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# THE FUTURE OF THERMAL ANALYSIS

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ABSTRACT

It is well recognized today that materials characterization plays a key role in research, development and manufacturing. For this reason, thermal analysis came into the forefront of interest. The application of thermal analysis spread rapidly from traditional areas of inorganics to organics, including the immense field of polymers, and now it is broadly used in biology, medicine and agriculture. The future depends mainly on the availability of well educated and trained specialists. This lecture addresses, among others, the following questions: Are we sufficiently prepared to satisfy the worldwide demand for thermal analysts? Are we doing the necessary steps to fill the gap between demand and supply? What is (and what should be) the role of universities and societies with local, regional, national and international participation? Interaction with the industry, government institutions, international organizations (such as UNESCO and UNIDO) and other potential sources of financial, promotional and organizational assistance is discussed. It is shown how important it is to increase coordinated efforts at national and international levels. Suggestions are presented for setting priorities to achieve immediate and long-term goals in reducing the alarming shortage of thermal analysts.

## INTRODUCTION

In modern society, there is a cause-effect correlation between the level of education and technical development. On the one hand, highly educated and skilled professionals accelerate technical development; on the other hand, advanced technology demands more and more highly educated people. This rule applies also to thermal analysis and to the broad field of materials characterization.

In the second half of this century a population explosion occurred. (In China alone, the growth is 33000 each day!) This led to global efforts to better utilize the natural resources of food, energy, clothing and other basic necessities, and to develop and produce immense quantities of new, man-made materials for the increased consumption. In order to enhance productivity and improve the quality of both new and old materials, it became imperative to determine and optimize their properties. Hence materials characterization gained decisive importance in the technology of the 70's and 80's.

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Thermal analysis is one of the most versatile techniques, almost universally applicable in materials characterization. A method once applied almost exclusively for inorganics, it is now used for all kind of materials, and predominantly for polymers. As is well understood, heat is a form of energy contained in every material. In nature, practically everything is heated or cooled, i.e. the energy content changes. With the help of today's sophisticated instruments, these changes in thermal energy can be measured. The interpretation of the thermal changes allows a rapid, accurate, meaningful and comparatively inexpensive characterization of material properties. Thermal analysis is now needed for the industry, agriculture, biology, medicine - for almost every area of technology. The question is: are enough thermal analysts available to do the job? Unambiguously, the answer is no. This paper offers an overview of the present situation, and some suggestions for immediate and long-term programs.

DISCUSSION

a) Present Status

The Bratislava Workshop at the 8th ICTA (1985) issued a report(1) on the education of thermal analysts in twelve countries: Canada, Czechoslovakia, Finland, France, FRG, GDR, Hungary, Japan, Poland, Switzerland, U.K. and U.S.A. In summary, the report concludes that in most countries the thermal analysis education is inadequate. The primary responsibility for training thermal analysts rests with institutions of higher education: universities and colleges. Typically, these institutions have no special thermal analysis courses in the undergraduate curriculum. The subject may be incorporated briefly in the courses of general, analytical or physical chemistry, but formal education in thermal analysis, if any, is offered only to a very limited number of graduate or other students with special interests. There is no uniformity in course material, even among institutions in the same country. The schools usually differ in their teaching objectives as well as in the availability of instruments. The latter is one of the major factors that may limit the extent of training even if qualified teaching staff is available.

There were some exceptions reported. For example, in Japan, methods of thermal analysis are taught at all universities and technical colleges(2,3); in the U.S.A., an innovative audio course was developed providing primary and continuing education(1).

However, the general educational situation at the 8th ICTA was rather bleak. Mainly for this reason, a decision was made to organize an ICTA Education Committee for promoting globally the education of thermal analysts. Members were invited from different parts of the world, short- and long-term goals were set and the work was started. In 1987, this author submitted a report to the IUPAC "Committee on the Teaching of Chemistry"(4) on developments that took place during the years after the 8th ICTA. It emphasized the important role that universities and professional associations of thermal analysts - from local and regional groups to national and international societies - can and should play in complementing the limited education offered by schools. Obviously, the contribution of the societies is vital because their members are scientists who actually practice thermal analysis and already have developed certain expertise. Thus, a group of expert professionals is readily available to give lectures, publish papers, exchange information and teach colleagues who left school without any education in thermal analysis. A leading educator noted in 1975 that more than half of the chemists were involved (at that time) in polymer research(5). This number did not even include those working in development and production. Today, the proportion should be much higher. Literature reviews show that the majority of thermal analysis publications is not anymore related to inorganics, but it is distinctly and constantly shifting toward organics, and particularly toward polymers. This fact has to be kept in mind when the future of thermal analysis, the future of thermal analysts and their education is considered.

Recent experience in Brazil shows a good example of healthy interaction between government, the institutes of higher education, and associations or groups of scientists. In October 1987, upon the suggestion and with the support of the ICTA Education Committee, the Macromolecular Institute in Rio de Janeiro organized the 1st ETA (Thermal Analysis) Conference Course in Brazil(6). The week-long event attracted an enthusiastic audience of 112 professionals, many of them novices in our area. Six thermal analysis groups were formed to cover the various regions of that huge country. They are busy now in promoting the 2nd ETA Conference scheduled in Sao Paolo for October 1989. The

organizers will invite the participation of thermal analysts from all over South America.

In order to evaluate present and future sources of support for the education and training of thermal analysts, it is necessary to deal briefly with the role of the industry, government and international organizations (such as UNIDO, UNESCO, etc.), and with the availability of textbooks and other educational material.

