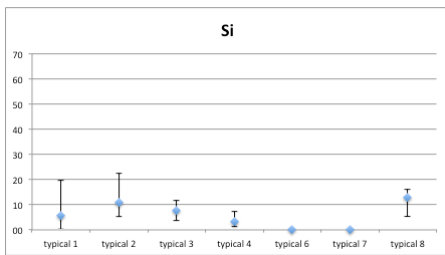
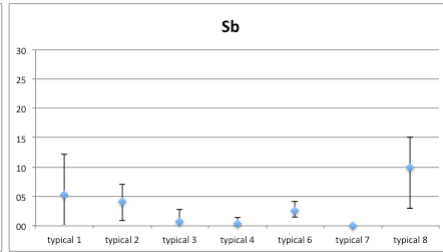
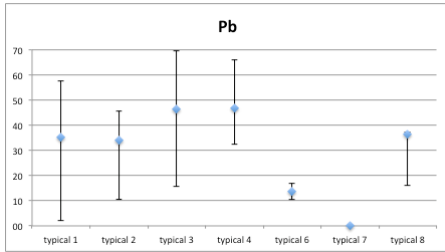
Below figures show that for the (main) elemental constituents, the composition variation within companies is greater than the composition variation between companies. The error bars represent the minimum and maximum reported concentration.



**Commented [k6]:** Not all companies reported ranges for all elements. For oxide, the concentrations are calculated so error bars were not included.



**PMC Refinables Project**  
Identification of parameters allowing a structural representation of the PM slags  
16 March 2015





**Structural representation of the Slags, production of PM containing materials other than doré**

The current description of Slags, production of PM containing materials other than doré in the registration dossier is ‘Slags produced as by-products in the smelting of precious metals bearing feeds to produce a precious metals containing material other than doré subject to further refining. They are typically rich in SiO<sub>2</sub>. Depending on the fluxing agent used, slags in this group may contain ferrous and non-ferrous metal oxides, phosphates, silicates, sulphides/sulphates and/or fused salts in varying concentrations.’

The oxide content of the slags was not reported but based on the elemental composition and speciation information reported by members, the oxide content of each slag was calculated. Main constituents were then identified both for the speciation and the elemental composition.

**Main constituents - species**

Below table shows the constituents for which the maximum of the company typical concentrations ≥ 10% (i.e. constituents for which at least 1 company reported typical concentration ≥ 10%).

|                          | Al <sub>2</sub> O <sub>3</sub> | CaO  | Fe <sub>2</sub> O <sub>3</sub> | Na <sub>2</sub> O | SiO <sub>2</sub> | Sum  |
|--------------------------|--------------------------------|------|--------------------------------|-------------------|------------------|------|
| Min typical conc (%)     | 4,7                            | 1,8  | 4,2                            | 0,1               | 26,9             |      |
| Max typical conc (%)     | 17,6                           | 27,2 | 11,6                           | 50,9              | 41,6             |      |
| Average typical conc (%) | 11,2                           | 11,3 | 8,0                            | 19,3              | 33,2             | 82,9 |

**Commented [k7]:** Member comment: It is quite common for slags of this type to contain significant NaCl

**Question:** can all members confirm the main constituents are (mainly) present in above assumed speciation? Some members reported presence of AgO but available Outotec reports show presence of metallic silver (mechanically entrapped in the slag); can members reporting AgO provide a ratio Ag/AgO? And is reported speciation based on available analysis or on expert knowledge?

Below table shows the sum of above constituents for all reported slags, production of PM containing materials other than doré.

| Slag code | Sum main constituents - species (%) |
|-----------|-------------------------------------|
| 1         | 86,0                                |
| 2         | 77,7                                |
| 3         | 76,6                                |
| 4         | 91,4                                |

It is noted that for the main constituents Al<sub>2</sub>O<sub>3</sub>, CaO, Na<sub>2</sub>O and SiO<sub>2</sub>, the average of the company typical concentrations is ≥ 10%. If we were to define the Refinables as well-defined substances and we apply the “< 80%/≥ 10%” rule of the ECHA SID guidance (i.e. for multi-constituent substances, the typical concentrations for main constituents should be ≥ 10%), Al<sub>2</sub>O<sub>3</sub>, CaO, Na<sub>2</sub>O and SiO<sub>2</sub> are thus identified as the main constituents of the Slags, production of PM containing materials other than doré. However, these 4 constituents do not allow defining the substance up to 80% (sum average typical concentrations Al<sub>2</sub>O<sub>3</sub>, CaO, Na<sub>2</sub>O and SiO<sub>2</sub> = 75%).

**Commented [k8]:** Typical concentration defined in Registration Dossiers as the average of the company typical concentrations.

