Краткие сообщения

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A NEW METHOD OF MATERIAL RESOURCES MANAGEMENT BASED ON MATERIAL FLOW COST ACCOUNTING FOR INDUSTRIAL ENTERPRISES

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In the article a new method of material resources management for industrial enterprises is introduced. The method is based on the concepts of sustainable development and the elements of environmental management theory, such as life cycle assessment and material flow cost accounting. Steps that have to be completed in order to improve material resources efficiency are outlined and discussed in detail. Two possible optimization routines are also introduced and reviewed, namely: search for a better production technology via comparative analysis of available alternatives of manufacturing operations and material flows redistribution procedure. The flowchart of material flows redistribution algorithm is shown.

Keywords: material flow cost accounting, material resources management, industrial enterprise management, efficiency improvement.

Today large industrial enterprises have to deal with increasing importance of ecological factors and associated restraints enforced by government and society. To ensure efficient operation of these enterprises, it is imperative to implement new practices based on the concepts of sustainable development [1] and related managerial tools [2, 3]. In the article, one of such methods is given.

The method consists of the following steps:

1) construction of the material flow model;
2) modeling data collection;
3) resource consumption survey;
4) model correction;
5) material flow cost accounting;
6) priority allocation among elements of the system;
7) optimization.

The process of the material flow model construction and related calculations (steps 1, 4 and 5) are well described in [4].

Model construction requires verified data about incoming and outgoing material flows volumes, as well as detailed information about system costs per quantification center for a set period of time. In case data collection cannot be carried out because of technical or other reasons (continuous enclosed production lines, for example), the model can be corrected by merging adjacent quantification centers or an additional modeling of the production process can be employed with the help of Markov chain with absorbing states [5].

Resource consumption survey is comparison of planned system costs and material flow volumes with their actual values. It is recommended to move from the large scale model to more detailed one, up to the production unit or operation. In the process, it is sufficient to decompose only those parts of the model where notable divergence between planned and actual values occurred. It is also important to find the source of these divergences and correct the model accordingly.

Priority allocation is evaluation of quantification centers (or material flows) by the chosen efficiency indicator. Usually, for quantification centers such indicator is ratio of the outgoing material flows

cost to their volume. Main objective of this step is to make a clear order in which system's elements will be processed during the optimization step.

In particular, we talk about search for an alternative ways of production: by replacing individual elements (or groups of elements) with possible alternatives, a new value of efficiency indicator can be achieved. The process is comprised of the following steps:

1) search for the most critical quantification center (or group of related quantification centers, if it is not possible to replace only one);

2) analysis of existing alternative technologies, equipment and its work modes;

3) modeling of each found alternative;

4) replacement of the processed elements with one of the alternatives;

5) material flow model recalculation, evaluation of the replacement effect;

6) installation of the alternative which produces best effect.

It is worth noting, that actual replacement of the equipment requires additional expenses on purchase, installation, removal or reconfiguration. These expenses must be taken into account when system costs are defined for new quantification centers. Besides, most of technological solutions require different resource input for the same output, which makes it necessary to recalculate volumes of related material flows and system costs of related quantification centers. Complete analysis of all available configurations of the system can prove to be time consuming, if possible at all. To ease the task, it can be solved for a fragment of the system (relatively independent group of quantification centers). Also, some of the alternatives can be discarded beforehand based on simple logical statements; for example, among alternatives with the same rate of material consumption, the one with the least system costs value would provide best effect with any combination of other elements.

Another way to improve material resources efficiency of an industrial enterprise is to redistribute volumes of the material flows. Essentially, it means to find material flows volumes which do not violate integrity of the model and provide better value of the chosen efficiency indicator. The method is based on assumption that quantification centers' system costs change proportionally in relation to the volumes of incoming (outgoing) material flows. Then to reduce outgoing material flows cost (and therefore improve efficiency of the resources) volumes can be redistributed in favor of flows with the least cost/volume ratio. Obviously, such manipulations are possible only within groups of homogeneous flows, so for every quantification center outgoing flows must be distributed between these groups. To describe the algorithm more formally, following designations are introduced:

QC[i] – i-th quantification center (i = 1, 2, …, n);

MF[i, j] – material flow between QC[i] and QC[j] (j = 1, 2, …, n);

MF[i, j].V – material flow volume, tons;

MF[i, j].Min – minimal allowed volume for MF[i, j], tons;

MF[i, j].Max – maximal allowed volume for MF[i, j], tons;

MF[i, j].CPV – cost per volume ratio for MF[i, j], ruble/ton;

MF[i, j].S – QC[i];

MF[i, j].M – flow's mark (M0 – not marked, M1 – processed);

QC[i].IncMF – group of material flows incoming to QC[i] {MF[1, i], MF[2, i], …, MF[n, i]};

QC[i].IncMF[k] – group of homogenous material flows incoming to QC[i] (material k, where k = 1, 2, …, m);

SQC – selected quantification center;

SMFG – selected material flows group;

To explicitly define the order in which said groups of material flows should be processed, we suggest using a list of pairs (k; $\sum_{i=1}^{n}\sum_{j}\mathrm{QC}[i].\mathrm{IncMF}[k][j]$) sorted in descending order of the second component (rating). It will allow us to prioritize the most "expensive" materials and process related flows first. The flowchart of the material flows redistribution algorithm is shown in Fig. 1.

