

Research on the Development Trend of Building Energy Conservation Patent in China

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The research is financed by the Humanities and Social Science Project of Education Department of Henan (No. 2019-ZZJH-087).

Abstract: *In this paper, the definition of building energy efficiency determine the patent search expression, from building energy efficiency high annual patent distribution, patent holder, the applicant technology association, the cooperative relations, hot spot and the distribution of the province has carried on the thorough analysis, finally, in combination with the practical situation of our country specific advice is given on the development of building energy efficiency.*

Keywords: *building energy conservation; Patent analysis; Development situation*

Date of Submission: 30-12-2019

Date of acceptance: 14-01-2020

Building energy conservation refers to the reduction of energy consumption as far as possible in the production of building materials, building construction and construction of structures and in the process of use, under the condition of meeting the same needs or achieving the same purpose. Specific to point to in the structure of the planning, design, newly built, rebuilding and expansion of), the transformation and use process, implement energy conservation standards, energy-saving technologies, processes, equipment, materials and products, improve the heating of the heat preservation and heat insulation performance and efficiency of heating, air conditioning and refrigeration heating system, strengthen the building energy system operation and management, use of renewable energy, on the premise of guarantee the quality of the indoor thermal environment, increasing the energy exchange between indoor and outdoor thermal resistance, to reduce the heating system, air conditioning and refrigeration heating, lighting, hot water supply due to large amounts of heat consumption of energy consumption. Patent documents are a collection of technical, legal and economic information, which is an important source of obtaining the latest global technical information. According to the statistics of the world intellectual property organization, 95% of the new technologies and inventions in the world are recorded in patent documents, and about 80% of the technical information only appears in patent documents. The number of patents and the trend of development can reflect the latest development of science and technology in a country (region). The application of patent analysis can comprehensively and objectively reflect the development process of building energy conservation in China, study and judge the current hot spots of building energy conservation technology, and predict the development trend of building energy conservation technology.

I. Determination of patent retrieval expression

According to the definition of building energy efficiency, a preliminary search expression was selected: TI,ABST+= building energy efficiency or TI,ABST+= energy-saving building or TI,ABST+= green building or TI,ABST+= environment-friendly building. By using the innojoy patent retrieval system of baoding, we searched Chinese patents and selected the check boxes of invention patents, utility models and appearance design patents. By searching, we found that as of October 24, 2019, there were 2,103 such patents in China. In order to improve the recall rate of patent information, we adjusted the search expression as follows according to the initial search result: (TI,ABST+= energy saving or TI,ABST+= environmental protection or TI,ABST+= green) and (TI,ABST+= building materials or TI,ABST+= walls or TI,ABST+= doors and Windows or TI,ABST+= roofing)) and (SIC=E04 or SIC=C04 or SIC=F24 or SIC=E06 or SIC=C09 or SIC=G01 or SIC=B28 or SIC=G05 or SIC=25-01 or SIC=C03). A search revealed a total of 17,472 such patents (retrieved on October 24, 2019).

II. Patent analysis on the development trend of building energy conservation

2.1 Annual distribution of patent applications

According to 17472 pieces of an application for a patent for the annual, analysis: an application for a patent for China's building energy conservation field first appeared in 1985, in the subsequent years, although the patent filings have increased every year, but every year are not more than 50 patents, it can be seen that building energy efficiency technology development is slow, we called the stage of building energy efficiency technology budding period (1985-1998); From 1999 to 2004, the number of patent applications in the field of building energy efficiency increased significantly, with the annual number of applications gradually rising from 63 to 327. From 2005 to 2018, the number of patent applications rose from less than 500 to 2,927, showing an obvious linear upward trend. We call this stage the period of rapid development. It should be pointed out that the annual application volume in 2008 and 2009 is basically the same. The reason may be that the subprime crisis in 2008 brought a great impact on the field of building energy conservation in China. Since it takes 18 months for a patent to be filed and made public, the data in 2019 is incomplete and for reference only.

2.2 High patentee analysis

The top 10 patent holders in the field of building energy efficiency are listed in the table.

	Type of patent (number of applications)	Invention	Utility model	Appear- ance design	Summ-ati on	(%)
1	Lyjian technology group new building materials high-tech co. LTD	105	101	0	206	1.18
2	Anhui tongxi jinpeng aluminum co. LTD	57	93	0	150	0.86
3	Beijing University of Technology	118	15	0	133	0.76
4	Shenzhen haichuan industrial co. LTD	112	0	0	112	0.64
5	Shandong University of Science and Technology	47	33	0	80	0.46
6	Tongji university	63	8	0	71	0.41
7	Harbin hongsheng building energy saving system r&d center	27	24	10	61	0.35
8	Shenyang architecture university	55	6	0	61	0.35
9	Suzhou gold mantis curtain wall co. LTD	30	30	0	60	0.34
10	Kunming University of Science and Technology	24	26	0	50	0.29
10	Chongqing university	34	16	0	50	0.29

As can be seen from the table, the proportion of invention patents in the top ten applications in the field of building energy conservation is significantly larger than that of utility models, and there are almost no appearance design patents, indicating that the technical and scientific content of patents in this field is relatively high. Among the top 10 applicants, enterprises and universities account for half and half, and there is no individual phenomenon, which indicates that the patent in the field of building energy efficiency requires the full cooperation of the team, and individual ability is not enough for research and development. At the same time, we can find that the proportion of the patents of the top ten high-yield patent applicants in the field of building energy conservation is relatively low, indicating that the patents in the field of building energy conservation are relatively scattered, with no accumulation of technology, let alone the phenomenon of technology monopoly.

