Summary of Statistics of Papers published in Volume 23 (2005) of DRYING TECHNOLOGY-An International Journal

Statistics compiled and analyzed by Wu Zhonghua, PhD student, ME Dept., NUS, Singapore.

Total count of peer-reviewed papers published in 12 issues of Year 2005: 150; Impact factor: 0.987

1 Paper Statistics by Region and Countries

1.1 Paper statistics by region

Table 1 Statistics of papers by region

Total count of papers : 150						
Asia	Europe	North America	South America	Middle east	Africa	Oceania
43	**51**	**11**	**22**	**10**	**1**	**12**

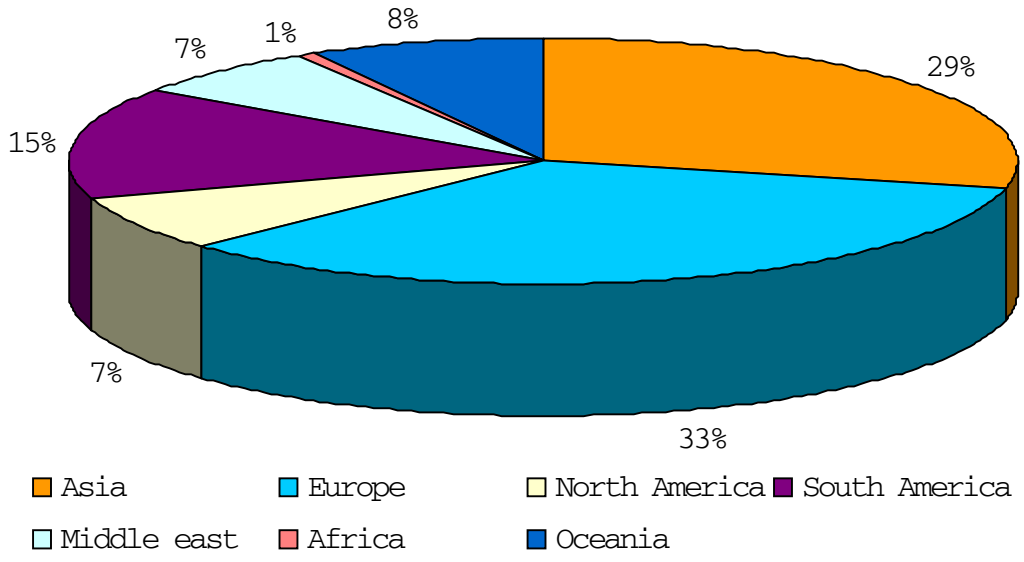


Figure 1, Percentage of contributed papers from different regions

1.2 Paper statistics by countries of origin

Table 2 Statistics of papers by country of origin of first author

Position	Number of papers	Countries
1	15	Brazil
2	13	P.R. China
3	12	Poland, Japan
4	7	Canada, New Zealand
5	6	France
6	5	Sweden, Singapore, Thailand, Australia
7	4	Finland, UK, Iran, Greece, America
8	3	Spain, Chile, Germany, Portugal
9	2	South Korean, Turkey, Argentina, Hong Kong, India, Jordan, Oman, Kuwait, Nicaragua
10	1	Belgium, Bulgaria, Cameroun, Cyprus, Indonesia, Ireland, Mexico, Nicaragua. Russia, Malaysia

2.0 Paper distribution by research topics

Table 3 Statistics of papers published in vol. 23 of Drying Technology (2005) by research areas

General research area	**Specific area**	**Number of papers**
Review: current and future trends		**7**
Theory, fundaments		**20**
Modeling and simulation		**33**
Process control		**5**
Energy and resources savings		**4**
Product quality		**11**
Drying or dewatering of different materials	Food, Agricultural products and Biomaterials	**58**
	Chemicals and Minerals	**3**
	Textiles, Paper and Wood	**9**
	Ceramic, Soil, Building materials and Waste sludge	**7**
Drying equipment		**5**
Drying technologies	Spray drying	**12**
	Microwave drying	**10**
	Superheated steam drying	**6**
	Fluid bed drying	**7**
	Freeze drying	**9**
	Spouted bed drying	**8**
	Infrared drying	**2**
	Vacuum drying	**1**
	Other (EHD, heat pump, etc)	**5**

