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ПРИМЕНА НА СПОЈНА МАТРИЦА ЗА ФЛОТАЦИСКО ПРЕТСТАВУВАЊЕ

THE APPLICATION OF THE CONNECTION MATRIX FOR THE FLOTATION REPRESENTING

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Intraduction

The connection matrix is the basis for generalised computer packages for mass balancing which have been produced in recent years.

The investigated examples will illustrate clearly the advantager of using the connection matrix to produce the necessary set of linear equations to evaluate the circuit. In the simple example it's not difficult to assess the number of streams which must be sampled in order to produce data for a unique set of equations for the system.

However, in order to calculate a stedy-state mass balance for an entire complex circuit, a more analytical method of generating "n" linear equations for "n" unknowns is required. Any plant flowsheet can be reduced to a series of NODES, where process streams either join or separate. Simple nodes have either one input and two outputs ("a separator-S") or two inputs and on output ("a junction - J"). It has been shown that, providing the mass flow of a reference stream (usually the feed) is known, the minimum number of streams which must be sampled to ensure production of a complete circuit mass balance is:

$$N = 2(F + S) - 1$$

where

F - number of feed streams;

S - number of simple separators;

The method involves the use of the "connection matrix - C " where each element in matrix is:

$$C_{ij} = \begin{cases} +1 \text{ for stream j flowing into the } i^{th} \text{ node (feed)} \\ -1 \text{ for stream j flowing out of the } i^{th} \text{ node (product)} \\ 0 \text{ for stream j not appearing at the } i^{th} \text{ node (interval stream)} \end{cases}$$

A material matrix - "M" can be defined, where each element in the matrix is:

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$$M_{ij} = C_{ij} \cdot B_j$$

where

B_j - represents the mass flowrate of solid in stream j

A component matrix - "A", can also be defined, where each matrix element is:

$$A_{ij} = C_{ij} \cdot B_j \cdot a_j = M_{ij} \cdot a_j$$

where

a_j - representing the component value (assay, % in size fraction, dilution ration, etc.)

In matrix form the set of linear equations that must be solved is:

$$\begin{pmatrix} C_{11}C_{12}\ldots\ldots C_{1(s-1)} \\ C_{21}C_{22}\ldots\ldots C_{2(s-1)} \\ \ldots\ldots \\ \ldots\ldots \\ C_{n1}C_{n2}\ldots\ldots C_{n(s-1)} \\ C_{11}a_1\ldots\ldots C_{1(s-1)}a_{(s-1)} \\ C_{21}a_1\ldots\ldots C_{2(s-1)}a_{(s-1)} \\ \ldots\ldots \\ \ldots\ldots \\ C_{n1}a_1\ldots\ldots C_{n(s-1)}a_{(s-1)} \end{pmatrix} \cdot \begin{pmatrix} B_1 \\ B_2 \\ . \\ . \\ . \\ . \\ . \\ . \\ . \\ B_{(s-1)} \end{pmatrix} = \begin{pmatrix} -C_{1s} \\ -C_{2s} \\ . \\ . \\ -C_{ns} \\ -C_{1s}a_s \\ -C_{2s}a_s \\ . \\ . \\ -C_{ns}a_s \end{pmatrix}$$

