International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 5 May 2022, pp: 1540-1542 www.ijaem.net ISSN: 2395-5252

Application of the Optimization Problem in Choosing Furnace Materials For Iron Smelting

Phan Thi Van Huyen
Faculty of Fundamental Science, Thai Nguyen University of Technology, Vietnam

Submitted: 15-05-2022 Revised: 20-05-2022 Accepted: 25-05-2022

ABSTRACT:In recent years, optimization methods have been widely and effectively applied in economics, engineering, transportation, information technology, and many other scientific disciplines. This article will systematize a real-life model that needs the help of Mathematics to solve production cost problems in business to clarify the relationship between Mathematics and practice

KEYWORDS: Optimization, Optimal, Mathematical model, Furnace materials.

I. INTRODUCTION

Currently, the direction of scientific research to serve practice and solve problems arising in practice is of great interest. One of the most interested directions is the field of mathematical optimization [1-33].When planning production and design based on optimization principles, it will save costs in terms of capital, raw materials, time and labor while increasing efficiency, productivity and quality of work. Therefore, the problem is to model real-world problems into optimization problems. Then, the results of the optimization problem will give us the most reasonable production plan in practice.

II. METHODOLOGY

In this paper, we consider the production of cast iron not as smelting it from a mixture of different materials but as a mixture of metals of different chemical composition, each of which is considered to be smelted from a kind of furnace material (Furnace material is understood as a starting product for metallurgy). In the iron-smelting industry, choosing whether different furnaces determines the use of different iron-smelting technologies . In the composition of the furnace materials, there will be iron ores with other types such as rust, martin kiln slag, scrap steel… Choose whether different furnace materials will produce different chemical compositions of smelted iron. For a quality cast iron product, the percentages of sulfur, manganese, phosphorus and some other elements should not exceed a predetermined value.

In fact, in the cast iron industry, the manufacturer wants to find out whether the furnace is optimal, it means the composition of the furnace materials, so that the production cost is the cheapest while still ensuring the requirements for the composition. chemistry. Now, we will build a mathematical model for this problem.

Consider a factory iron plant with a total of n furnaces. We sign:

x_j is the part of cast iron smelted from the j-th furnace material, $j = 1..n$ (as a percentage in a ton of cast iron). Then $\sum_{j=1}^{n} x_j = 1$

a_{ij} is the percentage of the i-th element (sulfur, manganese, phosphorus) can be produced from the j-th furnace material and a_i is the maximum allowable percentage of the i-th element in the finished cast iron. Since the total percentage of element i in all furnaces does not exceed the maximum allowable percentage, it is necessary to ensure the following conditions: $\sum_{j=1}^{n} a_{ij}.x_j \le a_i$

d_j is the maximum part of iron that can be smelted from the j-th furnace material, $j = 1..n$. So that $0 \le x_j \le d_j$.

c_j is the production cost for one tonne of cast iron assuming smelting from the j-th furnace material,

$j=1..n$. Then the total production cost of the factory is $\sum_{j=1}^{n} c_j x_j$.

So the mathematical model for this problem is :

$$\sum_{j=1}^{n} c_j x_j \to \min \text{ with conditions}$$

$$\begin{cases} \sum_{j=1}^{n} x_j = 1 \\ \sum_{j=1}^{n} a_{ij}.x_j \le a_i, i=1...r \\ 0 \le x_j \le d_j, j=1..n \end{cases}$$

Solving this problem, we will determine the set of solutions $(x_1, x_2, ..., x_n)$ determine the part smelted iron from the furnaces so that when choosing this option, the plant will have the lowest cost while still ensuring the requirements for the chemical composition of the finished cast iron.

III. CONCLUSION

The paper presents a method application of the optimization problem for the choosing furnace materials for iron smelting. This further elucidates the two-way intimate relationship between mathematics and practice and the important role of mathematics in practice. In the future, the author's follow-up studies will carry out research on optimization for the processes occurring in the engineering process.

ACKNOWLEDGMENT

This work was supported by the Thai Nguyen University of Technology

REFERENCES

[1]. Horst, R., & Tuy, H. (2013). *Global optimization: Deterministic approaches*. Springer Science & Business Media.

[2]. Tuy, H., Hoang, T., Hoang, T., Mathématicien, V. N., Hoang, T., & Mathematician, V. (1998). *Convex analysis and global optimization*. Dordrecht: Kluwer.

[3]. Migdalas, A., Pardalos, P. M., & Värbrand, P. (Eds.). (2013). *From local to global optimization* (Vol. 53). Springer Science & Business Media.

[4]. Horst, R., & Tuy, H. (1997). Global optimization. *Journal of the Operational Research Society*, *48*(8), 850-850.

[5]. Floudas, C. A. (2013). *Deterministic global optimization: theory, methods and applications* (Vol. 37). Springer Science & Business Media.

[6]. Horst, R., & Pardalos, P. M. (Eds.). (2013). *Handbook of global optimization* (Vol. 2). Springer Science & Business Media

[7]. Horst, R., & Tuy, H. (1996). Lipschitz and Continuous Optimization. In *Global Optimization* (pp. 603-679). Springer, Berlin, Heidelberg.

