A NEW HUNGARIAN POLAROGRAPH

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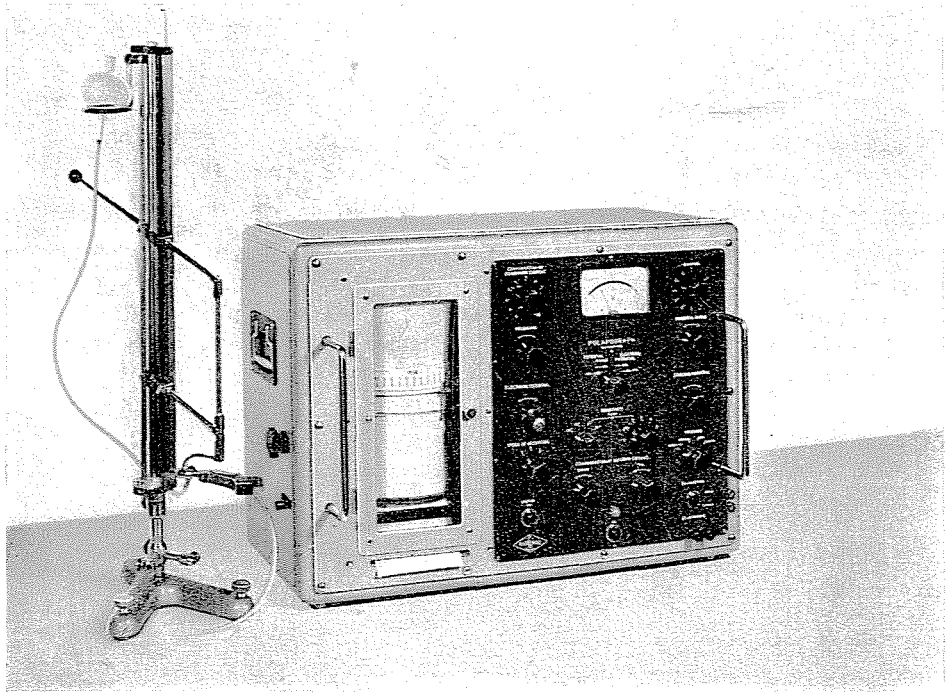
This is a short survey of the essence, of the application and of the main trends in polarography, followed by the description of the structure and the functioning of the automatic recording polarograph (code number: 961—109 P—1958) designed and produced in Hungary.

Since polarography was elaborated in the early 1920's by the academician Heyrovsky the method has steadily gained ground, its importance increased. The polarograph was a rare and special instrument at first. During the last decade however it has become an essential device of modern laboratories. It is equally appreciated by organic and inorganic chemists, by biologists and physicians.

The basic principle of the polarograph is the following. Electrodes are arranged in a receptacle containing a suitable solution of the material to be tested. While continuously increasing the tension on the electrodes, the current passing through is recorded. The anode is usually a large surface mercury electrode, the cathode being ordinarily a dropping mercury electrode. Such a cell does not follow Ohm's Law. By continuously increasing the electrolyzing tension at the terminals of the cell, the current is not increasing continuously but in steps. The tension pertaining to the unexpected increase in current intensity, the so called half-step potential, is characteristic of the material being tested. The intensity of the so-called diffusion current passing through is proportional to the concentration of the material. Consequently, by simply measuring the position and height of the various steps a qualitative and quantitative analysis can be carried out. The metallic ions that can be reduced on the dropping mercury cathode ara the easiest to analyze by this method. As various organic compounds are also reduced under the above circumstances, the method is similarly applicable in organic chemistry, biochemistry and medicine. It is superior to other analytical methods by being readily applicable and sensitive. In the case of series analyses a single analysis can be carried out in a few minutes. By using the correct cell, some tenths of milliliters of the solution to be tested are necessary. Greatly diluted solutions (10^{-3}—10^{-6} mol/liter) can be tested properly.

Consequently, the polarography is of great importance in the field of trace analysis and of microanalysis. Beyond the above practical applications, by the use of polarography considerable successes have been achieved in theoretical research too (*e. g.* electrode reactions, catalytic processes, characteristics of complex materials, etc.). The method is in steady development.



