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Scientometric Analysis of Thorium Research in India: a Case Study

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ABSTRACT

In this paper presents the analysis and interpretation of data collected for the identified period. The investigation is a scientometric analysis of research productivity in Thorium and a sum total of 1790 records were global and 310 records were India obtained from the Web of Science for 5 calendar years spanning from 2008 to 2012. The study gives an analytical view of the research literature output in Thorium from India in context of the global scenario by area, language and forms of publications, Publication of journals and Research Institutions.

KEYWORDS: Scientometrics, Bibliometrics, Thorium Literature, Thorium Citation

INTRODUCTION

The present study belongs to general scientific level of methodology and is concerned with scientometric analysis of research literature output in thorium from India. The study is based on research literature as covered by Web of Science, between the years 2008 and 2012 in the context of contributions by the scholars, Research institutions, their geographical location, language of contributions and Publications and the like with a slant to India, as a nation.

OBJECTIVES OF THE STUDY

In this study the Scientometric analysis of the thorium research literature (2008-2012) from India in a global context. Hence, the study aims to collect the global output data in thorium in order to fix up the relative position of India while fulfilling the major objective of identifying the dimension of literature output in thorium research from India. The main objectives of the present study are as follows:

- To find out the quantitative and qualitative aspects of the world literature output in thorium research as found recorded in Web of Science between 2008-2012;
- To identify the country-wise distribution of global thorium literature output;
- To identify the journals with a higher productivity in thorium and their performance during the years under study;
- To identify the quantum of contributions by participating nations in the thorium research and the relative position of India among them;
- To analyse the Indian contributions in thorium research with the objective
- To find out publication productivity of India,
- To find out the highly productive Indian authors and institutions,

The Present Study is undertaken aiming at the Scientometric analysis of thorium research literature output from India facilitating a global outlook.

SCIENTOMETRICS

The immediate precursor to Scientometrics is Bibliometrics. In quicker subsequent sessions, a number of fields with 'metrics' as a suffix in their nomenclature appeared. There are many metric fields that deal with the development and application of measurement in the area. They include Bibliometrics, Scientometrics, Informetrics, Librametrics, and Webometrics. Regarding the etymology of the term 'metrics', Sengupta (1992)1 in one of his papers, stated that the term metrics is "derived either from the Latin or Greek word "metricus" or "metrikos" respectively, each with the same meaning -- measurement". According to J.M. Tague-Sutcliffe (1992)2, "Scientometrics is the study of the quantitative aspects of science as a discipline or economic activity. It is part of the sociology of science and has application to science policymaking. It involves quantitative studies of scientific activities, including, among others, publication, and so overlaps bibliometrics to some extent."

ABOUT THORIUM

Thorium (symbol Th, atomic number 90) is a radioactive chemical element. It is a silvery-white metal at room temperature, but will readily oxidize when exposed to air, and only occurs naturally in oxidized form. Although thorium is not fissile, it can be bred in a nuclear reactor to the fissile isotope U-233, and so has potential as a nuclear fuel source. It is also used as an alloying element with other metals, and is the primary ingredient in gas lantern mantles.

It was discovered in 1828 by the Norwegian mineralogist Morten Thrane Esmark and identified by the Swedish chemist Jöns Jakob Berzelius and named after Thor, the Norse god of thunder. India's Kakrapar-1 reactor is the world's first reactor which uses thorium rather than depleted uranium to achieve power flattening across the reactor core. India, which has about 25% of the world's thorium reserves, is developing a 300 MW prototype of a thorium-based Advanced Heavy Water Reactor (AHWR). The prototype is expected to be fully operational by 2013, after which five more reactors will be constructed. The reactor is a fast breeder reactor and uses a plutonium core rather than an accelerator to produce neutrons. As accelerator-based systems can operate at sub-criticality they could be developed too, but that would require more research. India currently envisages meeting 30% of its electricity demand through thorium-based reactors by 2050.3

Table - 1
Year wise Distribution of Research Literature in Thorium

S. No	Publication Year	World Records			India Records		
		Records	TLCS	TGCS	Records	TLCS	TGCS
1	2008	335	456	2731	63	38	297
2	2009	334	334	2193	56	29	305
3	2010	357	256	1410	68	23	162
4	2011	380	121	713	69	4	60
5	2012	384	32	219	54	3	24
Total		1790	1199	7266	310	97	848

Table 1 displays the year-wise distribution of research productivity in Thorium for a period of 5 years from 2008 to 2012. The total global publication count is found to be 1790 and the maximum output occurred in the year 2012 numbering 384 and this formed 219 Total Global Citation of the total output. The total India publication count is found to be 310 and the maximum output occurred in the year 2011 numbering 69 and this formed 60 Total Global Citation of the total output. It is inferred that the Research literature output in Thorium registered a gradual increase.

