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THE MODEL OF TACTIC–COORDINATING SYSTEM ———APPLICATION OF SUCH A SYSTEM IN THE PRETREATMENT OF WASTEWATER.

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Abstract Many social systems are influenced very much by certain environments and they are also under the condition of competition and compromise. In the decision making of such systems, pure optimum seeking methods would be simply refused because of the loss of some player's benefits and it is therfore impossible to carry out the tactics in those systems. So, the mediating theory and the model of tactic–coordinating system are used in this treatise to deal with the tactics in such kind of systems. The taxation of the wastewater drainage in the system of pretreatment of wastewater is used as an example for calculation and analysis.

Keywords: Tactic–coordinating System; Mediating Theory; Pretreatment of Wastewater.

I. Introduction

According to the Chinese environmental pretection policy, every source of wastewater (factory) should be charged tax or fine to the local government or the environment pretection authority. Part of the tax or fine is returned to the payers to build installations of the pretreatment of wastewater. Because of the increasing demand of environmental protection, the government and the environment protection authority often require the decrease of the total amount of the filthy objects in the wastewater drainage. It is comparatively fair to adopt the balanced treatment method to carry out such a plan. According to this method, the amount of reduction should be equally distributed to every source of wastewater and all the sources must reduce the concentration of filthy objects in the wastewater to reach the standard. It seems to be theoretically reasonable and economical, however, to build installations of pretreatment of wastewater in some important sources of wastewater according to the optimum method. Supposing, there are 8 sources of wastewater in a region. In accordance with the environmenal protection regulations, 25% of the total amount ot filthy objects must be reduced. When the method of balanced treatment is adopted, the expenditure is shown in Table 1. When the method of optimum seeking and centralized treatment is used, the results are shown in Table 2.

Table 1

Ordinal Number of Sources	1	2	3	4	5	6	7	8	Region
Ratio of Reduction	25%	25%	25%	25%	25%	25%	25%	25%	25%
Expenditure (thousand yuan)	30	375	150	150	180	60	300	90	1355

Table 2

Ordinal Number of Sources	1	2	3	4	5	6	7	8	Region
Ratio of Reduction	0	50%	0	0	15%	0	30%	0	25%
Expenditure (thousand yuan)	0	600	0	0	135	0	330	0	1065

It is quite clear that the expenditure of the optimum method is much lower than that of the balances treatment method by 2.9 million yuan when the same amount of filthy objects is reduced. So the optimum method seems to be very reasonable. However, when the optimum method is really adopted, some problems would appear. According to Table 2, more money and energy are spent for source 2 and 7 to reduce filthy objects in the wasterwater without relative compensation. So it is hard for these two sources to behave actively.

This problem also exists in the distribution of natural resources. When a number of systems are involved the benefits of the players concerned are contradictious, even the optimum seeking method can not simply used. Therefore the model of tactic—coordinating system is introduced in this treatise to solve such a problem.

II. Conceptual Model of the Tactic—Coordinating System

Among the decision making of some economic, military, scientific and social systems, some are easily influenced by the environment of system which belongs to a system under the condition of competition and compromise. In the consideration of the decisions in such a system, all the possible conflicts among the people concerned and all the contradicts between people and the system environment must be considered. The conflicts of benefits of the players in the system are not fundamentally rooted and they can be solved through the way of discussion and coordination. The plan of building installations of pretreatment of wastewater and the policy of collecting or returning tax and fine for draining wastewater are just the decision of such a kind of system.

So, the conceptual model of tactic—coordinating system (Fig, 1) is introduced to solve this kind of problem.

First of all, the plan of reducing filthy objects must be worked out according to the demand of environmental protection authority to reduce the total amount of the filthy objects in the wastewater drainage in the present system. Then, the project of balanced treatment system and project of optimum system must also be established. Based on these projects, the project of zero point system should be worked out. This project ought to be comparatively fair and reasonable and can be used as the basis of the first round of negotiation among the sources of wastewater. If agreements are reached in the negotiation, then the project is the improved one and can be carried out immediately. If no agreements are reached, further discussions and coordination, then, are needed. The project must be improved for the next round of negotiation. In this way, the improved system can be finally achieved. When every possible project is not successful, the local government and the environmental protection authority can take actions of further mediation or arbitration.