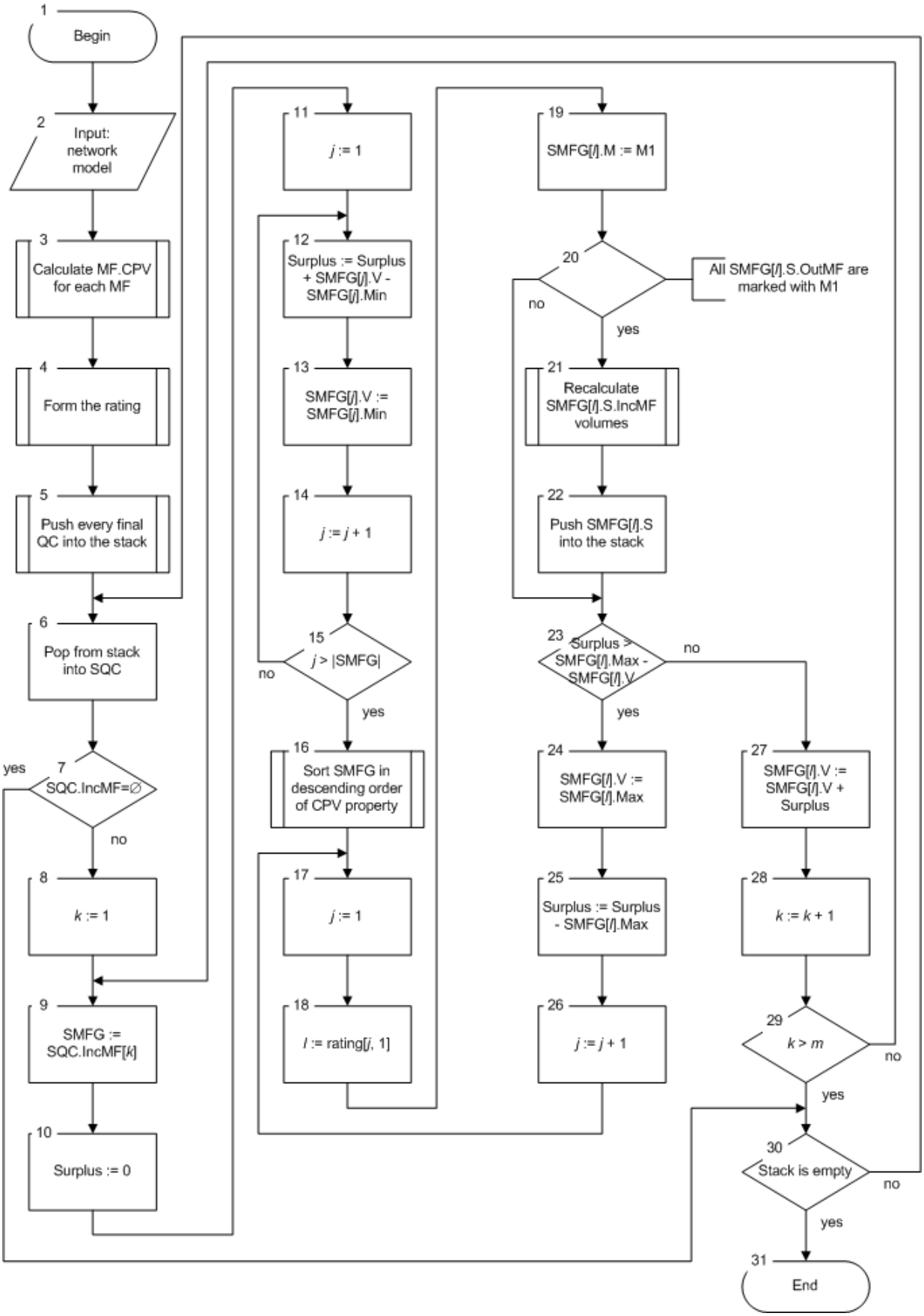

Fig. 1. Flowchart of material flows redistribution algorithm

To achieve best possible effect from the application of described method it is necessary to carry out modeling and optimization procedures at the regular periods of time. Commonly, this period spans one year, but due to global economical instability and rapid technological advancements it would be more reasonable to repeat said procedures whenever new production technology is developed or material (energy) prices change noticeably. Also, emergency situations (such as equipment failure) cause changes in the limitations of the model or even its structure and therefore call for local rescheduling of the production.

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МЕТОДИЧЕСКИЕ ПОЛОЖЕНИЯ ПО УПРАВЛЕНИЮ МАТЕРИАЛЬНЫМИ РЕСУРСАМИ ПРОМЫШЛЕННОГО ПРЕДПРИЯТИЯ ПРИ ПОМОЩИ ОЦЕНКИ МАТЕРИАЛЬНЫХ ПОТОКОВ

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Приводятся методические положения по управлению материальными ресурсами промышленного предприятия при помощи оценки материальных потоков. Разработанные методические положения базируются на концепции устойчивого развития и элементах методологии экологического менеджмента, таких как анализ жизненного цикла продукции и оценка стоимости материальных потоков. Перечисляются шаги, которые необходимо выполнить для повышения эффективности использования материальных ресурсов, раскрывается их сущность. Также рассматриваются два возможных способа оптимизации производственной системы, а именно: поиск альтернативных способов производства путем сравнительного анализа возможных вариантов производственных операций и процедура перераспределения материальных потоков. Показана блок-схема алгоритма перераспределения потоков.

Ключевые слова: оценка стоимости материальных потоков, управление материальными ресурсами, управление промышленным предприятием, повышение эффективности.

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