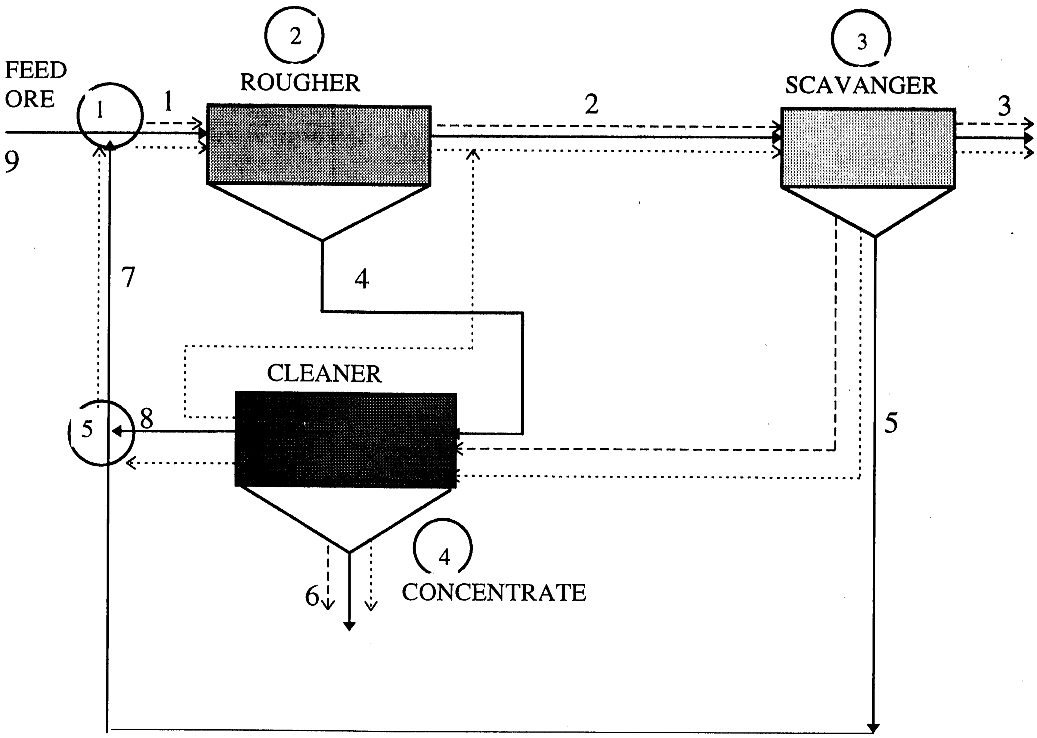
The practical application of the connection matrix will be shown on the clasical - conventional flotation circuit and on the cleaning - scavanger (C - S) type flotation circuit, using the computer standard programme.

A diferent flowsheets of flotation circuits

The circuits shown on the fig. 1 and fig.2 (the examples of flotation flowsheets: classical - convenventional type and cleaning - scavenging type in five (3 + 2) variantes, specially the flowsheets with full lines with the following results obtained:

Table 1.

	(C - C) type	(C - S) type
Stream	Assay (%) Me	Assay (%) Me
1	–	0.24
2	0.43	0.41
3	0.02	6.80
4	7.45	–
5	2.40	–
6	18.00	16.80
7	–	2.25
8	1.25	0.01
9	0.24	0.02



