

Guideline for green design of commercial refrigerating appliances

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Abstract. This paper investigates the overseas and domestic backgrounds for green design of commercial refrigerating appliances, and regulates the purposes and basic principles of eco-design of commercial refrigerating appliances, the eco-design requirements, eco-design process and key points, major methods of eco-design, and eco-design evaluation and improvement. This paper provides the guiding targets for the commercial refrigerating appliances manufacturer, standardizes the enterprise behavior of commercial refrigerating appliances, and leads the commercial refrigerating appliances enterprise to implement the product green design, which is of great significance in promoting the transformation and upgrading of commercial refrigerating appliances, enhancing the green manufacturing level and increasing the green product supply.

The commercial refrigerating appliances include the refrigerated display cabinet, refrigerated storage cabinet, commercial kitchen refrigerator, ultra-low temperature freezer, quick freezing cabinet, trolley type refrigerated cabinet, assisted service refrigerated display cabinet (counter), self-service refrigerated display cabinet (counter), air cooled cooling equipment, air cooled refrigerated appliances, commercial vending machine, commercial ice cream machine and commercial ice maker. The commercial refrigerated appliances shall be the branch of refrigerated product. More than one century has already passed since the first refrigerator came out. True Manufacturing, Turbo Air, Hoshizaki (Japan) Corporation, and other overseas old brand commercial refrigerated product manufacturer have multi-years of production history, and have established the production base or sales network in China in recent years. However, the commercial refrigerated appliances industry in China started relatively late. As the new industry developed after the reform and opening up, the commercial refrigerated appliances industry in China has kept the rapid development in recent years, under the joint driving of the domestic and overseas market demand. Through years of development, China has already formed the perfect industry chain of commercial refrigerated appliances, with the relatively mature technology and market. At present, China has already become the major producer and consumer of commercial refrigerated appliances. Therefore, the eco-design of commercial refrigerating appliances accords with the requirements of consumption upgrading, increases the supply of green products, enables the consumer to select and use the green products, and reduces the impacts of refrigerant, foaming agent, and toxic and hazardous materials in the commercial refrigerating appliances, so

as to ease the pressure on resources and energy, and reduce the adverse impacts upon the environment and human beings [1, 2].

The green design of commercial refrigerating appliances is also called "environmental conscious design", "eco-design" or "design for the environment". It intends to optimize the environmental impact of commercial refrigerating appliances and bring the environmental factors into the product design and development activity, so as to improve the environmental performance of commercial refrigerating appliances within their life cycle. The eco-design is the activity which intends to systematically consider the impacts of selection, production, sales, use, recovery, processing and other links of raw materials upon resources and environment at the product design and development phases, as per the concept of whole life cycle, strive to minimize the resources consumption during the whole life cycle of the product, try to use less or not use raw materials containing toxic or harmful substances, and reduce the production and emission of pollutants, so as to realize the environmental protection. The eco-design is the significant measures to realize the pollution prevention. The pollution prevention is the fundamental method to change the development pattern of "treatment after pollution". As shown in the study, 80% resources consumption and environmental impact are subject to the product design phase. At the design phase, it is required to fully consider the existing technical conditions, raw materials guarantee and other factors, and optimize the solution against the resources and environmental problems at each link, which may maximize the resources conservation and reduce the environmental pollution from the source.

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The eco-design phase includes the determination of the design products and objectives, planning and organization, requirements analysis, preparation of design specification, product design and implementation design, completion of scheme design, general scheme design, systematic design, engineering design and other relevant documents. During the design process, it is required to consider the product life termination (end) handling (reuse, recycling and disposal) requirements, select the appropriate handling methods and estimate the costs. It is required to select and apply the product design tools compatible with the environment, such as the life cycle assessment (hereinafter referred to as "LCA"), so as to optimize the product design. Meanwhile, it is required to select the final disposal methods of the product as per the minimum environmental impact principle.