2.1 Paper statistics by general research themes

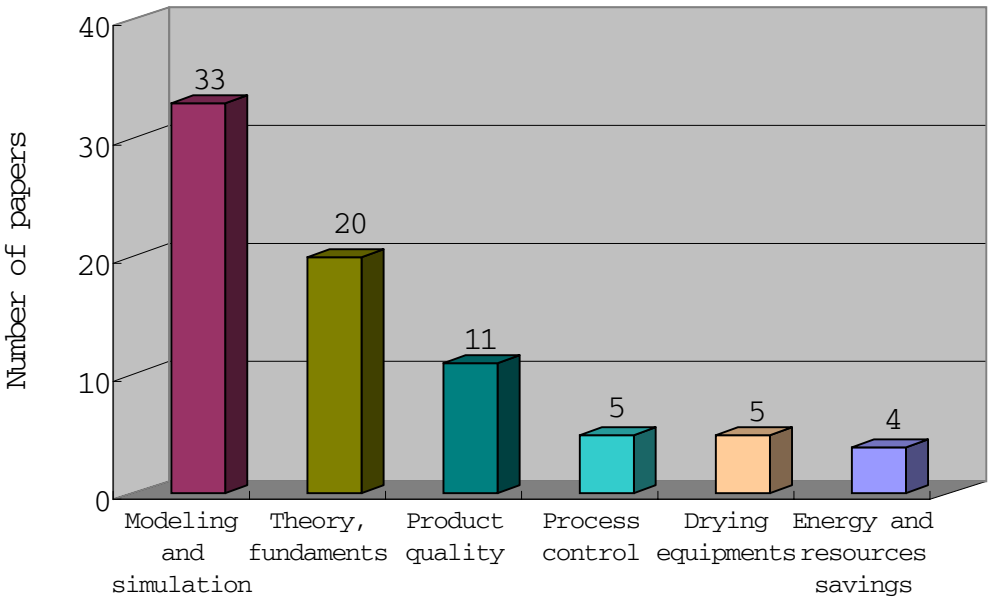


Figure 2 Number of papers in various thematic research areas (DRT,2005)

2.2 Paper statistics according to type of product dried

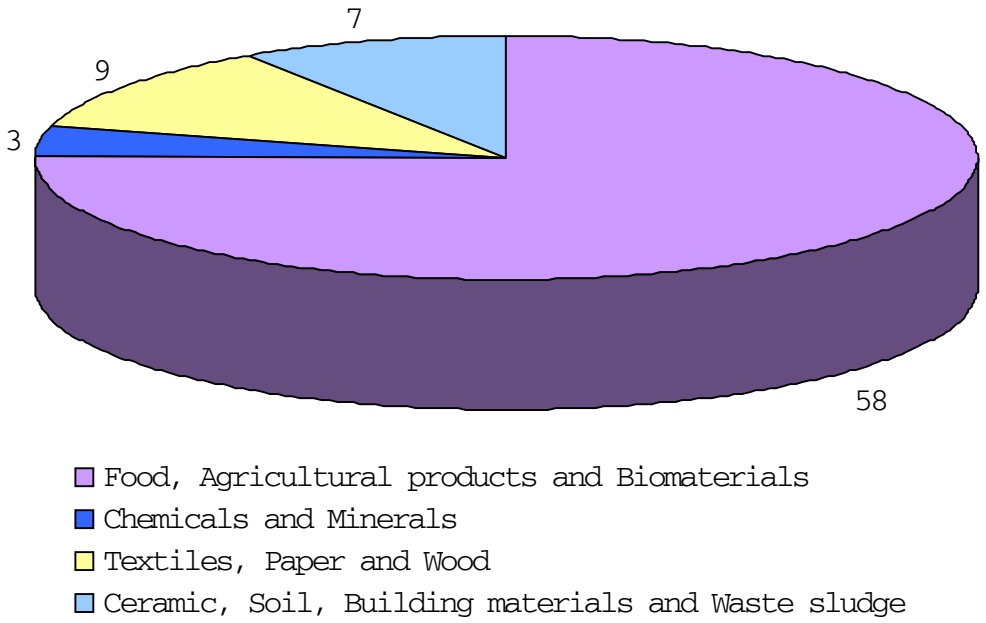
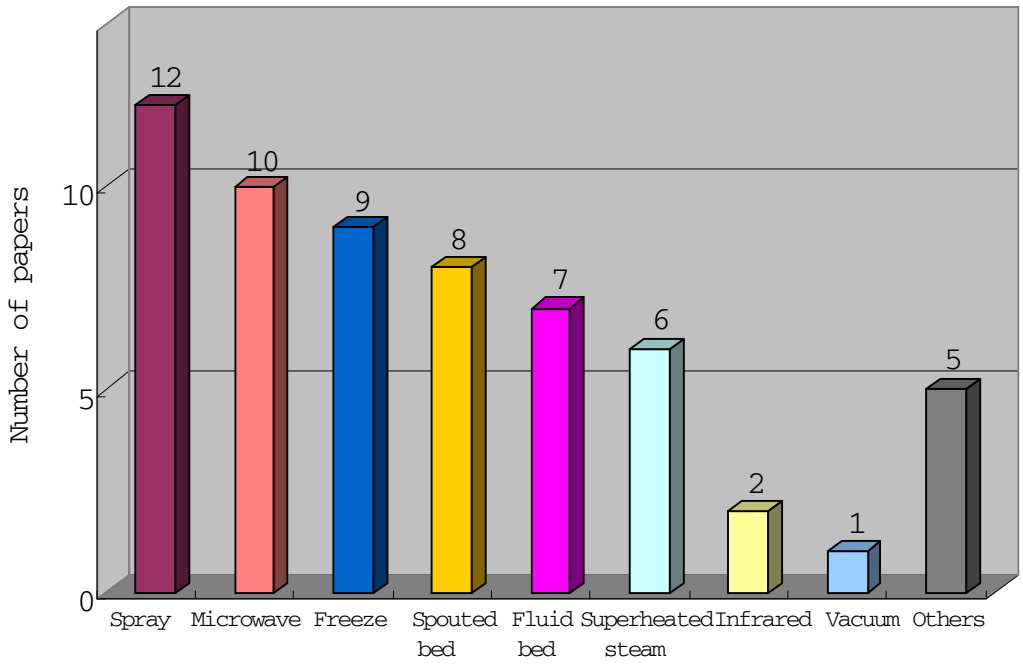


