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ABSTRACTS

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INTRODUCTION

Dear friends and colleagues,

It is my great pleasure to invite you to the 8th International Workshop for Young Scientists "BioPhys Spring 2009" which will be held in Lublin on 21-22 May 2009. The meeting will continue the tradition of previous workshops oriented on training of young researchers and exchange of professional experience in physics applied to biological, agricultural and food systems. In 2008 the Slovak University of Agriculture in Nitra and the Szent Istvan University in Gödöllő, Hungary jointed the Organizing Committee of the Workshop increasing the international level of the event.
We cordially invite young scientists up to age of 35 year to participate in the BPS 2009 Workshop and to present results of research in application of physics to life sciences. The workshop is organised as an opened English spoken event without any fee. Two-page abstracts of contributions will be published in the BPS Book of Abstracts. Papers can be submitted for publication in International Agrophysics, Research in Agricultural Engineering, and/or Scientia Agriculturae Bohemica. It is my pleasure to invite you to spend a few days of May 2009 in friendly atmosphere between young people in Lublin.

Józef Horabik

Chairman of the Scientific Board

SCIENTIFIC BOARD

I. LECTURES

HOW PLANT ROOTS AND BIOTA ENGINEER THE SOIL PHYSICAL ENVIRONMENT

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The aggregated mixture of mineral particles, organic compounds, life, gases and water that forms soil produces arguably the most complex material on earth. Soil has greater biodiversity than any other environment, due mainly to the vast surface area and structural heterogeneity of its pore space. This habitat is to some extent a product of engineering by roots and soil biota. Biological exudates bind soil into more physically stable units that resist breakdown from rainfall, trampling or vehicle compaction. Roots and fungal hyphae form reinforcement rods within soil, creating a material akin to a fibre reinforced composite. Earthworms ingest physically unstable or compacted soils and egest casts with more favourable properties.

This talk will discuss the biological processes involved in the physical engineering of soil by roots and soil biota. A major focus will be the application of concepts taken from materials science and engineering to describe the fundamental processes underlying changes in physical behaviour.

In materials science and engineering, structural development and breakdown can be quantified and modelled from fundamental properties such as bond energy, fracture resistance and rheology. For soil, the derived data are necessary to begin developing deterministic models of structure formation. One of the driving factors in soil structural breakdown is the resistance to fracture. This is described by fracture mechanics, which has shown that organic compounds typical of root exudates can double the fracture toughness of dry clays (Zhang *et al*., 2008). Although the stability of dry soils represents an extreme condition where greatest susceptibility to breakdown by water is often observed, only the top few millimetres ever reaches this condition in nature. Elastoplastic fracture mechanics can describe crack resistance in wet soils, with a water potential flux from -0.5 kPa to -50 kPa doubling bond energy due to capillary cohesion and shrinkage (Yoshida and Hallett 2008). Capillary cohesion was measured directly in a controlled system using parallel rough surfaces that were pulled apart in tension. These data showed that reduced surface tension improved spreading on increasingly rough surfaces, so the expected relationship between surface tension and cohesion was not observed. Microbes will often reduce

surface tension, but in similar tests with microbial exudates, adhesion by biological 'glues' increased the stress required to pull apart the plates. Further testing, using rheological approaches, found biological exudates to increase viscosity over a wide range of water contents for numerous soils with different mineralogy (Barré and Hallett 2009). In wet soils, a localised viscosity increase of soil by root and microbial exudates could nucleate the formation of aggregates. This is particularly relevant to the formation of the rhizosphere adjacent to plant roots.

Roots provide direct reinforcement to soil in addition to providing plant anchorage. In tests on willows and barley plants, our research has found a correlation between the cross-sectional area of soil covered by roots and shear reinforcement (Loades *et al.* 2009; Mickovski *et al.* 2009). Various properties of the roots and soil have been measured to unravel the mechanisms underlying soil reinforcement by roots. From the relationship between the stiffness and strength of roots versus their diameters, a fibre bundle model taken from materials science provides a reasonable prediction of the reinforcing effect of roots. With this approach, the progressive breakage of roots from most to least susceptible can be modelled. At larger scale, the impact of roots on soil reinforcement can be studied using engineering approaches, such as a geotechnical centrifuge. With this approach, plant roots have been observed to cause a downward migration of failure surfaces that result in landslides. Woody plants are increasingly adopted in engineering projects as a green solution to stabilise slopes, instead of the traditional approach of using rigid metal nails.

Slope stabilisation is an obvious application for the engineering of soil physical behaviour by plants and biota. The complex interactions between biological and physical processes underlies the longer term sustainability of all soils, particularly when they are used extensively for farming, forestry or other land-based activities.

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CARTOGRAPHY OF THE CELLULAR STRUCTURE OF PERICARP TISSUE WITHIN THE WHOLE FRUIT USING MACROVISION AND CONFOCAL MICROSCOPY

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In order to map the cellular structure of tomato pericarp tissue within the whole fruit, methods that take into account the biological variability are developed at two different scales.

Pericarp cellular structure in fruit is studied with the objective of relating histology to fruit mechanical and sensory properties. Cellular structure is the result of fruit growing and is not homogeneous within the tissue or the fruit. The impact of this heterogeneity on the properties is still not clarified. For this purpose, it is required to quantify not only the average cellular structure but also variations of cell morphology and cell arrangement within the tissue or the fruit. Another constraint to tackle with is the huge variability observed between individual fruit making the differences between experimental factors difficult to reveal. This can be overcome by building estimators of the cellular structure through a statistical approach. Methods have to be sufficiently rapid to analyze a representative number of samples.

Microscopic techniques are generally used to quantify the cellular structure. In the case of fruit, cells can be very large (200 µm for apples, up to 1 mm for tomato) and only a few of them are observed using microscopic techniques. Up to 1 cm² fields of view can be obtained by macrovision or stereomicroscopy (Cheniclet *et al.*, 2005). Macrovision and appropriate image texture analysis allow the rapid comparison of a large number of samples (Devaux *et al*., 2008). Morphological measures are usually extracted from 2D images though properties imply 3D structure. 3D estimators have been developed from 3D images acquired by confocal microscopy (Legland *et al.*, 2008). Both techniques can be applied on thick sections (100-500 µm) of fresh material, thus minimizing sample preparation.

An experiment is presented that aimed at mapping the variations of cellular structure of tomato pericarp in the whole fruit. The objective was to compare the results obtained using 3D estimation at the microscopic scale to the 2D measure extracted at the macroscopic scale. The same samples were analysed at the two scales. The approach involved a proper sampling scheme of pericarp from a set of 14 fruits, the control of the section position during image acquisition and the development of local measure of morphological parameters.

At the macroscopic scale, grey level granulometry by closing was applied using linear structuring element within orientations 0 and 90°. Running windows were considered to locally assess the cellular structure according to the distance to the epidermis. Average cell sizes were assessed in the two directions allowing computing an elongation factor. At the microscopic scale, surface area of cell walls was extracted from the 3D images after cell segmentation. The estimation took into account the sampling probability computed from the outlines of tomato quarters. For the two scales, 10 classes of geodesic distances from the pedicel and 20 classes of distance to the epidermis were considered to locally assess surface area and build the map of cellular structure.

Both scales provided a consistent description of cellular variability within a model tomato quarter. The two techniques can be envisioned to build a multiscale approach of cell morphology quantification.

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METHODS OF THE THERMAL STABILITY INVESTIGATION OF BIOLOGICAL MATERIALS

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Biological materials are very complicated, they have complex chemical composition, structure, phase, conformation, etc. Important factor which has impact on properties of the biological materials is temperature, but the most significant is the influence of the presence of free or bound water, different binding energy in each water bond in the material and sorptive properties of the materials. Influence of physical properties on the time and on the history of the external conditions is a characteristic feature of biological materials.

Physical and chemical processes running in the material due to temperature changes can be investigated by method of thermal analysis. They are the analytical techniques that measure physical and chemical properties of the sample as a function of the temperature or time [1, 2]. The sample is subjected the temperature program and the dependence measured value (heat, mass, volume, specific heat etc.) on the time and temperature are determined. It is provided by using following methods of thermal analyses:

- differential thermal analysis (DTA), differential scanning calorimetry (DSC) – provides information on thermal effects which are characterized by an enthalpy change and by temperature range, such as phase transitions (melting, crystallization etc.)
- thermogravimetric analysis (TGA) – measures the mass (change of the mass), provides information on the content of components.

Others methods of thermal analysis [1]:

- thermomechanical analysis (TMA)
- dynamic mechanical analysis (DMA)
- dielectric thermal analysis (DETA)
- evolved gas analysis (EGA)
- …

Contribution deals with differential scanning calorimetry and thermogravimetic analysis, as a methods providing information about thermal stability of materials, more in details. Some experimental data and physical interpretation is given.

Differential scanning calorimetry (DSC) is a technique in which difference in heat flow (power) to a sample and to a reference is monitored against time or temperature while the temperature of the sample, in a specified atmosphere, is programmed. In practise, the heat is supplied to the sample contained in the pan, and similarly, to the reference in its pan [2]. As well as information about thermal effects are provided by differential scanning calorimetry, the specific heat and changes in the specific heat can be measured.

Thermogravimetic analysis (TGA) measures the mass of the sample which is subjected to a temperature regime. Results give information on the content of volatile components e.g. water, on decomposition behaviour and on the ash or filler content [3].

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STRESS AND ELECTRIC FIELDS IN BIOLOGICAL CELLULAR TISSUES

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keywords: tissue, cell, wall, stress, turgor

The cellular materials represent an example of inhomogeneous materials in which some small part of their volume is a source of their many fundamental properties. To properties of this type belong also the material responses on presence of both the electric and mechanical stress fields. The cell walls and their properties play fundamental role in this case either in relation to the turgor pressure in case of the stress field and/or sap and wall electric conductivities and permittivity in case of the electric fields. In both cases the water activity and/or water content play important role. Present state in this area is shortly reviewed with special reference to parallel combination of both the fields.

