

# Patent Activity on Water Pollution and Treatment in China – a Scientometric Perspective

Junpeng Yuan<sup>13</sup>, Weiping Yue<sup>23</sup>, Cheng Su<sup>13</sup>, Zheng Wu<sup>23</sup>, Yuntao Pan<sup>13</sup>, Nan Ma<sup>23</sup>,  
Zhiyu Hu<sup>13</sup>, Fei Shi<sup>23</sup>, Zhenglu Yu<sup>13</sup>, Yishan Wu<sup>13</sup>

*junpengyuan@gmail.com ; weiping.yue@thomsonreuters.com*

<sup>1</sup> Institute of Scientific and Technical of Information of China, Beijing, 100038 (P.R.China)

<sup>2</sup> Thomson Reuters, Beijing, 100190 (P.R.China) <sup>3</sup> ISTIC-Thomson Reuters Joint Lab for Scientometrics Research

## Abstract

This research intends to study the patent activity on water pollution and treatment in China. Data were collected from Derwent World Patents Index between 1985 and May 2008. Total volume of patents, technology focus, assignee sector, and the comparison with triadic patents are analyzed. It is found that patents on water pollution and treatment applied in China has grown by 200-fold. However, the number of high quality triadic patents with priority country of China remains small. Nevertheless, China's technology focuses on water pollution and treatment seem to parallel global and triadic patent trends. Furthermore, except for individual patent assignees, both Chinese universities and enterprises play an important role in patent activity of water pollution and treatment. This research provides a comprehensive picture of China's innovation capability in the area of water pollution and treatment. It will help China's local governments to increase their regional S&T capability and will provide support to strengthen strategic planning and science decision-making in China.

## Introduction

According to the report "National Water Environment Quality in 2006" published by the Ministry of Environmental Protection of the People's Republic of China, over 33% industrial wastewater and 90% of residual wastewater was discharged without treatment into rivers, lakes and oceans in China. Water pollution has become one of the most important factors restricting the development of China's economy and society. Thus, it has drawn great attention from national and local governments. In June 2006, the Chinese government started to carry out the National Water Pollution Control and Treatment Project, which aims to improve the comprehensive S&T capability in water pollution control and treatment in China. However, water pollution control and water treatment is a *long-term, arduous* and complicated *systematic project*. At present, the key technology in the area has not been identified and serious loss of the situation has not changed. It is necessary to investigate and study the technology status and development trend in this area.

Patents cover technology achievements in all applied research areas. Patent analyses have always been used to either to compare patents of various technological sectors/sub P sectors nationwide, and degree of collaboration among these sectors (Narin 1987, 1988); or to map/compare the technological strength in relation to world profile (Grupp & Schmoch, 1999). Innovation indicators and patent analysis method used to exploit new technologies by Alan Porter (2005), Breitzman and Moge (2002) discussed many applications of patent analysis, and the application of patent indicators in stock market has also been discussed by Breitzman & Narin (2001). Many researchers have applied patent analysis at national level to show the technology innovation and trend (Barroso & Quoniam, 2003; OECD, 2008; Trajtenberg, 2001; Zhou & Stenbridge, 2008), Bhattacharya (2004) has investigated the patent activity of two developing countries - China and India, in the US patent system.

This paper applies scientometric methods and data mining techniques to analyze patents applied in China on water pollution and water treatment since 1985. The quantitative characteristics, distribution in specific technology areas and comparison with triadic patents have been explored. It aims to draw a full picture about the current status and development

trend of water pollution and treatment in China, so as to lead to the further discussion of the issues and challenges that China are facing in the area. This research will help to increase China's indigenous innovation capability and S&T capability in the area of water pollution and treatment and will provide support to strengthen the strategic planning and science decision-making in the same area.

## **Data and Methods**

The data sources of patent documents are from Derwent World Patents Index® (DWPI) on Delphion platform provided by Thomson Reuters. DWPI covers patents from 41 countries and regions, provides unique DWPI manual codes, and rewrites the original patent titles and abstracts into more descriptive language. Each DWPI manual code represents a unique concept, which normalizes all the different expressions of the same concept.

The water pollution and treatment is a complex system, which covers many disciplines. In order to retrieve data comprehensively and accurately, we used both the DWPI manual codes and important keywords in search. In addition, the search strategy was revised and validated by technology experts. The search was conducted in May 2008. The final version of the search strategy is as follows.

