Research on the Division and Analysis Method of Water Efficiency Standards for Industrial Industries in Industrial Parks

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Abstract. This article proposes a water efficiency index system and water efficiency standard levels for admission and evaluation management of industrial enterprises in industrial parks, as the existing unit product water quota index is difficult to apply to the water efficiency management needs of industrial industries in industrial parks. A method for determining water efficiency standard levels is also proposed and applied to the determination of water efficiency standard levels in the industrial industry in the Zhejiang Toumen Port Economic Development Zone in Linhai City, assisting in improving water efficiency in industrial parks.

Keywords: industrial parks · water efficiency standards · water efficiency index · water using of unit output value

1 Introduction

Water resources, as an important basic resource for economic and social development and a controlling factor for ecological environment, determine the development space of the economy and society. Industrial parks are the main water units for the economic and social development. It is of great significance to implement the rigid constraint system of water resources and promote the intensive and economical utilization of water resources [1, 2]. The management of specific water-using enterprises mainly focuses on controlling their water use efficiency, which mainly includes admission management for new water-using households, plan management for existing water-using households, and progressive price management for exceeding quotas and plans. However, the current basis for controlling the water use efficiency of industrial enterprises is the unit product water quota [3–5]. The quota management system that uses product water quotas as water efficiency indicators has some problems, such as the inability to cover all industrial products, the difficulty of measuring the water loss in enterprise water supply and distribution processes, and the difficulty of measuring water efficiency for industrial enterprises with multiple products [6–8]. Therefore, it is difficult to meet the needs of the changing industrial development in current industrial parks, and it is urgent to develop

G. Vilas et al. (Eds.): ICEMED 2023, AEBMR 254, pp. 205–212, 2023.
https://doi.org/10.2991/978-94-6463-224-8_27

a comprehensive and widely applicable water efficiency index system. Therefore, it is of great significance to conduct research on water efficiency standards for industrial industries in industrial parks to strengthen water management in the park and promote the improvement of water use efficiency.

2 Overview of the Research Area

Zhejiang Toumen Port Economic Development Zone is located in Taizhou City, Zhejiang Province. It is a national-level economic and technological development zone with a total area of 72.95 square kilometers. The development zone has formed three leading industries, including advanced manufacturing industries such as automobile manufacturing, pharmaceuticals and health, and new materials. There are many enterprises in the development zone, with a total of 203 settled enterprises, including 97 large-scale enterprises and 106 small and medium-sized enterprises. These enterprises mainly involve pharmaceuticals, chemical industry, trade and industry, synthetic leather, automotive parts, electroplating, steel rolling and processing, daily plastic products manufacturing, and other industries.

Currently, the main water supply for the park is provided jointly by Xihu Water Plant and Weimin Water Plant. The water source is mainly from the Niu Tou Shan Reservoir and Tongliao Reservoir. Some industrial enterprises directly extract water from the river network. According to the survey, the current water consumption in the park is 45.57 million cubic meters, mainly for industrial use.

3 Water Efficiency Index Design

Water efficiency index is an important index to measure the water use efficiency of enterprises, which can reflect the water use efficiency of enterprises, water management level, water saving status of main water equipment, etc. Specific indicators that can be used include unit product water consumption, unit value-added water consumption, water reuse rate, water leakage rate, and water meter equipment availability [9, 10]. The advantages and disadvantages of each water efficiency index are analyzed in Table 1.

Water efficiency indicators for industrial parks are important technical indicators for implementing the red line of total water consumption and intensity control and strengthening water quota management [11, 12]. According to the stages of serving water use efficiency control for industrial enterprises in the industrial park, there are two specific uses. The first is to be used in the admission management of new industrial enterprise projects to assess whether the new enterprise meets the water use efficiency requirements for entering the industrial park. The second is to be used in evaluating the water-saving level of existing industrial enterprises in the park to assess whether the existing enterprises meet the water use efficiency requirements of the industrial park.

Although indicators such as water reuse rate, water leakage rate, and water meter equipment availability can reflect water use and water-saving levels intuitively and clearly, they have problems such as complex data acquisition and weak correlation with products. Unit product water consumption can better reflect the water use efficiency of a single product, but it has the problem of insufficient representativeness. Unit value-added

Table 1. Water Efficiency Index Characteristic Comparison Table.

Indicator Name	Advantages	Disadvantages
Unit product water consumption	Strong targeting, some product quota standards already exist	Product categories are too complex and are greatly affected by market changes
unit value-added water consumption	The indicator has strong comprehensive applicability, and the water value is relatively intuitive	There are significant differences among industries, and it is greatly affected by price fluctuations
water reuse rate	The water-saving level of production equipment and processes is reflected intuitively and clearly	Data acquisition is difficult, and the correlation with product indicators is weak
water leakage rate	The water-saving management level is reflected intuitively and clearly	Data acquisition is difficult, and the correlation with product indicators is weak
water meter equipment availability	Reflects the level of water metering	Difficult to directly reflect the level of water-saving

water consumption can reflect the water use efficiency of certain types of enterprises, but there is a problem of reasonable classification of industry categories. Based on this, the study proposes a water efficiency index system that combines unit product water consumption and unit value-added water consumption. For enterprises whose product water consumption indicators are already covered by relevant national, provincial, and municipal water quota standards, the unit product water consumption index should be prioritized. For enterprises whose product water consumption indicators are not clearly defined, the unit value-added water consumption index should be used.

