Mapping the Research on Gasification to Syngas Production Using Scientometry Analysis from 2007 to 2017

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A complete mapping of the research output of syngas from biomass gasification was developed using the citation data from 2007 to 2017, with the help of Web of Science (WoS) and HistCite, which is a software oriented to determinate the yearly research output, the ranking of countries and institutions according to the total location citation score (TLCS), and the list of journals and articles with the highest mean citations in the field. Results show the significant increase in the number of documents published on gasification for syngas production from biomass, during the studied 11-year period. The country and institution with the highest research output are the Republic of China and the University of Maryland, respectively. The more significant number of articles and the highest TLCS values came from developed countries such as China, USA and Italy, which have more research advantages in this field than developing countries. The top three outputs journals were International Journal of Hydrogen Energy, Fuel, and Applied Energy, being the same top three cited references. Articles published with higher TLCS values had a higher impact in the area of gasification to Syngas Production and played a relevant part in developing research trends in this topic.

1. Introduction

The continuous development of computational tools has dominated the growth in the number of articles and research carried out in recent years, due to this tools facilitate the process of publication and compiling research results, in addition to their compilation through databases (Robinson-Garcia *et al.*, 2017). The study and collection of data on a specific topic are called bibliometric or scientometry, and is commonly used to measure the magnitude of research on any topic of interest (Juliani and de Oliveira, 2016),(Robert *et al.*, 2017). Bibliometric provides a statistical database of scientific works allowing to measure the evolution of number of publications by countries and institutions (Laengle *et al.*, 2017),(Stand *et al.*, 2017),(Sarmiento *et al.*, 2017),(Manotas *et al.*, 2017). This is how library professionals have developed, thanks to current technological facilities, bibliometric methods to explore the impact of any field of knowledge (Hajduk, 2017),(Sempéré, 2017). Many areas of research use bibliometric techniques to examine the implications of their area, making quantitative and statistical analyses to describe publication patterns within a given field (Y. Zhang *et al.*, 2017),(Zhong *et al.*, 2016). Researchers can use bibliometric assessment methods to determine the influence of a single author, to describe the relationship between two or more authors or works, to identify the pattern of publication and authorship, citations used for a subject, articles of most significant impact, etc., over a period of time (Zheng *et al.*, 2017),(C.-C. Zhang *et al.*, 2017),(Waltman, 2016).
Bibliometric can be applied to the area of obtaining syngas from biomass, which has been shown to be a sustainable and viable energy resource. Safer has investigated the most efficient syngas composition to reduce irreversibilities (Safer *et al.*, 2017), as well, Yao has developed a model to facilitate the optimization of the energy and economic viability of gasification systems concerning with biochar and syngas (Yao *et al.*, 2018).
The main contribution of this work is to apply the techniques and computer resources of bibliometric to evaluate the research on the production of Syngas by gasification, quantifying the countries, journals, and institutions of higher study and the quality of scientific articles in the last ten years.

2. Methodology

2.1 Bibliometric Methods

The bibliometric method allowed to reach a complete idea of the research related to syngas production by gasification, based on the representative properties of each article published in the main journals. The bibliometric analysis allowed a systematic treatment to quantitatively analyze scientific publications to detect particular research trends. Nowadays, the definition and application of bibliometric, scientometry and information science have not been delimited, but differences can be identified as explained by several authors (Siluo and Qingli, 2017),(Hood and Wilson, 2001),(Martin-Martin *et al.*, 2016),(Sengupta, 1992).
The bibliometric resources helped to explore, organize and analyze large amounts of historical information from research results, thus improving the identification of hidden trends that supported the decision-making. In this study, the information was obtained from the WoS repository of Thomson Routers, obtaining 278 results that included from each document the title, author, journal, references cited, words, year, type of document, language, institution, and country.

2.2 H Index

Jorge E. Hirch in 2005 proposed the H index as a method to evaluate the performance and footprint of scientists, academics, and the respective institutions, journals, and country, and it is pointed out as the H publications, with H citations for each scientist. The usefulness of this method in this work was to find the documents with the highest quality or impact on a large number of articles. In this article, the H index was used to study different countries, organizations, and journals according to the guidelines outlined above.