1. OVERSEAS AND DOMESTIC BACKGROUNDS FOR GREEN DESIGN OF COMMERCIAL REFRIGERATING APPLIANCES

In 2009, the European Parliament and Council of the European Union published *Establishing a Framework for the Setting of Eco-Design Requirements for Energy-Related Products* (ERP Directive No. 2009/125/ EC), including the relevant contents of household electrical refrigerating appliances directive. In 2009, China issued *General Principle and Requirements of Eco-Design for Products* (GB/T 24256-2009 [3]), regulating the general principle and requirements of eco-design for products. In 2015, China issued *General Principles for Eco-Design Product Assessment* (GB/T 32161-2015 [4]), regulating the principle and methods of eco-design products evaluation, and preparation methods of life cycle evaluation report. As per these two significant standards within the eco-design field, and in combination with the present development status of commercial refrigerating appliances industry eco-design in China, it is required to provide the detailed requirements upon the commercial refrigerating appliances in accordance with *General Principle and Requirements of Eco-Design for Products* (GB/T 24256-2009), and ensure that the commercial refrigerating appliances designed as per this standard conforms to the relevant eco-design requirements provided in *General Principles for Eco-Design Product Assessment* (GB/T 32161-2015).

At present, there are many theoretical studies and gradually increased standards, but there still lacks of the eco-design standards related to the commercial refrigerating appliances with the vast quantity and broad influence. Besides, the development progress of China's eco-design products is much slower. The main reasons are as follows: many enterprises manufacture the OEM product, while the design technology is grasped by the foreign companies. Therefore, such enterprises are in no hurry to consider the eco-design researches, and do not have their own eco-design system. Meanwhile, many small and medium-sized enterprises lack of the research

capacity in this regard, and it is hard for them to establish their own ecological product development system. Most of them are waiting for the national policy and the promotion and application of large-scale enterprises' technical research results. Some domestic enterprises with the research and product development capacity, still do not actually form the ecological product R&D system of their own characteristics, and are especially deficient at the following aspects:

(1) They still do not establish the eco-design standards system. At present, the overseas enterprises have already evaluated the ecological properties from the perspective of environmental impacts of product life cycle, while the domestic enterprises still evaluate the eco-design products as per the single index, such as without CFC, energy saving, low noise, and etc. Therefore, it is still not the actually eco-design standard.

(2) China still lacks of the complete and systematic eco-design evaluation, examination and assessment system, and does not form the complete laws and regulations system, while the eco-design is still subject to the vigorous cultivation of the relevant departments.

(3) The product eco-design of overseas enterprises not only stays at the consciousness and concept level, but also establishes the detailed and operable methods and assessment and management fundamental platform. Meanwhile, it has already been pushed from the product design to the eco-design and management of the product chain. China still stays at the concept discussion level, and lacks of the controllable design indexes and operable systematic design methods, as well as the basic data design and pattern support design.

(4) For the substitution of toxic and hazardous materials, the lead-free solder research has already been conducted in some units, but they are only the lab results, and are almost not promoted and applied.

2. PURPOSES AND BASIC PRINCIPLES FOR ECO-DESIGN OF COMMERCIAL REFRIGERATING APPLIANCES

The purpose of commercial refrigerating appliances eco-design is to reduce the environmental impact at the product design, raw materials extraction and processing, production, packaging, transportation, marketing, use, abandonment, and the subsequent handling, disposal and other phases, and reduce the environmental impact through the eco-design. This paper will provide the guiding targets for the commercial refrigerating appliances manufacturer, standardize the enterprise behavior of commercial refrigerating appliances, and lead the commercial refrigerating appliances enterprise to implement the product green design, which is of great significance in promoting the transformation and upgrading of commercial refrigerating appliances, enhancing the green manufacturing level and increasing the green product supply.

The basic principles for eco-design of commercial refrigerating appliances include: the requirements-oriented, advanced technology, scientific methods,

environmental-friendly, economic rationality, and abundance by law.

The requirements-oriented principle means that the eco-design shall be oriented by the comprehensive requirements: from the integrated perspective, it is required to take the integrated consideration of the commercial refrigerating appliances and the resources integrated utilization requirements of its system; from the process perspective, it is required to comprehensively consider the environmental requirements of commercial refrigerating appliances at each stage of its life cycle, especially the environmental requirements during its use, abandonment and processing process; from the performance perspective, it is required to adopt the customized design, avoid the functional waste and enable the commercial refrigerating appliances functions to properly reflect the system requirements.

The advanced technology principle means that the eco-design shall be based on the applicable technology: In design, it is required to give preference to the advanced design technology; meanwhile, it is required to pursue the enhancement of commercial refrigerating appliances environmental index, based on the premise that the technical performance index of the commercial refrigerating appliances will not be reduced; the feasible manufacturing technology shall be based on; it is required to adopt the product light weight design; it is also required to adopt the relatively mature environmental technology, reduce the complexity of integrated technology, and carry out the organic integration with the design technology.

The scientific methods principle means that the eco-design shall be based on the scientific theory: the circular economy theory, industrial ecology theory and life cycle theory shall be based on.

