

Visualization Analysis of Research Status and Hotspots of Christmas trees Based on CiteSpace

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Abstract: This paper aims to discuss the research frontiers and research hotspots of Christmas trees, compare and summarize the current research status of Christmas trees, with a view to providing references for the establishment of universally applicable Christmas trees and related scientific research. This paper is based on the Web of Science (WOS) and China National Knowledge Infrastructure (CNKI) databases with "Christmas trees" is selected for the subject term to perform visual analysis and comparison of 722 WOS documents and 2267 CNKI documents after deduplication by year, country/region, institution, journal, author, hotspots, keywords, keyword cluster, etc. Analyze, obtain the visual analysis results of subsea Christmas trees as a research hotspot.

Keywords: Christmas tree, Visualization Analysis, CiteSpace.

1. Introduction

Christmas trees are wellhead devices used to extract oil from blowing wells and machine production wells [1]. It is the main equipment used to control and regulate oil and gas production in the uppermost part of oil and gas wells. It is mainly composed of a casing head, tubing head, and Christmas tree [2]. Wellhead Christmas tree is one of the core equipment in the process of oil and gas exploitation, which plays a crucial role in the production and safety of oil wells [3]. CiteSpace software [4] is a document visualization analysis software gradually developed under the background of scientometrics and data visualization. Through visualization, the basic knowledge and research hotspots of literature in a certain research field can be presented, and the research characteristics and evolution trends can be predicted. In this paper, the Web of Science (WOS) and China National Knowledge Infrastructure (CNKI) database were used as data sources, and CiteSpace software was used to visually analyze the current situation and hot spots of Christmas tree research, to objectively provide information in the field of Christmas tree research.

2. Materials and Methods

2.1. Data Sources

The foreign literature collected in this study comes from WOS. The Chinese literature was from CNKI. The subject search was used to search words "Christmas tree". The literature retrieved by December 30, 2020, was not limited in type. A total of 722 articles were retrieved from WOS and 2286 articles were retrieved from CNKI.

2.2. Research Method

The research method of this paper is based on CiteSpace, a software for citation visualization analysis developed by American Professor Chaomei Chen [5-6], which focuses on the analysis of potential knowledge contained in scientific literature, uses scientometrics and data visualization methods to identify it, and displays the new trends and dynamics of scientific development. This study is based on the citations of WOS and CNKI and uses version 5.7.R3 released on December 25, 2020, for research and visual analysis. Firstly,

the collected data were preprocessed, and 9 duplicated articles in CNKI citation were removed from the data reweighting to obtain 2267 articles. Copy the data in the pre-processed "output" to "data", then create a new project in CiteSpace and set Time Slicing, Selection Criteria, Links, and Pruning. The year, country/region, institution, journal, and keywords were sorted out and analyzed. Node size is proportional to the frequency of node type content. The thickness and quantity of cables between nodes represent the degree of connection between nodes. The closer the connection is, the thicker the cable is.

3. Results

3.1. Annual Analysis of Christmas Tree Research

Research reports related to the Christmas tree appeared in foreign countries at the beginning of the last century, and the citation based on WOS can be traced back to 1949. After 1900, the research literature in this field began to increase, especially in the recent 10 years, the number of publications increased significantly [7]. The annually published quantity of research related to the Christmas tree is shown in Fig. 1 and Fig. 2.

3.2. Country / Region Analysis of Christmas Tree research

National co-occurrence analysis was carried out by CiteSpace software, and relevant parameters were set as follows: Time Slicing: 1990-2020; Years Per Slice: 1; Node Types: Country; Selection Criteria: Top 30; Links Strength: Cosine. The map of the national cooperation network is shown in Fig. 3. According to the parameters in the upper left corner, 752 countries/regions in the world have published literature related to Christmas trees, and there are 822 cooperative relationships among them. The larger the node in the figure, the more articles are published by the country/region. It can be seen that the United States has the largest number of publications in this field, with a total of 198 articles, followed by the following countries/regions: Denmark (87 articles), China (24 articles), Canada (19 articles), France (14 articles), Germany (13 articles), India (10 articles), Norway (10 articles), Australia (9 articles).

