# THEORETICAL AND PRACTICAL ASPECTS OF PHASE EXPRESS-METHOD OF MEAT PRODUCTS QUALITY CONTROL

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SUMMARY: Some fragmente of the theory of the electric phase method quality test based on complex researches of the phenomena determining the correlation of iron field, tested products field, external electric field involving the theory of the field, linear electric circuit field and Maxwell's eguations are presented in the work. The results of the researches that show experemental function dependence of phase changes in the electric circuit of the analyser upon the concentration and electrophysical properties of ingredients are given.

INTRODUCTION: To solve the problem of the product quality as a whole,it is necessary to develop some effective methods and means of automatic analysis of the qualitative and quantitative composition of the raw, half-finished and finished products during all the stages of their processing. Electric methods of analysis of substance concentration and electric characteristics have been widely used by recearchers for nearly a century since they are simple and effective. At present electric methods of analysis find practical application in automatic systems of control and processing. As all methods and means of control known are based only on the dependence of amplitude changes of the electromagnetic field upon the concentration and nature of the ingredient, the practical use of these methods is limited mostly within pure solutions. Further remodelling of analysers by native and foreign firms is based on the design of numerical conductormetric devices which preserve their main defect - that they can be used for the concentration control of two-component substances only.

MATERIALS and METHODS: It was decided to investigate complex changes of the electromagnetic field of the measuring system cell containing products in connection with the electrophysical properties of the latter. In this case not only amplitude can be used for the analysis but phase changes of the current as well. Electric phase method quality test based on the results of the percentage content of the ingredients in products has been studied. Phase changes reading are not influenced by electromechanical affects and they can help to solve the problem of designing new numerical analysers. Phase method analysis must cope with the question of determining quantitative and qualitative composition of ingredients upon the second characteristic of complex specific conductivity of the substance - its reactive component. Since all electric methods of analysis are rapid ones and have the same physical base including electrical, registering and signalling devices, the phase method studied may be applied in automatic systems of control. Complex study of a number of functional figures (active and reactive components, complex resistance module) widens the sphere of application of the electric method analysis as far as ingredients composition and concentration tests in many - component products. Solutions of edible salt, nitrogen, lactic acid, soda, starch, ets, were used as samples of such ingredients.

RESULTS and DISCUSSION: The method spoken is based on Maxwell's first eguation which for the most meat products, referred to the group of imperfect dielectrics and semiconductors, could be written as

$$roth = (\sigma + \omega \mathcal{E}_0 \mathcal{E}'' + i \omega \mathcal{E}_0 \mathcal{E}')$$

"Recently Svintsov (1990)" where $\sigma$ is the specific conductivity, $\omega$ is the circular frequency, $\mathcal{E}'$ and $\mathcal{E}''$ are material and apparent components of the complex dielectric penetration of the air.

Linear electric circuit theory having been used, phase analyser was designed to realize the phase method. The resulting expression of the measuring system is as the following:

$$F = -arctg \frac{2 \cdot R2/X}{(R2/R)^2 - 1 + (R2/X)^2} \quad (2)$$

$$U2 = U1 \cdot \left| \frac{1}{2} \cdot \frac{(R2/R - 1)^2 + (R2/X)^2}{\sqrt{[(R2/R)^2 - 1 + (R2/X)^2]^2 + 4 \cdot (R2/X)^2}} \right| \quad (3)$$

where F - is the phase shift, R2 - is the regulated resistance of the measuring system, R, X is the active and reactive component the complex resistance of product and U2, U1 is the resulting and initial voltage of the system. Expressions 1 and 2 being used, the dependence of the phase shift and resulling voltage upon the electrophysical properties of products and the resistance of the measuring system is shown on Figures 1 and 2.

The diagrams prove that phase method may be used for the analysis of substances having a wide range of concentration. Besides varying the resistance value R2 one can get any required working capacity of the system. If should be underlined that its working capacity can be high enough in case of minute change (it depends upon the concentration) of the active component of substance conductivity, i. e. phase method will solve the problem of concentration analysis when operating systems do not work.

Electronic blocks calculations resulted in experimental model analyser with numerical indication and a set of conductormetric cells. The device operates at the alternative tension of 220 V and the frequency of 50 cycles per second.

The aim of the researches with the analyser was to determine the experimental dependence of the phase shift upon the electrophysical properties and concentration of substances taking into account their practical application in meat industry.

Universal methods had been used to prepare solutions of different concentrations, then conductormetric detecting element was filled inturn. The results obtained are given on the table.

CONCLUSIONS: The results obtained have led to the conclusion that and experimental phase shift amplitude dependence upon the relative value of the cell resistance variation agrees with the analitical dependence determined by expressions 2 and 3. Parallel measuriments of the phase shift and the amplitude were made. The results testify to the advantage of the phase methods, the latter giving synonymous value of the concentration by the phase shift and the concentration amplitude dependence is correlated with the conductivity dependence upon the concentration having extreme points.