INTRODUCTION

The cell walls play important role in physical properties of cellular biological structures. These structures are generally aggregated systems in which all basic physical states of matter (solid, liquid and gas) participate. The structure unit of such a structure is semi-closed cell characterized by strong mechanical bonds to another cells. There are these bonds that are responsible for quasi-solid behaviour of the cellular structure. Even if the cell walls represent minor part of the cell volume and the same can be concluded in relation to the dry matter content of the real cellular structure, the dry matter of the cell wall plays crucial role in the mechanical properties of a real cellular structures (Boal 2002). Similar conclusions can be made also in relation to electric, thermal and other properties (Heimburg 2007).

This paper tries to give some more information on sources of the described behaviour. The information on interaction of stress and electric fields in real agricultural plant cellular materials are also given.

MECHANICAL PROPERTIES AND MECHANICAL TESTING

Macroscopic deformation of cellular materials is not simple; generally it is superposition of deformation of the individual cells and flowing in the intercellular walls. The actual strain can reach tens or hundreds percents. This is why the stress-strain relations have to be expressed in so call true parameters. At higher strains the mechanical dewatering of the deformed product as well as the individual cells has to be taken into account.

Moisture content as well as turgor press in the compressed individual cells play important role in deformation processes. The role of turgor pressure is studied on manipulated specimens after their soaking in special solutions of different

concentrations (mannitol solutions). Modulus of elasticity decreases with increasing mannitol concentration (decreasing turgor). At the same conditions strength of the tested product increases. The participation of flowing during the mechanical test can be studied by special tests like stress relaxation or creep.

ELECTRIC FIELDS IN CELLULAR PRODUCTS

The cellular structure can be understood as a complicated part of the electric circuit in which cell walls are represented mostly as capacitors and intracellular and intercellular saps as conductors. This model shows that most part of electrical potential is represented in the cell walls and only small part of the potential is located in the intrinsic parts of cells. From time of Personius and Sharp (1938) there is known that destruction of the cell walls (e.g. by heating at temperatures more than about 60^{o} C) leads to increasing conductivity of cellular product more than 100 times. But electric behaviour of cell structure with functional cell walls has to be described as a superposition of dielectric and conductive abilities usually via complex relative permittivity where the real part expresses dielectric properties and the imaginary part gives the conductive properties.

Measurements of the complex permittivity in biological tissues show that both parts (real and imaginary) decrease with increasing frequency of the signal that is used to measurement. Our measurements on potato tissue at frequencies 0.01-500 kHz show that results obtained at different frequencies are very similar and the most important differences are observed for ratio of imaginary and real parts at frequencies 10-100 kHz.

COMBINATION OF MECHANICAL AND ELECTRIC TESTING

Our measurements show that both parts of relative permittivity decrease in compressed potato tissue with increasing deformation and this decrease is stronger mainly at frequencies below 100 kHz. At 500 kHz the real relative permittivity is nearly constant during whole compression test. The permittivity development during the compression test copies some stages of the mechanical test, in all cases there was observed increase of permittivity values prior the final rupture. This change could be understood as some indication of the internal destruction corresponding to decrease of derivative of stress versus strain. Some part of the observed permittivity changes during loading is reversible, but the irreversible changes were observed, too. At real part of relative permittivity the highest irreversible decreasing effect was observed at frequencies 0.5-50 kHz whereas the same trend at the imaginary part of relative permittivity was observed only at frequencies higher than about 10 kHz. On the other hand at lower frequencies the imaginary part of permittivity increased during deformation irreversibly. The observed irreversible changes are small; if the observed

permittivity changes during compression were determined in tens of percents, the irreversible changes are represents only in few percents.

ELECTRIC PULSES

The effects of electrical pulses of high intensity on properties of biological tissues are very complex and important. The effects are studied sometimes as "electric breakdown", i.e. as the pulse aftereffect consisting in increase of electric conductivity similar to the above mentioned effect described by Personius and Sharp (1938). The conductivity increase is caused by defects of cellular wall produced by the pulses. The process is termed sometimes as "electropermeabi-lization" and/or "electroporation". The permeation of the cell walls is a starting point for mechanical dewatering, mechanical fractionation and/or separation, and genetic manipulations. Increase of product electric conductivity is a starting point of some form of Ohmic heating. Theory of the process is reviewed by Weaver and Chizmadzhev (1996).

CONCLUSIONS

Deformation of cellular aggregates can be described by traditional terms: stress and strain at high deformations have to be expressed in terms of "true" parameters at least. Turgor stress and cell wall permeation by cellular sap participate at high strains. The cell walls plays also important role in electric properties of the biological tissue. Change of cell wall permeation and/or electric conductivity are sources of changes in aggregate conductivity of two orders at least. There exists similarity between traditional deformation curves and strain plots of both parts of complex permittivity of the deformed tissue. Only small part of the changes is irreversible.

Tissue cell wall properties can be modified either by temperature or by electric pulses of high intensity. The pulses change properties of individual cell walls as well as properties of the whole aggregated tissue. The tissue changes caused by the electric pulses are only partly reversible.

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MODELING MECHANICAL PHENOMENA IN GRANULAR MATERIAL WITH DISCRETE ELEMENT METHOD

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Granular materials play an important role in many industries such as: structural, chemical, pharmaceutical, agricultural or food. These materials have properties between those of solids and liquids, and arguments have been made that they should be treated as an additional state of matter in their own right. Beddings of granular materials as formed of discrete particles of various shapes, with friction acting in contact areas are inherently discontinuous. Generally they are also anisotropic, their physical properties differ measured in various directions due to the way of bedding and the load history.

In a recent two decades substantial increase in industrial applications of numerical simulations of behavior of granular solids have been observed. Among numerous propositions put forward microstructural approach appears to be particularly promising. Discrete Element Method (known as DEM) initiated by Cundal and Strack in 1979 [1] is one of the most frequently used. It is based on a computational technique in which the positions and velocities of each particle are calculated at each time step through integration of Newton's equations of motion. Scheme of the method consists of three fundamental steps: 1) contact detection, 2) contact force calculations (elasticity, viscous dumping, friction, cohesion, adhesion), 3) calculations of change in the velocity and the position of particles according to Newton's law of motion.

Efficient application of DEM for modeling behavior of granular materials requires application of contact models reflecting real behavior and realistic material parameters [2]. Mechanical characteristics of granular materials of biological origin and food powders are strongly dependant on moisture content and individual grains are highly deformable as compared to mineral powders. Such a material cannot be treated as rigid and in design or modelling of processes elastic behaviour should be considered. In particular the presence of water changes both surface properties and mechanical properties of seeds endosperm, which influence in-bulk behavior.

Laboratory tests and numerical DEM simulations indicated that two basic contact models: elasto-plastic or visco-elastic should be used to model impact behavior of rapeseeds at different moisture content [5]. Elasto-plastic model was found to describe fairly close impact of dry seeds (moisture content of 5.5 and

7.5% w.b.) while in the case of wet seeds (moisture content of 15 and 34% w.b.) visco-elastic model gave better fit. Efficient criterion for the model selection was a ratio of rise time to fall time (TR) of contact force – time characteristic. TR lower than 1 calls for elasto-plastic model, while for TR greater than 1 visco-plastic model should be applied.

The DEM applied to study the contact force distribution in a silo proved to be very powerful tool for studying effect of geometrical parameters, filling method (rain, central, with global viscous dumping) and friction [4]. Central filling resulted in vertically oriented force chains in the whole volume of specimen while circumferential filling resulted in high concentration of vertically oriented force chains in the center of the sample. Frictional conditions were found to modify distinctly the distribution of intergranular forces at the onset of discharge.

Discontinuity, unhomogeneity and anisotropy of granular media still poses numerous unresolved questions for science and technology. Numerical simulations seem to be promising supplement to theoretical considerations and laboratory testing. The DEM modelling technique requires extensive and costly computations so current solutions are limited to two-dimensional models or 3D systems not exceeding 10^4 particles. Specific questions in interest of numerical simulations are, to quote several*:* granular flows, granular compaction, segregation, convection, avalanches, surface waves, collisions and friction, inelastic collapse, jamming and fluctuations, energy flows, strength properties, anisotropy of packing, stress fluctuation and the uncertainty of physical and mechanical data.

Moarefvand and Verdel [3] have developed a “probabilistic distinct element method” to take into account the uncertainties in data and to analyse their effects on the model results. This method allows entering most of the necessary physical and mechanical data under probabilistic form and returns results also expressed in this form. The method seems to be very useful through coupling the uncertainty of data with originally deterministic DEM.

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COMPUTER VISION METHODS FOR PLANT WELLNESS CONTROL

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keywords: plant wellness, leaf inclination, machine vision, monitoring, irrigation control

Monitoring of greenhouse plants gives a straight diagnosis on their health and wellness. A computer vision method was investigated for detection and localization of leaves' wilting as a sign of visual appearance. Tomato, cucumber and paprika were tested using side projected canopy images. The camera was focused on the plant canopy from horizontal direction in order to obtain images covering the leaves. At defined time scales images were taken to analyze leaf and stem movements as the visual signs of plant state. The machine based control can be applied successfully in greenhouse crop production. The parameters of the control unit were identified and adjusted in each case of the plant, as well.

INTRODUCTION

Wellness refers generally to the state of being healthy. Weather plants have the feeling of well being or not, healthy plants are productive, and provide safe and secure food. Since plants do not change their location, temperature, moisture content, and other physical parameters of their environment are used to keep them in a healthy state. If all of these are similar to that which the plant would experience in its natural environment, it will generally fight off any insect or disease problems. Visual appearance is a useful sign for the grower, and monitoring the plant itself gives a straight diagnosis about the health of plant. Some of the wellness parameters that can be quantified by machine vision technique are as plant color, growth rate, leaf and stem movement and insect recognition.

APPLIED EQUIPMENT

The image analyzing algorithm requires input files of preset operating parameters, camera position and plants morphological features. These values should be adjusted for different plants, camera or measurements. The leaves and stems on the image could be separated by the image processing algorithm according to the differences in their shape. A general leaf inclination value was calculated from the local orientations at each point on the visible leaf's and stem's edge lines.