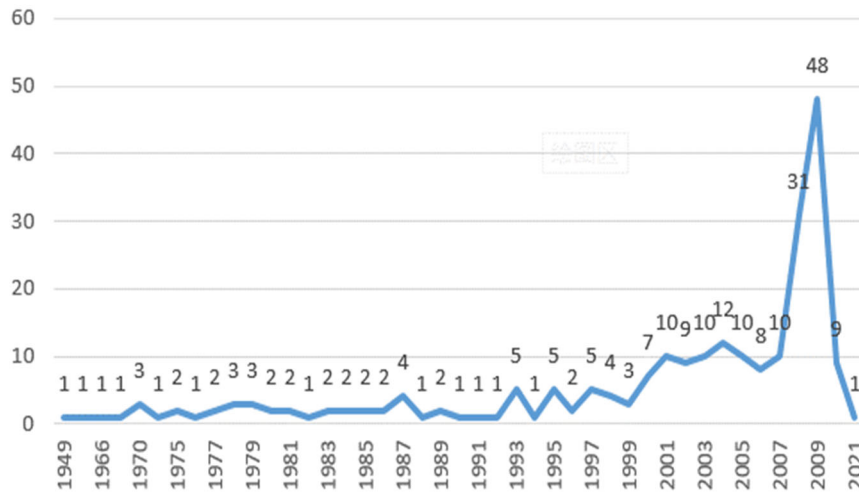


Figure 1. Annual distribution of WOS publication volume

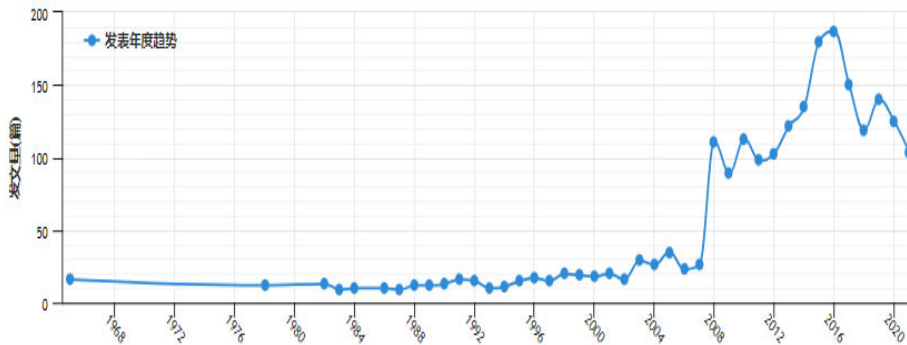


Figure 2. Annual distribution of CNKI publication volume

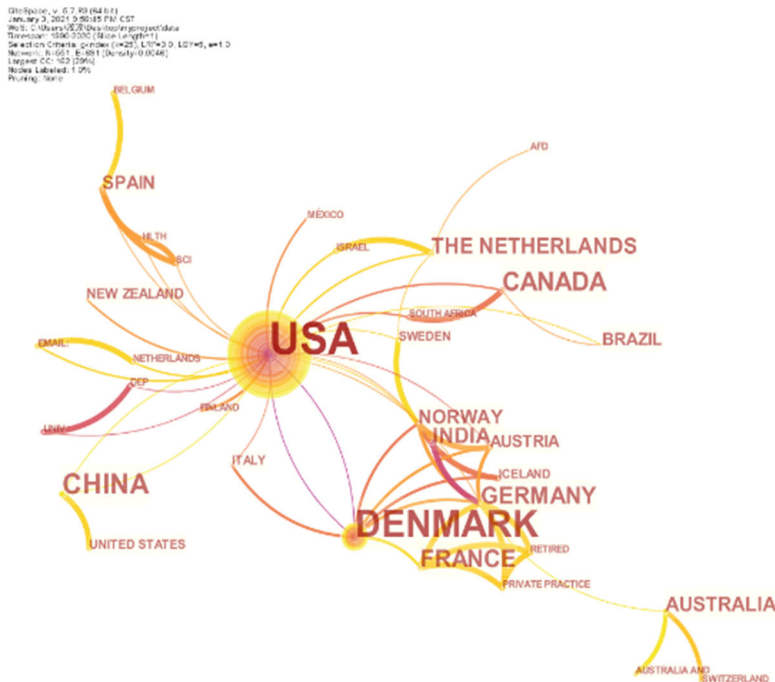


Figure 3. National cooperation network Map of Christmas trees related research

3.3. Institutional Analysis of Christmas Tree Research

CiteSpace software was used for institutional co-occurrence analysis, and the relevant parameters were set as

