Linking mass and energy flow analysis with time management

Jutta Geldermann, Hannes Schollenberger, Otto Rentz

Institute for Industrial Production
University of Karlsruhe (TH)
Hertzstr. 16
D - 76187 Karlsruhe
Tel.: +49 – (0)721 – 608.4584
Fax: +49 – (0)721 – 758909

High cost level of labour and stricter environmental legislation require time and material efficiency in industrial production. Especially in small and medium size enterprises (SME) exists a high optimisation potential. Due to new environmental legislation, also processes should be adapted in order to comply with new emission limit values and to reduce material input. For example in the car refinishing sector, the software tool IMPROVE® has been developed on the basis of the LCA software Umberto® for identifying optimisation potentials with regard to material consumption, cost and emission reduction.

Mass and energy balances as used in life cycle assessment for the valuation of processes refer to a certain time period (often one year). For a more detailed analysis however the LCA approaches are not sufficient. Therefore this paper proposes the linking of mass and energy flow analysis with time management.

As the underlying process models can be based on the assumptions of Petri-Net-Theory, the consideration of time aspects is possible by implanting an hierarchical structure. By using subnets, representing different views or levels, it is possible to describe a production process as a hierarchical system. For linking mass and energy flow analysis with time management, three or more distinct levels with identical numbers of *transitions* and *places* can be designed. In the first level the whole process chain is described. All the results of the underlying subnets are joined here to an overview. In the lowest level the interrelations between the different materials are specified and calculated. Each level between these two can be considered as a specific input level for a different material group, but also for operation time.

This combination offers the possibility of an integrated optimisation of the production process with regard to environmental and organisational aspects. Thus the interaction of changes in time (process or working time) and material use can be considered, e.g. the variation of drying time due to the substitution of conventional paints by waterborne paints.

In the sector of car refinishing comprehensive time management studies have been conducted. The data on time and material consumption can be evaluated simultaneously by using hierarchical IMPROVE® in an integrated manner. By this, new environmental performance figures on the basis of time can be calculated, permitting a broader evaluation of the costs of emission reduction methods, especially when they result in a process modification. By using scenario techniques different strategies can be analysed and used as a support for decision making and for bench marking.