Industry. Managers of industrial research and production are the first to feel the heat because of the lack of much needed materials scientists. The industry has to do more than what it is doing, but certainly it made already some contributions. More and more industrial chemists are assigned to attend thermal analysis courses, lectures, and some larger companies sponsor in-house presentations. In its own interest, the industry will increase its support for basic and continued education, and for the training of its technical staff in thermal methods.

Government. Academic institutions and professional societies seek and may receive funds from their government, or less frequently from international organizations. Individual government departments, agencies, or government-financed institutions (such as the National Science Foundation in the United States) support basic or advanced training as well as targeted projects.

Publications. Information dissemination is a top priority. There is no need to elaborate how basic is the aid given both to educators and students by well written, up-to-date textbooks, reference books, manuals, audio courses as well as periodicals, society newsletters, conference proceedings, etc. Progress is made both in the quality and quantity of publications, but much more improvement is needed.

At the present, the education of thermal analysts is in its development phase. Many schools, responding to the demand, seek ways and means to introduce, or improve thermal analysis education. Membership of our societies is increasing, and more local groups were born. New instruments were produced to measure further properties by thermal methods, and laudable efforts were made to introduce simple, inexpensive thermal analytical instruments affordable by the schools.

Altogether, a moderate progress can be recognized. Much more has to be done. Among all the sponsors and promoters of the

thermal analysis education, the scientific community has to take primary responsibility in defining the programs that help to fulfill the ambitious goal of having as many well trained and educated thermal analysts as many are needed by the economy. It is our own future that is at stake.

b) Short-term projects

1. It is very urgent to update and upgrade the education of professionals who already use thermal methods but had no or little systematic thermal analysis education.

2. It is necessary to create additional societies and thermal analysis discussion groups, and also to improve and invigorate the existing ones. With proper organization, they can best promote the needed cooperation between schools, industry and government. Thermal analysis societies are ideally suited to take initiatives as they are per se interested in, and devoted to the further development of thermal methods and their applications. They may ask educators from different schools of their region, or even their country, to set guidelines for a thermal analysis course material. The word "guideline" is emphasized because the actually taught material may vary with the educational profile of the school; but the guideline will still establish a minimal standard. The societies may also play a key role in mobilizing sponsors from the industry and in providing information that governmental sources may request before approving funds.

Particularly in developing countries, financial support may be obtained from branches of the United Nations. An example is the 1984 Seminar at the Indian Institute of Technology in New Delhi cosponsored by the UNIDO and the Department of Science and Technology of the Government of India. This seminar(7) brought together scientists from all over India, and experts of worldwide reputation from abroad. A part of the program was the thermal characterization of polymers.

3. In Japan, major thermal analysis instrument manufacturers support the education of thermal analysis(8). This cooperation is an example to be followed.

c. Long-Term Projects

1. Studies show that it takes 8-10 years to train specialists up to a Ph.D. level in materials characterization (including of course, thermal analysis). The majority of thermal analysts do not need a Ph.D., but they still need many courses in

basic and applied sciences, and need further training for specialization. National societies and also government institutions, recognizing its economic importance may help convince or direct a number of prestigious schools in various countries to put an emphasis on educating scientists in materials characterization. Theoretical and practical thermal analysis education will become, with justification, a prerequisite for certain degree or diploma. (This may vary from school to school and certainly from one country to the other). Grants and support will be available, no doubt, from industry, from government institutions and from all sectors where specialists educated in materials characterization are needed.

2. The upgraded education in the schools will be certainly complemented by scientific meetings organized by national societies as well as by international scientific organizations. In a few years, the impact will be noticed. The alarming shortage of experts will subside, particularly because many schools may follow the examples of leading universities.

3. It will be necessary to establish "Materials Characterization Institutes" (MCI). Predictably, longer time will be needed for achieving this goal; it is branded therefore a "long-term" program, but the time is now here to start it. The MCI will be devoted, among others, to train scientists in all techniques of materials characterization. This type of institute may be independent, or set up as a part of a university. It may become the center of both research and training, accommodate visiting scholars, and contribute significantly to the scientific and economic development of the country. It may become eventually self-supporting through receiving reimbursements for contract research and services.

## CONCLUSIONS

It is obvious that urgent actions are required to meet the demonstrated need for a large number of well trained thermal analysts. ICTA, the only worldwide confederation of thermal analysis societies, will continue its historical role in promoting both immediate and long-term educational goals. The future is bright and promising. After a good start, through improved communication, efficient coordination and the broadest cooperation we hope to fully achieve our educational objectives.

REFERENCES

1) W. Ludwig and S. St. J. Warne: Report on the Workshop: Education, Publication and Standardization in Thermal Analysis. Thermochimica Acta, 110, pp. 23-39 (1987).

(2) H. Tanaka and K. Kawabata: Proceedings, 8th ICTA '85, Bratislava. Ibid. 92, p. 219 (1985).

(3) T. Ozawa: Personal communication. May, 1987.

(4) E. Turi: Report to the IUPAC "Committee on Teaching of Chemistry". Boston, August 1987. (ICTA News, 20 (No. 2), pp. 12-14 (1987).

(5) B. Wunderlich: Graduate Education in Polymer Science Through Audio Courses and Thermal Analysis. Unpublished proposal. December, 1985.

(6) E. Turi: "New Groups and Societies". ICTA News, 20 (No. 2.), pp. 17-18 (1987).

(7) E. Turi: "Thermal Characterization of Polymeric Materials". Proceedings on the Seminar on "Matrix Resins and Composites". Indian Institute of Technology, New Delhi, India. (I. K. Varma, Editor.) March, 1984.

(8) T. Ozawa: Personal communication. May, 1987.