follows: Time Slicing: 1990-2020; Years Per Slice: 1; Node Types: Institution; Selection Criteria: Top 50; Links Strength: Cosine. The cooperation network map of institutions is shown in Fig. 4. According to the parameters in the upper left corner, a total of 1204 institutions around the world have published

literature related to the Christmas tree, and there are 1140 cooperative relationships among them. According to the distribution analysis of countries/regions, the larger the node in the figure, the more articles published by the institution. The top 10 institutions by the number of publications are Offshore Oil Engineering CO.LTD. (44 articles), Baoji Oilfield Machinery Company [8] (39 articles), Offshore Oil and Gas Research Center of China University of Petroleum, Beijing [9] (37 articles), Department of Forestry (37 articles), Danish Centre for Forest (36 articles), Department of Botany

(34 articles), Chuazhong Oil & Gas Mines of Southwest Oil and Gas Field Company (32 articles), Washington State University Research and Extension Center (32 papers), School of Science, Beijing Jiaotong University (32 papers), INNTEST Company (32 papers). Through these data, we can preliminarily infer that the School of Science of Beijing Jiaotong University has made some achievements in the research of Christmas trees [10]. In addition, you can see the close cooperation between research institutes and universities through the lines in the figure.

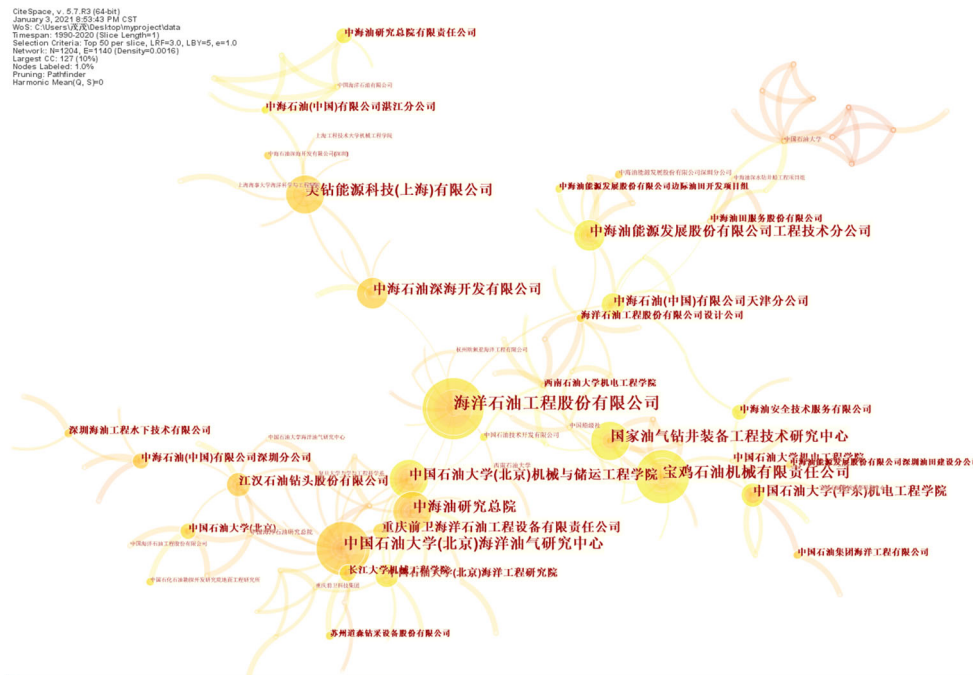


Figure 4. Institutions cooperation network Map of Christmas trees related research

3.4. Journal Analysis of Christmas Tree Research

A total of 722 WOS articles were distributed in 144 journals. The top three publications were SCANDINAVIAN JOURNAL OF FOREST RESEARCH (21 articles,

accounting for 2.909 %) and HORTSCIENCE (19 articles, accounting for 2.909 %). (17 articles, 2.355%). China Petroleum Machinery [11] (75 articles, 10.01%) was the journal with the largest source of CNKI literature, and the top 10 journals and sources are shown in Table 1.