It can be seen from the annual applications of the top ten patentees in the field of building energy conservation that although the earliest patent in the field of building energy conservation in China appeared in 1985, the current top ten patentees in the field did not start to participate in building energy conservation until 2003. This shows that the early patentees involved in the field did not get bigger and stronger over time. At the same time as you can see, the enterprise patent filings are relatively concentrated in a given year or a few years, new building materials of high technology such as green building science and technology group co., LTD., is concentrated in the 2014 to apply for a patent, anhui with the sunrise jinpeng aluminium industry co., LTD., an application for a patent for concentrated in 2014 and 2016, shenzhen oceanpower industrial co., LTD. Patent concentrated in 2008; The patent application distribution of university research institutions such as Beijing university of technology has obvious continuity for many years. This shows that the enterprise's r & d ability to a certain technology hot spot is obviously better than that of universities and research institutes; The latter are more familiar with the technological development of the field and have a stronger insight into the technological frontier. After a second search, it was found that lujian technology group new building materials high-tech co., LTD., which ranked first in patent rights, had applied for all 206 patents in September 2014, and all of them related to the technology of external wall self-insulation system. This indicates that the enterprise has absolute advantages in the field of external wall self-insulation technology.

2.3 Applicant's technical correlation analysis

Through the statistics of the main classification Numbers of the top ten patentees in this field, the technical correlation analysis is carried out by using the social network analysis software. The line indicates that

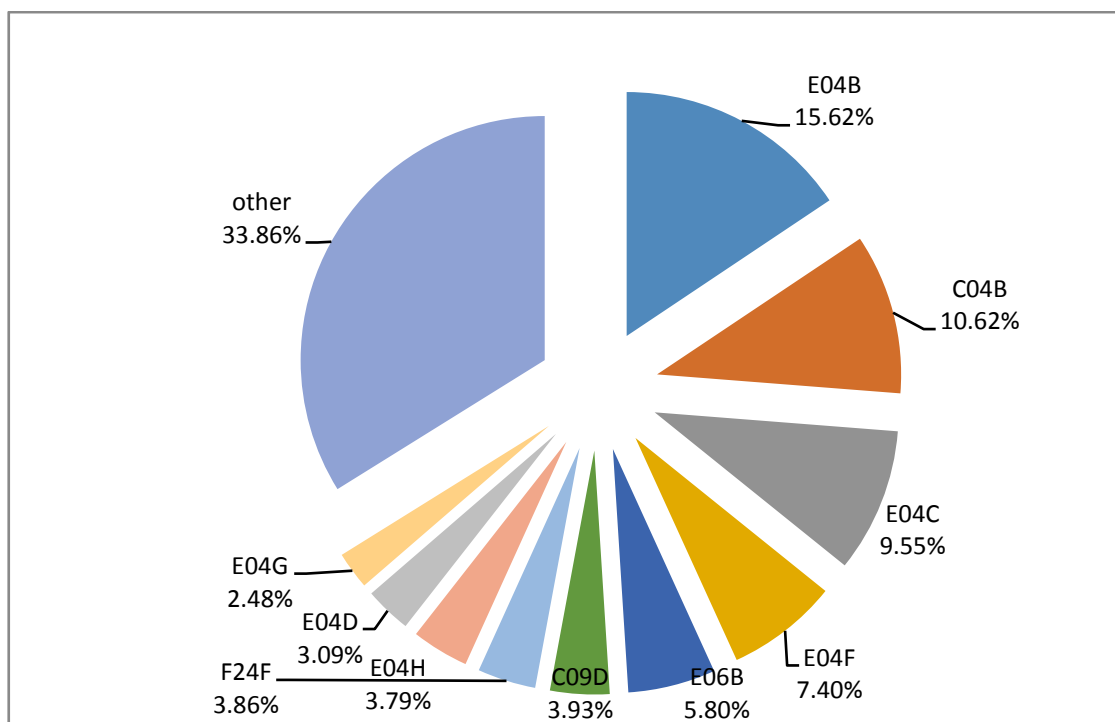
there is a technical correlation between the patentees, while the thick line indicates the technical correlation between the two. According to the technical correlation chart, it is found that the connection between Lvjian technology group new building materials high-tech co., LTD., which ranks the first in the number of patent applications, and Beijing university of technology, which ranks the third, is relatively thick, indicating a strong technical correlation between the two. A further search revealed that both possessed a large number of patents in the technology of energy saving in general building construction (E04B). Therefore, Beijing university of technology is an ideal technical partner for Lvjian technology group new building materials high-tech co., LTD. At the same time, for Beijing university of technology, Lvjian technology group new building materials high-tech co., ltd. is an important target customer for its patent technology transfer. However, anhui tongxi jinpeng aluminum co., LTD., which ranks second in the number of patent applications, has less technical connection with other units. After the second search, the company's patents mainly focus on building energy-saving doors and Windows (E06B), with the number of patent applications ranked higher enterprises and institutions do not have too much technology overlap, which also shows that the enterprise in the building energy-saving doors and Windows have a relatively obvious technical lead.

