

PREFACE

CHEMICAL ENGINEERING IN BRAZIL: A GROWING PRESENCE IN THE COUNTRY AND IN THE WORLD

The number of papers published by the Brazilian scientific community in all fields and indexed by the ISI (*Institute of Scientific Information*, Philadelphia, USA) has steadily increased since 1981. It is of interest to compare the evolution of the number of publications for different countries and in different fields. For this purpose, the ISI's National Science Indicators Database – NSI was used. The NSI is a database of summary publication and citation statistics for the period 1981-2002 that reflects research performance in over 170 countries classified into 105 separate fields in the sciences, social sciences, arts and humanities.

Brazil's share of world science papers has grown from less than 0.50 % of ISI-indexed papers published during 1981 to 1985 – or roughly 11,100 papers – to 1.32 % of the database, or about 48,500 papers, in the most recent 5 year period (1998-2002). Thus, Brazil has increased its position in the world publication statistics from 28th to 18th place in 21 years. If we consider the growth rate in the period 1981-2002 for the 22 countries that had a greater than 1 % share in the most recent 5 year period, Brazil's performance is even more outstanding. Brazil's 4.4 fold growth rate is the fifth largest, exceeded only by South Korea (33.1), Taiwan (13.6), China (8.9) and Spain (4.7). The need to sustain and, if possible, increase this effort is obvious considering the figures presented here.

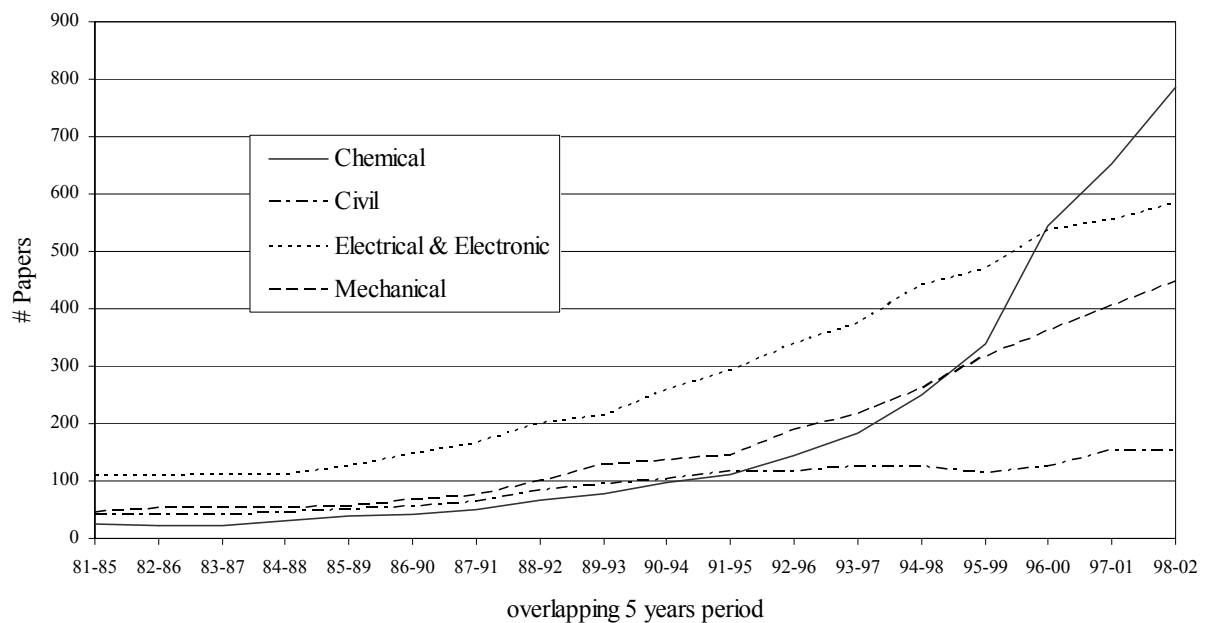
Another interesting aspect is the contribution of each field within the countries. Of the five countries above with the fastest growth rate, the profiles of Brazil and Spain are the most similar to the average world distribution. South Korea, China and Taiwan, in contrast, have above average contributions from fields like engineering, chemistry and materials science relative to the world average.

