CHEMICAL ENGINEERING TRANSACTIONS
VOL. 62, 2017

A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet

Guest Editors: Fei Song, Haibo Wang, Fang He

ISBN 978-88-95608- 60-0; **ISSN** 2283-9216
DOI: 10.3303/CET1762263

Research on the Innovative Ability of Green Chemical Technology in Eastern Region of China - Based on the perspective of Talent Competitiveness

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The chemical industry is the basic sector of the national economy. The status of chemical technology is directly related to the level of economic and social development in a country or region. However, the level of chemical technology relies on the ability of chemical talents to innovate. Therefore, this article from the perspective of the competitiveness of chemical talents to conduct a comprehensive study of the level of green chemical technology in eastern China to comprehensively analyze the development of green chemical technology in different regions of eastern China, to find the problems, and to put forward corresponding improvement measures, it is of great significance. At the same time, this study can also provide useful guidance for other regions to carry out green chemical technology upgrading research, which has important reference value.

1. Introduction

The chemical industry is the basic raw material industry in China and also the pillar industry of the national economy. The speed and scale of its development have a direct impact on all sectors of the social economy. Due to special geographical location and economic development environment, the eastern region of China has become one of the most important petrochemical industrial bases in China and has for a long time effectively promoted the rapid economic and social development in the region. However, for a long time, China's For a long time, the equipment and technology of China's petrochemical industry are mainly introduced, the extensive mode of production has not completely changed, in the production process there are some disadvantages and shortcomings, such as raw material utilization rate is low, backward production technology, environmental pollution etc (zhang, 2008).Therefore, for the development of green chemical industry, all the eastern regions of China have made strategic decisions to actively carry out green chemical technological innovation since the 1990s. Whether the decision effectively promote the development of green chemical technology in our country, how the level of green chemical technology in these areas? Talent is the primary resource and the main promoter of green chemical technological innovation. Therefore, this paper tries to make a comparative analysis of the development level of green chemical technology in all regions of eastern China from the perspective of talent competitiveness, scientifically evaluate the differences in the development level of green chemical technology in all regions in eastern China, and so as to further promote the green chemical technology in this region The innovation has important practical significance. Talent is the first resource, and it is the main driver to carry out the innovation of green chemical technology. Therefore, this paper attempts to start from the perspective of talent competition, the comparative analysis of the green chemical technology development level of each region in eastern China, differences in evaluation of green chemical technology development level of each region in East China science, has important practical significance to further promote the innovation of local green chemical technology.

2. Overview of the research area

Eastern China lies in the eastern margin of Asian Continent, on the west coast of the Pacific Ocean. There are several provinces and municipalities in eastern China, such as Beijing Municipality, Tianjin Municipality,

Please cite this article as: Yanyan Chen, 2017, Research on the innovative ability of green chemical technology in eastern region of china - based on the perspective of talent competitiveness, Chemical Engineering Transactions, 62, 1573-1578 DOI:10.3303/CET1762263

Shanghai Municipality, Hebei province, Jiangsu province, Zhejiang province, Fujian province, Shandong province, Guangdong province, and Hainan province. The resource-rich eastern areas have regional superiority with respect to science and education, by encompassing the economic, political and cultural centres of China. Over 50% talents are accumulated in the area, as the major driving source of national innovation.

3. Construction of the evaluation index system and evaluation method

3.1 Establishment of the evaluation indices system

Based on the principle of talent competitiveness evaluation index system construction at the regional level as well as related studies(Zhu et al., 2012; Liang, 2013; Li, 2013), the evaluation index system of regional green chemical technology innovation talents competitiveness is established, as shown in the following Table 1.