2.4 Analysis of the applicant's cooperative relationship

By calculating the cooperation matrix of the top ten patentees in the field of building energy conservation, it is found that there is no cooperation among the top ten patentees. By changing the retrieval parameters, the technical cooperation relationship in the field of building energy conservation is analyzed. We found that only a few companies had patent partnerships, such as shenzhen haichuan industrial co., ltd. and Shanghai qipeng chemical co., ltd. in the field of energy-saving paint compounds. The vast majority of high patentees do not have any cooperation relationship, even the enterprises and institutions with strong patent technology relevance, such as Lvjian technology group new building materials high-tech co., LTD., which ranks the first in patent application volume, and Beijing university of technology, which ranks the third, do not have any technical cooperation. This shows that the industry-university-research cooperation in the field of building energy conservation in China is still weak, and the lack of necessary strong alliance in the field of building energy conservation will also affect the sustainable and healthy development of this field.

2.5 Technical hot spot analysis

Based on the analysis of the IPC technology composition in the field of building energy conservation, it is found that a total of 298 subcategories are involved in this field, among which the main IPC subcategories and their proportion are shown in the figure below. The proportion of the top 10 subcategories, such as E04B, C04B and E04C, is 66.14% of all ipcs, and the specific meaning is shown in the table.



As can be seen from the figure, the current IPC technology hotspots in the field of building energy conservation are relatively dispersed, and no technology research hotspots with absolute advantages have been formed. Energy-saving technology for the construction of walls, roofs, floors and ceilings of general buildings; Energy-saving technology of building materials such as mortar and concrete; The energy-saving technology of building structural components is the top three in the research focus of IPC technology in the field of building energy conservation in China. This shows that the building energy saving technology in China is mainly concentrated in the field of building structure, building materials, structural technology and so on.

Table 10 main meanings of the top 10 IPC subclasses

IPC	Main meaning
E04B	general building structure (such as walls, roofs, floors, ceilings, etc.)
C04B	cement and its compositions (e.g. mortar, concrete, etc.)
E04C	structural members; Building materials
E04F	building renovation works (such as stairs, floors, doors and Windows, etc.)
E06B	building stationary or mobile closure devices (such as doors and Windows, curtains, sun screens, etc.)
C09D	paint composition (e.g. paint, etc.)
F24F	air conditioning; Air humidification; ventilation
E04H	spray baths or pools in buildings; The mast. A fence
E04D	roof covering; Skylight; gutter
E04G	scaffold and mold shell; The template. Construction equipment or other building AIDS

2.6 National and provincial distribution

Through searching, it is found that the top ten provinces in the field of building energy conservation patent application and their proportion are shown in the table. It is obvious that the number of patent applications for building energy efficiency is in direct proportion to the economic aggregate of each province, so it is not surprising that Jiangsu, Shandong and Guangdong are among the top three. In particular, Beijing was followed by Liaoning (no. 7) and Heilongjiang (no. 10), which may be closely related to geographical and climatic distribution. In winter, the temperature in northeast China is relatively low, so people have more urgent requirements on the thermal insulation of external walls, roofs, doors and Windows of buildings, which promotes the development of energy-saving building technology in this region.

Ranking	Province of applicant	Application number	Ratio of
1	Jiangsu	2086	11.98%
2	Shandong	1758	10.10%
3	Guangdong	1570	9.02%
4	Beijing	1489	8.55%
5	Shanghai	1139	6.54%
6	Zhejiang	1025	5.89%
7	Liaoning	999	5.74%
8	Anhui	783	4.50%
9	Hunan	726	4.17%
10	Heilongjiang	641	3.68%

III. Conclusions And Recommendations

Building energy saving technology has been emerging in China for more than 30 years. At present, some domestic energy saving enterprises and universities are more enthusiastic about the research and development of this technology. At present, the hot spots of IPC technology in the field of building energy conservation are scattered, and no research hot spots with absolute advantages have been formed. Through analysis, it is found that the proportion of patents of high yield patent applicants in the field of building energy conservation is low, which indicates that the patents in the field of building energy conservation are relatively scattered, and there is no technology accumulation, let alone the phenomenon of technology monopoly. Through further analysis, it is found that the industry-university-research cooperation in the field of building energy conservation in China is still weak, and the lack of necessary strong alliance in the field of building energy conservation will also affect the sustainable and healthy development of this field.

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Ma Yanfei. "Research on the Development Trend of Building Energy Conservation Patent in China". *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, vol. 16, no. 6, 2019, pp. 45-49.