[8]. Floudas, C. A., & Visweswaran, V. (1995). Quadratic optimization. In *Handbook of global optimization* (pp. 217-269). Springer, Boston, MA.

[9]. Betts, J. T. (2010). *Practical methods for optimal control and estimation using nonlinear programming*. Society for Industrial and Applied Mathematics.

[10]. Ahlfeld, D. P., & Mulligan, A. E. (2000). *Optimal management of flow in groundwater systems: an introduction to combining simulation models and optimization methods*. Academic Press.

[11]. Kalaba, R., & Spingarn, K. (2012). *Control, identification, and input optimization*. Springer Science & Business Media.

[12]. Wasch, H., Kolmanovsky, I., Steinbuch, M., & Del Re, L. (Eds.). (2014). *Optimization and optimal control in automotive systems* (Vol. 455, p. 205). Heidelberg: Springer.

[13]. Kameda, H., Li, J., Kim, C., & Zhang, Y. (2012). *Optimal load balancing in distributed computer systems*. Springer Science & Business Media.

[14]. Villani, C. (2009). *Optimal transport: old and new* (Vol. 338, p. 23). Berlin: Springer.

[15]. Peyré, G., & Cuturi, M. (2019). Computational optimal transport: With applications to data science. *Foundations and Trends® in Machine Learning*, *11*(5-6), 355-607.

[16]. Vinter, R. B., & Vinter, R. B. (2010). *Optimal control*. Boston: Birkhäuser.

[17]. Leonard, D., Van Long, N., & Ngo, V. L. (1992). *Optimal control theory and static optimization in economics*. Cambridge University Press.

[18]. Zhu, H., Wang, Y., Wang, K., & Chen, Y. (2011). Particle Swarm Optimization (PSO) for the constrained portfolio optimization problem. *Expert Systems with Applications*, *38*(8), 10161-10169.

[19]. Sellis, T., & Ghosh, S. (1990). On the multiple-query optimization problem. *IEEE*

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 5 May 2022, pp: 1540-1542 www.ijaem.net ISSN: 2395-5252

Transactions on Knowledge & Data Engineering, *2*(02), 262-266.

[20]. Johari, N. F., Zain, A. M., Noorfa, M. H., & Udin, A. (2013). Firefly algorithm for optimization problem. *Applied Mechanics and Materials*, *421*, 512-517.

[21]. Han, K. H., & Kim, J. H. (2000, July). Genetic quantum algorithm and its application to combinatorial optimization problem. In *Proceedings of the 2000 congress on evolutionary computation. CEC00 (Cat. No. 00TH8512)* (Vol. 2, pp. 1354-1360). IEEE.

[22]. Ghaddar, B., Marecek, J., & Mevissen, M. (2015). Optimal power flow as a polynomial optimization problem. *IEEE Transactions on Power Systems*, *31*(1), 539-546.

[23]. Han, K. H., Park, K. H., Lee, C. H., & Kim, J. H. (2001, May). Parallel quantum-inspired genetic algorithm for combinatorial optimization problem. In *Proceedings of the 2001 congress on evolutionary computation (IEEE Cat. No. 01TH8546)* (Vol. 2, pp. 1422-1429). IEEE.

[24]. Weber, J. D., & Overbye, T. J. (1999, July). A two-level optimization problem for analysis of market bidding strategies. In *1999 IEEE Power Engineering Society Summer Meeting. Conference Proceedings (Cat. No. 99CH36364)* (Vol. 2, pp. 682-687). IEEE.

[25]. Qi, L., Wang, F., & Wang, Y. (2009). Z-eigenvalue methods for a global polynomial optimization problem. *Mathematical Programming*, *118*(2), 301-316.

[26]. Bard, J. F. (1983). An efficient point algorithm for a linear two-stage optimization problem. *Operations Research*, *31*(4), 670-684.

[27]. Bhurjee, A. K., & Panda, G. (2012). Efficient solution of interval optimization problem. *Mathematical Methods of Operations Research*, *76*(3), 273-288.

[28]. Törn, A., Ali, M. M., & Viitanen, S. (1999). Stochastic global optimization: Problem classes and solution techniques. *Journal of Global Optimization*, *14*(4), 437-447.

[29]. Schutze, O., Lara, A., & Coello, C. A. C. (2010). On the influence of the number of objectives on the hardness of a multiobjective optimization problem. *IEEE Transactions on Evolutionary Computation*, *15*(4), 444-455.

[30]. Chen, G. Y., & Cheng, G. M. (1987). Vector variational inequality and vector optimization problem. In *Toward interactive and intelligent decision support systems* (pp. 408-416). Springer, Berlin, Heidelberg.

[31]. Goelzer, A., Fromion, V., & Scorletti, G. (2011). Cell design in bacteria as a convex optimization problem. *Automatica*, *47*(6), 1210-1218.

[32]. Rüschendorf, L. (1983). Solution of a statistical optimization problem by rearrangement methods. *Metrika*, *30*(1), 55-61.

[33]. Fiol, M. A., Yebra, J. L. A., Alegre, I., & Valero, M. (1987). Discrete optimization problem in local networks and data alignment. *IEEE Transactions on computers*, *36*(06), 702-713.