The computer vision method was tested under the conditions when leaves were partly hidden in the canopy. To prevent water stress and to ensure the wellness of the plants a tolerable wilting rate was identified by the developed model. An automatic irrigation control was relied exclusively on the leaf and stem inclination.

MACHINE VISION BASED IRRIGATION

A machine vision based irrigation was applied as a relay board controlled by the PC printer port turned an irrigation pump on and off to water the plants.

The paprika plants were irrigated with about 100 gram of water at the sametime when they have not received any water in the past hour and the estimated inclination value of the selected canopy were dropped below -51°.

In the tomato experiment three plants were irrigated with about 200 gram of water at the same time when they have not received any water in the past hour and the estimated inclination value of the selected canopy area dropped below -48°.

After measuring the inclination value in the selected canopy area, the control algorithm triggered the water pump on if wilting occurred. The irrigation control was relied exclusively on the leaf and stem inclination. Besides leaf and stem inclination, plant height, vertical center of gravity, the optical monitoring system measures other color and morphological parameters of plant growth in vivo and in situ and continuously calculates the desired graphs.

CONCLUSIONS

Based on the validation measurements it can be stated that the image analysis approach was applied successfully for measuring leaf and stem inclination of different plants as paprika, tomato, cucumber and other plants. It is a feasible solution to follow canopy motion, to quantify wilting rate and wellbeing state of plants.

The developed algorithm can also be used for automatic irrigation of different plants. In irrigation experiments of paprika and tomato plants had the visual symptoms of wilting at an inclination level at around -50 degrees and they were quasi turgid when leaf inclination was around –40 degrees. In the experiments the change in canopy inclination was about 20% between wilted and turgid.

The optical method was also tested when leaves were partly hidden in the canopy. A given degree of water status as measured by the applied method had more or less similar physiological response in paprika and tomato. Finally, it can be concluded that the machine based control can be applied successfully in greenhouse crop production. The parameter of the control unit should be adjusted in each case of the plant, as well.

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II. PRESENTATIONS OF YOUNG SCIENTISTS

LEAD MIGRATION IN THE DARK-GREY PODZOLIC SOIL IN THE CONDITION OF ARTIFICIAL POLLUTION

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keywords: lead, soil pollution, migration, soil profile

INTRODUCTION

Parent rock of which the soils developed is the natural source of heavy metals in those soils. Although the amount of heavy metals of such natural source varies a great deal, it is not a menace to soil fertility, and therefore it does not impair plant growth and crop quality. In results of human economic activity, the soil can be polluted by the cumulation of heavy metals- chemical compounds with phytotoxic properties. Large parts of agricultural soil are contaminated with lead (Pb). Although most environments are not heavily contaminated, the low levels observed nonetheless pose a high risk of heavy metal accumulation in the food chain. Therefore, approaches to develop plants with reduced heavy metal uptake are important. The main factor influencing the mobility of heavy metals in the soil environment is its reaction, which affect the stability of humus complexes with metals. In soil with pH considerably above 7 (alkaline and carbonate soils of high sorption capacity), the transfer of heavy metals into non-soluble forms takes place without any additional agrotechnical treatments.

MATERIALS AND METHODS

Object of researches was dark-grey podzolic soil polluted by lead. The experimental area is $300m^2$ divided on 17 plots of $2m^2$. Heavy metal was applied into top layer of soil as water salt solutions with dose-320 mg/kg of soil for Pb ($Pb(CH_3COO)_2$). The samples were taken from the research field of Lviv National Agrarian University, from the layer of 0-60 cm deep. After mineralizing the fraction of lead was determined in soil, using AAS method.

RESULTS AND DISCUSSION

A great influence on the content of the heavy metals was exerted by the material from which the soils had been formed, i.e. parent rocks. However, the natural configurations in the ecosystems are often affected by anthropogenic

pollution. The mobility of elements, connected with their biological availability, depends not only on soil factors but could also be a result of interactions between ions occurring in the soil solid phase.

Table 1. Concentration of lead in the dark-grey podzolic soil profile

Depth, cm	Control, mg/kg	2006 year, mg/kg	2007 year, mg/kg	2008 year, mg/kg
0-10	12,8	151,2	135,1	130,4
10-20	12,6	146,3	138,3	128,2
20-30	11,2	22,8	29,1	35,4
30-40	10,9	21,3	27,6	32,6
40-50	10,6	15,6	18,3	23,6
50-60	10,3	15,1	17,4	23,1

In profile of dark-grey podzolic soil the distribution of the studied elements generally depends on the genetic horizon. The content of lead decrease in eluvial horizon, while it increases in illuvial horizon. The concentration of heavy metal decreased gradually with the depth of soil profiles to the lowest content in the bedrock horizon. The main form of lead are fraction connected with organic matter and iron oxides. The maximal contribution of these fractions in surface horizons plays a decisive role in total distribution of lead in the soil profile. Lead fraction, in tested soil (control), is situated in range of 10.3-12.8 mg/kg.

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THE MICROBIAL METABOLIC ACTIVITY OF TECHNOGENIC SOILS OF FORMER SULPHUR MINE "JEZIÓRKO"

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keywords: soil, metabolic activity, respiration, microbial biomass

INTRODUCTION

The negative changes on the territories of sulphur mine by underground sulphur melting "Jeziórko" (Poland) resulted in the technogenic transformation of the natural landscapes and vegetation, destruction of fertile soils, pollution of the environment by sulphur compounds, acidification, chemical changes and pollution of the soils, surface and underground waters. Soil sulphur pollution cause to decrease of soil biological activity, namely microbial biomass and soil respiration processes (Levyk and Brzezińska 2008). The investigation of metabolic quotient of microbial associations (qCO_2) of technogenic soils will show soil actual microbial activity (Anderson and Domsch 1990).

MATERIAL AND METHOD

The soil samples were taken from experimental plots located at a different distance from the sulphur boring-well 10 m, 20 m, 40 m and 200 m (sod-podzolic soil in the pine-birch forest) in Jeziórko. The investigated soils were not managed or reclaimed and underwent natural self-restoration processes. The sod-podzolic soil profiles in forests neighbouring sulphur mine Jeziórko were not disturbed during sulphur excavation and were regarded as controls.

The laboratory tests were conducted on air-dried sieved (2 mm) soils according to following methods: soil respiration activity (Włodarczyk 2000) and microbial biomass (SIR method, Sparling *et al.*) – by chromatographic method using gas chromatograph GC-14 Shimadzu; metabolic quotient of microbial associations (qCO_2) – calculated as the ratio between soil respiration and microbial biomass (Anderson and Domsch 1990).

RESULTS AND DISCUSSION

High sulphur content in investigated soils and afterwards strong soil acidification caused the significant decrease of soil microbial biomass and then it caused the decrease of soil respiration processes (Levyk and Brzezińska 2008).

The drastic, 5-16-fold lose of the soil respiration activity and microbial biomass (in comparison to forest sod-podzolic soil) was observed in upper horizons of soils located on the area closer to the boring well in Jeziórko sulphur mine. Relatively high values of metabolic quotient of microbial associations of

technogenic soils located at 20 m and 40 m from the sulphur boring-well confirm that in the presence of low soil microbial biomass the metabolic activity of soil microorganisms is significantly higher than the same parameter of control forest experimental plot (Tab. 1). Therefore initial processes of soil formation on the investigated plots are actively proceeding under primary natural succession.

Table 1. Biological parameters of technogenic soils of former sulphur mine "Jeziórko"

Soil profile localization		Respiration activity, mg C-CO_2 kg^{-1} 24 h^{-1}	Microbial biomass, mg C_{mic}· g^{-1}	$qCO_2 \cdot 10^3$, mg C-CO_2 · mg C_{mic}^{-1}·24 h^{-1}
10 m	0-10 cm	1.3	0.081	0.016
	10-20 cm	1.34	0.060	0.022
20 m	0-10 cm	4.89	0.163	0.030
	10-20 cm	2.06	0.074	0.028
40 m	0-10 cm	4.23	0.190	0.022
	10-20 cm	2.54	0.108	0.024
200 m	0-10 cm	21.29	1.275	0.017
	10-20 cm	11.97	0.344	0.035

The increase of metabolic quotient of microbial associations is the result of stress caused by strong technogenic influence of underground sulphur mining. However, a low qCO_2 value observed in soil close to the boring well (10 m), as well as a high qCO_2 value in deeper horizon of control forest soil indicate that this index may not useful for evaluation of the biological status of soil polluted with sulphur.

CONCLUSIONS

Obtained results shows a high microbial activity of technogenic soils left after underground sulphur melting and assert that, in time, as affected of natural processes of soil formation and self-restoration processes of vegetation, properties of technogenic soils will approximate to the same properties of undisturbed soil.

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ESTIMATION OF SOIL DIELECTRIC CONSTANT BY SATELLITE OBSERVATIONS

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Soil stores 0.001% of all Earth's water. It looks like not much, but it is the same amount as in the Earth's atmosphere. Water stored in soil is very important because it is one of the factors which govern the energy flow and hydrologic cycle of Earth. The knowledge about soil moisture gives an opportunity to forecast crop production, erosion, to predict floods, droughts, and many others. Some agriculture professionals are beginning to use environmental measurements such as soil moisture to schedule irrigation.

The work employed images of Western Polesie (Poland) taken by Advanced Synthetic Aperture Radar (ASAR) which operates at 5.331 GHz and is mounted on ENVISAT satellite. Using that frequency of electromagnetic waves gives an opportunity to retrieve dielectric constant of soil. Because of significant dielectric constant contrast between dry and moist soil, obtaining dielectric constant of soil is the first step to estimate soil moisture of the investigated region.

