SOME ASPECTS OF FUZZY TECHNIQUES APPLICATION IN BIOTECHNOLOGY

Jiří Nekola
Inst. of Chemical Process Fundamentals,
Czechoslovak Academy of Sciences, Prague

Miloš Vítek
Univ. of Chemical Technology, Pardubice
Czechoslovakia

The applications of fuzzy sets theory realized so far make it possible to characterize some advantages of fuzzy techniques in investigation of complex systems.

As for the aims followed in the presented paper these advantages can be stressed:

- The database is being enlarged by the data describing the substance of the problems examined not respecting their original form. In the preliminary stages of investigation it concerns namely the phenomena, the substance of which is uncertain or vague, which cannot be precisely measured, can be estimated only on the basis of expert analysis or on the basis of subjective judgement. Fuzzy techniques make it possible to quantify information in verbal form and operate with it as with a linguistic variable, get them comparable with the data stemming from standard measurements or with the data in classic statistical form.
- It is possible to handle with estimated parameters of the respective model in relatively wide intervals according to the expert guesses, corresponding to the requirements of the real situation.
- The changes in uncertainty levels can be respected corresponding to the changes of conditions and the development of the knowledge of the topics.

Knowledge and experience gained so far are applicable on specific systems, in which uncertainty, uncompleteness and imprecise measurements are prevailing.

One of these areas is biotechnology and processes in bioreactors. The paper has been mainly concentrated on modelling of decisive and only partially quantifiable factors in these processes and in specific types of bioreactors. For the input and the functioning in biotechnological processes and bioreactors a great deal of subjectively estimated data is characteristic. The biotechnological process itself and its regulation are connected with a number of uncertain and varying factors corresponding to different stages of reactions.

There is no doubt that within the biotechnological processes synergetic principles exist as an important element of regulation, which performs useful automatic and self-organizational effects. The recognition, conscious, and intentional using of synergetic aspects occuring in biotechnological processes are possible by application of fuzzy techniques.

It concerns namely the metastable phases of the reactions. The description by means of fuzzy techniques can include possible variants of reactions and composition of their elements, event. of phases transitions. Relatively high referring ability in this respect has been observed, which seems to be most important for the purposes of an efficient regulation namely in the preliminary stages of model verification. Fuzzy techniques in these stages are useful for the recognition and characteristics of similarity and self-regulation.

It is obvious that fuzzy techniques could be efficiently used even in the cases of multidimensional analysis of stable phases and for the estimation of parameters characteristic for the regulation of complex systems.

There are many ambiguous factors from the qualitative point of view, which could influence the quantitative form of elements as for modelling biotechnological processes. The mechanical summation of such factors could be misleading and therefore new approach to integration procedures seems to be more appropriate. The ecological, economic and social criteria can be followed as very important effects of biotechnological processes. The results of cooperation, integration and self-organization, which are of possibilistic nature, have been mentioned. They show only partial membership to the set of "ideal" solutions.

Conclusions has been made for the given case of a bioreactor and biotechnological procedures that the evaluation of system output is multisided and multivariable. Fuzzy techniques proved to be very promissing methods and important tool with a high referring ability for the regulation purposes and namely for the quantification of laboriously measurable and only expertly estimated factors representing the final effect.