The polarography by solid and streaming electrodes, further the method of the amperometric titration should only be mentioned here.

Polarographs can be classified into two groups according to the method of recording current intensity. The classic design is the photographic recording with the help of a mirror type galvanometer. With this method the necessity of vibration-free arrangement of the galvanometer and of darkening the test room makes tests circumstantial. That is why nowadays the use of devices equipped with an electronic amplifier and a directly recording device is spreading especially for practical purposes. Taking into account the requirements of the market, the present polarograph has been designed according to the second alternative. All controlling, automatizing and comfort elements indispensable in a modern instrument are built in.

The electrolyzing tension necessary at the tests can be taken at will either from an outside accumulator or from the stabilized current source

built into the apparatus. In consequence of the novel design of the voltage dividing and feeding system, the width of the tension range and its location in the potential scale can be regulated independently from each other. This is an essential advantage in comparison to the majority of polarographs produced until now. The tension at taking polarograms is adjustable within wide ranges: 1—3 Volts. The cathode potential is adjustable from + 1 to — 3,5 Volts. For adjustment purposes a voltmeter of variable measuring ranges is built into the polarograph. In determining the ranges of these values the latest trends in testing methods (*e. g.* complex chemistry) necessitating relatively high potentials have been taken into account. The continuously increasing electrolyzing tension (the range and location of which has been adjusted as described above) is fed on the cell by a potentiometer actuated by a synchronous electromotor. The recording tape is moved by the same electromotor, consequently tension can be read directly on the axis, of the tape. The moving of the recording tape is adjustable to three different speeds. The value of the cathode potentional can also be read from the above-mentioned voltmeter. The tension fed on the cell can be so adjusted as to enable polarograms to be taken at will either at increasing or decreasing tension. The feeding of the paper tape can be made independent from tension regulation. Consequently changes of the diffusion current can be recorded while terminal voltage remains constant. By this provision the apparatus is made capable of performing amperometric titrations.

Intensity of the electrolyzing current is measured as follows: Current is connected on a loading resistance. The tension drop on the resistance (5 millivolts at the maximum at limit deviation of the instrument) is fed into a three-step vibrator input amplifier. The recording instrument is connected through a rectifier to the output of the amplifier. Sensitivity of current measurement is adjustable in 28 steps between $1 \cdot 10^{-9}$ and $8 \cdot 10^{-6}$ A/mm values. The adjusting knobs are calibrated directly in A/mm units. The calibration can be simply checked with the help of a standard resistance built into the apparatus. For checking the standard resistance is connected in place of the polarographic cell. If a "polarogram" is taken in this arrangement, an oblique line will be drawn by the recording instrument, corresponding to Ohm's Law. By this method the reliable functioning of the whole apparatus can be simply checked.

The apparatus is also equipped with an R—C deriving member. Therefore the apparatus is suitable, beyond taking normal polarograms also for recording derived polarograms.

Beyond the above-mentioned devices the apparatus is also equipped with all the control possibilities of modern polarographs (compensation by diffusion and condenser current, damping, etc.)

Specifications

Mains connection : 110—220 Volts, 50 c/s
Electrolyzing tension range : continuously adjustable from 1 to 3 Volts
Limit values of dropping electrode potential + 1 V and — 3,5 V
Current sensitivity : adjustable in 28 steps between $1 \cdot 10^{-9}$ and $8 \cdot 10^{-6}$ A/mm
Accuracy of recording ± 2,5 p. c.
Accuracy of measuring amplifier ± 1 p. c.
Effectiveness of the stabilizer in the case of a 10 p. c. change in mains voltage, a change of ± 1. p. c. in amplification
Compensation of diffusion current : continuously adjustable from 0 to 3,2 mA/V
Damping : in case of a drop time of 3 seconds 1 : 75, adjustable in 12 steps
Width of recording tape : 100 mm
Tape length : 200 mm
Running time of the tape : adjustable in 3 steps from approx. 3,6 to 9 minutes.
Designed by Tamás Domokos (Budapest, Technical University), János Gerő (Research Institute for Telecommunications) and Endre Juhász (Budapest, Technical University).
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