Analysis of Chinese Patents with Bioenergy Technology

Hou Yuanyuan[1] Shi Yanqin[2] Lv Huaqiao[3]

[1,2,3]Beijing Municipal Institute of Science and Technology Information, Beijing, China
[1] houyuan9601@yahoo.com.cn [2] shiyan6619@sina.com [3] huaqiao@eyou.com

Abstract

The China Patent Abstract Database was chosen; bioenergy technology patents between 1987 and 2012 were collected. Bioenergy technology patents were analyzed deeply from the total amount of patent applications, technology sub-class, and association analysis, respectively. IPC classification was employed to divide the patents into different categories and association analysis was adopted to discover the relations between technology fields. The patent trends of bioenergy technology were also discussed.

Keywords: Bioenergy, patent analysis, IPC association analysis

1. Introduction

Nowadays, the world has increasingly paid attention to the development and diffusion of alternative energy sources in order to reduce dependency on fossil fuels. Bioenergy is already seen as one of the key options on shorter and medium term to mitigate greenhouse gas emissions and substitute fossil fuels. [1] Bioenergy is renewable energy made available from materials derived from biomass. [2-5] Over the past five years were an important phase during the developing of the Chinese bioenergy, we have made a remarkable progress in field of methane, bio-fuel, bio-diesel, bio-fuel, bio-electricity generating, has been shaping Chinese bioenergy industry's rudiment. Facing thriving developing of bioenergy, Chinese government unveils a series of laws to boost the healthy development of biomass energy industry. The development of bioenergy in China is needed to meet the rising energy demand. Meantime, China is still a large agricultural country with an ample amount of biomass resources, such as livestock and agroprocessing wastes, which can generate substantial quantity of renewable energy. Bioenergy is very important for the development of China's renewable energy industry. We should analysis of trends in technological innovation in order to design appropriate policies for the promotion of bioenergy.

A patent is a special type of technology document. As an open source of knowledge, it contains rich content regarding technology innovations and is accessible by the general public. Most countries have adopted similar patent systems. A large number of patents are issued everyday and collected and published systematically worldwide. The patent documents are also strictly structured, providing standardized fields such as patent citation, issue date, assignee, inventors and technology field classification, etc. All these special features of patent documents make them a valuable source of knowledge regarding technology development. Therefore, the objective of this paper is providing an overview of the technologies development trends of bioenergy in China through patent analysis method.

2. Patent Analysis

The data used in this paper was extracted from the China Patent Abstract Database. Some keywords were used to identify relevant records in the databases. Two types of analyses were conducted using the data collected from the previous records: the number of patent applications; IPC correlation analysis, where we have created correlation maps to identify the most important technical topics in bioenergy field. In this research, we collected the bioenergy patent applications published from 1987 to 2012.

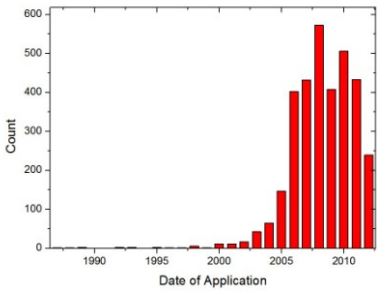

Fig. 1: The numbers of bioenergy patent applications of China

The evolution of the total number of bioenergy patent applications per year from 1987 to 2012 is shown in Fig. 1. The bioenergy Patent appeared in 1987.Since the mid-2000s, patent activity with respect to bioenergy technologies has begun gathering speed and has experienced a continuous increase until the present, with a peak in the number of applications reached in 2008.

Figure 2 show the technology life cycle of bioenergy patent in China. From 1987 to 2002, the number of patents and the number of patent applicants is in a relatively low number. From 2003 to 2005, the number of patents and applicants began to increase. In 2006, the number of patents and applicants has increased rapidly. From 2006 to 2010, the number of patents and applicants is in a relatively high number, bioenergy technology into the growing period.

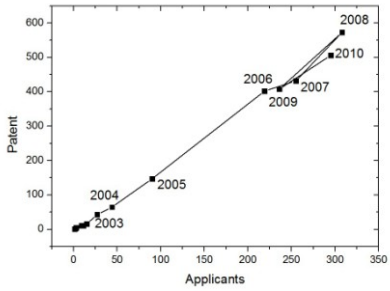

Fig. 2: Technology life cycle of bioenergy patent

Table 1 shows the top ten applicants who applied for bioenergy related patents. As shown in Table 1, the applicants include some well-known companies and institutions like Sinopec Group, Tsinghua University, Institute of Process Engineering Chinese Academy of Sciences, Tianjin University, Kunming University of Science and Technology and so on.

Table 1:Ten largest corporate bioenergy patent applications

Rank	Assignee Name	Number of Patent Applications
1	Sinopec Group	191
2	Tsinghua University	117
3	Institute of Process Engineering Chinese Academy of Sciences	43
4	Tianjin University	42
5	Kunming University of Science and Technology	40
6	North China Electric Power University	38
7	Harbin Institute of Technology	35
8	Dalian University of Technology	34
9	Nanjing Industrial university	31
10	Zhejiang University	29

We used the International Patent Classification (IPC) class to indicate technology fields in Table 2. In the data, “Essentially based on components consisting of carbon, hydrogen, and oxygen only” (C10L1/02) ranked first, followed by “Ester interchange” (C11C3/10). In fact, since the 1970s, technologies for utilizing biomass to create energy have developed beyond the simple combustion of fuels such as firewood and now include technologies for the production of biofu-

els, cogeneration technologies, and methane fermentation of organic wastes. The most common forms of biofuels are biodiesel and bioethanol. Biodiesel is usually produced from oil crops, while bioethanol is mainly derived from the fermenting of saccharides from grains such as corn, from sugar cane and sugar beet, or from grapes. [6] In addition, "by esterification of fats or fatty oils" (C11C3/04) and "Fats; Fatty oils; Ester-type waxes; Higher fatty acids, i.e. having at least seven carbon atoms in an unbroken chain bound to a carboxyl group; Oxidised oils or fats" (C12P7/64) ranked third and fourth, respectively.