Table 1. Comparison of authentication performance with existing algorithms

Number	Journal name or source	number of publications	percentage (%)
1	China Petroleum Machinery	75	10.01%
2	Oil Field Equipment	50	6.68%
3	Horticulture Week	42	5.61%
4	China University of Petroleum (East China)	35	4.67%
5	Di Huo	30	4.01%
6	China Petroleum and Chemical Standard and Quality	29	3.87%
7	China Offshore Platform	27	3.60%
8	Science News	24	3.20%
9	Harbin Engineering University	22	2.94%
10	Well Testing	21	2.80%

3.5. Author Analysis of Christmas Tree Research

Author analysis was carried out by CiteSpace software, and the network map was obtained as shown in Fig. 5. According to the parameters in the upper left corner, a total of 780 authors around the world published literatures related to Christmas trees, and there were 865 cooperative relationships

among them. The top 10 authors can be found as follows: INVALID(193 papers), ANONYMMOUS (112 papers), Menglan Duan[12] (53 papers), ARNE KIRKEBYTHOMSEN (31 papers), ANSI (30 papers), BRUNNER BERND (29 papers), BSI (28 papers), CLAIRE BIRD (26 articles), Pengju Zhang (25 articles), and COLEMAN MCCLENEGHAN (25 articles).

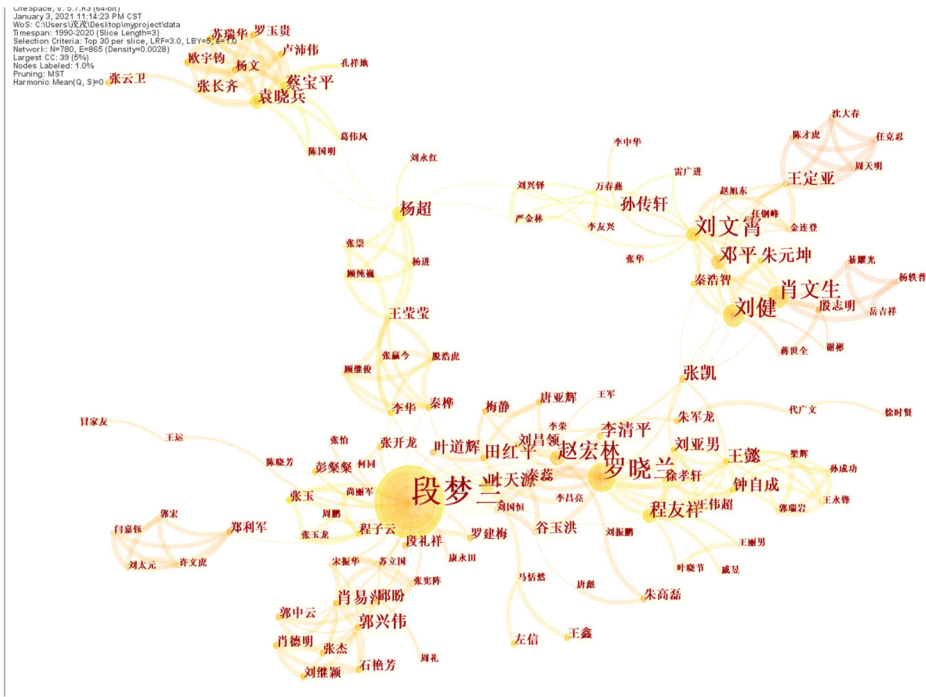


Figure 5. Chinese author cooperation network Map of Christmas trees related research

3.6. Hotspot Analysis of Christmas Tree Research

Each document has 3-5 keywords, which are considered to be the common topic of attention of scholars in this field. The analysis of keywords can find the research hotspots in this field. Keyword analysis in CiteSpace is mainly obtained through co-word analysis. This paper directly analyzes the original keywords of the literature and the supplementary keywords from the database through the Keyword co-occurrence network. At this time, the node type in the main interface of CiteSpace needs to be set as "Keyword". Other parameters are as follows: Time Slicing: 1990-2020; Years Per Slice: 3; Selection Criteria: Top 50; Links Strength: Sliced. After initial analysis of the data, finally set the pruning method to minimum Spanning tree, Pruning Sliced Networks.

In the process of graph pruning, keywords with the same meaning are merged, and the obtained keyword co-occurrence knowledge graph is shown in Fig. 6. There are 67 nodes, 97 connections, and the network density is 0.0439. Each cross node represents a keyword, and the larger the cross node, the more frequently the keyword appears. "Christmas tree" appeared the most frequently, 201 times. Through the connection can explain the correlation of Christmas tree research. The top 20 keywords with frequency are shown in Table 2. It can be seen from the keywords that there are many researches on subsea Christmas tree. As a research hotspot, Christmas tree is also used in the design and test of drilling equipment, and Christmas tree is mainly used in the petroleum industry [13] and natural gas industry [14]. Industry, materials [7], storage, etc.