Table - 2
Time Series Analysis

S. No	Year	Count (Y)	X	X2	XY
1	2008	335	-2	4	670
2	2009	334	-1	1	334
3	2010	357	0	0	0
4	2011	380	1	1	380
5	2012	384	2	4	768
Total		1790	0	10	144

Straight line equation is applied to arrive at projections for future growth under Time Series analysis. Straight Line equation

$Yc = a + bX$
Since $\sum x = 0$
$a = \sum Y/N = 1790/5 = 358$; $b = \sum XY/\sum x2 = 144/10 = 14.40$
Estimated literature in 2017 is when X = 2017 – 2010 = 7
=358+14.40*7=358+100.80=458.80
Estimated literature in 2020 is when X = 2020 – 2010 = 10
=358+14.40*10=358+144.00=502.00

On the application of the formula of Time Series Analysis and subsequently, from the results obtained separately for the years 2020 and 2015, it is found that the future trend of growth in Thorium research output may take an increasing trend during the years to come. The inference is that there is a positive growth at the global level in research literature output in Thorium.

Table - 3
Distribution of Language of Publications

S.No	Language	World Records			India Records		
		Records	TLCS	TGCS	Records	TLCS	TGCS
1	English	1760	1197	7230	310	97	848
2	German	8	0	4	0	0	0
3	Chinese	7	0	6	0	0	0
4	French	4	0	17	0	0	0
5	Japanese	4	1	1	0	0	0
6	Polish	3	1	4	0	0	0
7	Portuguese	2	0	0	0	0	0
8	Spanish	1	0	4	0	0	0
9	Ukrainian	1	0	0	0	0	0
Total		1790	1199	7266	310	97	848

The above table reveals the language of publications. The research literature output in Thorium during the period of coverage was found to be in 9 languages among which English was predominant with 1760 count form global and 310 for Indian count. Non-English contributions belonging to other 8 languages of the total output forming a single number. English proved to be the lingua franca to the scientific community engaged in Thorium research across the world. There was not even a single one in Hindi.

Table - 4
Source Wise Distribution of Literature of Thorium

S. No	Document Type	World Records			India Records		
		Records	TLCS	TGCS	Records	TLCS	TGCS
1	Journal Article	1571	1041	6219	280	82	729
2	Article; Proceedings Paper	118	100	389	23	14	100
3	Review	38	47	630	5	0	18
4	Editorial Material	20	10	25	1	1	1
5	Meeting Abstract	17	0	1	0	0	0
6	Letter	13	0	0	1	0	0
7	News Item	7	0	0	0	0	0
8	Correction	6	1	2	0	0	0
Total		1790	1199	7266	310	97	848

The above table indicates the document wise distributions of publications of Thorium. Those documents are classified into 8 categories according to the nature of publication. The data from the table revels that most prevalent form of publication is journal article with the global 1571 records and India were 280 records. Note as a source of Proceedings takes second place in the order to the global 118 records and India were 23 records, followed by Review (38 and 5), Editorial Material (20 and 1), Meeting Abstract (17 and 0), Letter (13 and 1), New Item (7 and 0) and Correction (6 and 0). It could be noted from the analysis that authors from the Bhabha Atom Research Centre contributed more in the form of journal article.

Table - 5
Top 10 Global Thorium Research Institutions

S. No	Institution	Records	TLCS	TGCS
1	Bhabha Atom Research Centre	146	104	379
2	Chinese Acad Science	47	60	258
3	Russian Acad Science	46	31	79
4	Unknown	34	5	11
5	Los Alamos National Lab	29	24	149
6	Gazi University	24	36	66
7	University of California	21	13	93
8	Woods Hole Oceanoq Institute	20	33	166
9	CNRS	18	8	101
10	University of Notre Dame	18	29	142

The above table provides the types of institutions in Global, where from the contributions originated. It is found from the table that, 146 publications were from Bhabha Atom Research Centre, followed by 47 publications from Chinese Acad Science and 46 publications form Russian Acad Science.

Table - 6
Top 10 India Thorium Research Institutions

S. No	Institution	Records	TLCS	TGCS
1	Bhabha Atom Research Centre	146	64	379
2	Indira Gandhi Centre for Atom Research	17	7	34
3	Aligarh Muslim Univ	14	4	76
4	Indian Institute of Technology	9	3	78
5	National Institute of Technology	8	3	33
6	Shivaji University	8	1	12
7	BARC	6	1	5
8	Atom Minerals Directorate Explorat & Research	5	1	10
9	Jiwaji University	5	4	45
10	University of Kerala	5	1	15

The above table provides the types of institutions in India, where from the contributions originated. It is found from the table that, 146 publications were from Bhabha Atom Research Centre, followed by 17 publications from Indira Gandhi Centre for Atom Research and 14 publications form Aligarh Muslim University.