REFERENCES:

- Rogov, I. A., Gorbatov, A. B. and Svintsov, V. I. (1990): " Meat and Milk Products Disperse Systems." Agropromizdat, Moscow. 320 pages.

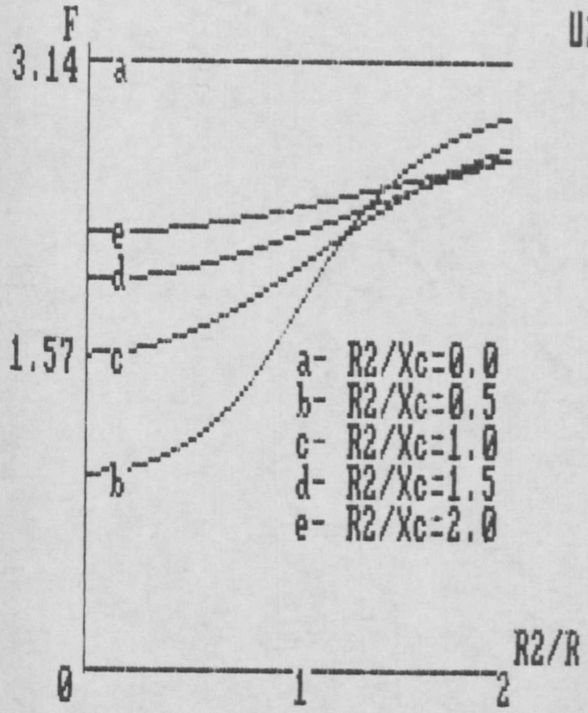


Fig.1. The relationship between the phase move F and relation resistance R2/R.

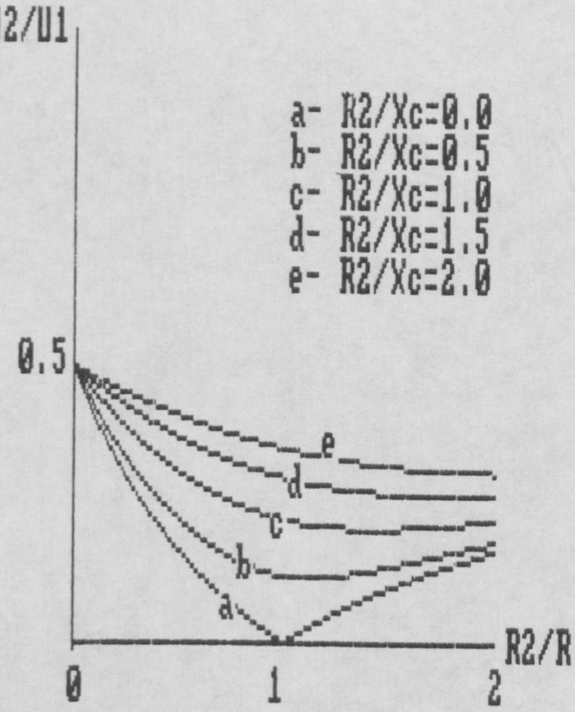


Fig.2. The relationship between the tension U1/U2 and relation resistance R2/R.

TABLE. Experimental phase shift and voltage amplitude dependence upon the ingredients concentration.

| Substance | Concentration (%) | Cell resistance (ohm) | Regulated resistance (ohm) | Phase shift (deg.) | Voltage amplitude (V) | Substance | Concentration (%) | Cell resistance (ohm) | Regulated resistance (ohm) | Phase shift (deg) | Voltage amplitude (V) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Na Cl | 1 | 62 | 20 | 150 | 0.966 | $C_3H_6O_3$ | 1 | 310 | 70 | 120 | 0.341 |
| | 2 | 36 | 20 | 108 | 0.379 | | 2 | 280 | 70 | 97 | 0.293 |
| | 3 | 26 | 20 | 45 | 0.330 | | 3 | 240 | 70 | 30 | 0.364 |
| | 4 | 20 | 20 | 27 | 0.483 | | 4 | 200 | 70 | 12 | 0.417 |
| | 5 | 17 | 20 | 18 | 0.637 | | 5 | 150 | 70 | 7.5 | 0.550 |
| | 6 | 15 | 20 | 9 | 0.716 | | | | | | |
| $NaHCO_3$ | 1 | 53 | 18 | 90 | 0.643 | $NaNO_3$ | 0.1 | 700 | 120 | 139 | 1.444 |
| | 2 | 48 | 18 | 72 | 0.602 | | 0.3 | 540 | 120 | 110 | 0.861 |
| | 3 | 32 | 18 | 54 | 0.576 | | 0.5 | 210 | 120 | 89 | 0.643 |
| | 4 | 24 | 18 | 40 | 0.530 | | 0.7 | 160 | 120 | 64 | 0.420 |
| | 5 | 19 | 18 | 32 | 0.492 | | 0.9 | 120 | 120 | 60 | 0.547 |