Table 2: Top five technology fields based on the IPC class

IPC	Class Name	Number
C10L1/02	Essentially based on components consisting of carbon, hydrogen, and oxygen only	564
C11C3/10	Ester interchange	293
C11C3/04	by esterification of fats or fatty oils	184
C12P7/64	Fats; Fatty oils; Ester-type waxes; Higher fatty acids, i.e. having at least seven carbon atoms in an unbroken chain bound to a carboxyl group; Oxidised oils or fats	136
C12P7/06	Ethanol, i.e. non-beverage	122

Association analysis is a useful method for discovering interesting relationships hidden in large data sets. The uncovered relationships can be represented in the form of association rules or co-occurrence graphs. [7] An event map, a sort of co-occurrence graphs, is a two-dimension undirected graph, which consists of event clusters, visible events, and chances. An event cluster is a group of frequent and strongly related events. The occurrence frequency of events and co-occurrence between events within an event cluster are both high. In this study, the association analysis and IPC data will be adopted to generate association diagrams.

The patents of bioenergy was classified by IPC code and selected via the number of appearing times of every specific IPC code. Every patent will be assigned to a specific category according to its IPC code and may be assigned to several categories if its IPC field contains more than one code. Meanwhile, the number of patents for an IPC category will be counted for showing its occurrence frequency. Based on a threshold setting (e.g., 10 was set for this study) on the number of patents in an IPC category, a certain number of the leading IPC categories will be selected and then be utilized to generate the association diagrams.

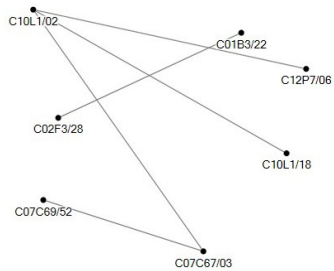

Fig. 3: The IPC association diagrams for bioenergy patent applications from 1987 to 2005

The IPC association diagrams for bioenergy patent applications were used to visualize the major IPC classification. We used the NodeXL to analyze of bioenergy patent IPC data. An association map has two components: the point, and the lines. The width of line represents the degree of association. Figures 3 show the association for the bioenergy patent from 1987 to 2005. As shown in Fig. 3, there is some correlation between the seven areas of bioenergy technology. This time period the number of patents is less, so there is no strong correlation between the various technical fields. The behavior of the application cluster around one of the main areas of technology has not yet appeared. Technology development prospects are uncertain.

From 2006 to 2012, the field of bioenergy technology associated behavior occurred significant changes, as shown in Figure 4. There is a strong correlation be-

tween C10L1/02(Essentially based on components consisting of carbon, hydrogen, and oxygen only), C11C3/10(Ester interchange) and C11C3/04(by esterification of fats or fatty oils). Overall, C10L1/02, C11C3/10 and C11C3/04 were the center of bioenergy technology field, surrounded by C12P7/06 (Ethanol, i.e. non-beverage), C12P7/10 (Multiple stages of fermentation; Multiple types of micro-organisms or reuse for micro-organisms), C12R1/865 (Saccharomyces cerevisiae), C12R1/645 (Fungi), C12R1/89 (Algae), C10L1/04 (essentially based on blends of hydrocarbons), C12N15/63 (Introduction of foreign genetic material using vectors; Vectors; Use of hosts therefor; Regulation of expression) and so on. This shows that bioenergy technology is relatively mature.

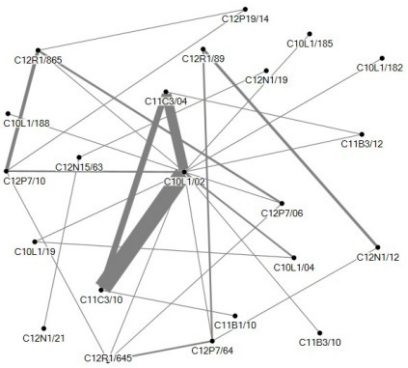

Fig. 4: The IPC association diagrams for bioenergy patent applications from 2006 to 2012

3. Conclusions

The bioenergy patent applications have been evaluated by using the China Patent Abstract Database. Bioenergy technology patents were analyzed deeply from the total amount of patent applications, technology sub-class, and association analysis, respectively. The bioenergy Patent appeared in 1987.Since the mid-2000s, patent activity with respect to bio energy technologies has begun gathering speed and has experienced a continuous increase until the present, with a peak in the number of applications reached in 2008.The top technology fields (represented by IPC class) was "Essentially based on components consisting of carbon, hydrogen, and oxygen only" (C10L1/02). The association diagrams show that a strong correlation was existed between C10L1/02, C11C3/10 and C11C3/04. Nowadays, the bioenergy technology is relatively mature.

4. References

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