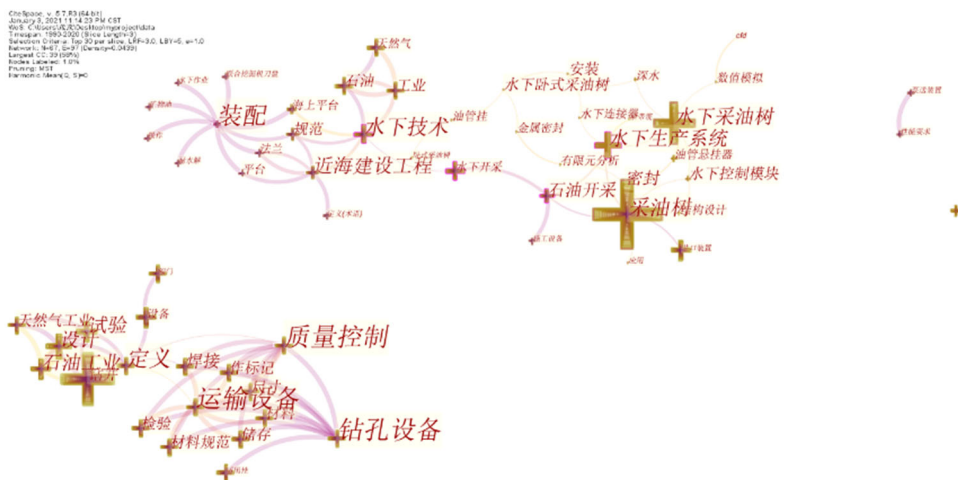


Figure 6. Map of research keywords related to Christmas trees

3.7. Keyword Cluster Analysis of Christmas Tree Research

On the basis of the analysis of the research hotspots of keywords, cluster analysis can also be carried out. Cluster

analysis [15] can analyze the research situation from different perspectives in this research field, and can directly and quickly capture the academic frontier in the field of Christmas tree research. For the time validity of the cluster analysis, the time period of this analysis is: 2000-2020. All keywords are

clustered, and the results show three clusters, as shown in Fig. 7. They are: Christmas tree, subsea Christmas tree, petroleum industry.

Table 2. High frequency keywords of Christmas tree related research

Number	Keywords	occurrence number	centrality
1	Christmas tree	201	0.18
2	Subsea Christmas tree	111	0.12
3	Drilling	92	0.00
4	Design	87	0.01
5	Experiment	81	0.01
6	Equipment	79	0.02
7	Petroleum industry	78	0.01
8	Natural gas industry	77	0.00
9	Valve	72	0.00
10	Petroleum	69	0.02
11	Natural gas	68	0.00
12	Definition	66	0.08
13	Industry	66	0.02
14	Subsea production system	61	0.23
15	Wellhead device	57	0.00
16	Material	56	0.00
17	Applicability	56	0.00
18	Storage	55	0.00
19	Underwater mining	55	0.33
20	Material specification	55	0.00