Figure 3 Number of papers on drying of different materials (DRT,2005)

2.2 Paper statistics by specific research topics- drying technologies (DRT,2005)



4 (a) Distribution of papers according to dryer type

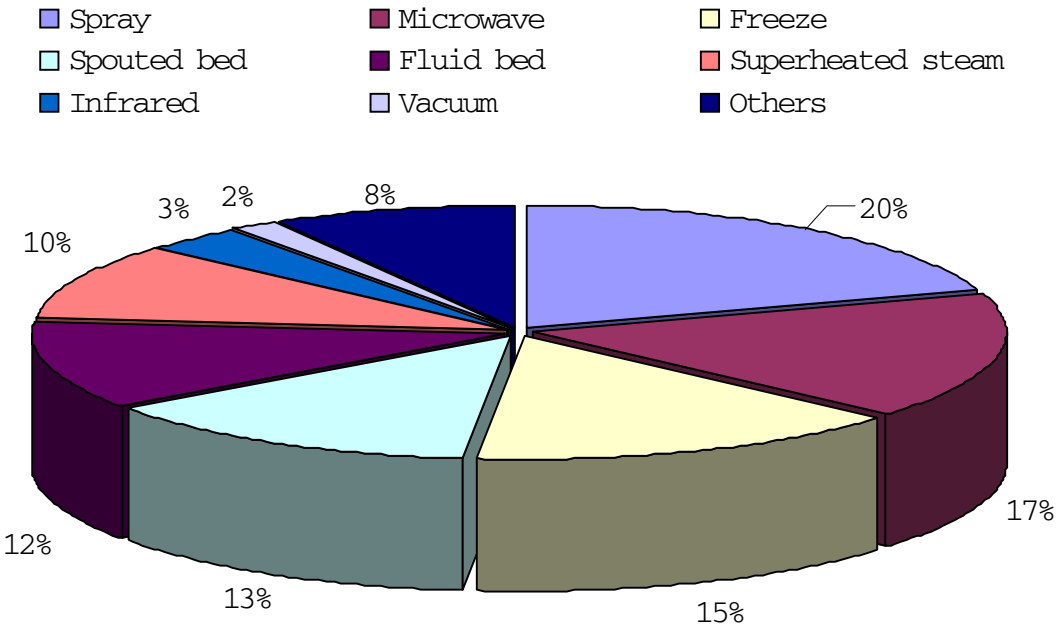


Figure 4 b Distribution of papers according to dryer type

1.3Research interests of countries with active R&D in drying (DRT, 2005)

Table 4, Papers published in DRT, 2005, distribution by countries and research areas

Research areas	Countries & Number of papers
Theory, fundamentals	New Zealand (5)
Modeling and simulation	Poland(4), Chile (3), France (3), Singapore (3)
Product quality	Brazil (2), Poland (2)
Drying and dewatering of foods, agricultural products and biomaterials	Brazil (8), P.R.China (8), Poland (5), Australia (4)
Drying of textiles, wood and lumber	Sweden (4)
Drying of ceramics, soil, and building materials, waste sludge, etc	Japan (3)
Spray drying	Poland (3)
Microwave drying	Japan (3)
Superheated steam drying	Japan (3)
Fluid bed drying	Brazil (2), Chile (2), Poland (2)
Spouted bed drying	Brazil (3), Thailand (2)
Freeze drying	Hong Kong (2)

1.3.1 Brazil

The research interest is focused on drying of foods, agricultural product and biomaterials, fluid bed and spouted bed drying, and product quality. High level of activity in universities.

