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Construction and Application of Energy Efficiency Index System in Cigarette Enterprises

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Abstract. In order to guide and standardize energy efficiency benchmarking in cigarette enterprises, promote energy-saving emission reduction work, this paper researches on how to structure the energy efficiency index system reasonably and scientifically. The index system is established from the enterprise, process, equipment aspect, which includes all links, such as conversion, purchase storage, delivery distribution, terminal energy consumption. The energy efficiency benchmarking can be implemented according to the energy efficiency index system, and the energy saving potential can be found out by discovering the problem of energy utilization in each link and each energy level. The application practice shows that the energy-saving rate can reach over 18%, and continue to promote energy-saving emission reduction of cigarette enterprises through carrying out the energy-saving reform on the basis of reasonable application of the energy efficiency index system.

Introduction

China is the largest tobacco country of the world, which has about 32% cigarette production and 35% tobacco production of the world [1]. Although are under a low energy consumption, cigarette enterprises still consume a lot of energy. In recent years 10-thousand industrial added value energy consumption, and total emissions of COD have decreased significantly through actively exploring energy-saving emission reduction and gradually establishing energy management system [2].Nonetheless there still has a great potential in energy-saving, especially in energy efficiency levels[3].

The State Council issued the "energy-saving emission reduction 12th five-year plan" in 2012 to clearly demand to carry out of thousands of enterprises energy saving and low carbon action, to conduct energy efficiency benchmarking activities and to improve China's total energy efficiency. Energy efficiency benchmarking research and implementation work gets actively promoted in China's 11th five-year plan. NDRC Energy Research Institute, textile, cement, steel and other industries carry out studies of energy efficiency benchmarking [4].Cement and nonferrous metal industries launch comprehensive energy efficiency benchmarking activities, and will be gradually extended to the steel, electric power, chemical, tobacco and other industries.

Constructing cigarette enterprises energy efficiency index system is an important basis to the implementation of energy efficiency benchmarking and analysis work [5]. At present, researches and constructions on cigarette enterprises energy efficiency index system are still in initial stages. This paper mainly introduces how to construct a reasonable energy efficiency index system of cigarette enterprises.

Construction principle of energy efficiency index system

In general, the energy efficiency indexes should include three types of indexes:

First are the indexes which can be able to reflect status and energy efficiency of enterprises, and cover all the production processes, such as comprehensive energy consumption of unit product and comparable energy consumption of unit product.

Second are the indexes which can be able to reflect energy efficiency of main process flow, link and equipment, such as process energy consumption, energy utilization efficiency of main equipment and so on. These indexes are further refined to the first grade ones. By comparing those indexes, we can find the gaps with benchmarking enterprises in specific processes and links.

Third are key technical indexes of some vital process and equipment, such as pressure, temperature, gas composition and so on. These indexes are not energy efficiency indexes, but are closely related to a specific process or even whole factory's energy efficiency. It's not only important factors affecting energy efficiency but also specific reasons for the gap in energy efficiency. Analysis of differences between first and second indexes always starts from the third indexes.

Thus, constructing index system should obey the following principles [6].

Comprehensive principle: Construction of indexes can comprehensively reflect the overall situation of enterprises energy utilization and energy efficiency, cover the major energy using processes and links. It's helpful to find the main problems and causes in the using of energy and to identify the key factors affecting energy efficiency. It also lays a foundation for the formulation of effective, feasible and comprehensive improvement measures and schemes.

Independence principle: each index should be relatively independent, less coupling and repetition. Affecting between each index should be avoided in the selection. Correlation between each index should be reduced.

General principle: determined index should be professional data which is general, common, and easy to obtain. Calculation of index value should obey general and unified standards, methods and calibers to facilitate comparison in analysis between each enterprise, improve the comparability.

Representative principle: it means that indexes should reflect main aspects of energy utilization efficiency in the whole or a part of an enterprise. Or it's important factors to affect energy utilization efficiency. At this point of representative, the construction of index system should be fine.

