Petroleum and Coal

STRATEGIC PATENT ANALYSIS OF REAL TIME OPTIMIZATION APPLICATIONS IN UPSTREAM SECTION OF OIL AND GAS INDUSTRY

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Abstract

The patents were classified in terms of date, zone, country and owner(s) in time period of 1985 to 2010. The analysis showed that USA was the largest country for technology patent registration; Schlumberger was the pioneer company and in 2008, the most number of patents granted. Patent analysis of this study helped to determine the current technology trend and addressed the roadmap for developing the next generation of RTPO and associated technologies.

Keywords: Real time optimization; Patent analysis; Oil and Gas Upstream Industry; Technology trend; Real time production optimization.

1. Introduction

In the field of technology management, use of information or documents, patent applications and data analysis is an important asset. In general, patent analysis, can provide useful information that through analysis and evaluation of the information, a technology can be fully understood [1].

The sequence of decisions made during patent analysis clearly has legal consequences. Based on Skinner's definition of a good decision maker, a number of key decision points were identified [2]:

o Decide what is searchable– frame the search problem as distinct from the original request.
o Decide what can be expected from the search, given the available sources of information and their limitations, budgetary constraints, legal deadlines and company timeframe. Communicate it to others.
o Decide on the timing and sequence of decisions to be made during the search. Plan a strategy for searching (use of online databases, Internet sources, print publications or expert contacts), document the search pathway and reasons for following it.
o Decide where uncertainty will arise and manage it effectively– use methods of retrieval that will reduce uncertainty (e.g. citation searching to identify relevant coding), question and respond to results as they come up, revise the strategy accordingly, aim for comprehensiveness.
o Decide how best to work with risks, and understand their consequences. Keep up to date with search tools, their strengths and weaknesses, be informed about legal processes, and maintain confidentiality.
o Decide how to identify opportunities and create alternatives. Be a detective, challenge assumptions, question the results (what exactly does it mean if you have zero hits?).
o Decide how to deal with complexity and ambiguity. Decide when you have finished a search, organize electronic files and papers, document the search strategies and choices made, and annotate the results.
o Legal decisions are made by attorneys as a consequence.

One of the main challenges in the chemical processes is how to best operate the plant under different conditions such as feed compositions, production rates, energy availability and feed/

product prices. One of the techniques that have received considerable attention in the process industry is Real-Time Optimization (RTO). RTO attempts to optimize plants profit as operating conditions change continuously [3-10].

Nowadays, promoting RTO is a competition for capital within producing corporations. The project teams that are aware of this fact and then clearly outline the purpose, benefits, costs and strategic business alignment of their proposals will be in a beneficial position to secure funding. Because RTO is still an emerging discipline, classifying projects of this character is still dependent on an individual's viewpoint.

In oil and gas upstream industry, the RTO technology has several applications [11-20]. These applications can be divided into two main areas: Real Time Production Optimization (RTPO) and Real Time Drilling Optimization (RTDO).

This paper intended to enable classification of RTPO in an objective manner and to determine the current technology trend and the next generation of RTPO and associated technologies.

2. Patent search policy

Recently some novel tools have become available for patent research, and some old ones have been enhanced. For now, discussions still continue about the best techniques of patent search. The reality is that in order to accomplish a serious search, all possible relevant policies should be applied. In many situations, smart use of keywords combined with classifications is the main way to go [21-22].

In various cases, the patent classification system is some years behind technology development. In such instances, the main approach is the "shotgun search", using one or more patent classifications to employ a wide range of keyword search strategies. Such search strategies must make smart use of proximity operators to recover documents that include search terms which meaningfully grouped together. Often such searches still produce hundreds of potentially relevant patents. Reviewing several hundred documents an hour is best done with a good computer connection to a "text only" version of a service, which allows rapid display of keywords in context of full text. It is normally appreciated that patent abstracts are superficial and poorly done, and the real nuggets of truth may be buried under the boilerplate somewhere in the summary, claims or description of embodiments of a patent document. Often the description of the prior art highlights some old patent beyond the reach of electronic indexing [21-22].