1.3.2 P.R.China

Practical drying technologies for foods, agricultural and biomaterials appears to be the main research interest in P.R. China

1.3.3 Japan

R&D in Japan appears to devote more effort on drying of building materials using microwave and superheated steam drying technology. (based only on DRT,2005)

1.3.4 Poland

Research in Poland dealt with drying of foods, agricultural and biomaterials, spray and fluid bed drying- wider assortment of technologies and products.

1.3.5 Sweden and New Zealand

It was interesting noted that Sweden and New Zealand have more contributions on drying of wood and paper and theoretical studies on drying, respectively.

==========

Overall observations

The following observations are not generalizations since the sample size is too small in almost all cases to make any conclusive statements. Readers are cautioned to view the statistics with this in mind.

It appears that drying R&D activity in the public domain in North America has declined substantially over the past decade. Indeed, in 2005 there was no paper from USA (and just one from Russia) out of the 150 papers published in volume 23 of Drying Technology. IDS2002 and IDS2004 also had very few contributions from academics in the USA and fewer than has been the norm from Canada. Since Professor Mujumdar moved from Canada to Singapore the Canadian

contribution to drying R&D shows a distinct and clear decline. Relative to its southern neighbour, Canada still makes a discernible contribution to the world literature on drying. It is likely that much of drying R&D in USA is now carried out by industry and is therefore not in the public domain. Many of the active researchers in US universities may have retired but their successors have not continued in the field. Proactive effort is needed to get young academics to undertake challenging engineering science based research on challenging interdisciplinary problems of drying. The advent of areas like bio-nano-info has clearly make a dent in drying R&D in US academia.

Drying activity in South America, particularly in Brazil, shows a sharp rise; on the other hand Mexico also shows a sharp decline in drying activity. In fact it has been very active for over two decades but much of their research appeared in local journals in Portuguese. Likewise, Asian countries are increasing activity in drying R&D. Much of Chinese literature on drying is still published mainly in Chinese language journals and hence is inaccessible elsewhere. India is the latest entry in drying R&D which seems to correlate will with a rise in economic and industrial activity. It is expected to make more contributions in this area over the coming decade. It seems that a decrease in drying R&D reflects achievement of a state of maturity of industrial development. Rapidly developing economies seem to recognize the need and role of drying technologies in various industrial sectors. Thus, China, India, Brazil etc as rapidly emerging economies and Australia, Canada, and New Zealand as countries with strong commodity markets will lead in drying R&D in coming years.

R&D in newer areas e.g. nanomaterials, biotechnology products etc has yet to take off in a measurable way. Academic research seems to be well ahead of industrial operations as many of the newer ideas have yet to penetrate the market. Superheated steam drying technologies seem to be making a major comeback especially with the rise in energy costs which will likely continue over next decade as major population areas such as China, India, Brazil, Indonesia, Iran etc will raise their standard of living and extend their energy requirements to sustain it. Developing countries can leapfrog and directly embrace newer, more efficient drying technologies rather than use older hot air drying technologies if a suitable superheated steam drying or indirect drying technologies are available to them. This has already happened in the case of wood drying kilns; USA and Canada were among the last countries to use the highly efficient and effective vacuum steam drying kilns for timber drying because of heavy prior capital investments in conventional hot air kilns; many developing countries have already installed such dryers in their operations. This type of leapfrogging has already occurred in other industries e.g. mobile phones have flooded the Indian and Chinese markets while the conventional land-line based telephone service was never widespread in these countries. Lack of prior development has its own benefits!

With rising cost of energy (costs rose 50% during just six months in the USA) it is likely that drying R&D will get a shot in the arm and US industry will examine their drying operations carefully to save energy and reduce greenhouse gas emissions. If carbon tax is implemented universally then thermal drying will definitely be a unit operation to watch. However, unless industry makes a tangible contribution to drying R&D of which it is the main beneficiary. It is unlikely academics will rush into solving their drying-related problems; firstly they are unaware of the specific needs and secondly because no other agencies will subsidize R&D needed by industry. Also, further R&D is likely to take place in use of renewable energy, particularly solar energy, in large scale drying operations where insolation levels justify such applications.

Finally, an important point to note is that, as the looming energy crunch and oil shortages will boost worldwide production and utilization of the vast coal reserves, the need for drying of coal will drive R&D in this area which has been ignored for a long time. Use of superheated steam to dry products like coal, wood, paper, foods, pulp, sludges etc on large scale will come back in vogue simply because there will be no alternative competing technologies that can save energy while offering other major advantages.

Readers are welcome to write to Dr. Arun S. Mujumdar (mpeasm@nus.edu.sg) their thoughts on the simple statistical analysis presented here.

Wu Zhonghua
Department of Mechanical engineering
National University of Singapore
SINGAPORE

October 19, 2005