The dielectric constant of soil was computed using Dubois Model. After that four different sites on the satellite image were selected: cultivated field, forest, meadow and wetland. Then geostatistical analyses of empirical semivariograms were employed to find spatial distribution of computed dielectric constant of soil. The analyses showed, that for all subsets, the separation distance, over which spatial dependence of dielectric constant is apparent, was very short. This means, that the mean value and standard deviation of dielectric constant are representative measures for a sufficient description of chosen areas. The analyses also revealed that the wetland had the biggest value of mean soil dielectric constant, which meant the biggest soil moisture. The most isotropic region was the meadow, because it had the smallest variation of obtained dielectric constant of soil. The computed variation of the forest was very big, probably because Dubois Model is not good for areas with high vegetation. That is why computed dielectric constant of soil under forest is probably false. Moreover, all the computed dielectric constants appeared to be too small. Perhaps because the radar “can see” not only water in soil, but also water in plants which cover the investigated sites. Vegetation layer can be treated as a mixture of plants and air. This layer underestimates apparent dielectric constant, because no matter how high water content of plants is, such mixture has very low density, and, because of that, low dielectric constant.

The research showed a great potential of the used method, but further investigations are necessary.

APPLYING OF ATOMIC ABSORPTION SPECTROSCOPY (AAS) FOR DETERMINATION OF METAL CONCENTRATION IN SOIL

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Method of atomic absorption spectrometry belongs to one of the strictest methods for metals determination. This technique can be used for investigation content of metals in drinking water, waste waters, but also in solid samples like soils or plants. In general, diversity of component contained in soil and plant causes that such materials are highly difficult for analysis. Application of atomic absorption spectrometry (AAS) enables to determine even trace amount of metals in relative short time. Method grounds mainly on three quantitative laws:

Kirchhoff – Bunsen law:

Absorption line originates from free atoms, not from compounds.
Free atoms can absorbate radiation with the same wavelength as for emission.
Obtained absorption spectra are unique for given element.

Lambert – Beer law:

$$A = \log(I_0/I) = \varepsilon bN$$

where: A – Absorbance
I_0, I – Current intensity, before and after absorption
ε – Molar index of absorption
N – Number of atoms
b – Length of optical way

Absorption additivity law:

$$A = A_1 + A_2 + A_3 + \ldots + A_n$$

Soil and plant samples should be prepared in special way for AAS. There are a lot of methods for samples mineralization. Metals can be determined in total, available, exchangeable and other forms. Depending on necessities different solutions are used to metals extraction for example water, aqua-regia, hydrochloric, acetic acid, mixture of acids or salt solutions. Apart from mineralization, measuring accuracy of AAS depends also on suitable preparation of calibration curve. Requirement of solutions dilution and fitting of samples to calibration curve are one of not numerous limitation of atomic absorption spectrometry, which can be minimized by autosamplers and high experience of analyst. Exceeding of straightforward range of calibration curve can give understated or bigger values than true in depending on sort of interferences. Three basic kinds of interferences can be found:

Spectral:

- Absorption lines of determined metal overlap with other presented in sample
- Molecular absorption when flame contains compounds which absorption spectra are placed in wavelength range absorbed by determined element
- Scattering of radiation on small particles caused by presence of oversaturated liquid or aerosol gas-solid in absorption region.

Chemical:

- Ionization in gas phase
- Reaction in solid phase of sample leading to formation not dissolving compounds (oxides, hydroxides, silicates, phosphates or sulfates).

Physical:

- Interferences visible in nebulization process as a consequence of different physical properties of sample and standards (viscosity, density, surface tension).

High sensitivity and low limit of detection support for usage of atomic absorption spectrometry. Analyses are fast and characterize by high repeatability. Method requires very small amount of solution. Cost of analyses and exploitation is relatively low. Additional advantage is possibility of extending of measurement system, full automatization, which enables to minimize of dilution and injection error.

Atomic absorption spectrometry belongs to very selective methods. there are a lot of methods, even for such complex materials as soil or plants, which can eliminate matrix or others components influence when its spectra lines can attenuate or magnify signal of determined metal. Despite of numerous interferences which can be found during determination of elements in soil or plant there are a lot of ways of solution and elimination these interferences. All interferences are well defined and widely described in literature.

IMAGE ANALYSIS FOR SOIL MACROPORE CHARACTERIZATION

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Soil macroporosity is a sensitive indicator of changes in its structure during such processes as cultivation, including vehicle wheel traffic, tillage operations, fertilization type or even compacting raindrop impact, root enlargement and earthworms activity. Porosity affects transmission of water and solutes or gas exchange, which determines plant productivity. Continuity of pores is essential when describing infiltration of liquids in soil.

The most common methods to characterize total porosity or pore size distribution are: mercury porosimetry (pore diameter range 7.5-0.004 x 10^{-6} m), nitrogen adsorption isotherms (0.05-0.001 x 10^{-6} m) or pF curves (>50-0.1 x 10^{-6} m). Soil scientists successfully apply image analysis for precise quantification of areal macroporosity. The development and accessibility of image analysis tools results in increasing accuracy of pore size distribution measurements with this technique.

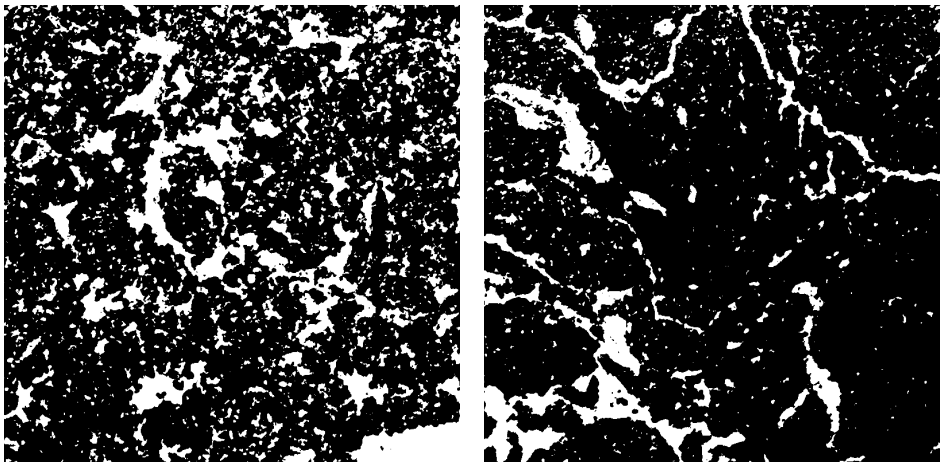
Fig. 1. Examples of thin soil sections used in experiment

In the experiment we used thin soil sections like in Fig.1. Two tillage methods on Eutric Fluvisol soil were compared: ploughing to depth of 20 cm (CT) and uncultivated soil (NT). Soil sections were obtained in the following way: undisturbed soil was taken into metal containers, saturated with Polimal 109 polyester resin, after hardening cut to 1 cm thickness and polished. Samples were taken in horizontal and vertical plane at depth 0-8 cm and 10-18 cm. Afterwards samples were scanned with the resolution of 2400 dpi. Binary images (Fig.2) were analyzed with Scion Image and/or Image J software for Windows to determine total porosity, pore diameter, perimeter and area of pores >11 μm. Pore

elongation was described by shape factor SF (Pagliai *et al.* 2000) and calculated from equation:

$$SF = perimeter^2/(4\Pi x\ area) \quad (1)$$

SF<2 regular pores 2<SF<5 irregular pores SF>5 elongated pores



a) b)

Fig. 2. Binary images of scanned soil sections. Vertical direction of sampling at depth of 17 cm. a) conventional tillage (CT), b) no tillage (NT). Black area represents pores, white represents solids.

The method of determining soil areal macroporosity is fast and soils sections may be used to determine additional relations like e.g. fractal dimension. Elongation of pores, which is estimated easily with the technique indicates its continuity and helps to predict liquid infiltration in the soil.

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SULPHUR AND NITROGEN UPTAKE IN CONDITIONS OF DIFFERENTED SOIL SUPPLY WITH THOSE COMPONENTS

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keywords: nitrogen uptake, sulphur uptake, nitrogen fertilization, sulphur fertilization

ABSTRACT. The results were based on an analysis of plant material of an exact field vegetative experiment which was set up using a completely randomized block method. The uptake of total sulphur and total nitrogen by orchard grass was calculated on the basis of percentage content of those nutrients and plant yields. It was stated that the biggest influence both on total sulphur and total nitrogen uptake by the analysed plant was exerted by nitrogen fertilization. It was also proved that sulphur fertilization influenced the uptake of total sulphur and total nitrogen.

INTRODUCTION

Fertilization is a basic agricultural practice which regulates soil capacity of satisfying plants nutritional requirements. At the same time, it is one of the most essential factors which shapes the quantity and quality of yields. The most effective element which influences plant yielding is nitrogen. Recently a significant role in forming the quantity and biological value of field crops yield has also been assigned also to sulphur.

The aim of the undertaken study was to analyse sulphur and nitrogen uptake by orchard grass in conditions of differented soil supply with those components.

MATERIAL AND METHOD

The presented study has been conducted basing on plant material obtained from the exact field vegetative experiment which was set up using a completely randomized block method. The experiment has been set up on brown soil created from loess in granulometric composition of silt-loam. The experiment scheme enclosed 9 manurial objects in 4 replications. It included 2 variables: sulphur fertilization and nitrogen fertilization on three levels. An orchard grass (*Dactylis glomerata* L.) variety Amba was a tested plant which was harvested three times in the vegetation period.

The uptake of total sulphur and total nitrogen by orchard grass was calculated on the basis of percentage content of those nutrients and plant yields.

RESULTS AND DISCUSSION

Related to the experimental factors, the uptake of total sulphur and total nitrogen by orchard grass was clearly differentiated (tab. 1). The biggest influence on the total S uptake by the analysed plant was exerted by nitrogen fertilization.

The application of N as ammonium nitrate increased the total sulphur uptake from 15,8 do 36,3% (I year) and from 9,9 do 21,2% (II year). It was also stated that the uptake of total sulphur increased as an effect of S fertilization. Sulphur fertilization contributed to the increase in the total S uptake from 10,3 to 17,9% in the first and from 5,1 to 14,9% in the second year of the experiment. A similar reaction of sulphur uptake by grass fertilized with sulphur was observed by Scott et al. 1983 and also by Jones and Ruckman 1969.

