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RESISTANCE OF WHEAT SEEDS INFLUENCED BY TENSILE FORCES AND ELECTROSTATIC FIELD

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A b s t r a c t. Some correlation between a grain resistance and tensile force that influeces a grain can make it possible to determine electrostriction forces. These forces result from the external influence of an electrostatic field on a seed-grain. The paper presents a laboratory stand and research results of the tensile force and electrostatic field influence on wheat grain resistance values.

A testing machine constructed at the Department of General Electrical Engineering, Lublin Technical University was used for the experiments. An insulated meter was used to measure grain resistance values and a system of bridge, a strain gauge and an A/D converter was used to measure the force. "Sigma" spring wheat seed grains were the experimental samples 5 measuremental series at forces within the range: 0 to 17N were carried out during tensile tests of grains.

The results indicate a distinctive dependance of wheat grain resistance values on the tensile force. Some insignificant decrease of grain resistance values was observed during the initial phase of force raise (the range between 0 and 2N). Then a constant resistance increase at the time of force raise was observed. The highest change of resistance occurred within the final stage of tensile test, i.e., within the range: 10 to 17N. When the force of 17 N was reached the grain was damaged (a tensile failure).

Seed resistance values depend on the electric field intensity. When it grows the resistance decreases and is approximately linear. The maximum change of about 5.5% occurred when the field increased from 0 to 5 kV/cm.

K e y w o r d s: grain, resistance, stresses, electrostatic field

INTRODUCTION

Electric field applied to a dielectric results in some deformation of its electron primary configuration. In the case of solids it leads to changes of geometrical dimmensions [3]. This phenomenon is known in physics as electrostriction.

The electrostriction phenomenon is very weak thus it has not been applied in technology yet. However, some geneticists and biologists who deal with plant production, indicated a possibility to use it in practice [2]. They found that the electric field stimulates growth of the plants whose seeds were previously influenced by that field. Electrostriction forces cause deformations inside a seed (stressing or tensing particular layers), and results in a change of its density. Some laboratory experiments, the results of which are presented below, were carried out to prove this hypothesis.

THE LABORATORY AND MEASUREMENT TECHNIQUES

The laboratory to measure seed resistance vs. tensile forces

To generate certain mechanical stresses a prototype tensile testing machine was constructed in the Department of General Electrical Engineering, Lublin Technical University [1]. The schematic diagram of the machine is presented in Fig. 1.

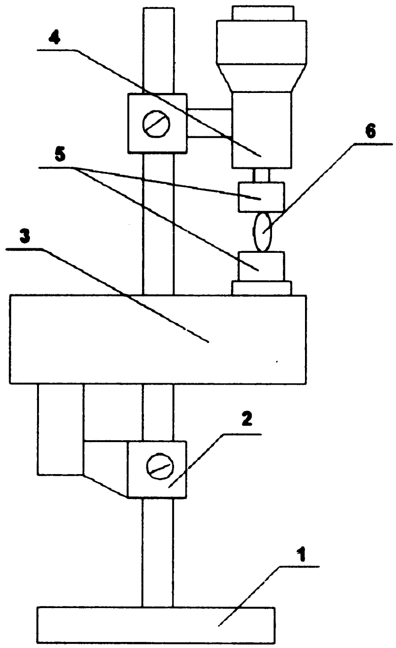

Fig. 1. Tensile testing machine: 1- supporting structure, 2- force converter holder, 3- tensometric force converter, 4- pressure unit, 5- electrodes and an inserted seed, 6- seed.

A tensometric force converter was used in a system (balanced bridge) to measure the force. The converter (3) and the pressure unit (4) were fixed on a precision height setting micrometer (1). It enabled us to adjust the holder (2) that fixed the converter and the pressure unit, depending on a seed size. A micrometer screw was used to exert pressure and allow fine force regulation. The examined seed was inserted between the holders (5) specially designed and glued with a conductive glue. The holders ensured co-axial and firm support of the seed. The laboratory unit structure allowed us to generate the compressive or tensile stresses. The testing machine cooperated with the force and resistance measuring system. Figure 2 presents the layout of the laboratory unit.

The force converter (3) cooperates with the measurement of the force influencing the seed. The seed resistance value is read by an insulation resistance meter (5).