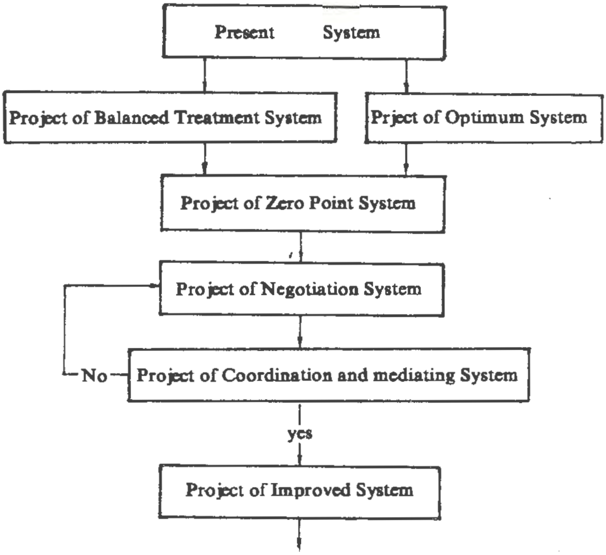

Fig. 1

III. The Calculation and Application of the Model of Tactic–Coordinating System

(1). The calculation of the project of balanced treatment system. Suppose the total amount of reduction of filthy objects in a region is $\triangle P$ and the amounts of the filthy objects drainage from the sources of wastewater are P_1, P_2, $\cdots P_n$, the amount of reduction in all the sources is $\triangle P_i$, the

$$\frac{\triangle P_i}{P_i} = \frac{\triangle P_k}{P_k} = \frac{\triangle P}{P} \quad , (i \neq k)$$

here, $$P = \sum_{i=1}^{n} P_i \quad , \quad \triangle P = \sum_{i=1}^{n} \triangle P_i$$

So, in the project of balanced treatment system, the expenditure X_i for reducing filthy objects in the pretreatment of wastewater can be calculated according to the functional relation of different sectors of the national economy. That is $X_i = f(\triangle P_i)$. The total expenditure of the region should be

$$X = \sum_{i=1}^{n} X_i$$

(2). The calculation of project of optimum system. Based on the objects and demand to the present system, the regional optimum model can be established as follows:

(Expenditure) $\min \sum_{i,j} C_{ij} W_{ij}$, $(i = 1, 2, \cdots n)$

(Quality of Water) $\max \sum_{i,j} b_{ij} W_{ij}$, $(j = 1, 2, \cdots m)$

s. t. $\sum_{i,j} a_{ij} W_{ij} \geq A$

$$\sum_j W_{ij} \leqslant K_i$$

$$\sum_j q_{ij} W_{ij} \leqslant H_i$$

$$W_{ij} = 0, \ or \ 1.$$

Where, i is the ordinal number of the sources; j is the ordinal number of the project which deals with the treatment of wastewater; W_{ij} is the j project of source i; C_{ij} is the expenditure of carrying out j project in sourece i; b_{ij} is the reduced amount of BOD in source i after j project is carried out. a_{ij} is the reduced amount of COD in source i after j project is carried out; A is the demand of reduction of COD; K_i is the number of possible installations in source i for pretreatment of wastewater. q_{ij} is the reduced amount of filthy object in source i after j project is carried out; H_i is the amount of filthy object in the wastewater drainage in source i. So the expenditure for the pretreatment of wastewater in this region is

$$Y = \sum_{i=1}^{n} y_i = \sum_{i,j} C_{ij} W_{ij}$$

The soft–ware system of interreactive multiobjective program can be adopted in the calculation of the optimum model. the results must be the limitation of the total amount of investment and the limitation of the numbes of installations which deal with the pretreatment of wastewater.