4 Division and Determination Method of Water Efficiency Standard Levels

4.1 Division of Water Efficiency Standard Levels

According to the differences in water efficiency indicators serving different production stages and different water efficiency requirements, water efficiency standards are divided into two levels, and the specific division criteria are as follows:

Level I: Represents the water efficiency standard with advanced water use level. In terms of water efficiency indicators, the unit product water consumption should reach the advanced level, or the unit incremental water consumption should be at a level within 30% ahead of the water use level of existing enterprises in the park.

Level II: Represents the water efficiency standard with general water use level. In terms of water efficiency indicators, the unit product water consumption should reach the general level, or the unit incremental water consumption should be at the average level of the water use level of existing enterprises in the park.

4.2 Principles for Determining Water Efficiency Levels

Based on the development of industrial industries in industrial parks, the total water consumption and intensity control requirements, and combined with the investigation of water use efficiency of existing enterprises, the following principles for determining water efficiency levels are proposed:

(1) Principle of Advancement: Under the constraint of water consumption intensity indicators in industrial parks, the division of water efficiency levels should promote enterprises to strengthen water conservation and improve water use efficiency.
(2) Principle of Differentiation: Water efficiency indicators for different levels and industries should have certain differences, and the higher the level in the same industry, the more advanced the water efficiency standards should be.
(3) Principle of Applicability: The proposed water efficiency standards and indicators should be applicable to the characteristics of the industrial structure in the industrial park and guide related enterprises in the park to save water.

4.3 Methods for Determining Water Efficiency Levels

According to the water efficiency level standards and designed water efficiency indicators, different methods are proposed to determine different water efficiency indicators in different levels.

(1) Method for determining Level I water efficiency standards:

Unit product water consumption indicator: Based on the national, Zhejiang province, and Taizhou city's established industry product water consumption quota standards for different industries, the advanced value of the water quota index clearly stated in this standard is taken as the Level I water efficiency standard.

Unit incremental water consumption indicator: With reference to the industrial classification specified in the "National Economic Industry Classification," for different types of industries in the classified industries, based on the unit incremental water consumption of representative enterprises in the investigation area, the more advanced value is taken as the Level I water efficiency standard.

$$I_1 = \frac{\sum_{i=1}^{N} I_i}{N} \tag{1}$$

where I_1 is the Level I water efficiency standard for a certain industry; I_i is the unit incremental water consumption of a typical enterprise i in a certain industry; N is the number of enterprises whose unit incremental water consumption is within the smallest 30% among typical enterprises.

(2) Method for determining Level II water efficiency standards:

Unit product water consumption indicator: Based on the national, Zhejiang province, and Taizhou city's established industry product water consumption quota standards for different industries, the general value of the water quota index clearly stated in this standard is taken as the Level II water efficiency standard.

Unit incremental water consumption indicator: With reference to the industrial classification specified in the "National Economic Industry Classification," for different types of industries in the classified industries, based on the unit incremental water consumption of representative enterprises in the investigation area, the more advanced value is taken as the Level II water efficiency standard.

$$I_2 = \frac{\sum_{i=1}^{M} I_i}{M} \tag{2}$$

where I_2 is the Level II water efficiency standard for a certain industry; I_i is the unit incremental water consumption of a typical enterprise i in a certain industry; M is the number of enterprises whose unit incremental water consumption is within the smallest 50% among typical enterprises.

5 Determining Water Efficiency Standards in the Study Area

5.1 Water Efficiency Analysis of Typical Industrial Enterprises

The study focused on surveying 81 relevant enterprises, selected from 8 industries, including pharmaceutical manufacturing, chemical raw materials and chemical product manufacturing, electroplating, automotive parts and bearing manufacturing, steel rolling processing, synthetic leather, daily plastic product manufacturing, and trade. The unit incremental water consumption of typical enterprises in the Toumen Port Economic Development Zone of Zhejiang was investigated to determine the minimum, maximum, and average unit incremental water consumption values for each of the 8 industries. The survey results of water use efficiency for typical enterprises in the research area are shown in Table 2.

5.2 Determination of Water Efficiency Standards in the Research Area

According to the determined leading industry, for the industry types clearly specified in the standard, the water efficiency standard indicator of unit product water consumption is selected. The Level I water efficiency standard is the advanced value of the water quota determined in the "Zhejiang Province Water Quota (2019)" standard, and the Level II water efficiency standard is the general value. For industries and products that are not clearly specified in the standard, the water efficiency standard indicator of unit incremental water consumption is selected, and the calculation results are shown in Table 3.

Table 2. Survey of Water Use Efficiency for Typical Enterprises in the Research Area.