The environmental friendly principle means that the eco-design shall take the environmental protection as the target: in the eco-design of commercial refrigerating appliances, it is required to give preference to the environmental friendly advanced design technology. It is required to ensure the safety of commercial refrigerating appliances during the processing and manufacturing, use and maintenance, final disposal and other processes. When the functions of commercial refrigerating appliances are realized, it is also required to pursue the light weight, reuse and recycling, and improve the environmental impact of equipment life cycle, especially the environmental impact during the use, abandonment and processing process. Except for considering the commercial refrigerating appliances' own environmental impact, it is also required to attach great importance to the resources integrated utilization performance enhancement of commercial refrigerating appliances, and reduce the secondary pollution.

The principle of economic rationality means that the eco-design shall be based on the premise of economic adaptability, and it is required to comprehensively consider the environmental interest of commercial refrigerating appliances, including the environmental benefits and costs. Meanwhile, it shall also give consideration to the environmental interest of the

enterprises, customers and society, and adopt the economic and rational environmental technology.

The principle of abundance by law means that the eco-design shall take the abundance by law as the criterion, while it is required to abide by the restrictive requirements of national and international regulations, satisfy the technical standards and voluntary agreement, and the market or consumer requirements, development trend and expectation, and reach the social and investor's expectation.

3. ECO-DESIGN REQUIREMENTS OF COMMERCIAL REFRIGERATING APPLIANCES

3.1 Life cycle phase

The life cycle phase of commercial refrigerating appliances considered in the eco-design shall include: the obtaining, selection and use of raw materials, including the selection and use of environmental protection refrigerant and foaming agent; the product design, such as EMC electromagnetic interference and product condensation, and product light weight design; product manufacturing, such as enhancement of product qualification rate, and reduction of waste materials; packaging, transportation and distribution, such as the use of biodegradable plastic bags, miniaturized packaging of the product, and green packaging design; maintenance and repair, and enhancement of detachability rate of the product's parts and components, and product use. The recycling and disposal shall be implemented by the qualified authority.

3.2 Environmental factors

At each phase of the life cycle, the statistical environmental factors shall include: the consumption of resources and energy; the emission type and amount of hazardous materials at the production link, for instance, the emissions of exhaust gases and waste water; the pollution resulted from the noise, radiation, electromagnetic field and other physical effects; the produced waste materials, for instance, the foaming agent during the production process; recycling (reuse, recycling, energy recovery and etc.), including the recovery of flammable refrigerant; and design service life.

3.3 Standards to follow

The manufacturer should equip the measuring instrument of energy as per the requirements of GB 17167 [5], while the energy efficiency indexes for the product shall conform to the requirements of GB 26920.1 [6]. The safety design, electromagnetic compatibility design, eco-design special requirements, restricted substances testing methods and requirements, product packaging, restricting excessive packaging and recyclability rate of commercial refrigerating appliances

shall conform to the requirements of GB/T 26125 [7], GB/T 26572 [8], GB/T 31268 [9], and GB32355.1 [10] separately.

3.4 Laws, regulations and other technical requirements

The requirements of compulsory environmental protection laws and regulations are as follows: the substitution of CFCs substances; energy efficiency standards; the relevant laws and regulations that conforms to the food safety; RoHS regulations; noise and electromagnetic compatibility; environmental protection regulations related to the production process; and the limit value requirements of recovery rate and reuse rate.

The requirements of non-compulsory environmental protection laws and regulations are as follows: hazardous substances requirements of materials and hazardous substances requirements of packaging.

The minimization principle is as follows: it is required to minimize the quantity of parts and components, minimize the materials type and quantity, maintain the higher standardization and generalization rate, adopt the equal life design principle (if possible), be easy for maintenance and repair, disassembly, warehousing and distribution.

4. ECO-DESIGN PROCESS AND KEY POINTS OF COMMERCIAL REFRIGERATING APPLIANCES

4.1 Eco-design process

The eco-design process of the commercial refrigerating appliances may be classified as follows: requirements analysis, concept design, structure design, and detailed design, while the variable phases of the design process have their own eco-design key points.

4.2 Eco-design key points

The eco-design key points in the requirements analysis are as follows: first, it is required to consider the ecological economic and policy impacts. For the analysis of market and enterprise situations, it is required to consider the ecological economic and policy impacts. For the environmental guideline of the organization, please see GB/T 24001 [11]. Second, it is required to consider the ecological new technology and research results. For the discovery and selection of innovative design scheme of the commercial refrigerating appliances, it is required to consider the ecological new technology and research results, and rely on its feasibility and maturity. Third, it is required to consider the environmental and reproductive issues. For the requirements analysis, it is required to consider the environmental and reproductive issues, and also add the environmental requirements into the requirements list.