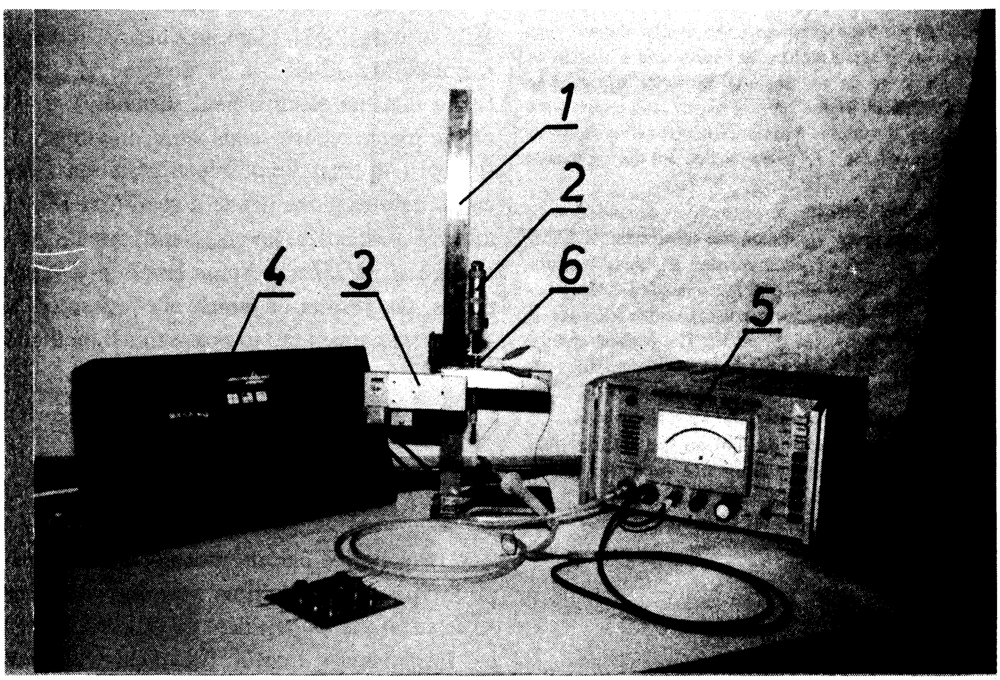

Fig. 2. The laboratory unit: 1- supporting structure, 2- pressure unit, 3- force converter, 4- force measurement system, 5- resistance meter, 6- fixing holder end a seed.

The construction of the measurement system and the special purpose holders to fix the investigated seed in the tensile testing machine is shown in Fig. 3.

Each holder gives certain tensile co-axial force and precise force measurements. It also isolates the seed from the machine elements and joins the measurement system.

The laboratory unit to measure crop seed resistance vs. electrical field intensity

A capacitor - measurement chamber - was used to generate the electrical field. The scheme layout of the system to measure seed resistance in an electrical field is schown in Fig. 4.

The chamber was made up with flat capacitor plates (2) to which the voltage from the high voltage supplier (5) was applied. The seed (1) was inserted inside the measuring capacitor, between electrodes connected to the resistance meter (4).

Constant electrode pressure was maintained by the vertical installation of the measuring chamber and the super pressurizing load (3).

Experimental methods

Wheat seeds called SIGMA were used. They are very hard and thus make the striction phenomenon visible. Prior to the tests some preliminary selection of seeds was done on grain screens to divide them into groups of equal geometry. The samples were checked using a microscope to remove damaged seeds. The choice of samples were put into an air conditioned unit to reach the given humidity and then the tests were carried out. A large random sample was used.

TEST RESULTS

Seed resistance measurements vs. compressive forces

There were 5 series of resistance tests for seed tension. Each test was repeated at the same force value within the range 0-18 N. The average graph of the seed resistance vs. the

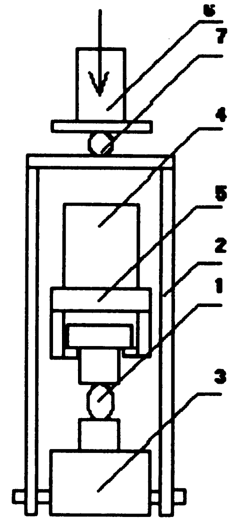

Fig. 3. The holder to measure the seed resistance vs. tensile forces: 1- seed, 2- upper isolating catch, 3- bottom isolating catch, 4- force converter, 5- yoke, 6- micrometer screw, 7- aligning element.

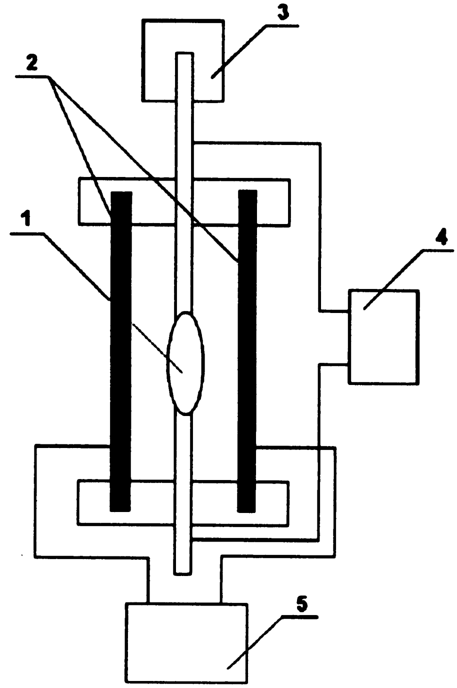

Fig. 4. The scheme layout of the system to measure seed resistance in an electrical field: 1- seed, 2- flat capacitor plates, 3- pressure load, 4- resistance meter, 5- DC high voltage supplier.

tensile force (in the form of relative values) is presented in Fig. 5.