2.1. Keyword searching

The main drawback of keyword searching is the English language as it is used and abused. However, here in detail are the specific problems:
- ✓ Poor translations: Probably 40% of US patents are filed from abroad, by people who may not use your favorite set of buzzwords for describing their technology. A great many Japanese translations are terrible, on the level of blind Martians describing an elephant. Machine translations are not always the worst source of garbage.
- ✓ Too many synonyms: In the area of chemistry, a compound may have twenty names, depending on the country or field of use. Use Chemical Abstracts to search with the CA registry number.
- ✓ Generic vs specific: There is always a chance that a patent out there dominates because it claims whole genera of applications or substances. Search for general terms as well as specific details.
- ✓ No spelling standards: Some people assume all databases are cast in American English. The World Patent Index, one of the best international databases, is created in the UK and full of British terms.
- ✓ Really bad titles and abstracts: No regulation decrees that these fields should aid in retrieval, and not all databases are created equal – some vendors provide titles and abstracts

enhanced by skilled indexers, whereas most others simply dump raw data from patent office files into their databases.

✓ Innovative lexicography: Everyone drafting patents is allowed to create novel terminology to describe inventions and ascribe new meanings to words. The system encourages bizarre descriptions.

✓ Errors and omissions: There are thousands of examples of obvious mistakes in titles and names of inventors and assignees as well as other important data such as cited patents. Very few of the errors in issued patents are ever corrected by the database suppliers, who often add their own.

✓ Date limitations: Most databases only go back about 30 years or so for searchable abstracts or text. Before that, there is only patent classification, unless you use such sources as Chemical Abstracts that have lately provided back-file coverage.

Systematic keyword searching involves drafting a grid of narrow, broad, and related terms, grouped together in proximity and related to other groups of terms expressing functionality or application. The terms must then be searched in rotation including every conceivable permutation and combination.

2.2. General and technical keyword specification

Keyword selection is one of the most important steps in patent search. It is directly related to the aim of the project. These keywords can be extracted from technical documents or discussion with researchers and expert persons. For the topic of "real time optimization in upstream oil and gas industry", following keywords was selected:

Dynamic real time optimization; Model Predictive Control; Non-linear Model Predictive Control; Gas Lift systems; Real time optimization of drilling parameters; weight on bit, bit rotation speed for obtaining maximum drilling rate as well as minimizing the drilling cost; Real time monitoring; Well regime analysis; Reducing time to decision; Data-integration; Real-time reservoir characterization, real-time formation pressure; Real time data acquisition; High frequency data; Real time Production Data Management System; real-time monitoring and surveillance of the field; Real time field modeling; Dynamic Reservoir Monitoring; dynamic behavior of the reservoir; digital oilfield technology; Logging While Drilling; Intelligent Well Completion; SMART completion; SMART Well; SMART artificial lift; SMART field

2.3. Patent classification

Patent classification is based on professionals in patent office who make judgment calls to classify patent documents according to the subject matter claimed. Therefore, classified patent files should be a perfect search tool. Unfortunately, the decisions of classifiers are often subjective, incomplete and random. There are several patent classifications such as European CLAssification (ECLA) and International Patent Classification (IPC).

3. Strategic analysis

Research activities in all over the world are high-priced. On the other hand, research projects are performed on the knowledge boundaries. This fact increases the risk and uncertainty of the research projects. In this situation, patents are one of the largest sources of strategic information in the world. Three types of strategic information can be extracted by patent analysis:

1) Technology trajectory: In a world that is changing ever more quickly, being able to look ahead and understand which aspects of that world will be changing, and to what extent, is a valuable tool for any innovator. Technology trajectory refers to a single branch in the evolution of a technological design of a product/service, with nodes representing separate designs.

2) Technological orientation of major companies: Patent analysis can help to find research concentration of main companies in several fields of technology and anticipate their future movement trend.

3) Appropriate joint ventures for strategic research projects: Patent analysis can introduce authentic joint ventures for the long time planning of research projects.

