A Prototype System for Evaluating Life Cycle Scenario of Chemical Products

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INTRODUCTION

Environmental consciousness is becoming a common concept for process development in the coming world. Though the life cycle assessment (LCA) is popularly known as a tool for evaluating environmental management, it takes much time and cost to perform it. It is desired, therefore to improve such evaluation process, and provide a decision-aid for environmental management including economic activities. With this point of view, in this paper, we propose a prototype system to evaluate life cycle scenario through a hierarchical approach that enables us to use intelligent applications combined with information technologies.

LIFE CYCLE ENGINEERING (LCE) MODEL

We have adopted the G2 software[1] which is known as a development environment for modeling, designing and deploying intelligent applications. Using a variety of interfacing capabilities of G2 besides the object-oriented approach, we can build a LCE model which is easy for model expansion/revision, application execution, and data collection/management on the distributed basis of available computer resources. (**Fig.1**)

For such LCE modeling, we have called attention on a hierarchical activity-based modeling method termed IDEF0[2]. Applying this modeling method, we can facilitate a modular design and cooperative work, and provide appropriate information necessary for continuous improvement.

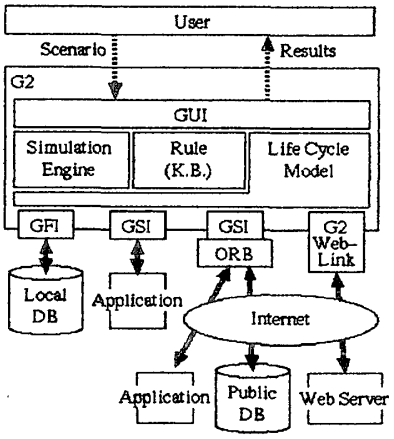

Fig.1 A Scheme of whole system

Modeling : An activity class is defined to express a set of activities belonging to the highest class level first. Next the lower classes which inherit the properties of their respective super class are derived consecutively. After all, they are to be expressed as a hierarchical structure. Also we prepare "control class" and "mechanism class" whose class definitions involve appropriate rules and/or procedures. By using knowledge-base regarding these, we can awaken any users by showing certain messages when some properties of the activity do not satisfy certain conditions under the present scenario.

Our model ranges from supply of the raw material and production of the original materials in the upstream to recycle and disposal in the downstream. Calculation regarding material balances, energy consumption, amount of CO_2 discharge, some costs, and much more if necessary are described as the formulas in the class definition. They are carried out on the basis of unit consumption, or of linear relation presently.

Interface : We develop some user interfaces by merging G2 user interface library to G2 menu system. In **Fig.2**, we show an example of the life cycle model attached the user interfaces.
Database : We provide the local DB in the form of EXCEL spreadsheet. By referring this, parameters involved in each object are given through G2 File Interface (GFI).

A CASE STUDY

While the share of ply-vinyl chloride (PVC) sheet for agricultural use (firm-vinyl sheet) is overwhelming the others in terms of economy and quality as well, disposal of the spent sheet is calling hot attention associated with what is known as the dioxin problem recently. It is significant, therefore, to evaluate totally various life cycle scenarios of PVC sheet involving the possibility of shift to the some alternative products, say PE sheet.

For example, the results in **Fig.3** show that material recycle (MR) is very effective both from energy consumption and CO_2 discharge regarding PVC sheet. (The energy consumption and CO_2 emission occur greatly at the production stage.) However, the other options like thermal (TR) and chemical (CR) recycles seem not so attractive with the present technology level.

Also, the analyses revealed followings: in the case of PE, CR seems to be a promising recycle option comparable to MR; we could have some possibilities of the shift from PVC sheet to PE sheet under certain circumstances.

The developed system can carry out these analyses easily just by setting several parameters through GUI that is provided as a scenario set-up menu. Moreover, its hierarcical modular structure is suitable for continuous improvement and a self-awaken mechanism that will make progress according to the collection of available activity models, applications and data appearing in future studies.

CONCLUSIONS

The case study revealed that optimizing recycle system, and improving technology levels are of crucial importance, and have real effects on the environmental problem besides the social consciousness about it. The proposed system is expected to support a variety of strategic decision making in LCE.

REFERENCES

1) G2 reference manual, Gensym Corp. Cambridge, 1995.

2) Marca, D.A and McGowan, C.L., "IDEF0/SADT", Eclectic Sol. Corp., San Diego, 1988.

3) Shimizu,Y. et. al.: Proc. 8th APCChE Congress, 7-6B-02, 223-226, 1999, Korea

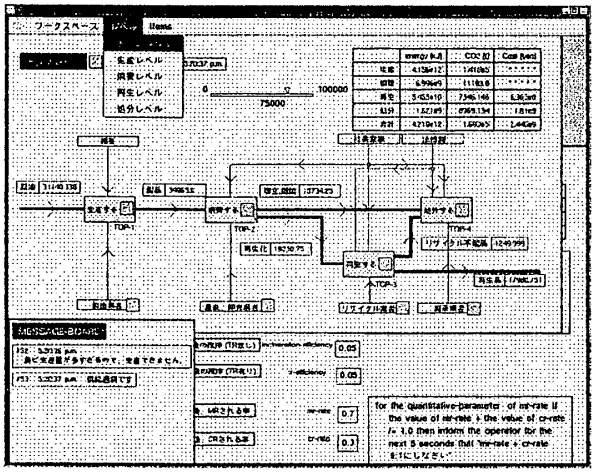

Fig.2 Life cycle model with user interface

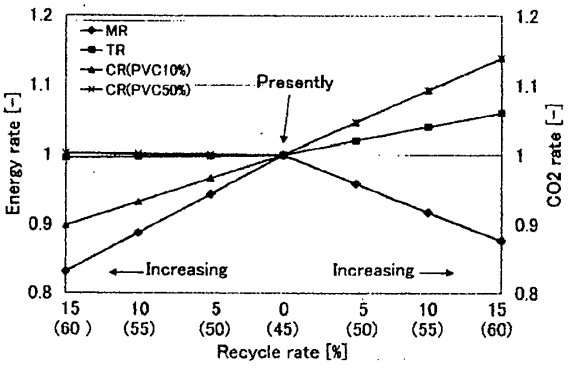

Fig.3 Effect of Recycle Options (PVC sheet)