2.3 Data sources

The Institute for Scientific Information (ISI) WoS frecuently is used to search for high-quality or hard-to-reach scientific literature through public sources of information. WoS is an essential source of data for any bibliometric analysis, as it allows its users to access a large number of bibliographic databases that are not ordinarily accessible.

2.4 Procedure

The scienciometry study covers from information treatment until the generation of results, is necessary to organize scientist information into four steps to perform the bibliometric analysis correctly, and this procedure can be seen in Figure 1.
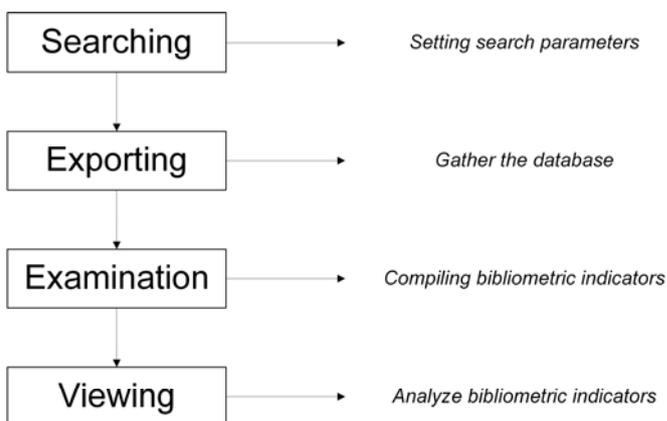

Figure 1: Process for performing bibliometric analysis

In the first step, which corresponds to Searching, the search criteria such as keywords and equations are define, instance in which the source of information its chosen and then the database its downloaded. Subsequently, in the Exporting step, is possible to manage the databases to be transferred to the software Hiscite, where Analysis or Viewing is finally achieved with specific bibliometric indicators.

3. Results and Discussions

The amounts of the annual publications of the eight most productive countries were analyzed as shown in Figure 2. The People's Republic of China has had a remarkable growth in publications from 2007 to 2012, with

a significant decrease in the volume of publications during 2013, although it would again reach its maximum number of publications for 2016, being currently the leader in publications per year uninterruptedly since 2012. On the other hand, the United States had shown a notable decrease in production volume since 2010 until 2015, when it significantly increased in this indicator. Similarly, Figure 2b shows the h-index of each country, where the leading countries, People's Republic of China and the United States stand out. Concerning to Figure 2a, we can appreciate the behavior of knowledge generation in People's Republic of China compared to that generated by the total of the eight countries exposed, where it is evident that from 2011 to 2016 People's Republic of China has shown a constant growth in the publication of articles related to gasification to produce Syngas. The People's Republic of China (56 documents) published the largest number of articles among the eight countries, followed by the United States (41 documents), Italy (24 documents), South Korea (19 documents) and Japan (15 documents).
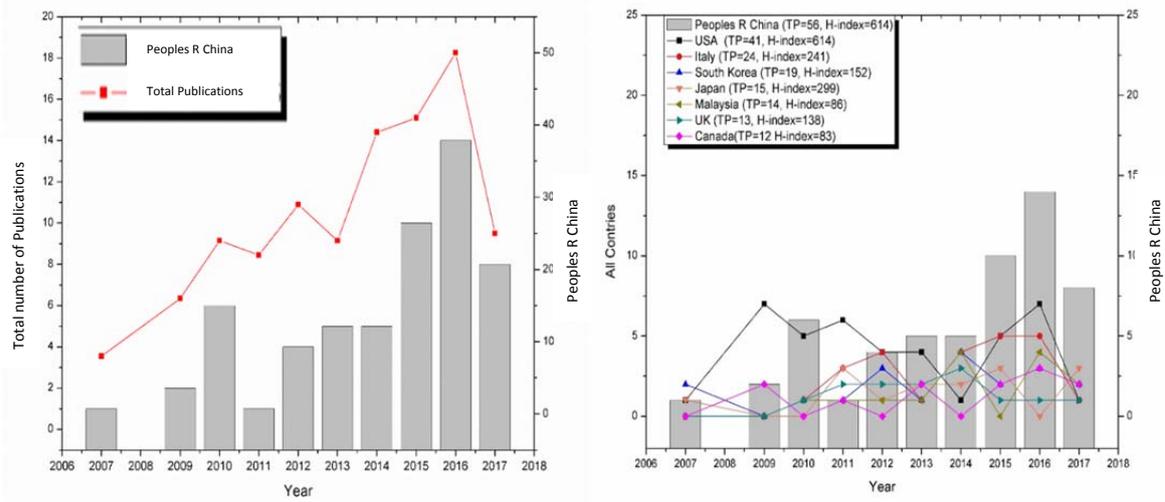