After patent search, classification and screening for "real time optimization in upstream section of oil and gas industry", the strategic analysis was performed. The analysis includes time trend of patent registration, geographical distribution of patents and policy specification of related companies in the field of the technology.

3.1. Time trend of patent registration

The number of registered patents per year in a specific field of technology can represent the history of activity in the technology. Figure 1 shows the number of patents per year for RTPO technology.
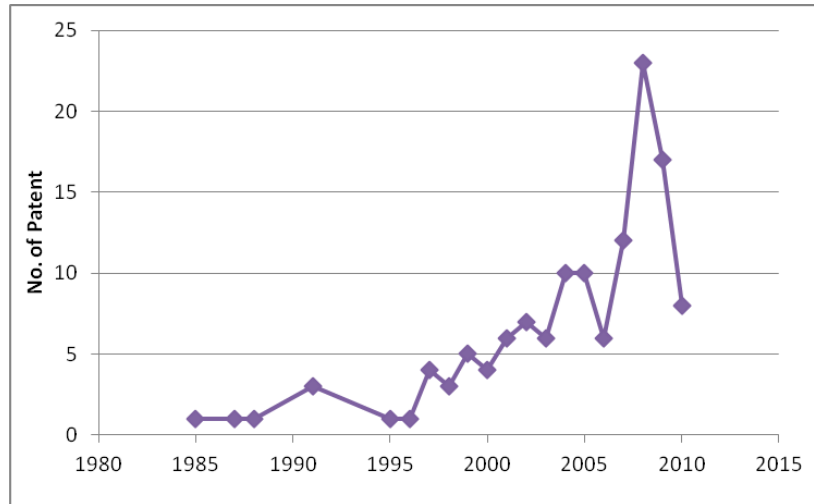

Figure 1. Number of patents per year for "real time optimization in oil and gas upstream"

This figure represents the increasing of investment in the research of the technology. However, in 2009 there is a reduction which extends to 2010.

3.2. Geographical distribution of patents

Totally, 129 patents are identified in this research that registered in different countries. According to geographical classification, 89 out of 129 cases are registered in the USA. Table 1 compares the number of registered patents in different region of the world for the field of the technology.

Table 1. Number of registered patents in different countries for RTPO technology (US: United States of America, WO: World Intellectual Property Organization (WIPO), EP: European Patent Office, EA: Eurasian Patent Organization, OA: African Intellectual Property Organization)

Region	No. of Patents	Region	No. of Patents
Total	129	EA	2
US	89	OA	3
WO	51	US,EP,WO	19
EP	24		

Figure 2 incorporates time trend of figure 1 and geographical distribution of table 1 to show an interesting statistics of the technology growth. The 19 patents which registered in all three well known regions (US, EP and WO) are those with most economic potential and should be technically focused in more details.

While US patent registration rate is the highest, WO patent rate is higher than EP ones. It reveals more inventor interests to grant patents in WO than EP.
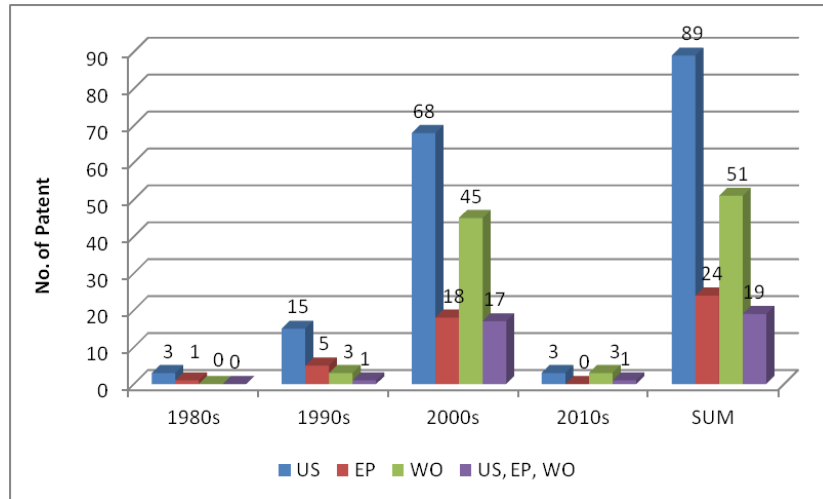
Figure 2. Time trend of patent registration in world regions

Table 2 shows the number of registered patents in different countries. The top 10 countries is shown in Figure 3. This shows that the USA, Canada and China anticipated being the most interesting markets for the technology.