It is required to carry out the generalized product requirements analysis before the concept design of commercial refrigerating appliances, and apply the life cycle theory to analyze the manufacturing, use and reuse after abandonment and disposal conditions of the product and parts and components, including the following several aspects: external requirements analysis (user requirements analysis, vendor requirements analysis, supplier requirements analysis, and etc.), internal requirements analysis, and the relevant stakeholder requirements analysis.

The eco-design key points of concept design are as follows: first, it is required to select the eco-friendly working principle. For the determination of solution to the working principle, it is required to select the eco-friendly working principle, based on the list of working principles and all sorts of variation of the working principles, and as per the scientific comparison. Second, it is required to select the light weight working structure. For the determination of solution to the working structure, it is required to select the light weight working structure, based on the list of working principles and all sorts of variation of the working principles, and as per the scientific comparison. Especially, it is required to pay attention to the light weight of moving parts and components. For the structural design, it is required to consider the easily maintained structure. Third, it is required to add the ecological criterion into the evaluation criterion. In the evaluation criterion of the concept design, it is required to add the ecological criterion, except for the technical and economic criterion. It is required to conduct the effective avoidance of the toxic and hazardous substances. It is also required to consider the mechanical safety and food safety of the product.

The key points at the concept design phase shall be the balance and optimization of the following target parameters, under the precondition that the relevant laws and regulations shall be conformed to: the functions of commercial refrigerating appliances: independent temperature zone, thermal insulation function, control method, refrigerating method, auxiliary function (quick freezing function, ice making function, and etc.), automatic cleaning function, volume, freezing capacity, display area, and effective volume; energy efficiency index, and selection of the appropriate thickness of foaming layer; the reduction of materials use amount, the use of energy saving materials, simplification of materials type; noise; mean time between failures; cost; the conduct of modularity design, including the convenience design of the operation.

The eco-design key points of the structure design are as follows: first, it is required to use the renewable materials, especially the selection of foaming agent and reduction of the use of plastic bags. Meanwhile, it is required to give preference to the renewable materials for the selection of raw materials of parts and components. Second, it is required to enhance the comprehensive utilization performance, while it is also required to adopt the enhancement of comprehensive

utilization performance of the commercial refrigerating appliances, as one of the main optimization objectives, during the optimization, selection, refining and enhancement of the structure design scheme. Third, it is required to simplify the structure of commercial refrigerating appliances and parts and components, while it is also required to generally simplify the structure of commercial refrigerating appliances and parts and components during the structure design process. Fourth, it is required to simplify the assembly and disassembly process. In the structure design, it is required to properly simplify the assembly and disassembly process, so as to facilitate the maintenance and final disposal of the commercial refrigerating appliances. Fifth, it is required to facilitate the clear separation of non-renewable materials. In the structure design, it is required to ensure the relatively structural independence and facilitate the clear separation of non-renewable materials, so as to facilitate the final disposal of the commercial refrigerating appliances. Sixth, it is required to add the environmental criterion into the evaluation criterion. In the evaluation criterion of the structure design, it is required to add the environmental criterion, except for the technical and economic criterion. Seventh, it is required to consider the mechanical safety and food safety, for instance, the sweeping of grooves and products. In the structure design, it is required to consider the mechanical safety and food safety of the commercial refrigerating appliances.

The eco-design key points of the detailed design are as follows: first, it is required to provide the ecological requirements of the key working processes, such as the welding and refrigerant filling, foaming and other links. The detailed design are divided into six parts, namely, case body, door body, refrigerating system, control system, accessories and packaging system. In the detailed design of production working processes, it is required to identify the key working processes of environmental impact, and also provide the ecological requirements of key working processes. The key points at the detailed design phase shall be the balance and optimization of the following target parameters, under the precondition that the relevant laws and regulations shall be conformed to: technical flow; processing equipment, testing equipment, tooling, tools and molds; selection and use amount of the auxiliary materials; the limit value of the content of the toxic and hazardous substances in the auxiliary materials, and conformity with the RoHS regulations; energy consumption, noise, pollutant emission and the recovery of refrigerant during the manufacturing process. Second, it is required to provide the comprehensive utilization instructions. In the instructions of the detailed design, except for the normal instructions, it is also required to provide the comprehensive utilization instructions in the relevant documents. Third, it is required to illustrate the assembly and disassembly sequence. In the description of the detailed design, except for the assembly description, it is required to add the disassembly description, and illustrate the assembly and disassembly sequence in the relevant documents. Fourth, it is required to illustrate the