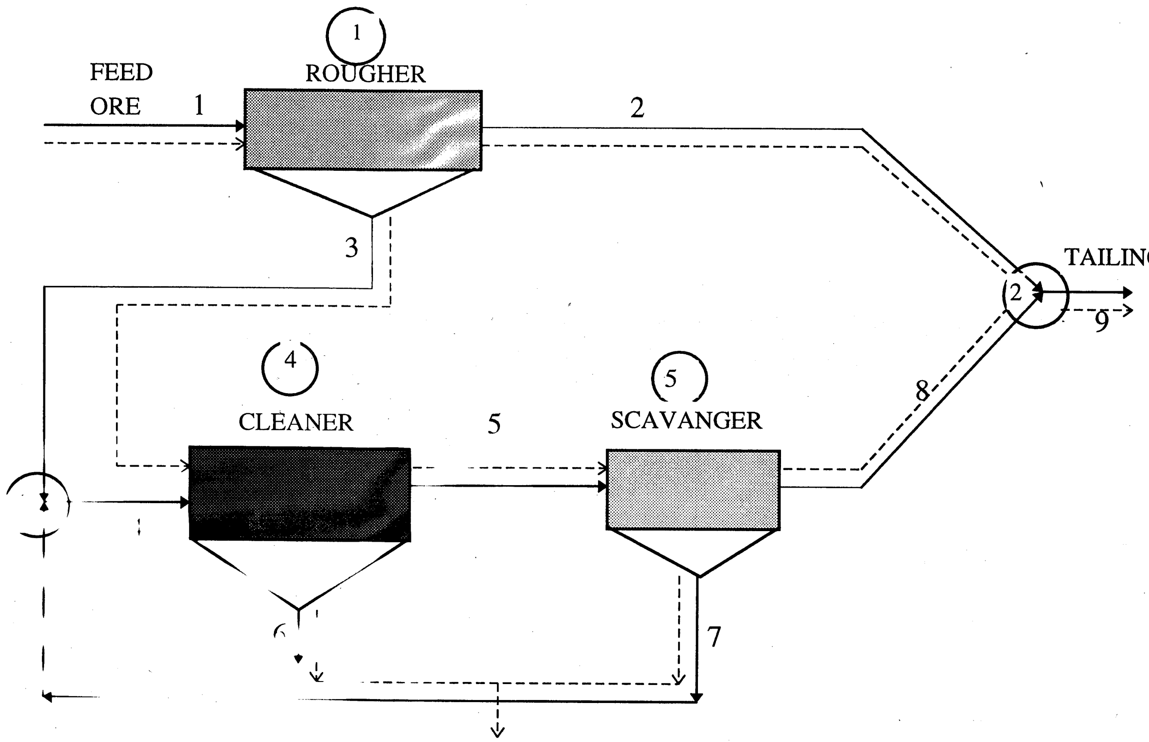


Fig. 1 Flotation flowsheets: 3.classical-conventional type (above) and 2. cleaning (c-s) type (below)

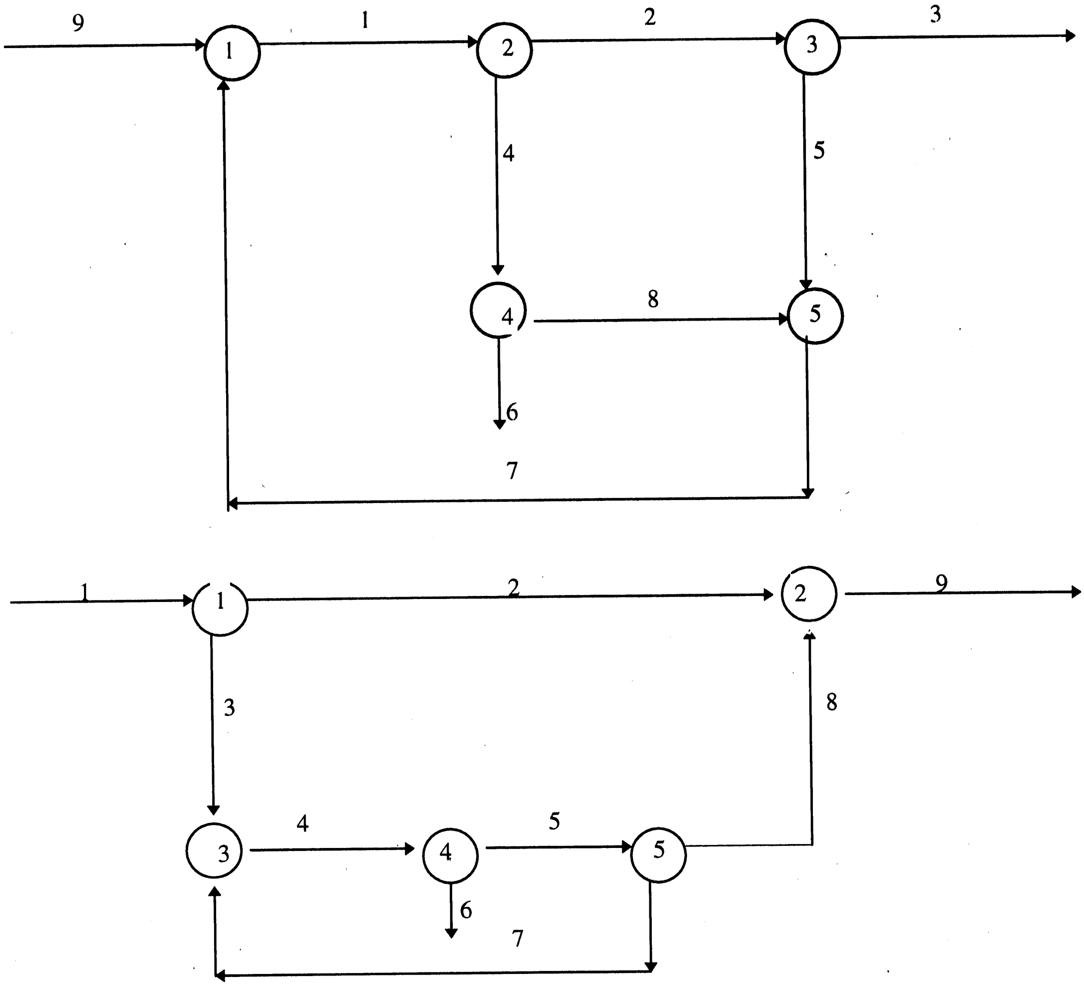


Fig. 2 - Flotation circuit in node forms: classical-conventional (above) and cleaning-scavenging (C-S type - (below) (full lines)