Table 2. Country distribution of the technology's patent registration.

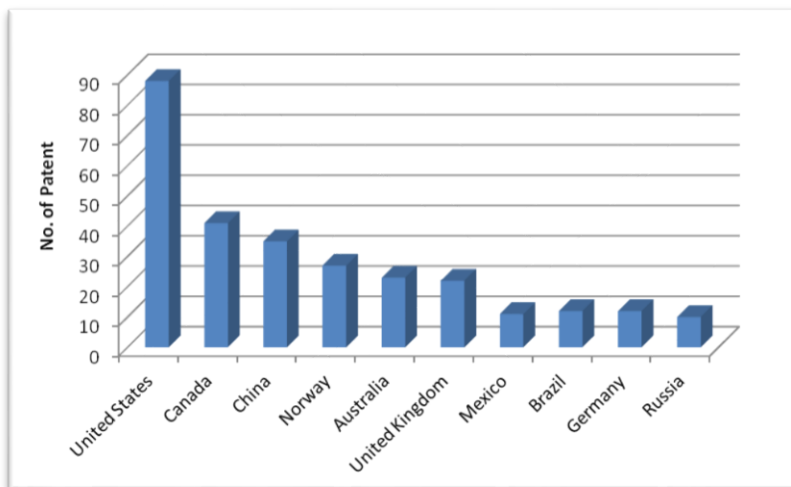| No.	Country	Number of patents	No.	Country	Number of patents
1	United States	89	13	Austria	2
2	Canada	41	14	India	2
3	China	35	15	Denmark	2
4	Norway	27	16	Egypt	2
5	Australia	23	17	Netherlands	1
6	United Kingdom	22	18	Korea	1
7	Mexico	11	19	Italy	1
8	Brazil	12	20	Arkansas	1
9	Germany	12	21	Czechoslovakia	1
10	Russia	10	22	Indonesia	1
11	France	5	23	Colombia	1
12	Japan	4	24	Hong Kong	1

Figure 3. Number of patent for top 10 countries

3.3. Policy specification of related companies

A study of collected documents in this research can be a powerful tool for identifying and classifying of the most active organizations and companies in the field of the technology. The most active companies are shown in figure 4. It is seen that "Schlumberger" has registered two times patents than Halliburton which is on the 2nd place.
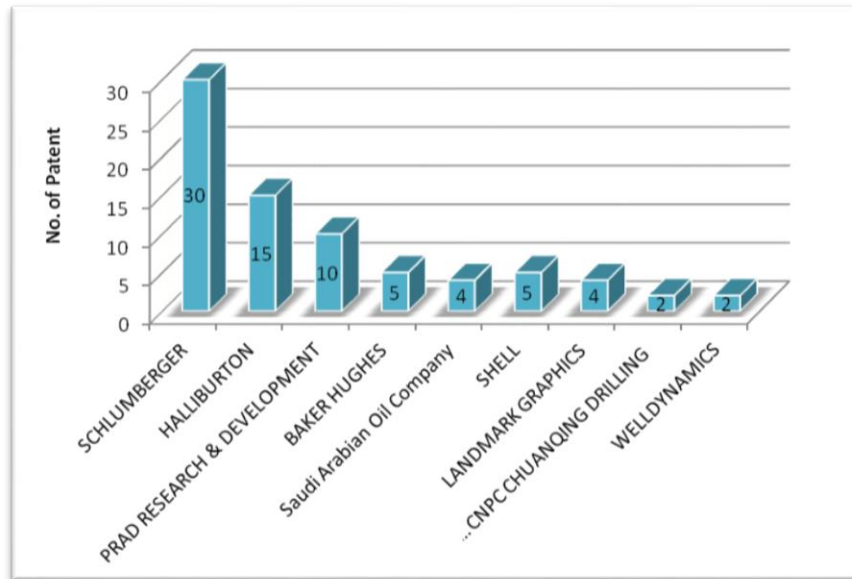