disassembly methods of non-renewable materials. In the disassembly description of the detailed design, it is required to highlight the disassembly of the non-renewable materials, and illustrate the disassembly sequence of the non-renewable materials in the relevant documents. Fifth, it is required to provide the recycling description of the commercial refrigerating appliances and the parts and components. The detailed design shall have the final disposal description where the recycling description of the commercial refrigerating appliances and the parts and components shall be provided.

5. ECO-DESIGN METHODS OF COMMERCIAL REFRIGERATING APPLIANCES

The eco-design methods of commercial refrigerating appliances include the life cycle design method and modularity design method, which may be individually used or used in combination. The methods adopted by the eco-design are including but not limited to these methods.

5.1 Life cycle design method

The life cycle design shall aim at the obtaining of raw materials, processing and manufacturing, use and maintenance, use and improvement, final disposal and other phases of life cycle, which adopts the enhancement of the resources utilization efficiency as the target, and the continuous improvement as the means, so as to implement the systematic design.

The life cycle design shall consider the requirements analysis, concept design, structure design, detailed design and other general product design process, can be combined with the modularity design, and can also adopt the concurrent design.

The use phase is the major link of commercial refrigerating appliances life cycle, while it is better to adopt the enhancement of resources utilization efficiency, reduction of number of operation faults, and shortening the downtime of maintenance and repair as the key targets of life cycle design.

The life cycle design process mainly includes the requirements decomposition, design analysis, target identification, technical R&D, and design improvement. As shown in Figure 1, it is required to disintegrate the ecological demand into each phase of the life cycle of commercial refrigerating appliances, analyze the present eco-design conditions of the product, identify the key design improvement targets, explore the feasible technical realization scheme, conduct the environmental enhancement upon the product design, and implement the life cycle assessment upon the commercial refrigerating appliances, so as to support the steps of basic process. For the principles of life cycle assessment, please see GB/T 24040.

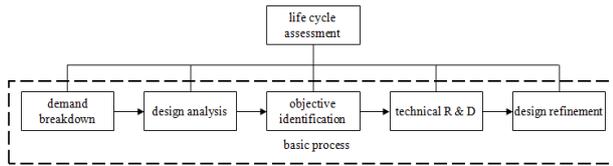


Fig. 1. Main process of commercial refrigerating appliances life cycle design

The life cycle design is the universal technical method of commercial refrigerating appliances eco-design. Its major ecological functions are as follows: the life cycle design intends to consider the ecological problems from the life cycle perspective, and enhance the wholeness of eco-design; it intends to identify the key targets and main links, and enhance the pertinence of eco-design; it intends to implement the technical R&D by centering around the main issues, which facilitates the breakthrough of eco-design key technologies; and it also intends to enhance the eco-design level at the entire life cycle and its each phase.

5.2 Modularity design method

Based on the comprehensive analysis of customer requirements, and as per the systems engineering idea, the modularity design shall disintegrate the commercial refrigerating appliances into the serialized, generalized modules and modules that have the independent functions and are easy for reuse and variance, and obtain the personalized products through the modular synthesis.

The modularity design should be open to the entire commercial refrigerating appliances family, fully use the similarity and reusability of the module, and effectively control the diversification of commercial refrigerating appliances. The diversification of commercial refrigerating appliances includes the external diversification of commercial refrigerating appliances that may be felt by the customer, and the internal diversification of commercial refrigerating appliances that may be felt by the enterprise.

The modularity design may be divided into the modularity design of the new commercial refrigerating appliances and existing commercial refrigerating appliances. The new product modularity design is the innovation of product structure and module, while the existing product modularity design is the rationalization of product structure and module. It may adopt the informatization to support the modularity design.

The process of modularity process mainly includes the module partition, module standardization, product modeling, configuration design, variant design and modularity assessment, while the life cycle assessment is relevant to the process of modularity design and the process of customized design, as shown in Figure 2. For the module partition principles of commercial refrigerating appliances, please see GB/T 30438 [12]. The module partition, module standardization, and commercial refrigerating appliances modeling form the process of product modularity design, while the

configuration design and variant design form the process of customized design of the product. It is required to implement the product modularity evaluation, so as to support the steps of the process of modularity design, and the process of customized design. The modularity evaluation mainly has the comparison value upon the identical products.