Table 1: Green Chemical Technology Innovation Talent Competitiveness Evaluation Index System

Objective layer	Factor layer	Weight	Index layer	Weight	Unit
talent competitiveness	Talent resource	0.369	Technical personnel number per ten thousand people	0.104	people
			The overall number of scientific and technological staff	0.080	105 thousand people
			The growth rate of scientific and technological staff	0.071	%
			The number of universities, colleges, and science and technology institutes	0.060	-
			The number of students in colleges and universities per 10,000 population	0.054	people
	Talent input	0.323	Investment in research and development	0.102	100 million yuan
			The ratio of investment in research and development to GDP	0.081	%
			The sum of appropriation expenditure on science and technology activities	0.063	100 million yuan
			Education appropriation input	0.077	100 million yuan
	Talent output	0.308	The number of accepted patent application	0.087	Piece
			The number of science and technology papers	0.075	-
			The volume of transaction of technical contracts	0.08	100 million yuan
			The added value of high-tech industry	0.066	100 million yuan

3.2 Research methods

3.2.1 Set pair analysis evaluation method

Based on current researches (Zhu et.al, 2010; Chen, 2014), the set pair method was modified to establish the set pair analysis static evaluation model for the objective evaluation on the ecological competitiveness of Jiangsu province.

(1) Building the evaluation matrix

Assume that n objects to be evaluated constitute the set $E=\{e_1, e_2 \ldots e_n\}$ and en is the nth. Every object to be evaluated has m evaluation indices $F=\{f_1, f_2 \ldots f_m\}$, and f_m refers to the m th index. The value of the evaluation index is recorded as d_{ij}(i=1, 2… n; j=1, 2… m). Then in line with set pair analysis method, a multi-target evaluation matrix Q is got:

$$Q = \begin{bmatrix} d_{11} & d_{12} & \dots & d_{1n} \\ d_{21} & d_{22} & \dots & d_{2n} \\ \dots & \dots & \dots & \dots \\ d_{m1} & d_{m2} & \dots & d_{mn} \end{bmatrix} \quad (1)$$

Based on the matrix Q, the evaluation indices are compared and chosen to decide the optimal evaluation set $U=[d_{u1}, d_{u2}\dots d_{un}]^T$ made up of optimal evaluation indices in all evaluation plans. In a similar way, the worst evaluation set is obtained as $V=[d_{v1}, d_{v2}\dots d_{vn}]^T$. d_{uj} is the evaluation index value ranking c_{pk} in the optimal evaluation set $U=[d_{u1}, d_{u2}\dots d_{un}]^T$, which is the optimal one during $[v_p, u_p]$ in the matrix Q , while d_{vj} is the evaluation index value ranking c_{pk} in the worst evaluation set $V=[d_{v1}, d_{v2}\dots d_{vn}]^T$, which is the worst one during $[v_p, u_p]$ in the matrix Q.

By comparing the evaluation index value W_P and the corresponding index value d_{uj} in the optimal set $U=[d_{u1}, d_{u2}\dots d_{un}]^T$, the similar degree matrix A of objects and the set [u,v] without weights can be got:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} \quad (2)$$

By comparing the evaluation index value W_P and the corresponding index value d_{vj} in the worst set $V=[d_{v1}, d_{v2}\dots d_{vn}]^T$, the opposite degree matrix A of objects and the set [u,v] without weights can be got:

$$B = \begin{bmatrix} b_{11} & b_{12} & \dots & b_{1n} \\ b_{21} & b_{22} & \dots & b_{2n} \\ \dots & \dots & \dots & \dots \\ b_{m1} & b_{m2} & \dots & b_{mn} \end{bmatrix} \quad (3)$$

In the matrix A and B, $\begin{cases} a_{pk} = \dfrac{u_p v_p}{d_{pk}(u_p + v_p)} \\ c_{pk} = \dfrac{d_{pk}}{u_p + v_p} \end{cases}$, with b_{ij} as the similar degree and the opposite degree of the object evaluated f_m and the set [u, v].

If d_{ij} imposes positive influence on the evaluation result,

$$\begin{cases} a_{ij} = \dfrac{d_{ij}}{d_{uj} + d_{vj}} \\ b_{ij} = \dfrac{d_{uj} d_{vj}}{d_{ij}(d_{uj} + d_{vj})} \end{cases} \quad (4)$$

If d_{ij} imposes negative influence on the evaluation result,

$$\begin{cases} a_{ij} = \dfrac{d_{uj} d_{vj}}{d_{ij}(d_{uj} + d_{vj})} \\ b_{ij} = \dfrac{d_{ij}}{d_{uj} + d_{vj}} \end{cases} \quad (5)$$