Figure 4. The most owner of patent in the field RTPO

Even though "Halliburton" ranks the second largest patent registration, the time trend for patent registration reveals that "Prad Research & Development" which is on rank three, is more active in the last years of study (Figure 5). This is the same for "Baker Hughes" and "Saudi Arabian Oil Company" which rank four and five in the number of patents. "Schlumberger" has both the most number of patents and most active company in the studied years.
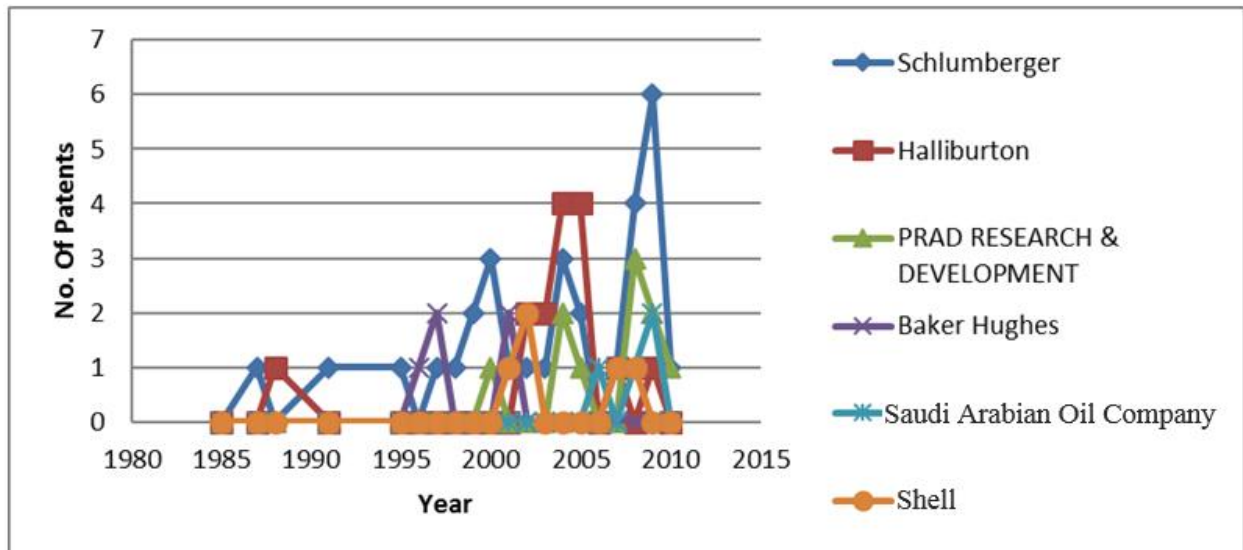

Figure 5. Companies patent registration over time

4. Conclusions

Being innovative is inevitable action for companies in the promptly changing economic environment and tough competition of second decade of 21st century. A successful product must balance three components: marketing, technology, and user experience. Technology plays a key role among these three. Developing a technology development strategy provides competitive materials and processes, resulting in a superior product. The first step for devising a technology development strategy is to decide if the technology is worth an investment and how the technology would develop in the future. Patent analysis is one of the best tools to draw a technology development strategy for companies. In this research, a patent analysis of real time production optimization (RTPO) technology was accomplished in terms of strategic considerations. The analysis includes time trend of patent registration, geographical distribution of patents and policy specification of related companies. In accordance with time trend of patent registration, it is seen a rapid increasing of patent registration. This fact shows the growing importance of this technology in the studied years. Also, the study of geographical and companies policy demonstrates that the investment on the "real time optimization in upstream section of oil and gas industry" increased in the past years in developed regions. These facts illustrate the promising perspective of the technology.

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