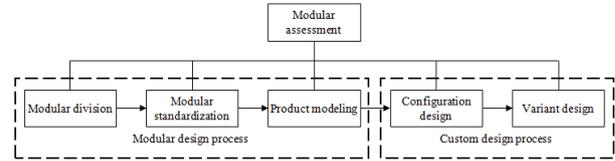


Fig.2. Main process of modularity design

The modularity design is the generic technical methods of commercial refrigerating appliances eco-design. Its major ecological functions are as follows: it intends to support the fast customized design, satisfy the customer's individual requirements, and avoid the waste of manufacturing resources; it intends to enhance the modular production lot, achieve the scale benefit, and make full use of the efficiency of manufacturing resources; it intends to facilitate the use and maintenance, reduce the equipment outage loss, and extend the product life span; it intends to realize the detachability and facilitates the recycling of parts and components; and it also intends to realize the product environmental enhancement through supporting the modularity improvement.

6. ECO-DESIGN EVALUATION AND IMPROVEMENT OF COMMERCIAL REFRIGERATING APPLIANCES

The setting principles of the eco-design evaluation index of the commercial refrigerating appliances are as follows: First, it shall include the orientation principle. It is required to highlight the eco-design key points, promote the safe and feasible environmental technology, and guide the eco-design development direction of the commercial refrigerating appliances, through establishing the evaluation index system and evaluation indexes. Second, it shall include the integrity principle. The evaluation index system shall be open to the whole design process, the life cycle of the commercial refrigerating appliances, and the commercial refrigerating appliances family. Third, it shall include the simplicity principle. The evaluation index shall be simple, definite and easy to operate. Fourth, it shall include the comparability principle. In the identical commercial refrigerating appliances, the evaluation index shall be comparable.

The eco-design evaluation is a repeated process, which runs through the main process of eco-design, including the preparation of product design specification, product preliminary design, implementation design and other phases. The main evaluation contents include: the appropriateness of design tools, technical feasibility of design scheme, environmental impact assessment,

economic assessment, conformity assessment of eco-design targets and principles, and etc.

The commercial refrigerating appliances eco-design assessment falls into two types, namely, the process assessment and product ecological level assessment. The assessment adopts the comparison with the recent like products, systems or parts and components, while the assessment methods may adopt the radar chart method, LCA method and etc. If the process assessment cannot satisfy the requirements, it is required to provide the specific improvement measures, and carry out the assessment again, until the assessment index requirements are satisfied.

After the completion of eco-design procedure of commercial refrigerating appliances, it is required to carry out the final assessment, while it is recommended that the final assessment shall adopt seven indexes for assessment, namely, the energy efficiency index, adjusted plot ratio, noise, materials use efficiency, mean time between failures, recovery rate, and recycling rate. The commercial refrigerating appliances manufacturer shall establish and implement the environmental management system and hazardous substances management system, while the environmental management system shall conform to the requirements of GB/T 24001.

The design assessment results shall be timely reverted back to the corresponding phase of eco-design, so as to continuously perfect the design tools, design scheme and product improvement plan. During the period from the commercial refrigerating appliances launch to the end of life cycle, the product manufacturer shall continuously improve the eco-design of product or repair accessories.

7. INFORMATION PROVISION AND SHARING OF COMMERCIAL REFRIGERATING APPLIANCES

It is required to collect and sort out the laws and regulations related to eco-design of commercial refrigerating appliances, and conduct the information communication and exchange along the supply chain direction, enabling the relevant stakeholders to follow the relevant laws and regulations. After the completion of eco-design of commercial refrigerating appliances, it is required to share the relevant product eco-design information with the relevant stakeholder.

8. CONCLUSION

The eco-design of commercial refrigerating appliances is the significant driving force to reduce the consumption of resources and energy, and the emissions of pollutants and greenhouse gas from the source, enhance the technology to develop towards the energy saving, low carbon and green technology direction, and further promote the industrial transformation and upgrading. Under the precondition that the product can conform to the user's service functions, it is required to

ensure the high utilization efficiency, biodegradability, biosecurity, poisonless and harmless property, or low poisonous and low harmful property, and low emissions of resources and energy during the design, production, use, abandonment, disposal, and other whole life cycle process, which is the core idea of commercial refrigerating appliances eco-design. Our human beings shall directly face the ecological destruction resulted from the modern scientific and technical development and application, while the ecological product may provide the wiser and more ecological decisions for the users.

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