**Commented [k9]:** Member suggestion: calculate the composition of the silicates (i.e. Al<sub>2</sub>SiO<sub>5</sub>, CaSiO<sub>3</sub>, Na<sub>2</sub>SiO<sub>3</sub>, Fe<sub>2</sub>SiO<sub>4</sub>) and sum those rather than the oxides to see if this achieves >80%.

Below table shows presence of the main constituents for all reported slags, production of PM containing materials other than doré.

| Slag code | Al <sub>2</sub> O <sub>3</sub> | CaO  | Na <sub>2</sub> O | SiO <sub>2</sub> | Sum  |
|-----------|--------------------------------|------|-------------------|------------------|------|
| 1         | 12,9                           | 27,2 | 0,1               | 41,6             | 81,9 |
| 2         | 17,6                           | 11,4 | 3,3               | 33,8             | 66,1 |
| 3         | 9,5                            | 4,7  | 22,9              | 30,5             | 67,6 |
| 4         | 4,7                            | 1,8  | 50,9              | 26,9             | 84,3 |

**Commented [k10]:** Low presence of Na<sub>2</sub>O to be double checked.



**Main constituents - elements**

Below table shows the elemental constituents for which the maximum of the company typical concentrations  $\geq 10\%$  (i.e. constituents for which at least 1 company reported typical concentration  $\geq 10\%$ ).

|                          | Al  | Ca   | Fe  | Na   | O    | Si   | Sum  |
|--------------------------|-----|------|-----|------|------|------|------|
| Min typical conc (%)     | 2,5 | 1,3  | 2,9 | 0,1  | 35,1 | 12,6 |      |
| Max typical conc (%)     | 9,3 | 19,5 | 8,1 | 37,8 | 40,7 | 19,5 |      |
| Average typical conc (%) | 5,9 | 8,1  | 5,6 | 14,3 | 38,7 | 15,5 | 88,1 |

Below table shows the sum of above constituents for all reported slags, production of PM containing materials other than doré.

| Slag code | Sum main constituents - species (%) |
|-----------|-------------------------------------|
| 1         | 88,6                                |
| 2         | 84,5                                |
| 3         | 85,1                                |
| 4         | 94,2                                |

It is noted that for the main constituents Na, O and Si, the average of the company typical concentrations is  $\geq 10\%$ . If we were to define the Refinables as well-defined substances and we apply the “ $< 80\%/\geq 10\%$ ” rule of the ECHA SID guidance (i.e. for multi-constituent substances, the typical concentrations for main constituents should be  $\geq 10\%$ ), Na, O and Si are thus identified as the main constituents of the Slags, production of PM containing materials other than doré. However, these 3 constituents do not allow defining the substance up to 80% (sum average typical concentrations Na, O and Si = 68,5%).

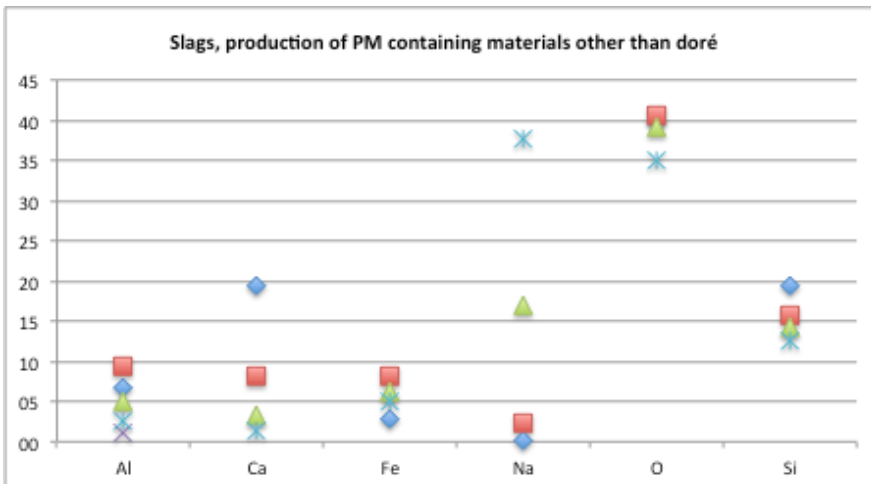
Below table shows presence of the main constituents for all reported slags, production of PM containing materials other than doré.

| Slag code | Na   | O    | Si   | Sum  |
|-----------|------|------|------|------|
| 1         | 0,1  | 39,8 | 19,5 | 59,4 |
| 2         | 2,4  | 40,7 | 15,8 | 58,9 |
| 3         | 17,0 | 39,2 | 14,3 | 70,4 |
| 4         | 37,8 | 35,1 | 12,6 | 85,5 |

**Commented [k11]:** Typical concentration defined in Registration Dossiers as the average of the company typical concentrations.