Process principle: determined energy efficiency indexes include not only main result indexes (indexes that can ultimately reflect the status of energy utilization) but also the process indexes (refers to the important indexes that can reflect intermediate processes and final results, and can describe causes of final results).It's significant influence factors in analysis of energy efficiency. And it's helpful to clarify the main network of benchmarking, recognize gaps, analyze gaps and appraisal management.

Construction of cigarette processing enterprises energy efficiency index system

At present, energy efficiency indexes only have a few major ones such as comprehensive indexes, unit consumption indexes, and economical energy consumption indexes. With the development and progress of industrial technology, a lot of new energy-saving technologies have been used. Due to the differences in energy-saving technology and reform process, original energy index system can no longer meet the needs of deepening whole industry's energy-saving work. So, it's necessary to constitute a new and more specific energy consumption index system to provide directions for industrial energy efficiency benchmarking work.

According to the construction principles of energy efficiency index system, we should establish a complete index system in the respect of three layers (equipment, process, enterprise) and four links. Specific indexes include: comprehensive indexes, purchase storage link indexes, conversion link indexes, delivery distribution link indexes, terminal energy consumption link indexes and recycle-use link indexes.

Construction of comprehensive indexes. Comprehensive indexes are constructed mainly from enterprise level and process level as showed in fig.1.

