A general form of material balance equations to be used to calculate quasi-binary sections of multi-component phase diagrams is derived here. When this general equation is reduced to ternary systems, it coincides with those, given in the Thermo-Calc manual. For a k-component system, altogether only (k-2) such independent equations should be written from the list of k(k-1)/2 possible equations.

Keywords: Thermo-Calc; materials balance; quasi-binary sections, multicomponent phase diagrams
Now, let us express $x$ from Eq.(3a) and let us substitute this equation into Eq.(3b), and finally express the result in the format of Eq.(1):

$$ (j_2 - j_1) \cdot w_j + (i_1 - i_2) \cdot w_j = j_2 \cdot i_1 - j_1 \cdot i_2 \quad (4) $$

Comparing Eq.(4) with the general Eq.(1), the following expressions are found:

$$ \alpha = j_2 - j_1 \quad (5a) $$

$$ \beta = i_1 - i_2 \quad (5b) $$

$$ \gamma = j_2 \cdot i_1 - i_2 \cdot j_1 \quad (5c) $$

Eq-s (5a-c) present the final equations of this manuscript. When applied to a ternary system, these equations simplify back to the equations provided in the Thermocalc manual. For a quasi-binary section made of altogether $k$ components between alloys $A_aB_bC_c...Z_z$ and $A_aB_bC_c...Z_z$, altogether $(k-1)$ materials balance equations of type (1) can be written between component A and between all other components, with the numerical coefficients to be calculated using Eq-s (5a-c). However, in fact the number of above equations can be reduced by one further equation, as Calphad codes such as ThermoCalc has the following built-in material balance equation:

$$ \sum_i w_i = 1 \quad (6) $$

where $I = A, B, C, ..., Z$.

Thus, the material balance equation for the last component may be ignored, and so for a $k$-component system altogether only $(k-2)$ materials balance equations of type (1) are needed. Let us note that for a $k$-component system altogether $(k-1)/2$ combinations of $i-j$ components exists. This is obviously larger than the $(k-2)$ equations needed (see Table 1). That gives the user a freedom to select arbitrary the $(k-2)$ materials balance equations, with the only condition that they should be mathematically independent. For example, for a 5-component A-B-C-D-E system in principle 10 materials balance equations of type (1) exist. However, it is sufficient to write only 3 of them, for example those, connecting components A-B, A-C and A-D. Also, in principle, equations connecting A-B, A-C and B-C could be written; however, this combination is useless, as these 3 equations are mathematically not independent.

2. Conclusions

It is shown that, to calculate quasi-binary sections of $k$-component phase diagrams, $(k-2)$ independent materials balance equations should be created in the format of Eq.(1). The constants in Eq.(1) are derived here and are written in Eq-s (5a-c) for any two arbitrary selected components I and J of any quasi-binary section in any multi-component system.

The number of components, possible numbers of materials balance equations, their requested number to perform calculations, and their ratio

<table>
<thead>
<tr>
<th>$k$</th>
<th>$k(k-1)/2$</th>
<th>$(k-2)$</th>
<th>ratio</th>
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<td>3</td>
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<td>4</td>
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</tr>
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<tr>
<td>10</td>
<td>45</td>
<td>8</td>
<td>5.63</td>
</tr>
</tbody>
</table>

2. Conclusions

It is shown that, to calculate quasi-binary sections of $k$-component phase diagrams, $(k-2)$ independent materials balance equations should be created in the format of Eq.(1). The constants in Eq.(1) are derived here and are written in Eq-s (5a-c) for any two arbitrary selected components I and J of any quasi-binary section in any multi-component system.

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