Serial number	Leading industry	Number of typical enterprises (units)	Unit Incremental Water Consumption (m3/10,000 yuan)	
			Minimum ~ Maximum	Average
1	Pharmaceutical Manufacturing	29	0.31–10.45	4.39
2	Chemical Raw Materials and Chemical Product Manufacturing	24	0.22–13.28	7.98
3	Electroplating	29	23.4–48.72	40.32
4	Automotive Parts and Bearing Manufacturing	14	0.99–3.36	2.19
5	Steel Rolling Processing	5	0.92–5.49	3.30
6	Synthetic Leather	25	1.82–6.85	4.24
7	Daily Plastic Product Manufacturing	5	1.04–2.22	1.68
8	Trade	15	0.87–6.86	4.81

Table 3. Results Table of Water Efficiency Level Standards in the Research Area (Unit Incremental Water Consumption).

Serial number	Industry type	Level I water efficiency standard	Level II water efficiency standard
1	Pharmaceutical Manufacturing	0.47	4.39
2	Chemical Raw Materials and Chemical Product Manufacturing	0.26	7.98
3	Electroplating	26.4	40.32
4	Automotive Parts and Bearing Manufacturing	0.18	2.19
5	Steel Rolling Processing	1.1	3.3
6	Synthetic Leather	2.07	4.24
7	Daily Plastic Product Manufacturing	1.15	1.68
8	Trade	1.22	4.81

6 Conclusion

Research has proposed to construct a water efficiency index system that combines the unit water consumption for product production with the unit water consumption for value-added production. The water efficiency standards are then divided into two levels, representing advanced and general water consumption levels, respectively. Further methods for determining water efficiency standards for different levels are proposed. Based on this, water efficiency standards for eight industries, including pharmaceutical manufacturing, chemical raw materials and chemical product manufacturing, electroplating, automotive parts, and bearing manufacturing in Zhejiang Toumen Harbor Industrial Park have been determined, which has important guiding significance for guiding the park to strengthen industrial water management. It is suggested to further study and establish a dynamic adjustment method for water efficiency standard levels to adapt to changes in the water consumption levels of park enterprises.

References

1. He H D, Chen S f, Sun X W. (2020) Preliminary studies on indicator system for water saving type industrial park. *China Water Resources*, **(01)**:39–42. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=SLZG202001020&DbName=CJFQ2020.
2. LI H J, (2021) Study on proofing agricultural output based on water quantity for water resources plan in Hami Industry Zone, Xinjiang. *Express Water Resources & Hydropower Information*, 42**(08)**:16–20. https://doi.org/10.15974/j.cnki.slsdkb.2021.08.003.
3. SHAO D H. (2015) The Mechanism of Improving Enterprises' Water-use Efficiency with Water Quota Management and Case Studies. *East China Normal University*. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=1015345618.nh&DbName=CMFD2015.
4. GUAN X K, YANG D, ZHANG H, et al. (2013) Research on Water Consumption and Efficiency of Management Performance Evaluation Based on the Entropy Method. *China Rural Water and Hydropower*, **(7)**:92–95. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=ZNSD201307029&DbName=CJFQ2013.
5. CHENG J Q, ZHAO N F, XIA L L, et al. (2015) Probe into the revision of water consumption norm for main industrial products in Jiangxi Province. *Jiangxi Hydraulic Science & Technology*, **41(02)**:123–126. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=JXSK201502012&DbName=CJFQ2015.
6. Li J X, Zhou T G, Chen L, et al. (2020) Studies on regulation mechanism of water taking and utilization based on quota and water consumption standard in Yong-kang City. *China Water Resources*, **(21)**:55–56+67. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=SLZG202021028&DbName=CJFQ2020.
7. WANG S W, LI Q F, QI H S, et al. (2019) Exploration and Practice of Regional Water Resources Assessment and Water Consumption Standard System. *China Rural Water and Hydropower*, **(05)**:29–33. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=ZNSD201905006&DbName=CJFQ2019.
8. ZHANG Y B, BAI X, HU M T. (2020) Study on the Evaluation Index System for the Implementation Effect of Minimum Allowable Value of Water Efficiency and Water Efficiency Grades Standards. *Standard Science*, **(01)**:10–13. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=SJBZ202001003&DbName=CJFQ2020.
9. HU M T, BAI X, CAI R. Status, (2020) Problems and Prospects of Water-saving Standardization in China. *Standard Science*, **(01)**:2020(01):6–9. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=SJBZ202001002&DbName=CJFQ2020.

10. GB/T 33749–2017, (2017) Guidelines for water efficiency benchmarking of industry enterprises.https://kns.cnki.net/kcms/detail/detail.aspx?FileName=SCSF00049396&DbName=SCSF.
11. HU C X, WANG R C, WENG S C. (2018) Water Efficiency Benchmarking and Comprehensive Evaluation of Green Development Resource Utilization in Major Industrial Cities of the Pearl River Delta. *Pearl River*, **39(11)**:8–13. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=RMZJ201811002&DbName=CJFQ2018.
12. WANG X L. (2009) The Evaluation Research Related to CP in Industry and Enterprise. *Dong Hua University*. https://kns.cnki.net/kcms/detail/detail.aspx?FileName=2009109564.nh&DbName=CMFD2009.