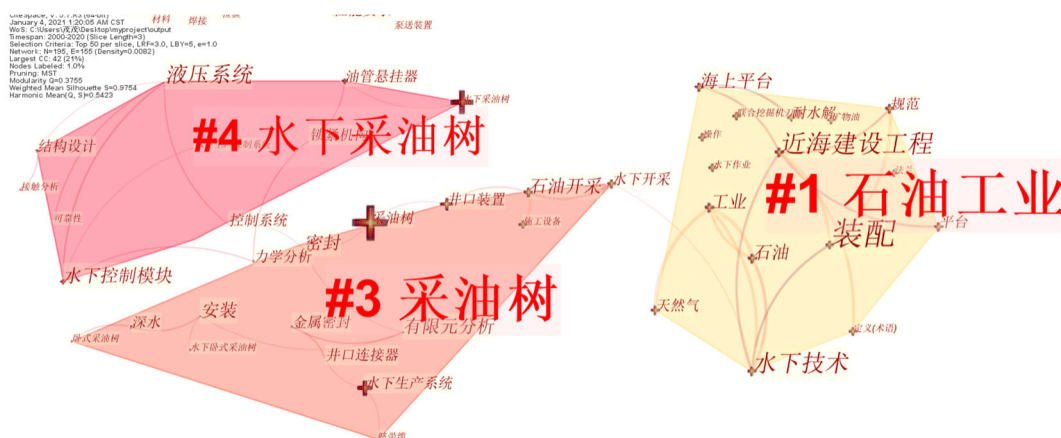


Figure 7. Keywords clustering map of Christmas trees related research

1) Cluster analysis of "Christmas tree" The subject word studied in this paper is Christmas tree, and it is normal to classify "Christmas tree" according to CiteSpace cluster analysis. The main keywords include underwater mining, horizontal Christmas tree, wellhead device, subsea production system, sealing, construction equipment, Christmas tree, subsea horizontal Christmas tree, deep water, installation, wellhead connection, finite element analysis, umbilical cord cable, oil mining, metal sealing.

2) "subsea Christmas Tree" cluster analysis The key words of the cluster named "subsea Christmas tree" mainly include: subsea Christmas tree, tubing hanger, structural design, mechanical analysis, control system, subsea production control system, reliability, hydraulic control, locking structure, contact analysis, subsea control module.

3) "Petroleum Industry" cluster analysis keywords named "petroleum industry" mainly include: flange, assembly, mineral oil, petroleum, industry, underwater technology, underwater operation, definition (terminology), hydrolysis resistance, operation, natural gas, offshore platform, combined excavator cutter head, platform, specification, offshore construction projects.

4. Discussion

4.1. Attention Has Increased and Focusing on Developed Countries

To a certain extent, the number of publications on research related to Christmas trees can reflect the attention of researchers in this field. It can be found that the number of publications in the past decade has increased significantly compared with that before. The number of publications based on WOS peaked in 2016, and the number of publications based on CNKI peaked in 2019. From the analysis of countries/regions related to the study of Christmas tree, the United States, Denmark and other developed countries have more research, and the United States is far ahead of the first. It can be analyzed that the cooperation between countries is also relatively close.

4.2. Petroleum Institutions and Prominent Author

Through visual analysis, we can get the domestic Offshore Oil Engineering CO.LTD., Baoji Oilfield Machinery

Company, Offshore Oil and Gas Research Center of China University of Petroleum(Beijing), Chuanzhong Oil & Gas Mines of Southwest Oil and Gas Field Company such as the upper oil and gas mining siltstones oil has a contribution to the research on the Christmas tree, and can be seen through the attachment cooperation between various agencies is very precise, In particular, the more institutions that publish, the closer the relationship between them and other institutions; Foreign Department of Forestry, Danish Centre for Forest, Department of Botany, Washington State University Research and The Extension Center, INNOTEST Company, and others have also made progress. According to the analysis of the authors of the research on Christmas tree, Menglan Duan from the Offshore Oil and Gas Research Center of China University of Petroleum (Beijing), Xiaolan, Luo, Jian Liu [16-17] and others from the School of Ocean Engineering of China University of Petroleum have done a lot of research, and there are very close connections among the authors, with a total of 4171 connections. Some foreign authors have published a large number of papers but have little correlation with each other.

4.3. Subsea Christmas Tree has Become a New Research Hotspot

Through cluster analysis, three cluster words are obtained: Christmas tree, subsea Christmas tree [18] and petroleum industry. Combined with the annual analysis of the paper, it can be concluded that subsea Christmas tree is a new research hotspot. Both Christmas tree and petroleum industry are relatively traditional research, and some keywords of equipment are relatively scattered and do not form a cluster, but they are also relatively traditional research on Christmas tree. The clustering of subsea production control system, subsea control module and other new keywords in recent years are also worthy of the attention of scholars in subsea Christmas tree research. It is also related to the development of offshore oil and gas extraction.

5. Conclusion

Through the CiteSpace visualization analysis of the research related to the Christmas tree, the research status of this field was obtained and it was concluded that the subsea Christmas tree was a research hotspot in the Christmas tree field. Some scholars' research could rank among the forefront of the world research, but the world influence in the Christmas tree field was still insufficient. The research advantages of major domestic petroleum institutions should be brought into full play to carry out international research in this field and deepen domestic and international research in the field of Christmas tree.

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