Within a country, the evolution of the various fields can be assessed by comparison of the relative growth rate of the field. In the case of Brazil, the growth rate of 30.2 for chemical engineering is by far the highest. The next closest field is materials science, with a growth rate of 20.9. Table 1 presents the growth rates for the top five fields. Figure 1 summarizes the evolution of the number of papers published in the four consolidated engineering specialties in Brazil: Civil, Mechanical, Electrical and Chemical Engineering.

Table 1: Number of papers published in 1981-1985, 1998-2002 and growth rate of the top five growth rate fields in Brazil.

Field of Knowledge	Papers published 1981-1985	Papers published 1998-2002	Growth rate
Chemical Engineering	26	786	30.2
Materials Science	76	1,586	20.9
Anesthesia and Intensive Care	7	124	17.7
Hematology	8	133	16.6
Dentistry and Oral Surgery	39	617	15.8

Figure 1: Evolution of the Number of Brazilian Papers Published per Main Engineering Field in overlapping 5 years periods



The enormous rate of growth of chemical engineering in Brazil is not a world tendency. When growth rates in chemical engineering are analyzed by country, South Korea is found to be in first place (34.6) followed by Brazil (30.2), China (26.3), Taiwan (13.3) and Spain (7.9). Thus, Brazil has the second largest growth rate, very close to South Korea. Moreover, these top performances are very different from those in other countries.

What then are the factors or circumstances responsible for this remarkable performance of chemical engineering in Brazil? Consolidation of a critical mass in the field and the effect of indexing of Brazilian journals by ISI can only partially explain this performance. Although there was a sharp increase in the total number of faculty in the eighties, this has stabilized in 2001 at approximately 370 professors distributed in 19 graduate programs. In this context, it is worth noting that chemical engineering is still the smallest of the four consolidated engineering fields. The Brazilian Journal of Chemical Engineering is the sole Brazilian engineering journal in the ISI database. Although the indexing of this Journal by ISI as of 1999 is very important, this alone does not explain the performance. Indeed, the annual share of Brazilian indexed articles published in this journal has fallen steadily from 37% in 1999 to 27% in 2002 as a direct result of the increase in the number of papers published in international journals.

There are at least three noteworthy historical and behavioral aspects that have made significant contributions to Brazil's present situation in this field:

1. From the late sixties on, the graduate programs were conceived on a very modern basis if compared with other programs in the country; this new model was inaugurated by COPPE - Coordenação de Programas de Pós-Graduação em Engenharia, Rio de Janeiro.

2. The existence of research funding instruments or agencies that have provided continuity of support for research and development in chemical engineering (including international agencies such as the World Bank, the Brazilian Federal government and state funding agencies, notably FAPESP in São Paulo state).
3. In the eighties, the increasing number of graduate programs created the conditions for a virtuous competition.
4. The emergence of a very articulated and demanding community that has come together to create opportunities and mechanisms, such as The National Meeting of Chemical Engineering Education – ENBEQ, to discuss and develop research and education.

Continued growth in chemical engineering in Brazil will require constant innovation and continued efforts to improve quality coupled with judicious investment of resources in technology development via, for example, the Sectorial Funds. Nevertheless, in the final analysis, it is up to each and every one of us, the individual members of the research community in chemical engineering, to rise to the challenge of transforming the best of our science into technology for the 21st Century.

AUTHORS:

Dr. Luiz Valcov Loureiro,

Chemical Engineering Department,
University of São Paulo – USP,
E-mail: valcov@usp.br

Professor Claudio Augusto Oller do Nascimento,

Chemical Engineering Department,
University of São Paulo – USP,
E-mail: oller@usp.br

Professor Ronaldo Nóbrega,

Graduate Program on Chemical Engineering, COPPE,
Federal University of Rio de Janeiro – UFRJ,
E-mail: nobrega@peq.coppe.ufrj.br