Figure 2: Number of publication, (a) the People's Republic of China, (b) Top eight countries

Figure 3 shows the publication distribution on a world map, representing by color and circle, the number of publications and the impact factor in terms of a local citation indicator for the publications. Regarding a global citation indicator for the eight most productive countries. The United States of America and the People's Republic of China have the highest overall citation scores, 760 and 614 respectively.
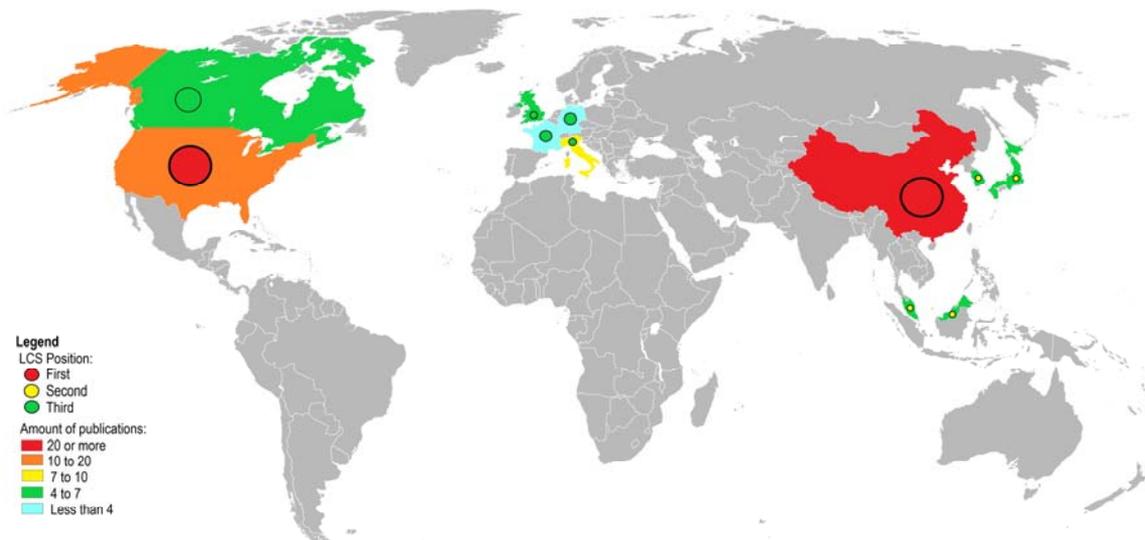