Table 1. The influence of sulphur and nitrogen fertilization on total sulphur and total nitrogen uptake by orchard grass

Object	2007		2008	
	Total S uptake (kg S·ha^{-1})	Total N uptake (kg N·ha^{-1})	Total S uptake (kg S·ha^{-1})	Total N uptake (kg N·ha^{-1})
S_0N_1	21,6	243,7	29,3	264,8
S_0N_2	25,2	290,9	32,2	315,2
S_0N_3	28,6	312,1	35,5	340,2
S_1N_1	24,0	253,9	31,9	292,6
S_1N_2	27,8	300,2	35,9	332,1
S_1N_3	32,5	366,8	37,3	383,4
S_2N_1	24,5	261,1	32,2	292,5
S_2N_2	29,7	328,5	37,0	344,7
S_2N_3	33,4	381,7	38,8	372,2

The uptake of total nitrogen by orchard grass was determined by nitrogen fertilization the most. It was expressed by the increase of total nitrogen uptake – from 18,2 to 46,2% in the first and from 13,5 to 31,0% in the second year. Similarly, an increase in nitrogen uptake as an effect of N fertilization was observed by Prasad 1973. The application of sulphur in elementary form also increased the total nitrogen uptake from 4,2 to 22,3% (I year) and from 5,4 to 12,7% (II year). Nonetheless, the influence of this experimental factor was lower in comparison to nitrogen impact.

Experimental factors which were used, clearly influenced total sulphur and total nitrogen uptake, which is connected with a huge role of those nutrients in yields forming.

CONCLUSIONS

1. Experimental factors had an impact on total sulphur and total nitrogen uptake.
2. The biggest influence of total sulphur and total nitrogen uptake was exerted by nitrogen fertilization.
3. Sulphur fertilization also contributed to the increase in the total sulphur and total nitrogen uptake. Nonetheless, the influence of this factor was lower in comparison to nitrogen impact.

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ANALYSIS OF THE DEGREE OF CRYSTALLINITY OF BACTERIAL AND PLANT CELLULOSE BY MEANS OF RAMAN MICROSCOPY

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Physico-chemical properties of cellulose and polymers containing cellulose are strongly related to a degree of crystallinity of cellulose. The degree of crystallinity characterizes the amount of crystalline cellulose in a sample. The biopolymer cellulose is considered as a two-phase system consisting of amorphous and crystalline domains. The degree of crystallinity directly influences on the accessibility for chemical derivatization, swelling, water-binding and mechanical properties of cell walls. Decrease of crystallinity causes unfavorable textural changes, i.a. tissues softening. Therefore, the degree of crystallinity is the very important property which needs to be taken into account when considering the manufacturing and applications of cellulose and cellulosic materials.

Determination of the degree of crystallinity was carried out by means of different methods. To the most popular belongs: wide angle X-ray scattering, nuclear magnetic resonance and Fourier transform infrared spectroscopy.

In this work Raman microscope was applied to the determination of bacterial and plant cellulose crystallinity. Raman spectroscopy is a spectroscopic technique based on inelastic scattering of monochromatic light. The frequency of photons in monochromatic light changes upon interaction with a sample. Photons of the laser light are absorbed by the sample and then reemitted. Raman effect consist in shifting up or down frequency of the reemitted photons in comparison with original monochromatic frequency. Raman shift provides information about vibrational, rotational and other low frequency transitions in molecules. The analysis of the

scattered frequencies gives information on the material chemical composition, state, aggregation, and factors like stress and orientation.

Two kinds of cellulose were used in the experiment. Bacterial cellulose was produced by bacterial strain of *Gluconacetobacter xylinus.* Plant cellulose was chemically isolated from apple cell walls. Both bacterial cellulose and cellulose from apple cell walls were subjected to preparation which removes undesirable fluorescence.

From dried samples 5 x 5 mm slices were cut and put under a lens of Raman microscope. The spectra were recorded over the range of Δv 150-3200cm^{-1}. The degree of crystallinity was counted according to a method described by Schenzel and Fischer (2001):

$$X_c(\%) = \left(\frac{I_c}{I_c + I_a}\right)10^2$$

where: X_c – degree of cellulose crystallinity (%), I_c – Raman intensity at Raman shift Δv =1481 cm^{-1}, I_a – Raman intensity at Raman Shift Δv =1462 cm^{-1}.

High crystalline cellulose characterize a presence of two distinct peaks at Raman shift $\Delta\nu$ = 1462 and 1481 cm^{-1}. The peak at $\Delta\nu$ = 1481 cm^{-1} does not exist in case of amorphous cellulose.

Fig.1. shows Raman spectra of bacterial and apple cellulose. On the basis of these spectra the degrees of crystallinity of both materials were calculated. The degree of crystallinity of bacterial cellulose amounts 47% and for apple cellulose this value is 17%.

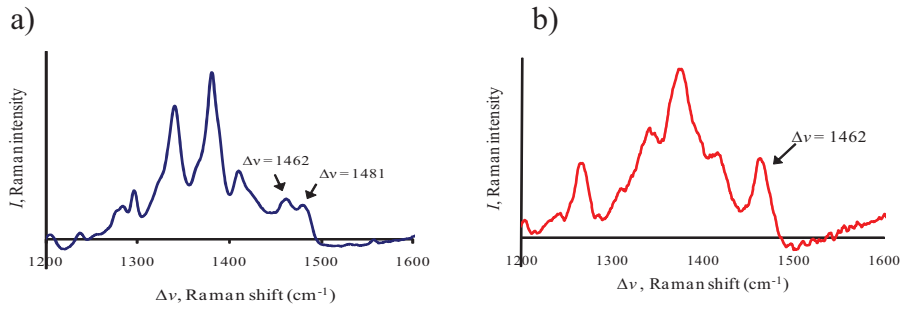

Fig. 1. Raman spectra of a) bacterial cellulose, b) cellulose from Apple cell walls AT the range of 1200-1520 cm^{-1}.

From this analysis it can be concluded that the degrees of crystallinity of plant and bacterial cellulose are significantly different. It can explain some distinct properties of these materials, like mechanical behavior or swelling capacity.

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BLACKSPOT VOLUME ESTIMATION IN POTATO BY COMPUTER IMAGE ANALYSIS

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keywords: potato tuber, blackspot, blackspot volume, image analysis

The paper is a continuation of research on potato tuber tissue blackspot after impact. Seven varieties of potato tubers stored six month were used. Ten tubers from each varieties of a similar size and shape without outer damages were taken. Next, mechanical test CHMI (standard test of the vegetables and fruits research) to induction of damage in the form of blackspots was used. After that, tubers were storage a room temperature for 48 h. Than tubers were cut into slices about 1,7 mm of thickness and a picture of each slice at the same optical conditions was made. A computer image analysis in Aphelion software of the picture were performed for detection and describe the blackspots. A number of blackspots and its area on the each neighbour slices were obtained. Knowing thickness of the slice and a number of slices with the blackspot, a volume of blackspots in tuber was estimated. The result of analysis will be used for elaboration of a new blackspot index.

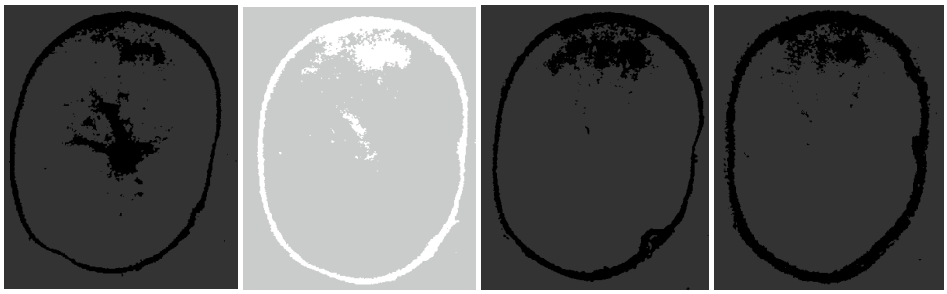

Fig. 1. The neighbour cross-sections of tuber with blackspots. Inner core and skin are visible on the picture too.

DMA ANALYSIS FOR OBSERVATION OF STARCH GELATION

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Potato specimens (length 2cm, cross section 5 x 3 mm) were tested by using DMA technology for determination of gelation start. In the report changes in the structure of starch are discussed from point of view of starch composition.

INTRODUCTION

Principle of Dynamic Thermo Mechanical Analysis (DMA, DMTA) is based on the specimen loading by definite force (strain, stress) and by the measurement of strain response at stress temperature.
These data allow us to create dependencies of elasticity module and loss angle on time, on the force frequency, on the deformation etc.
Gained behaviors are used for the characteristic material properties determination, for material damages, measurement of creep, for crystallization degree or for gel point determination.

MATERIAL AND METHOD

Table 1. Experimental conditions

Variety of potatoes	Nikola, Saturna
Temperature range	30 -90 deg. C
Deformation range	- 1 to +1 mm
Temperature step	1 deg/1 min
Deformation mode	Single cantilever
Loading	sinus
Humidity	70-90 %

GELATION

Gelation is process which is observed when starch is heated in water. Hydrogen bonds break, allowing water to enter the granule and the granule swells. Amylose migrates out of the granule.H-bonding between water and amylopectin increase.

RESULTS

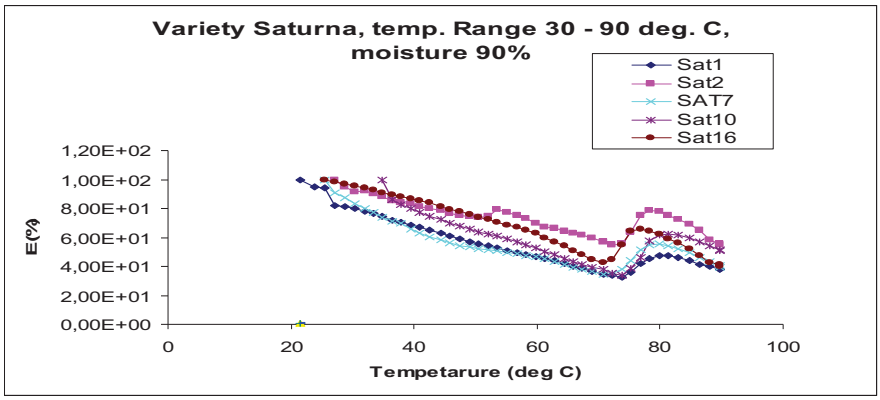

Fig. 1. DMA results of variety Saturna

DISCUSSION

All measurements (for both varieties) clearly show first (negative) peak approximately at 70 deg. C and second one (positive) at 80 deg. C. It possible to say that the first peak shows for starch gelatination. When the same specimen is tested again, this peak is not so visible.