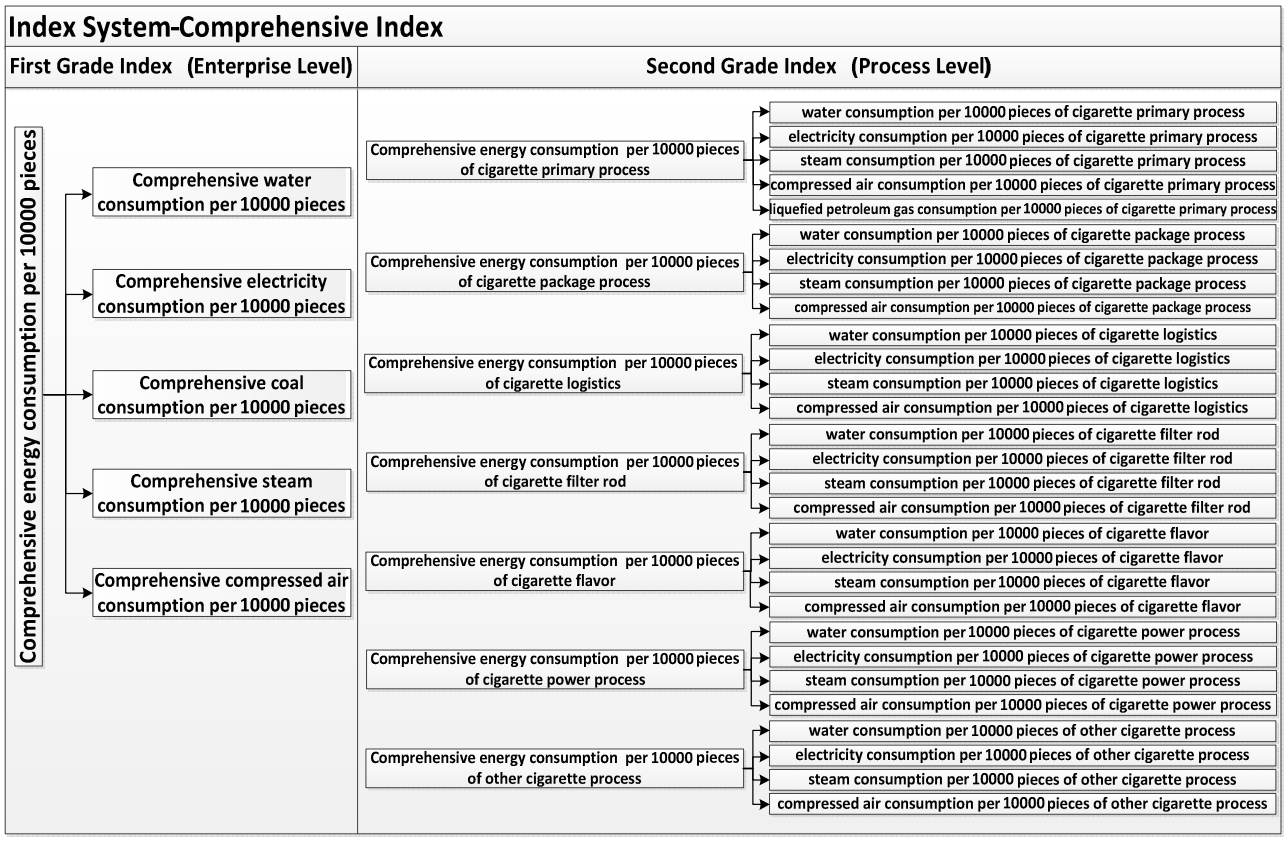

Fig.1 Composition of cigarette enterprises comprehensive indexes

Comprehensive indexes of enterprise level are called as the first grade indexes, mainly testing energy efficiency from comprehensive energy consumption per 10000 pieces. And it can be benchmarked alone.

Comprehensive indexes of process level are called as the second grade indexes, consisting comprehensive energy consumption per 10000 pieces of production processes and subsidiary departments. It can show the energy consumption of production processes and subsidiary departments.

Construction of purchase storage link indexes. Purchase storage link indexes include indexes of fuel purchase, such as coal calorific value, sulfur content, moisture, and volatile control indexes [7]. Those indexes mainly affect material quality, thus affecting indexes of energy consumption and emission reduction.

Construction of conversion link indexes. Cigarette enterprises conversion link includes boiler process, air compression process, and refrigeration process. So we can construct conversion link indexes from process and equipment level. Indexes of process level include steam/coal ratio, electricity/steam ratio, and water/steam of boiler, electricity/steam ratio of compressed air and refrigeration efficiency of refrigeration station. Indexes of equipment level include indexes of each boiler, air compressor and refrigeration machine.

Construction of delivery distribution link indexes. Transfer losses to water, electricity, steam and compressed air happen in the energy delivery distribution link and have certain influence to energy consumption per unit product. Therefore, delivery distribution link indexes mainly include water loss rate, steam loss rate, compressed air loss rate and electricity loss rate.

Construction of terminal energy consumption link indexes. Terminal energy consumption link indexes are constructed from process and equipment level (Fig 2).