(2) Building the evaluation model

Combined weights of all evaluation indices $w=(w_1, w_2\dots w_n)$ and the similar degree matrix A, the weighted similar degree matrix A_w of the objects and the set [u, v] can be obtained as follows:

$$A_w = W \times A = (w_1 \quad w_2 \ \dots \ w_m) \times \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} = (a_1, a_2, \dots, a_n) \tag{6}$$

Similarly, the weighted opposite degree matrix B_w of the objects and the set [u, v] can be obtained as follows:

$$B_w = W \times B = (w_1 \quad w_2 \ \dots \ w_m) \times \begin{bmatrix} b_{11} & b_{12} & \dots & b_{1n} \\ b_{21} & b_{22} & \dots & b_{2n} \\ \dots & \dots & \dots & \dots \\ b_{m1} & b_{m2} & \dots & b_{mn} \end{bmatrix} = (b_1, b_2, \dots, b_n) \tag{7}$$

a_j in the formula (6) is the similar degree of the jth object and the set [u, v] and b_j in the formula (7) the opposite degree of the j th object and the set [u,v].
(3) Calculating the relative closeness degree
The relative closeness degree r_j of the jth object and the optimal evaluation set $U=[d_{u1}, d_{u2} \dots d_{un}]^T$ is calculated as:

$$r_j = \frac{a_j}{a_j + b_j} \tag{8}$$

Then the relative closeness degree matrix R of the objects evaluated can be got:

$$R = (r_1, r_2, \dots, r_m) \tag{9}$$

r_j refers to the closeness degree of the object evaluated and the optimal evaluation set $U=[d_{u1}, d_{u2} \dots d_{un}]^T$, which means the bigger r_j is, the closer the object is to the optimal plan. In this way, the plan ranks higher among all plans evaluated.
(4) In multi-layer comprehensive evaluation, every layer uses the evaluation result of the next layer till that of the highest layer. Finally, based on all this, the comprehensive evaluation can be made.

3.2.2 Methods of weighting evaluation indices

The entropy evaluation method is to assess the practical value in line with the information loaded by the evaluation index to ensure the credibility of the evaluation result. Thus, this paper used entropy method to evaluate index weighting.

3.3 Data source

Data in this paper mainly comes from China Statistical Yearbook 2016, China Environmental Condition Bulletin 2016 and China Environmental Condition Annual Report 2016.

4. Evaluation Result and Analysis

According to the formula (1) - (9) in the evaluation method established in this paper, we can get the evaluation value of the innovation talents competitiveness of green chemical industry technological in East China in 2016 according to the original values of each evaluation index in 2015 and 2016, as shown in Table 2.
As shown in Table 2, the overall talent competitiveness is strongest in Shanghai, followed by Beijing, Jiangsu, Shandong and Tianjin. The contributing factors to intensified talent competitiveness include geological advantage, massive universities colleges institutes, well-developed scientific and education resources, talent aggregation, and the governmental support of huge investment in science and education development. In this way, these regions witness the initial driving force of scientific and technological talents to promote economic development and transformation. As a comparison, regions with the weakest and second last weakest talent competitiveness are Hainan and Hebei, respectively. The major cause to the less satisfactory situation is little science and technology activities investment and the small number of universities, colleges, and science and technology institutes in these areas. The power of science and technology innovation to promote the development of local high-tech and economy should be strengthened further.

Table 2: The evaluation value of the innovation talents competitiveness of green chemical industry technological

Area	Comprehensive Value	Talent Resource	Talent Input	Talent Output
Beijing	0.563	0.584	0.594	0.571
Tianjin	0.509	0.493	0.515	0.526
Hebei	0.456	0.365	0.530	0.508
Shanghai	0.584	0.566	0.572	0.599
Jiangsu	0.535	0.578	0.551	0.562
Zhejiang	0.521	0.545	0.569	0.556
Fujian	0.477	0.374	0.539	0.500
Shandong	0.499	0.503	0.525	0.446
Guangdong	0.515	0.518	0.581	0.560
Hainan	0.445	0.393	0.507	0.501