(3). The calculation of the project of zero point system. As the first round project of negotiation, the zero point project is:

a. The balanced treatment project is used to collect tax X from all source of wastewater drainage.

b. The optimum project is adopted to decide the expenditure Y for the regional pretreatment of wastewater.

c. The amount left X–Y would be returned in proportion to the sources based on how much they pay. Then the zero point project is the real expenditure Z_i^0 that the sources of wastewater must pay.

$$Z_i^0 = X_i - r_i(X - Y),$$

$$r_i = \frac{X_i}{X}, \ (r_i \text{ is a proportion coefficient})$$

The zero point project can make it possible that every source can get benefits from carrying out the optimum project. That is:

$$\text{i)} \ \sum_{i=1}^{n} X_i \geqslant Y \qquad , \qquad \text{ii)} \ Z_i^0 \leqslant X_i$$

(4). The calculation of the project of coordination and mediating system. According to the zero point project, the tax paid by every source of wastewater will be less than that it must pay based on the balance treatment system. However, those sources which build the installations of pretreatment of wastewater would turely spend more money and energy. It is reasonable for them to ask for more as compensation. This should be considered during the coordination process.

The project of coordination and mediating is to realize the results of the optimum system and, at the same time, it should make it possible that the sources have the abilities to pay the regulated tax for draining wastewater. Then the sources of wastewater shouldbe divided into two groups. Group A_I includes those sources which contribute quite much to the reduction of filthg objects in the wastewater drainage, $y_i > Z_i^0$. Group A_{II} includes the sources which have little or no contributions, $y_i < Z_i^0$. The formulation

$$Z_{Ii} = Z^0_{Ii} - r(X - Y)V_i, \qquad (i \in A_I)$$

$$Z_{IIr} = Z^0_{IIi} + r(X - Y)U_i, \qquad (i \in A_{II})$$

Where Z_{Ii} is the expenditure from the sources in group A_I; Z_{IIi} is the expenditure from the souroes in group A_{II}. The extra expenditure would be reduced for the sources in group A_I, r is the ratio of reduction. V_i and U_i are the factors in group A_I and group A_{II} which deal with the re–distribution of benefits. The rule of equal ratio distribution is used here:

$$V_i = \frac{Y_i - X_i}{\sum_i (Y_i - X_i)}, \ (i \in A_I); \qquad U_i = \frac{X_i - Y_i}{\sum_i (X_i - Y_i)}, \ (i \in A_{II})$$

The key problem in the process of coordination is how to decide the value of r. The rule in this treatise is to decide whether the coordination is satifactory, which is:

a. The real expenditure from every source of wastewater would be no more than that is must pay based on the balanced treatment project.

b. The characteristics of different occupational sectors must be considered.

c. The sources of wastewater which have great contributions to the reduction of filthy objects should be given preferential treatment.

IV. The Results of Calculation

The model of tactic–coordinating system has been used for the analysis of some sources of wastewater in Tianjin region. Through the analysis and calculations, the model introduced in this treatise has been proved to be quite useful. Under the condition r = 0.20, some results of calculation are shown in Table 3.

Table 3

	Ordinal Number of Sources	Amout of Reductien of Optimum Project (100 ton)	Amount of Reduction of Balanced Treatment (100 ton)	Expenditure of Balanced Tratment (100 yuan)	Expenditure of Zero Point System (100 yuan)	Expenditure of Improved Project (100 yuan)
Group A_I	1	2071.1	541.3	194.5	155.6	109.4
	2	387.6	118.9	42.8	35.4	24.8
	3	122.6	48.3	17.4	13.9	12.0
	4	169.3	150.5	54.1	43.3	40.3
	5	337.2	28.0	10.0	8.0	1.5
Group A_{II}	6	0	120.1	43.1	34.5	36.5
	7	0	52.7	19.0	15.2	16.1
	8	0	235.0	84.4	67.5	71.4
	9	0	83.9	30.1	24.1	25.5
	10	0	910.8	327.3	261.8	276.9
	11	0	14.8	5.4	4.3	4.5
	12	0	524.0	188.2	150.6	159.3
	13	0	256.2	86.5	68.5	72.4

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