Classical - connectional (c-c type) flotation flowsheet:

Node	n_p	n_m	J	S
1	2	1	1	0
2	1	2	0	1
3	1	2	0	1
4	1	2	0	1
5	2	1	1	0
			2	3

Note: the number of "+1" entries (n_p)
the number of "-1" entries (n_m)

There are three simple separators and two junctions, thus the minimum number of streams that must be sampled is:

$$N = 2\,(F+S) - 1 = 2\,(1+3) - 1 = 7$$

Cleaning - scavenging (c-s type) flotation flowsheet:

Node	n_p	n_m	J	S
1	1	2	0	1
2	2	1	1	0
3	2	1	1	0
4	1	2	0	1
5	1	2	0	1
			2	3

There are three simple separators and two junctions, thus the minimum number of streams that must be sampled is:

$$N = 2\,(F+S) - 1 = 2\,(1+3) - 1 = 7$$

There are mine flowstreams and five nodes, which can be represented by the connection matrix:

Classical - connectional flotation flowsheet:

$$C = \begin{vmatrix} -1 & 0 & 0 & 0 & 0 & 0 & +1 & 0 & +1 \\ +1 & -1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & +1 & -1 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & +1 & 0 & -1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & +1 & 0 & -1 & +1 & 0 \end{vmatrix}$$

Cleaning - scavenging flotation flowsheet:

$$C = \begin{vmatrix} +1 & -1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & +1 & 0 & 0 & 0 & 0 & 0 & +1 & -1 \\ 0 & 0 & +1 & -1 & 0 & 0 & +1 & 0 & 0 \\ 0 & 0 & 0 & +1 & -1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & +1 & 0 & -1 & -1 & 0 \end{vmatrix}$$

Procedure and computer presentation

Using the connection matrix C and asuming the stream $B_9 = 1$ (Fig. 1), then the material matrix form $M = C \cdot M$ will be following:

$$
\begin{vmatrix}
-1 & 0 & 0 & 0 & 0 & 0 & +1 & 0 \\
+1 & -1 & 0 & -1 & 0 & 0 & 0 & 0 \\
0 & +1 & -1 & 0 & -1 & 0 & 0 & 0 \\
0 & 0 & 0 & +1 & 0 & -1 & 0 & -1 \\
0 & 0 & 0 & 0 & +1 & 0 & -1 & +1 \\
0 & 0.43 & -0.02 & 0 & -2.4 & 0 & 0 & 0 \\
0 & 0 & 0 & 7.45 & 0 & -18.0 & 0 & 1.25 \\
0 & 0 & -0.02 & 0 & 0 & -18.0 & 0 & 0
\end{vmatrix}
\begin{vmatrix}
B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \\ B_6 \\ B_7 \\ B_8
\end{vmatrix}
=
\begin{vmatrix}
-1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0.24
\end{vmatrix}
$$

The connection matrix has enabled the production of the necessary set of linear equations for flotation circuit evaluation or flotation representing. The utilization of the standard computer programme shows the appropriate conditions and ilustrates the significant advantages of the connection matrix using.

Computer program gives:

$B_1 = 1.10$
$B_2 = 1.05$
$B_3 = 0.98$
$B_4 = 0.05$
$B_5 = 0.07$
$B_6 = 0.02$
$B_7 = 0.10$
$B_8 = 0.03$
$B_9 = 1.00$

Conclusion

In the recent years the applicantion of the connection matrix is represented as the basic for the worked out computer softwers for mass balansing. It is specially in important application for the both mass balance and data adjustment for an industrial flotation bank.A lot of various examples ilustrates the advantages of the connection matrix utility for the necessary set of linear equations to evaluate the different flotation circuit.

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