CONCLUSIONS

Results of DMA analysis showed possibility of its usage for gel point observation. For better reproduction of results is necessary to repeat measurements on the same experimental conditions. Next measurements will be based on the smaller temperature step.

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THE EFFECT OF OSMOTIC DEHYDRATION, TYPE OF OSMOTIC SOLUTION AND FREEZEING ON COLOUR CHANGES OF FREEZE-DRIED STRAWBERRIES

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keywords: strawberries, freeze-drying, osmotic dehydration, colour

INTRODUCTION

Freeze-drying provides the removal of water from the food and retains chemical, physical and biological properties of fresh food material. Food color is very important and often determines product acceptation by consumer. To reduce unbeneficial changes it is necessary to modify this drying method.
One from the manners is osmotic dehydration, which consist in water removing from the plant tissue with simultaneous penetrating the osmotic solution.
The aim of this work was to analyze the effect of osmotic dehydration, type of osmotic solution and freezing on colour changes of freeze-dried strawberries.

MATERIAL AND METHODS

Fresh and frozen Senga Sengana strawberries were dehydrated in osmotic solutions with water activity about 0.9: (sucrose solution 61.5% and glucose solution 49.2%), at temperature 30°C by 3 hours under atmospheric pressure in dynamic conditions. Osmotically dehydrated fruits were frozen and freeze-dried at the temperature of heating shelves 30ºC by 24 hours.
For received dried fruits colour changes were determined.

The colour changes for the surface of freeze-dried strawberries were determined with the use of Chroma – Meter CR-300 Minolta Company equipment in CIE $L^* a^* b^*$ agreement. The measurements were repeated ten times. For determined values figures were plotted and colour parameters were determined. The values of colour indicators were also determined: saturation index (SI) and hue angle (H).

RESULTS AND DISCUSSION

Osmotic dehydration in glucose and sucrose solution for fresh strawberries caused significant decrease in saturation index (SI) in comparison to fruits without osmotic pre-treatment. It was shown that type of osmotic solution isn't important.

Also for frozen strawberries osmotically dehydrated, significant decrease in saturation index was shown in comparison to fruits without osmotic pre-treatment. Type of osmotic solution has significant influence on the value of colour indicators for fruits osmotically dehydrated.

Storage of fruits caused increase in saturation index in comparison to strawberries osmotically dehydrated in fresh state, with the exception of fruits osmotically dehydrated in glucose solution. For those strawberries there was decrease of investigated index after long storage time.

CONCLUSIONS

For osmotically dehydrated fruits there was significant decrease in saturation index in comparison to strawberries without osmotic pre-treatment. Storage in frozen state caused an increase of saturation index in comparison to strawberries osmotically dehydrated in fresh state, with the exception of fruits osmotically dehydrated in glucose solution.

THE QUALITY EVALUATION OF ICE CREAM PRODUCED WITH ADDITION OF SELECTED STABILIZERS

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keywords: ice cream, stabilizing system, antifreeze glycoprotein (AFGP)

Ice crystallization is an important factor that determines ice cream's final quality. Large ice crystals cause a coarse, grainy, and icy texture. The initial ice crystals are formed in the freezer barrel and then grow in size during hardening and storage. Recrystallization during storage is influenced by various factors, including total solids, initial freezing temperature, unfrozen water, stabilizer type, sweetener type, and storage temperature (Sutton & Wilcox, 1998). Consequently, there is a current interest in the possible use of antifreeze proteins and several carbohydrate polymers to control ice crystal growth during freezing of food. These substances not only lower the freezing temperature, but also strongly retard recrystallization and the associated growth of large ice crystals during frozen storage and thawing (Feeney & Yeh, 1998). The inhibition of ice recrystallization

may be an important factor determining the smooth, creamy and texture of frozen foods, especially in ice creams. There are many theories how the antifreeze proteins and carbohydrate polymers can affect the recrystallization process. The mechanism of this inhibition is still a good field of study. Different type of proteins and polymers can show different types of effects on ice crystal and recrystallization process.

The objective of this work was to investigate the influence of stabilizing mixes – some standard substances, antifreeze proteins and carbohydrate polymers (as a alternative, cheaper and more available then antifreeze proteins substances) on recrystallization process, sensory and physical characteristics of milk ice cream. Gelatine, guar gum, xanthan gum, κ-carrageenan, alcohol and antifreeze glycoprotein (AFGP) were used. Sensory analysis was conducted directly after freezing and after one month of storage. Analysis of recrystallization process was done by taking photos of the ice cream samples with microscope Olympus bz-41 and digital camera SIS-Altra 20. Analysis of photos was done with software Image-Pro Plus.

The best sensory attributes, both before and after storage, obtained ice cream with addition of AFGPs. Directly after freezing, palatable evaluation had ice cream with addition of alcohol, whereas after storage, very good sensory assessment had ice cream with addition of standard stabilizing system. Based on the investigation it was also certified, that xanthan gum well cooperates with AFGPs and with alcohol. It was also ascertained, that the presence of guar gum led to the guminess, whereas κ-carrageenan gave good results only with cooperation with guar gum. According to the photos of ice crystals recrystallization process was strongly retard by addition of AFGP and addition of κ-carrageenan didn't bring such great results.

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EFFECT OF TEMPERATURE AND CONCENTRATION ON RHEOLOGICAL PROPERTIES OF TOMATO JUICE

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keywords: tomato juice, rheological properties, viscosity

Abstract: Flow characteristic of tomato juice using Brookfield viscometer at different temperature and solid concentration have been investigated. Apparent viscosity, flow behavior index and activation energy were evaluated. The obtained date indicates on pseudoplastic nature of the juice in the whole study conditions.

INTRODUCTION

Knowledge of rheological properties of vegetable juices is very important for food industry. They should be taken into account for calculating food equipment and process modeling (Sahin and Sumnu 2006). They are required to determine the energy consumption during pumping, power for mixing, to design heat exchange and evaporator (Barbosa-Canovas 1996, Boger and Tiu 1974, Rao 1999). Temperature and concentration can change not only apparent viscosity but also flow behavior index. Typical properties of the data for tomato juice are rather limited. Because of this the aim of the paper was to study rheological behavior of tomato juice as a function of temperature and solid concentration.

MATERIAL AND METHODS

Rheological properties were measured using Brookfield viscometer (Brookfield Engineering Laboratories: model LVDV-II + PRO). A sample of 500 ml of tomato juice was used in a glass baker for all experiments. The concentration of tomato juice was ranged from 2.72% to 5.22%. The temperature of sample was changed from 22 to 62°C and kept at constant value using water bath (Brookfield TC-502P). The rotational speed of viscometer was ranged from 0.1 to 1.6 s^{-1} using specific spindle S-61. The computer software (Rheolac 3.1) was applied to control viscometer and data acquisition. All experiments were carried out in three replications.

RESULTS

The influence of temperature on consistency coefficient was evaluated from Arrhenius relationship (Dak *et al*., 2007):

$$K = A_0 e^{\frac{E_0}{RT}} \quad (1)$$

where:
K –consistency coefficient,
A_0 – constant,
E_a - activation energy of flow (kJ·mol^{-1} K^{-1}),
R - universal gas constant (kJ·mol^{-1} K^{-1}),
T - absolute temperature (K).

The influence of concentration on consistency coefficient was evaluated from exponential relationship (Dak et al., 2007):

$$K = aC^b \quad (2)$$

where:
a, b - constants,
C – concentration of solid in juice.

The consistency coefficient decreased with increases in temperature and shear rate. A decrease of the consistency was also observed with decrease in solid concentration. The value of flow behavior index was less than 1, which means pseudoplastic nature of tomato juice.

CONCLUSION

The apparent viscosity and the consistency coefficient depended on shear rate at all levels of temperature and solid concentration, which indicates on pseudoplastic nature of tomato juice.

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POSIBILITIES OF USAGE MODELING AND COMPUTER SIMULATION IN DESIGN AND OPTYMIZATION OF FOOD PRODUCTION

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Computer modeling and simulation constitute implements which allow to improve functionality of each factory, independent on the scale or character of work. Those implements find the application to project or optimize all of the elements of production process. They give the possibility to define demand for personnel and major product system, estimation of its productivity and efficient work planning. They support making decision at the managing delivery chain and realization of modern conception of production directing for example JiT.

The achievement of benefits during optimization is conditioning by creating of reliable model of simulating system. That is the main and determining element in optimized action which are using that kind of methods. This process is a complicated and multiphase task, which demand adequate skills information and equipment.

Rich offer of softeners and results of experimental work based on modeling and simulation techniques, prove reliability of those methods. In the ago-food industry modeling and computer simulation is used to predict vesturing of fruits and vegetables. It is also used to optimize that kind of processes like pasteurization, sterilization, drying and freezing. That prove high elasticity and versatility of those methods in optimization.

With the computer development which are useful to process more and more data at shorter time, the meaning of those techniques at the production activity will grow. Integrated production systems by using simulation will have the possibility to dynamic analyzed and control production processes with taking the consider to variation and stochastic character.

Simulation and modeling ensure the time and money savings. They give in addition easy implementation of the new solutions which bear the interest of high level of the customers satisfaction, at the same time it is the key to achieve factory success.

CANOLA MIDDLINGS STORAGE EFFECT ON THE INCREASE OF PATHOGENIC FUNGI

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keywords: storage, middlings of canola, disease-causing microorganisms, mycotoxins

INTRODUCTION

In spite of many publications which conclude problems concerning microflor in the storage of canola, it is still an open question. Microbiological index which defines the situation on the whole, can not be described only by the number of microorganisms. A large number of microorganism, does not always mean bad quality and low technological value of our material.