Table 7
Productivity Based Ranked Order of Countries

S. No	Country	Records	TLCS	TGCS
1	USA	342	289	2180
2	India	310	175	848
3	Germany	167	103	814
4	Peoples R China	138	127	935
5	France	134	126	871
6	Russia	108	48	228
7	Japan	99	61	329
8	UK	87	65	764
9	Turkey	79	99	360
10	Brazil	59	34	154

The above table reveals that Productivity Based Ranked Order of Countries in Thorium research literature. It is found that the results of research in Thorium literature output originated from top 10 countries of which USA ranked first forming 342 Records of the total publication count. Second in the ranked order was India with 310 Records.

Table 8
Top 10 Thorium Research Journals in Global Wise

S. No	Journal	Records	TLCS	TGCS
1	Journal of Radio analytical and Nuclear Chemistry	123	71	290
2	Inorganic Chemistry	49	91	375
3	Annals of Nuclear Energy	45	34	86
4	Radiation Protection Dosimetry	40	10	55
5	Journal of Environmental Radioactivity	37	37	186
6	Radiochimica Acta	37	25	97
7	Journal of Nuclear Materials	34	40	123
8	Applied Radiation and Isotopes	31	36	149
9	Journal of Hazardous Materials	26	58	313
10	Earth and Planetary Science Letters	24	19	198

The cumulated records for the 5 years period revealed that, out of a sum total of 514 journals which published the Thorium research output, 10 journals formed the core list. Among the journals, it was the Journal of Radio analytical and Nuclear Chemistry stood first with 123 papers with the Total Global Citation Score was 290. Second in the ranked order was Inorganic Chemistry with 49 Papers, next by Annals of Nuclear Energy with 45 papers.

Table 9
Top 10 Thorium Research Journals in India

S. No	Journal	Records	TLCS	TGCS
1	Journal of Radioanalytical and Nuclear Chemistry	38	13	83
2	Asian Journal of Chemistry	12	0	2
3	Atomic Spectroscopy	12	2	14
4	Radiation Protection Dosimetry	11	0	7
5	Journal of Nuclear Materials	10	3	30
6	Radiochemical Acta	10	3	15
7	Desalination and Water Treatment	8	2	5
8	Journal of Hazardous Materials	8	4	69
9	Annals of Nuclear Energy	7	2	12
10	Desalination	7	6	41

Out of a sum total of 120 journals which published the Thorium research output in India, 10 journals formed the core list. Among the journals, it was the Journal of Radio analytical and Nuclear Chemistry stood first with 38 papers with the Total Global Citation Score was 83. Second in the ranked order was Asian Journal of Chemistry and Atomic Spectroscopy with an each 12 Papers, next by Radiation Protection Dosimetry with 11 papers.

Table 10
Distribution of Top 10 Authors

S. No	Author	Records	TLCS	TGCS	World Rank	India Rank
1	Manchanda VK	26	18	69	I	I
2	Acir A	18	34	40	II	
3	Godbole SV	18	11	38	III	II
4	Aggarwal SK	17	17	64	IV	III
5	Dacheux N	15	30	82	V	
6	Pathak PN	15	8	28	VI	IV
7	Albrecht-Schmitt TE	12	24	137	VII	
8	Andrews L	12	22	110	VIII	
9	Kumar A	12	16	34	IX	V
10	Misdaq MA	12	9	14	X	

The above table provides the list of authors in a ranked order based on authorship share when their collaboration also is taken into account against just the incidence frequency of their (author) names. Manchanda VK, who participated in a maximum of 26 publications and placed in the first rank (global and India) according to author name frequency, Acir A, with a publication count of 18, who were originally in the second rank in global and Godbole SV with a publication count of 18, who were originally in the third rank in global and second rank in India.

CONCLUSION

The study revealed a positive growth in Thorium research in India, though the annual turnover counts seemed small in the context of large Science Education system and available vast workforce. In the context of Indian Research Manpower and the development of Science and Technology India earning its leadership qualities in Research & Development in the Asia Pacific region, the quantum of publications output from India. India has miles to go but in a fast track. Exploring and exploiting the full potential for high level research and existing manpower for research, sure, India will have to achieve the crowning glory even earlier than 2020.

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