On the basis of the tests it was found that seed resistance depends on tensile forces. The resistance did not change in the initial tensile phase (F=0-6 N), however at higher values (F= 6 N) it grew. The resistance growth was approximately hyperbolic and reached its maximum which, in relation, to the initial value, was 30-50 %.

Seed resistance measurements vs. electrical field intensity

The measurements were carried out at 4 seed humidity values and 5 electrical field intensity values. 6 repeated tests were done at each value. The dependence of the seed resistance vs. the electrical field intensity is presented in Fig. 6.

Seed resistance values depend on the electric field intensity. When it grew the resistance decreased and as the graph shows, the tension is approximately linear. The maximum change, of about 5.5%, occurred when the field increased from 0 to 5 kV/cm. The electrical field has greater influence on grains of low humidity. The dependence of the seed resistance on its humidity is presented in Fig. 7.

ESTIMATION OF RESULTS

The results of the analysis proved the dependence of seed resistance on external compressive forces and the electrical field. The

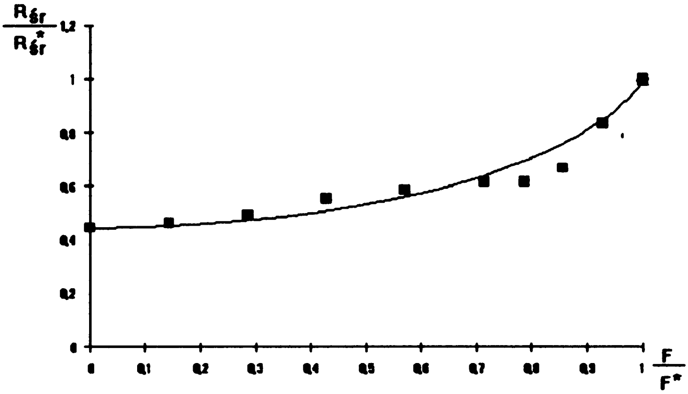

Fig. 5. The dependence of the seed resistance vs. tensile forces. Rśr - resistance mean, R*śr - seed resistance mean value obtained just before the failure of a test piece, F - tensile force value, F* - the force value at which all of the pieces within the sample serie failed.

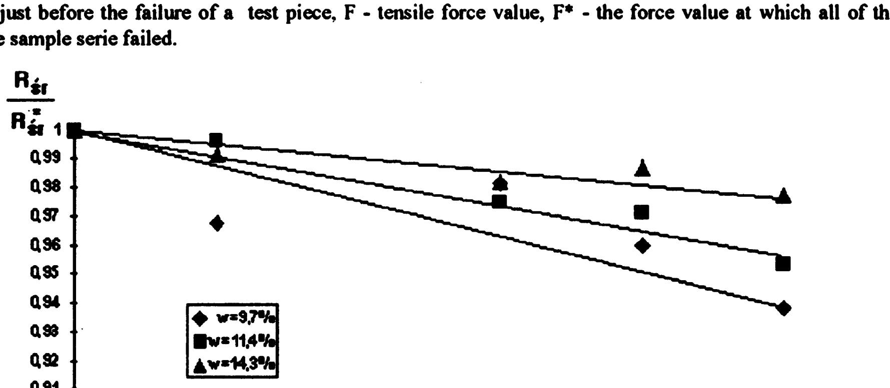

Fig. 6. The dependence of the seed resistance vs. the electrical field intensity: Rśr - resistance mean, R*śr - seed resistance mean value at no electric field.

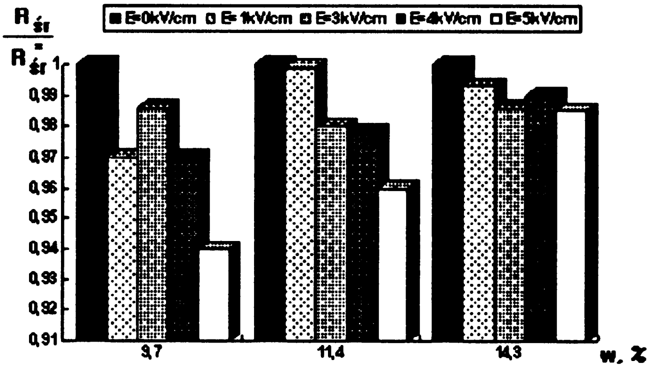

Fig. 7. Seed resistance as a function of electrical field intensity in dependence on seed humidity Rśr - resistance mean, R*śr - seed resistance mean at no electric field.

tests enabled us formulate the following conclusions:

1. Tensile stresses cause an increase in seed resistance.

2. An electrical field causes a decrease in seed resistance .

Seed resistance decreases when the field intensity grows and suggests that the striction forces caused by the field are not of a tensile force type.

The effect of electrostriction forces, which occurs as resistance falls, grows together with a decrease in seed humidity. This can be caused by its elasticity increase. At higher humidities seeds becomes plastic and the striction forces can cause some deformation of their internal particles without mechanical stresses. The results presented are the result of recently investigations and have not permitted further conclusions, yet.

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