Warehousing the fodder for animals is very difficult and risky, especially in our climate. Higher humidity and temperature of about 20^{o}C are proper conditions for growing disease-causing microorganisms. Properly dried material, does not allow pathogenic bacteria to grow, because the accessibility of nutrients included in the material is limited by the low water content. But the fungi can grow to medium cultures with a low water content, even at the level of 5.0%. The mildews are widespread in the whole environment and are still the mainspring of putrefaction in agricultural products.

The climate is not the only factor causing material infection. Pollution, dampness and cracked constitute perfect conditions for pathogenic fungi to reproduce effect. Properly carried out harvest could lower the growth of pathogenic fungi during storage by half. Full ripeness of the seeds plays an important role, too. The seeds which are unripe have more moisture (about 2.0%), and that parameter can cause our material to be destroy.

The best moisture in which we should storage middlings of canola is 7.0%, and the temperature is 7.0^{o}C.

The most common fungi in the storage are Penicillium, Aspergillus (Fig. 1) and Fusarium. The middling of canola contains about 30% of total proteins and about 10% of crude fat, nevertheless it is still endangered by pathogenic fungi. (Leupp J. L. *et al*. 2006)

The spores produced by the fungi, produce mycelium, which penetrates our material and spreads little by little, at the same time feeding on its nutrients. In the beginning, the growth of moulds is not observable but it causes an easy increase of temperature and moisture. Meanwhile white, green, brown and black overgrowth moulds appear. Such a batch can have several million of spores.(Ryniecki P. 1998)

Most moulds produce natural compounds, which are unnecessary for a mould that is a producer. Mycotoxins are secondary metabolites of fungi. The most common mycotoxins are aflatoxins, ochratoxins A and zearalenon. (Michael Z. 2006). These mycotoxins have an large losses in the world, cause adverse impact on humans and animals; also unfavourably influence the quality of vegetable products. All the mentioned above factors have a significant effect on the national economy (Gajecki M. 2008).

In spite of fact that a lot of societies work on this topic constantly, the problem still remains unsolved.

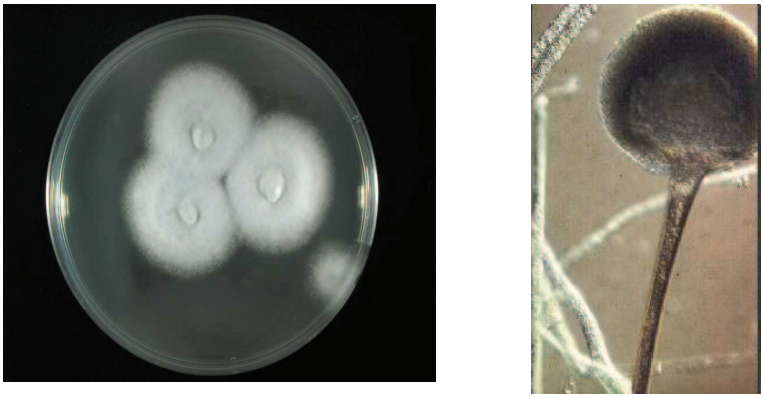

Fig. 1. *Aspergillus candidus*

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SLICE ELEMENT METHOD FOR ESTIMATION OF LOAD ON CYLINDRICAL INSERT IN GRAIN SILO

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LIST OF SYMBOLS USED

σ_v	- vertical stress	[Pa]	g=9.81	- earth's gravity	[m/s^2]
R	- silo radius	[m]	φ_w	- angle of wall friction	
r	- insert radius	[m]	φ_c	- angle of insert friction	
$\lambda = \sigma_v/\sigma_c$	- vertical to horizontal stress ratio		dz	- infinitesimal height	[m]
			z_0	- height from free surface of the grain to the top level of insert	
h	- insert height	[m]	L=2πr	- perimeter of the insert	[m]
ρ	- bulk density	[kg/m^3]			

The slice element method, was originally introduced for stress calculation in a vertical section of a silo by Janssen [1] in 1885. The method assumed constant bulk density and vertical stress along the cross-section of the bin and divided the silo into vertical slices with infinitesimal height dz. From the equilibrium of forces the differential equation was derived and stresses in silo fill and its shell were found. In the reported project the slice element method is used for calculation of vertical force acting on a cylindrical insert immersed in grain in the silo.

For calculations of vertical stresses two parts of the silo are considered: volume above the insert [1],[2] and the region between the top and the base of immersed cylinder. Pressure on the top surface of the grain was taken as a boundary condition for the upper region. For the lower region, solution of Janssen's equation for the proper height z_0 was used. The solution of the equilibrium equation for the area of the insert is as follows:

$$\sigma_v = \frac{\rho g}{N(r)}(1 - e^{-N(r)z}) + \sigma_0(z_0)e^{-N(r)z} \tag{1}$$

with:

$$N(r) = \frac{2\lambda(R\tan\phi_w + r\tan\phi_c)}{(R^2 - r^2)} \tag{2}$$

and $\sigma_0(z_0)$ is a solution of Janssen equation for top surface of the insert.

Vertical load on insert is given as:

$$F = \sigma_0 \pi r^2 - \lambda L \tan \phi_c \int_{z_0+h}^{z_0} \sigma_v dz \tag{3}$$

Figure below illustrates the solution of the equation (3) with: silo radius R equal to 0,2 m, coefficient of wall friction $\tan\varphi_w$ of 0,43, insert radius r of 0,075 m, coefficient of insert friction $\tan\varphi_c$ of 0,16 and stress ratio λ of 0,42. Parameters were adopted from an earlier performed laboratory testing. The calculated curve underestimate loads as compared to experimental data.

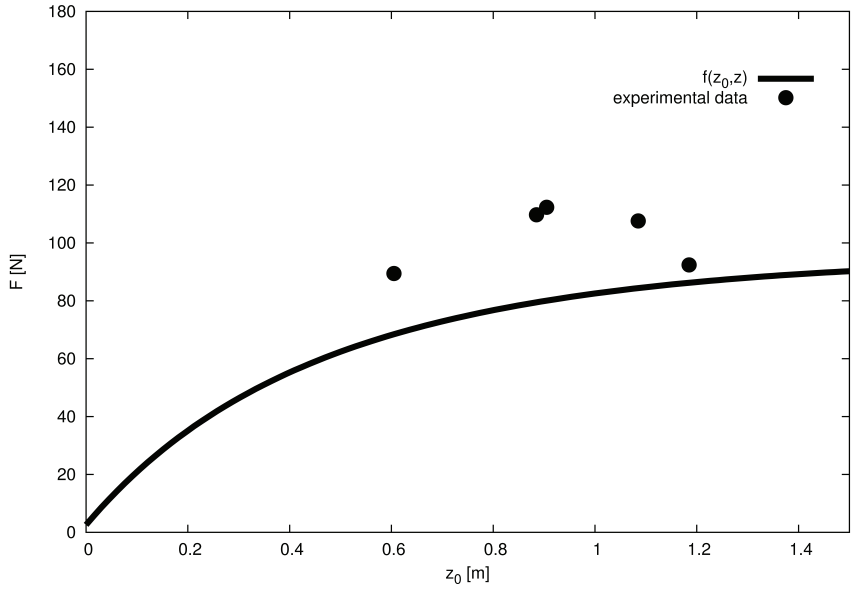

Fig. 1. Comparison between insert load calculated using slice element method and experimental data

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MEASUREMENTS OF SOLID CONCENTRATION CHANGES DURING SILO MUSIC USING TOMOGRAPHY

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keywords: cylindrical silo, ECT, dynamic effects, tomography, concentration

Abstract. The paper presents measurements of solid concentration changes during silo-music appearing in the course of confined granular flow in slender cylindrical silos. Solid concentration changes in the interior of the solid during gravitational silo emptying were measured with Electrical Capacitance Tomography sensors. Local 1D and cross-sectional 2D evolutions of solid concentrations in cohesionless sand during silo discharge were determined. The first ones were estimated directly from the raw measurement data and the latter were obtained from the reconstructed data by solving an inverse problem with a Linear Back Projection algorithm. The experiments in model silo were carried out with a different initial densities of the sand and wall roughness.

INTRODUCTION

The safety of silo structures is strictly connected with the knowledge of the distribution of bulk solid pressures on silo walls and silo bottom during silo discharge. It is especially important when discharging tall, slender silos wherein strong dynamic effects take often place as a result of a dynamic interaction between the flowing solid and silo structure (Tejchman 1998, Wilde *at al.* 2008). Measurements of concentration changes in the solid during dynamic silo flow have been performed using Electrical Capacitance Tomography (ECT) (Yang and Peng 2003, Niedostatkiewicz *at al.* 2009). It is a non-invasive method since it does not require a direct contact with the domain of interest and is a non-intrusive one since it does not disturb the physical process under examination. The target of the paper was to determine the location of pronounced solid concentration changes in its interior during silo music. The tests were carried out with initially loose sand and smooth silo walls.

EXPERIMENTAL SET-UP

Experiments were performed with a cylindrical perspex model silo (diameter d=0.2 m, height h=2.0 m, wall thickness 5 mm) containing non-cohesive, dry medium grain sand with a mean grain diameter of 0.8 mm. Sand was initially loose (volumetric weight γ=15.0 kN/m^3, void ratio e_0=0.76). Tests were performed for gravitational outflow with a diameter of the symmetric outlet of 0.07 m. Strong

dynamic effects accompanied by a booming sound, called “silo music” due to a dynamic interaction between solid and silo structure occurred from the beginning of the silo discharge during mass flow (Tejchman 1998, Wilde *at al.* 2008). They disappeared in the lower part of the silo when funnel flow took place. They were also suppressed when very rough walls were used. A change of mass into funnel flow was approximately in the middle of the silo height (0.85 m - 1.0 m above the outlet). The measurements of solid concentration changes were registered at the heights of h=0.30 m, h=0.85 m, h=1.0 m and h=1.5 m above the silo bottom; i.e. in the region of core flow (h=0.30 m), transition between core and mass flow (h=0.85-1.0 m) and upper mass flow (h=1.50 m), respectively. The ECT system was equipped with two sensors consisting of 12 electrodes surrounding the insulative silo. The solid concentration changes (directly related to the dielectric permittivity distribution) were expressed by a relationship between the solid area in the selected cross-section to the area of the entire silo cross-section–in the form of 1D plots (based on the raw data) and 2D images called topograms (based on the reconstructed data by using a Linear Back Projection algorithm). The 1D plots were evaluated in two different profiles: cross-sectional and along periphery.