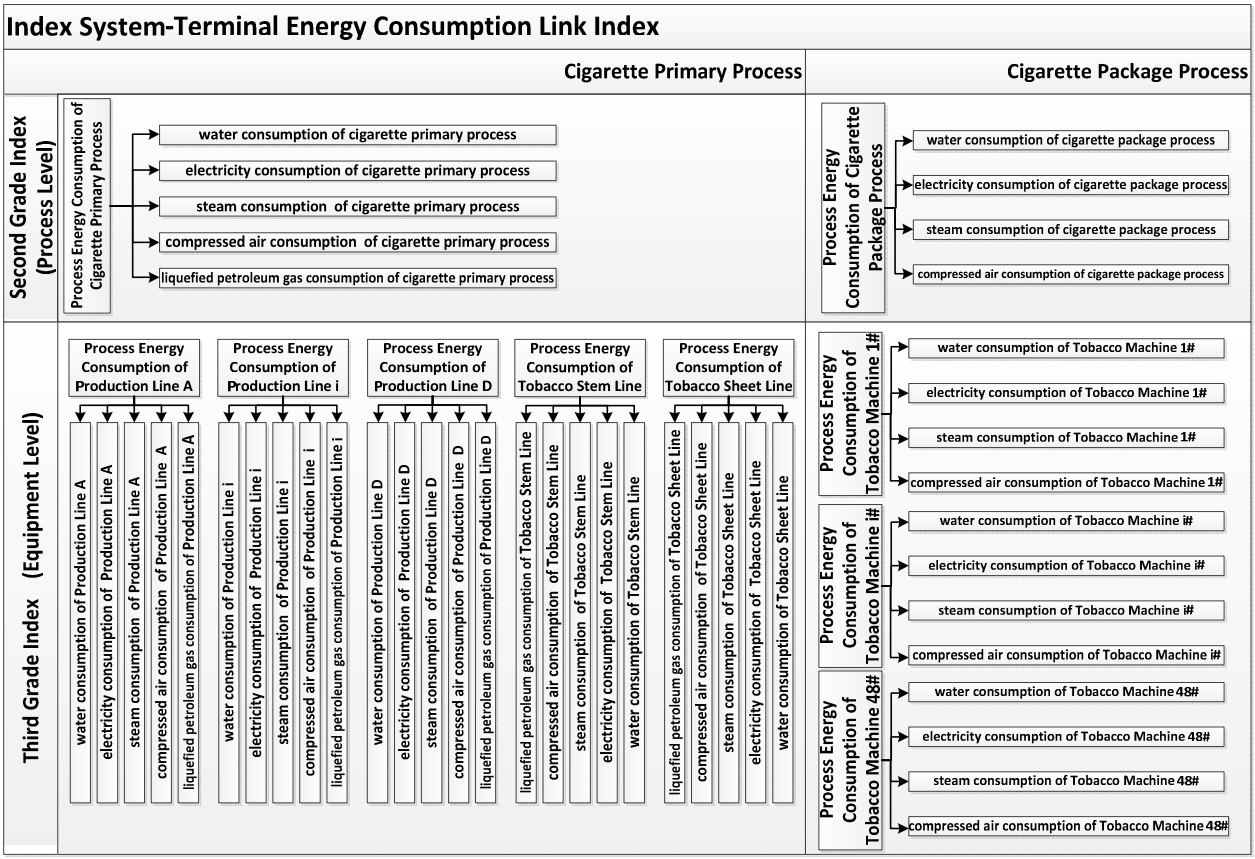

Fig 2 Construction of Terminal Energy Consumption Link Index

Construction of recycle-use link indexes. Cigarette enterprises recycle-use link mainly involves recovery and utilization of water and condensed water. The indexes include recovery rate of water and condensed water.

Effect of energy efficiency index system application

Annual consumption of energy purchased in a cigarette factory mainly includes bituminous coal, electric power and diesel. Its annual comprehensive energy consumption was 36280.445tce before benchmarking was conducted.

The cigarette factory uses energy efficiency benchmarking as major methods of innovation management and surpassing the advanced. Through a year of energy efficiency benchmarking, great potentials are found in treatment and utilization of water, utilization of condensed water, utilization of sonic soot blower and transformation of frequency conversion. After technical renovation, correlation index is improved obviously and comprehensive energy consumption per ten thousand declines 18% as showed in Table 1.

Table 1 Comparison of indexes before and after energy efficiency benchmarking

Category	Index Name	Unit	Before Bench-marking	After Bench-marking	Saving Rate
1	Comprehensive energy consumption per 10000 pieces	[kgce/10000 pieces]	3.69	3.02	18.15%
2	Electricity consumption per 10000 pieces	[kWh/10000 pieces]	8.25	7.21	12.61%
3	Water consumption per 10000 pieces	[t/10000 pieces]	0.28	0.23	17.86%
4	Coal consumption per 10000 pieces	[kgce/10000 pieces]	2.44	2.08	14.75%
5	Steam consumption per 10000 pieces	[kg/10000 pieces]	16.67	15.93	4.44%
6	Compressed air consumption per 10000 pieces	[Nm^3/10000 pieces]	5.68	5.52	2.82%

Conclusions

This paper constructs a scientific and reasonable cigarette enterprises energy efficiency index system including purchase storage link, conversion link, delivery distribution link and terminal energy consumption link in cigarette enterprise, process and equipment level. The author hopes to standardize the cigarette enterprise energy efficiency benchmarking through this energy efficiency index system and continue to promote cigarette enterprise energy saving and emission work through internal benchmarking, domestic benchmarking and international benchmarking.

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