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(((((A12-W11J OR D04* OR F05-A02C OR H05-L02 OR H06-C02 OR N07-L01B OR Q24-B10 OR Q24-P06 OR X25-H03) <in> MANUALCODES ) or (("waste water" OR "water pollut*" OR "water treat*" OR "water contr*" OR "water purif*" OR "water refin*" OR "water moni*" OR "water detec*" OR wastewater OR "water filtr*")) <in> TEXT ) NOT (U11* <in> MANUALCODES)) OR (((U11-C15Q or U11-C15B3) <in> MANUALCODES ) and (("wastewater" or "waste water") <in> TEXT ))) AND (PD>=1985-01-01))) NOT (A12-W11L <in> MANUALCODES)
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The search results with the above search strategy were further refined to patents applied in State Intellectual Property Office of the People's Republic of China (SIPO) and triadic patents. Triadic patents developed by OECD are defined as a set of patents taken at the European Patent Office, the Japan Patent Office and US Patent and Trademark Office that protect the same invention.

In this study, we use total applications, patent assignee distribution as well as the top 15 fields of patents applications. Thomson Data Analyzer was applied to clean and analyze patent data on water pollution and water treatment, including the data fields patent assignee, DWPI manual code, priority country, etc. The analysis focuses on China and the comparison between China and the rest of the world in particular triadic patent families. The priority date (first date of filing of a patent application to protect an invention) is the earliest and therefore closest to the invention date. Thus, in this paper the priority date is used for statistic analysis.

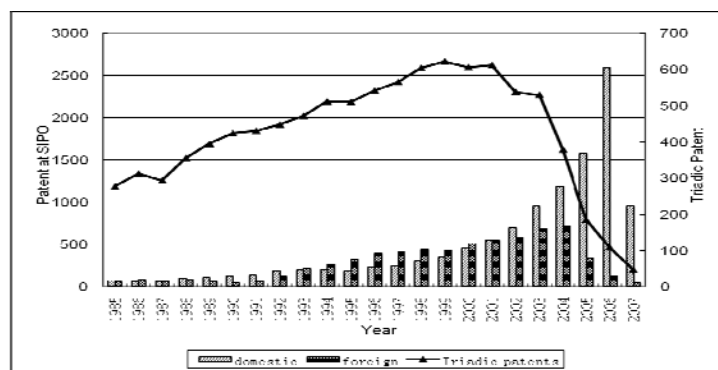
## **Results**

### *Overview on patents of water pollution and treatment in world and China*

Overall, the search strategy retrieved about 180,000 patent inventions worldwide on water pollution and treatment since 1985. The number of inventions in the area had kept increasing from 1985 and peaked by 2000. Then, the number of inventions per year has stabilized. The patent applicants spanned 86 different countries, demonstrating that the applied research of water pollution and treatment is global. In terms of the total number of patents, Japan demonstrated its dominant position; USA and Germany ranked second and third; China ranked 6th with 18,278 patent documents.

As shown in Figure 1, patent inventions on water pollution and treatment applied at SIPO have demonstrated a strong growth pattern. The number of applications increased over 200-fold by 2006. Within these applications, both the number and the percentage of domestic applications increased greatly, in particularly since 2000. This figure seems to show that the

Chinese government has strengthened environmental protection and raised corresponding financial support to science and technology in this area since 21st century. It is worth mentioning that the number of foreign applications decreased greatly in 2005. Nevertheless, in the same year, there are still many countries and regions such as USA, Japan, Australia, EU who applied patents actively in China, indicating the importance of the China market to those countries. In 2006, USA still led all others in patent applications on water pollution and treatment in China. (The number of patents in 2007 is comparatively low because it takes 18 months to publicize the patent applications).



**Figure 1. Trend of patents on water pollution and treatment**

Triadic patents are the highest value patents, normally representing the state-of-the-art technologies in the developed countries and regions. The distribution of triadic patents in water pollution and treatment across years shows a rapid increase from 1985 and a peak in 1999. However, the number of triadic patents has decreased since 2001. It might be because this particular field has become mature in the developed countries. The speculation will be examined later by the experts, who will be invited to join the next stage of this research. Further analysis shows that of 7061 total triadic patents, 2493 applied in China, showing that China market attracts over 35% high technologies. However, only 62 triadic patents' priority countries are China. Thus, high value innovations on water pollutions and treatment are still lacking in China.

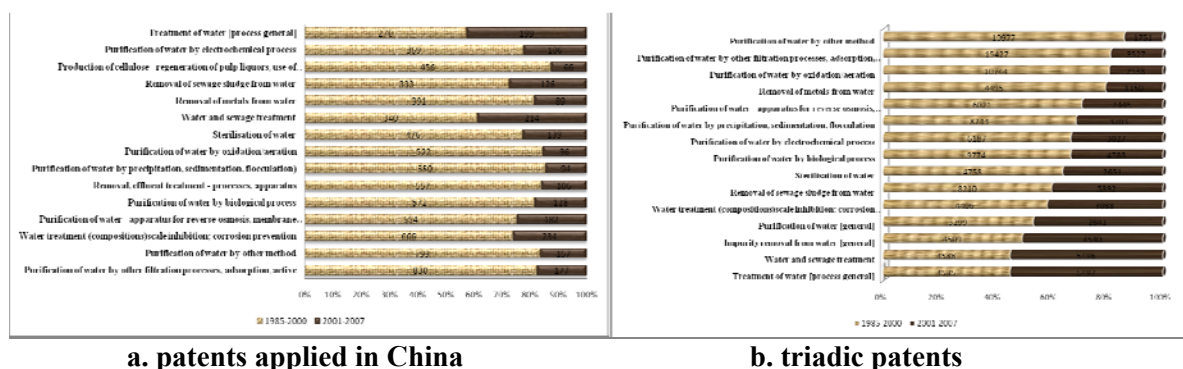
#### *Technology focuses of water pollution and treatment patents applied in China*