Figure 3: Global distribution of publications

The 92 publications selected in this study from the five most impactful journals are related to fuel, energy, and technology. Figure 4a shows the number of articles published in the top five journals with the most publications over the years from 2007 to 2017, where the notable growth in the volume of publications issued by INTERNATIONAL JOURNAL OF HYDROGEN ENERGY in the last 7 years stands out, with a maximum limit of nine publications associated with the generation of syngas by gasification in 2013. Figure 4b shows the leading performance of the five most productive institutions in research related to the study topic from 2007 to 2017. The University of Meryland ranks first in the ranking, having 3.59% of 278 jobs processed in the search, in turn has the highest overall total citation score with a value of 385. It is followed by the Chinese Academy of Sciences with 2.87% of the works, followed by the Petronas University of Technology with 2.87%. The ranking highlights that 3 of the most important institutions in terms of volume of publications are from the Asian continent and in turn have the highest total citation scores, which shows that although these countries have not had a constant amount of development of scientific work on this subject, they continue to remain at the top of the most cited publications.
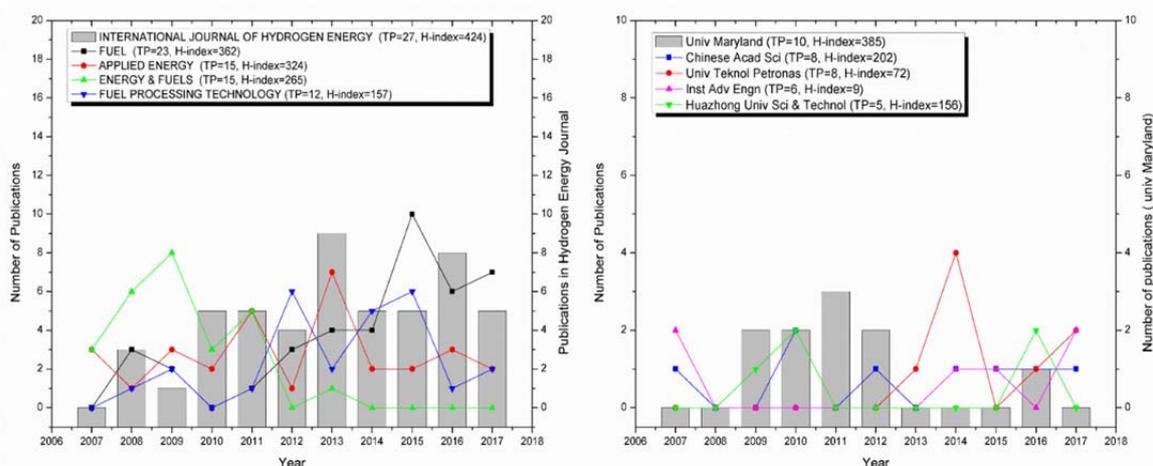

Figure 4: Number of publications, (a) per journal, (b) per institution

Table 1 shows the top ten authors concerning the topic, with their respective number of publication, total local citation score TLCS and total global citation score TGCS. Gupta AK is the author with the highest number of publication, TLCS and TGCS, which evidence the high quality of their research and knowledge in the subject area.

Table 1: Authors with more publications

Author	Recs	TLCS	TGCS
Gupta AK	10	47	385
Ahmed II	6	25	252
Andre RN	6	21	136
Pinto F	6	21	136
Yusup S	6	11	71
Hofbauer H	5	0	29
Lee SJ	5	3	28
Manenti F	5	1	20
Molino A	5	4	83
Nipattummakul N	5	16	199

Table 2 shows the type of documents most frequently consulted about syngas gasification along with the number of publications, TLCS and TGCS in each document type. As is to be expected, the type of document most frequently used for disseminating progress on the subject is the articles, this affirms in a forceful way that this type of document is being the main source of information on the latest advances regarding topics of scientific and engineering interest.

Table 2: Study by sort of document

Document Type	Recs	TLCS	TGCS
Article	206	193	2444
Proceedings Paper	39	7	84
Article; Proceedings Paper	16	22	291
Review	8	11	187
Article; Book Chapter	3	0	2
Meeting Abstract	3	0	0
Correction	1	0	1

4. Conclusions

As result of current government policies in different countries, it is believed that the use and research related to the production of syngas from biomass is increasing significantly. Currently, eight countries contribute predominantly to this research, with production focusing on People's Republic of China followed by the United States, Italy, South Korea and Japan. The research papers were published in journals such as INTERNATIONAL JOURNAL OF HYDROGEN ENERGY, Fuel, Applied Energy, and Energy and Fuels, by the most widely published authors of the University of Meryland and the Chinese Academy of Sciences, which shows that People's Republic of China and east countries greatly promote research on the subject under study.

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