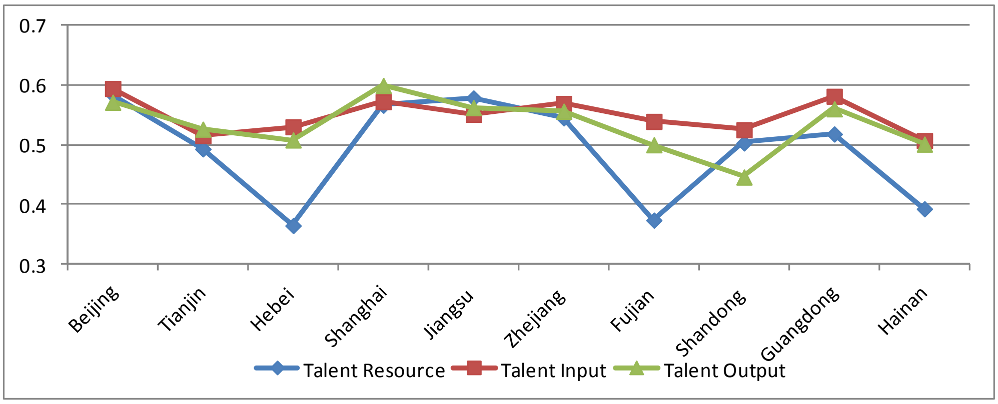

Figure 1: The evaluation results of eastern region in China

As seen in Table 2 and Figure 1, we can see that in terms of human resources, the eastern region of Beijing, Jiangsu, Shandong, Shanghai and Guangdong are the biggest pool of scientific and educational resources, topping the list of the number of universities, colleges and science and technology institutes as well as the percentage of in-school college students in ten thousand population. It lays solid foundation for the enhancement of local talent competitiveness. The scores of talent resource in Hainan, Fujian and Hebei are negative, hitting the bottom of the score list. The major reason is the small number of universities, colleges and science and technology institutes as well as inadequate talent attraction power.

In terms of talent input, Beijing obtains the highest score, followed by Guangdong, Shanghai, Zhejiang, Jiangsu and Shandong. The economy in these regions has been among the forefront of our country, with adequate financial resources, and large appropriation in education, science and development. The area of lowest score in talent input is Hainan, whose economic strength is the worst among the target regions. What is more, the funds for education and science and technology are limited, far less than those in the rest of the regions.

The highest level of talent output appears in Shanghai, followed by Beijing, Shandong, Jiangsu, Guangdong and Zhejiang. The regions with the last three levels of talent output are Hebei, Hainan and Fujian, respectively. The contributing factors are large investment in talent cultivation, education, and science and technology, and good environment of talent innovation. Remarkable results of economic development and shift have been achieved after more investment is released to talent innovation.

5. Conclusion

Without chemical industry, there is no industry. Without the progress of chemical technology, economic society is difficult to maintain rapid development. Therefore, this article from the perspective of the competitiveness of chemical talents on the eastern part of China's green chemical technology to conduct a comprehensive study to accurately understand the different regions of eastern China's green chemical technology development differences and their competitiveness level, the study found:

On the whole, the strongest competitiveness of chemical talents in eastern China is Shanghai, followed by Beijing, Jiangsu, Shandong and Tianjin. The weakest competitiveness of chemical industry is Hainan, followed by Hebei and other regions; Beijing, Jiangsu, Shandong, Shanghai and Guangdong have the most abundant science and education resources, while Hainan, Fujian and Hebei have the worst science and education resources; Beijing ranked the highest score in chemical talent investment, followed by Guangdong, Shanghai, Zhejiang, Jiangsu and Shandong, with the lowest score of evaluation in Hainan. Shanghai has the highest level of chemical talent output, followed by Beijing, Shandong, Jiangsu, Guangdong and Zhejiang with the lowest output of chemical talent in Fujian.

The chemical industry is the pillar industry of the national economy. The level of green chemical technology is directly related to the level of economic and social development in a country or region. The competitiveness of chemical talents directly determines the level of green chemical engineering. Therefore, in order to promote the chemical talents in promoting the innovation of this green chemical technology, the work of chemical talents in the eastern part of our country should vigorously promote the reform of chemical talent development system and policy innovation, highlighting the advantages of highly skilled personnel so as to release the bonus of human capital, to form a new situation in the development of green chemical technology to support the support of chemical talents.

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