The technology focus of a field can be measured through the distribution of its patents over various specific technological areas. In this study, if there are more concentrated patents in certain technological areas, these areas are defined as the technology focus in the field of water pollution and treatment. DWPI manual codes, the unique classification scheme that highlights the application aspect of an invention, are used to analyze technology focus. Based on the analysis of DWPI manual codes in terms of the number of Chinese patents in each sub-area, the top 15 areas include "Purification of water by other filtration processes", "Water treatment (compositions) scale inhibition", "Purification of water by other method", "Water and sewage treatment", etc. (See Figure 2a ).

Moreover, the comparison between the top 15 DWPI manual codes of patents applied in China and those of triadic patents demonstrates that 14 out of 15 top manual codes are the same, implying that the technology focuses in water pollution and treatment in China are in line with the ones in developed countries.

Figure 2a shows the patent distribution of top 15 DWPI manual codes in China over time. After comparing the patent numbers in those two different time frames 1985-2000 and 2001-present, we found that most applications in those technology focuses those areas after year 2001. In particular, 80% of patents on "Water treatment (compositions)scale inhibition;

corrosion prevention”, “Water and sewage treatment”, “Purification of water by biological process”, “Purification of water - apparatus for reverse osmosis, membrane filtration and ultra-filtration”, “Removal of sewage sludge from water”, “Purification of water by electrochemical process”, and “Sterilisation of water” were applied after 2000. However, the same analysis over patents in top 15 technology focus of triadic patents in the same time frame shows opposite trends (Figure 2b), that is, most triadic patents were applied before 2000, implying the maturity of technologies in USA, Japan and Europe.



**a. patents applied in China** **b. triadic patents**  
**Figure 2. Time frame of top 15 DWPI manual codes of water pollution and treatment patents (1985-2000 vs 2001-present)**

### Assignee sectors of water pollution and treatment patents in China

Assignee analysis of water pollution and treatment patents applied in China shows that individual inventors contribute a significantly higher proportion of patent applications (54%). Universities and enterprises also play an important role (both 19%) while research institutes produced only 8% of patents.

Further analysis of the top 20 assignees indicates that the Chinese universities (15 out of 20) are the majority, while there are only 3 research institutes and 2 companies (see Table 1). We also investigate the collaboration network of the top assignees but little collaboration among enterprises, universities, and research institutes is found.

### Conclusion

This paper intends to study water pollution and treatment patents applied in China since 1985. Total volume of patents, technology focuses, assignee sectors, and the comparison with triadic patents are analyzed. We found 1) patent activity on water pollution and treatment in China has grown by 200-fold. However, the number of triadic patents with priority country being China is small. 2) China's technology focuses in water pollution and treatment seem to parallel global and triadic patent trends. After year 2000, rapid increase of patents showed in several technology focuses. It is found that most patents in those fields were applied after year 2001, showing fast innovation in water pollution and treatment in China. 3) Besides for individual patent assignees, both Chinese universities and enterprises play an important role in patent activity of water pollution and treatment.

This study describes the development and current status of patent activity in water pollution and treatment in China. We hope that the study can provide science policy makers a whole picture about innovation capability in this particular field and help them to make better decisions.

The next stage of this study will invite experts in the field to explain the results from the patent analysis. Also, patent citation analysis of China's triadic patents should be able to help identify key technologies.

**Table 1 Top 20 assignees**

Rank	Assignee	number of patents
1	Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences	184
2	Tsinghua University	157
3	Harbin Institute of Technology	151
4	China Petroleum & Chemical Corporation	149
5	Nanjing University	128
6	Zhejiang University	113
7	Shanghai Jiao Tong University	89
8	South China University of Technology	88
9	Tongji University	84
10	Shanghai Wansen Water treatment Co.,Ltd	78
11	Tianjin University	65
12	Dalian University of Technology	43
13	Nankai University	38
14	Dalian Institute of Chemical Physics, Chinese Academy of Sciences	32
15	Shandong University	30
16	The Institute of Applied Ecology, Chinese Academy of Sciences	29
17	Southeast University	29
18	Sun Yat-sen university	27
19	Sichuan university	27
20	University of Science and Technology Beijing	27

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