Ill-posed problems and multicriteria programming

© A.A. Greshilov

Bauman Moscow State Technical University, Moscow, 105005, Russia

Solving ill-posed problems by methods of multicriteria mathematical programming has been considered. Several methods of multicriteria mathematical programming (method of compression of acceptance region and goal programming) are used simultaneously allowing considering additional types of restrictions (nonnegativity of the solution, boundedness of solution) which must be met by evaluation of solution and which do not require definition of the regularization parameters necessary in the classical methods of regularization. When registering a small number of isotopes the merger of the two types of uranium- 235 instant fission into one kind of division and two types of plutonium-239 fission into one kind of division is used. Simultaneously different variants of the nuclear explosion mechanism are considered. Determination of contributions of different fission kinds into the total activity of isotopes of krypton and xenon is performed by formation of a functional for a given moment of separation t_q and time measurements t of functions F_l.

They are obtained from the functional by its differentiation on the elements ρN_j of the system of linear algebraic equations (SLAE) at fixed values of the specific activity $\hat{a}_{ij}^{true}(t_q,t)$. Solving SLAE is performed by generating multiple objective functions and using the 4 methods of multicriteria mathematical programming, reducing multicriteria problem to one-criterion problem with constraints. The solutions of the mentioned one-criterion problem with constraints are obtained by the iterative computational procedures with the given specific activity $\hat{a}_{ij}^{true}(t_q,t)$ and when its assessment was specified for each iteration. The point estimates of the contributions of different fission kinds into the total activity of isotopes are determined. For definition of the moment of separation t_q contributions ρN_j are calculated for different values t_q and the value at which the

$$ratio \sum_{i=1}^{n}\left(\tilde{A}_i(t) - \sum_{j=1}^{m} a_{ij}^{true}(t_q,t)(\rho N_j) \right)^2 / \sum_{j=1}^{m}(\rho N_j)^2 \text{ is minimal is chosen.}$$

Keywords: *regularization methods, fission products, nuclear explosion, separation of isotopes, multicriteria programming, targeted programming, compression method, iterative method of solving*

REFERENCES

[1] Tikhonov A.N. *Doklady Akademii nauk SSSR – Reports of the USSR Academy of Sciences*, 1963, vol. 161, no. 3, pp. 501–504.

[2] Morozov V.A. *Vychislitelnye metody I programmirovanie: Novye vychislitelnye tekhnologii – Computational Methods and Programming: New Computing Technologies, (Electron. Edition)*. 2003, vol. 4, pp. 130–141.

[3] Malioutov D.M. A Sparse Signal Reconstruction Perspective for Source Localization with Sensor Arrays. *IEEE Transactions on Signal Processing,* 2005, vol. 53, no. 8, pp. 3010–3022.

[4] Zhdanov A.I. *Zhurnal vychislitelnoy matematiki i matematicheskoi fiziki RAN — Journal of Computational Mathematics and Mathematical Physics RAS*, 2005, vol. 45, no. 11, pp. 1919–1927.

[5] Greshilov A.A. *Nekorrektnye zadachi tsifrovoy obrabotki informatsii i signalov* [Some Ill-Posed Problems of Digital Information and Signal Processing]. Moscow, Universitetskaya kniga; Logos Publ., 2009, 360 p.

[6] Greshilov A.A. *Matematicheskie metody prinyatiya resheniy: Uchebnoe posobie dlya vuzov* [Mathematical Methods of Decision-Making: study book for higher school]. Moscow, BMSTU Publ., 2014, 645 p.

[7] Greshilov A.A., Lebedev A.L. *Sposob identificatsii jadernogo vzriva po isotopam kriptona I ksenona.* [A Method for Determining the Concentration of Inert Gas Isotope in the Mixture of Fission Products]. Patent № 2407039 Russian Federation, 2010, bulletin № 35, 21 p.

[8] Greshilov A.A., Tetukhin A.A *Vestnic MGTU im. N.E. Baumana. Seria Estestvennye nauki — Herald of the Bauman Moscow State Technical University. Series: Natural Sciences*, 2003, no. 2, pp. 3–19.

Greshilov A. A. (b. 1939) graduated from Moscow Engineering Physics Institute, Department of Experimental and Theoretical Physics, in 1964. Doctor of Engineering Sciences, professor at the Department of Higher Mathematics at Bauman Moscow State Technical University. The author of more than 200 scientific papers, including more than 30 monographs, 30 patents and Certificates of Authorship in the field of the development of mathematical methods of considering uncertainty of the initial information in the problems of mathematical physics, pattern recognition, forecasting, and other technical applications. e-mail: agresh@mail.ru