**Commented [k12]:** Low presence of Na to be double checked.

Below figure shows the variation of each (main) elemental constituent across the reported slags, production of PM containing materials other than doré.

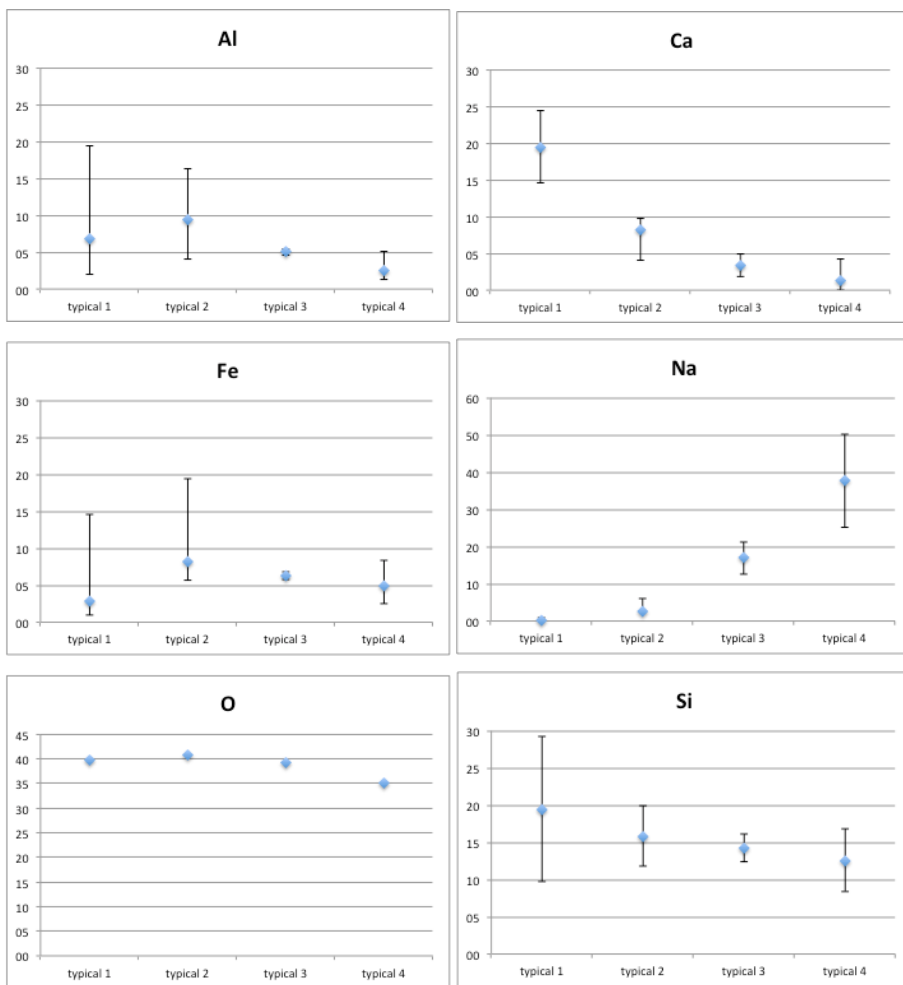




Below figures show that for the (main) elemental constituents, the composition variation within companies is greater than the composition variation between companies. The error bars represent the minimum and maximum reported concentration.

**Commented [k13]:** Not true for Na - to be double checked.

**Commented [k14]:** Not all companies reported ranges for all elements. For oxide, the concentrations are calculated so error bars were not included.





## Conclusions

- Two approaches were used for the structural representation: the species and elements representation (note that for the elements representation, the speciation was taken into account to calculate the oxide content). The elements representation is most in line with how the composition was reported in the Registration Dossiers of the Refinables, so it is recommended to use this.
- If the main (elemental) constituents are defined in line with the ECHA SID guidance (i.e. typical concentrations for main constituents should be  $\geq 10\%$ ), we can show presence of the same main constituents across companies for both types of slags (with the exception of 2 slags, for which composition needs to be double checked). However, when using this approach, we cannot define sameness up to 80%, but we can justify this based on the presence of a lot of 'minor' constituents in the Refinables (present in small concentrations).
- If the structural representation of the Refinables is defined up to 80% (i.e. by also taking into account 'minor' constituents), then we cannot show presence of the same constituents across all companies, because we have to take a lot of constituents into account (9 elemental constituents for the Doré slags).

Overall, for the slags, if we define the main constituents in line with the ECHA SID guidance, we can show presence of the same main constituents across companies, but we cannot prove sameness up to 80%.

### Concerns raised by members:

- ECHA SID guidance using the ">10% and 80%" rules is not going to be flexible enough for our needs and we will have to further split the slags (and other Refinables) to achieve satisfactory substance sameness.

**Commented [k15]:** Document to be updated with further input on compositions once received