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INSTRUMENTATION IN THERMAL ANALYSIS: PROGRESS REPORT

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ABSTRACT

Thermal analysis instrumentation, considered from the quantitative point of view, is one of the fastest growing techniques in instrumental analysis. Hardware improvements are characterized by the extensive computerization of data processing and control. The methodology continues to exhibit remarkable development.

QUANTITATIVE DEVELOPMENT AND OUTLOOK

According to a recently published survey [1] carried out among 1261 institutes and laboratories, intended purchases of new analytical instruments and equipment will increase by 5.13% in 1985 compared with 1984. TA instrumentation, with a gain of 4.2%, seems to be developing in a below-average manner. These data are, however, strictly absolute and not completely precise. If we take a closer look at the available figures, the overall picture changes dramatically: the average figure of 5.13% is distorted by such exotic gains as, e.g., the highly fashionable laboratory data management systems with 18.4%. A more careful examination shows that among 34 instrumentation types, staring with data management systems and ending with centrifuges, there are 14 above-average gainers but 20 below-average gainers; also, it is found that there are 17 gainers with higher increases and 16 gainers with lower increases than TA. With this perspective, TA appears nearly exactly at the mean. Still more favourable developments become visible if we consider a more reasonable figure: the growth rate calculated as the ratio of planned purchases and present users expressed as a percentage: in 1984 among the surveyed respondents there were 177 users of TA instrumentation, 11 of whom intend to replace or extend their existing equipment, and 42 new intending users, which results in a total of 53 new purchases; this represents a growth rate of 29.9%, which lifts TA to eighth among the 34 instrument categories examined. Compared with the analo-

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gous ranking data for 1983/84, this is a rise of six places from the previous year. No other instrument category has achieved such an improvement, so that this result promotes TA to the leader with regard to growth rate advancement.

HARDWARE DEVELOPMENTS

The most significant trend in TA instrumentation is the extensive computerization. This concerns not only data processing, including the visualization of output signals, thermogram evaluation, quantification of results, formation of derived functions (e.g., derivatives and reciprocals), storage of raw data and preparation of hard-copy reports, but also an increasing extent of control of instruments and the management of experiments [2–5]. The increasing performance of programmable calculators permits their limited use for the purposes listed above and their small dimensions and light-weight design facilitate the mobility of experimental equipment [7]. Thus, the computerization of TA instruments not only results in dramatically increased performance in terms of speed, accuracy and flexibility, but also in the ease of instrument operation, understandability of the results obtained and the convenience of operators and laboratory staff.

However, the power of computers must not be overestimated: such a giant project as the realization of the nuclear fission reaction was completed with old-fashioned, manually driven mechanical calculators. The designer of the first electronic computer (ENIAC), von Neumann, used to calculate quick numerical problems connected with the design and realization of the thermonuclear reaction manually without any artificial help; his results were usually obtained more promptly than those of Fermi with his logarithmic slide-rule and those of Feynman with his calculator, and it was remarkable how well all the three results correlated.

Another important problem with the application of computers is the plausibility of the results obtained. Here again an example from the recent past is illuminating: the early ENIAC confirmed the results of the Polish mathematician Ulam, which indicated the impossibility of the thermonuclear reaction—clearly a case of correct computation but insufficiently precise experimental data and/or an incorrect model. Hence we must be careful with computers!

METHODOLOGY

Despite the fact that TA is far from being a young discipline, a surprisingly large number of new techniques and methods continue to appear. In the reviewed work, the following aims are monitored: (a) increasing the

speed of measurements [6,7], (b) decreasing the experimental errors [6] and (c) making possible determinations that were previously impossible [8]. These goals are achieved by sophisticated measuring systems, original and novel designs of experimental equipment and exact and consistent employment of theoretical considerations. Thus, we continue to be creative.

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