TEST RESULTS

For the measurements at the height h=0.85 m above the silo bottom, pronounced fluctuations of solid concentration changes (based on the raw data measurement) in time took place for all pairs of the sensors at the wall (Fig.1). At the height h=0.30 m (i.e. in the area of funnel flow), sand pulsations did not occur. In turn, at the height of h=1.50 m, weak pulsations were observed due to free motion of the silo top. The results of the 2D visualization (reconstructed data) of the sand concentration (Fig.2) clearly indicate that at the height of about 0.85 m, flow changes from mass into funnel flow. Thus, a change of the flow type at the height of 0.85 m creates a natural hopper where the solid varies its flow(shear) direction. Due to that, pulsations of the material volume occur which lead in the presence of inertial forces and a frequency accordance between flowing sand and silo structure to strong dynamic effects.

Figure 3 shows the evolution of solid concentration at five different points on the basis of the reconstructed data (Fig.3). The measurements at h=0.85 m, 1.00 m and 1.50 m confirm also the presence of strong pulsations during flow. The final amplitudes of pulsations were composed based on a signal trend analysis. The signals were decomposed into a slowly varying component and an oscillating term by a moving window approximation by a third order polynomial through the least squares method. Next, the results of the amplitude distribution in cross-sections of the silo were shown in the form of 1D plots (Fig.4). The amplitudes of the pulsations are the highest at the height of h=0.85 m. Significant amplitudes

in the centre of the cross-section were also visible at the height of 1.00 m and 1.50 m. The amplitudes along the section points at the height of 0.30 m were the smallest due to funnel flow and stagnant zones.

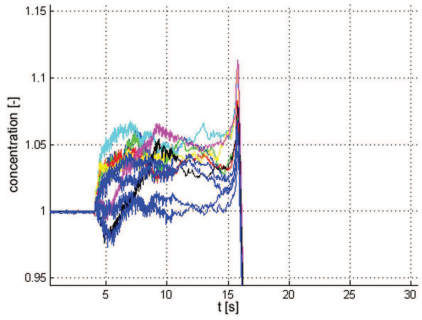

Fig. 1. Measured solid concentration changes in sand close to the wall during silo emptying at height h=0.85 m above the bottom (raw data)

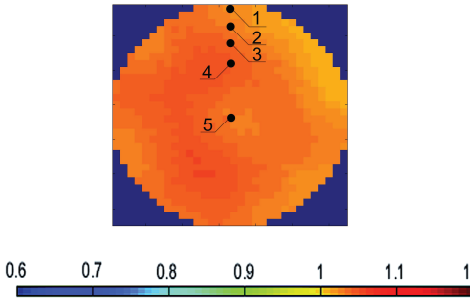

Fig. 2. 2D visualization of cross-sectional concentration changes of sand during silo emptying at height h=0.85 m at t=5 s (reconstructed data)

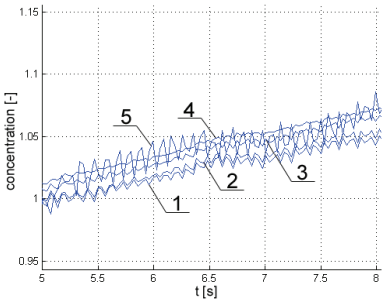

Fig. 3. Time responses of bulk solid concentration, during silo emptying at height h = 0.85 m for points 1, 2, 3, 4 and 5 of Fig.2 (reconstructed data)

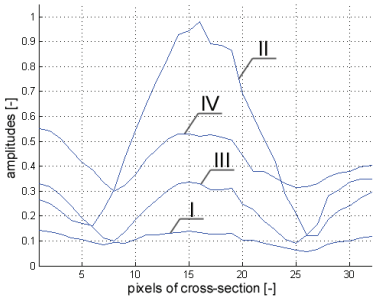

Fig. 4. 1D plots of amplitudes of concentration changes in cross-sections at height h=0.30 m (I), h=0.85 m (II), h=1.00 m (III), h=1.50 m (IV) (reconstructed data)

CONCLUSIONS

The results of the ECT method were demonstrated as continuous 1D curves showing the evolution of the solid concentration between arbitrary electrodes and as a 2D reconstructed cross-section images. The measurements indicate an existence of strong dynamic pulsations of the solid concentration in its interior during flow. The dynamic effects have their origin in the transition zone between

mass and funnel flow. They are generated by a change of the flow direction caused by an internal natural hopper.

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EVOLUTIONS OF SOLID CONCENTRATIONS IN RECTANGULAR SILOS USING ELECTRICAL CAPACITANCE TOMOGRAPHY (ECT)

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keywords: rectangular silo, ECT, tomography, concentration

Abstract. The paper presents results of solid concentration changes in bulk solids during granular flow in a rectangular silo with an Electrical Capacitance Tomography sensor located around the silo, both at the bin and at the hopper. Local 1D evolutions of solid concentrations in cohesionless sand during silo discharge were shown. They were estimated directly from the raw measurement data. The experiments in model silo were carried out with a different initial density of cohesionless sand and wall roughness.

INTRODUCTION

Electrical capacitance tomography (ECT) is the powerful measurement technique due to its high-speed capability, low construction cost, high safety and suitability for small or large containers (Williams and Beck 1995). ECT is used to obtain information about the spatial distribution of a mixture of dielectric materials inside an insulating vessel by measuring electrical capacitances between sets of electrodes placed around its periphery. It takes into account the fact that density changes in materials are proportional to the variation of the dielectric permittivity. Tomography technique is non-invasive (it requires no direct contact

between the sensor and the object or domain of interest) and is non-intrusive (it does not disturb the nature of objects being explored).

The intention of the presented results is to check the capability of ECT to determine solid concentrations during granular flow in a rectangular model silo. The results of concentration changes in cohesionlesss sand during silo flow were mainly presented as 1D plots (based on the raw data). The ECT method has been already successfully applied by authors to measure solid concentration changes in cohesionless sand during gravitational granular flow in a model silo with a cylindrical cross-section (Niedostatkiewicz *et al*. 2009). The ECT sensors have been also applied in rectangular containers by other researchers (Yang and Liu 1999), but they have been used to measure solid concentration changes in materials significantly different than sand and during static problems only.

EXPERIMENTS

Laboratory tests were carried out with a rectangular perspex model silo consisting of a bin and hopper during a dynamic mass flow. The height of the model silo was h=0.34 m, the width b=0.09 m and the depth d=0.07 m. The wall thickness was 5 mm. The tests were performed with a dry cohesionless sand with a mean grain diameter of d_{50}=0.8 mm. The effect of the initial solid density and wall roughness on the behavior of solids during silo flow was taken into account. Initially loose sand (with initial void ratio of e_o=0.82) was obtained by filling the silo from a pipe located directly above the upper sand surface which was vertically lifted during silo filling. Initially dense sand (e_o=0.55) was obtained by filling the silo using a so-called "rain method" (through a vertically movable sieve put always 0.20 m above the upper sand surface in the symmetry axis). The silo was emptied gravitationally by a rectangular outlet 0.005×0.07 m^2 located in the symmetry axi. A wall surface with a high roughness r_w was obtained by sticking a sand paper to the interior wall surface ($r_w \approx d_{50}$). The sand paper was fixed to the narrower walls in a model silo only (wider walls were always smooth).

48 electrodes were mounted onto the outer surface of the perspex silo (14 on each of the wider silo wall, 10 on each of the narrower wall). The tomography system registered 11 measurement frames per second, each frame consisted of 496 measurements. On the wider walls, 6 electrodes were rectangular 40.5×40.5 mm^2 (in the bin), 4 were multi-rectangular and 4 were triangular (in the hopper). In the case of narrower walls all electrodes were rectangular: 8 with dimensions 31.5×31.5 mm^2 (along the bin and along the upper part of the hopper) and 2 with dimensions 31.5×63.5 mm^2 (along the hopper bottom of the hopper). The sensors were equipped with ground electrodes to reduce fringe effects.

The solid concentration changes (related to the dielectric permittivity distribution) were expressed mainly in the form of 1D plots based on the so-called raw data. The 1D plots were performed for two different profiles: a cross-sectional and a wall one. The cross-sectional and wall values were obtained from a direct measurement between the electrodes in the bin at the heights of h=0.02 m and h=0.07 m above the transition between the bin and hopper and in the hopper at the height of h=0.02 m below the transition between the bin and hopper.

The values of the solid concentration between different pairs of electrodes at the same level of the silo differed by about 5% (initially loose sand) and 10% (initially dense sand).

RESULTS

The test results of 1D evolutions of the sand concentration for cross-sectional profiles at the height of 0.02 m above the transition between the bin and hopper during granular flow in the silo with smooth and very rough walls are demonstrated in Fig.1. The black arrows denote the end of measurements. The concentration values below 1 means material dilatancy (volume increase as compared to the initial state before silo discharge) and the concentration values above 1 means contractancy (volume decrease with respect to the initial state before silo discharge). In general, sand similarly behaved in cross-sectional and wall profiles independently of the wall roughness and initial density. The differences were of the order of 5%, both on case of measurement in the bin and in the hopper. In the bin with smooth walls, initially loose sand first slightly contracted (by 3-5%) and then slightly dilated (by 3%) (Fig.1a). In the hopper with smooth walls, initially loose sand was continuously subjected to dilatancy (by 13%) (concentration decreased). Initially dense sand shown dilatancy in the silo with smooth walls only (by 13%) (Fig.1b). In the hopper sand dilated (by 22%) with respect to the initial concentration.

In the silo with very rough walls, sand experienced mainly dilatancy. Initially loose sand slightly contracted at the beginning of the entire silo, and then dilated (by 0-5%) (Fig.1c). In turn, initially dense sand dilated only (by 23%) (Fig.1d) with respect to the begin of emptying. In the hopper sand strongly dilated (by 15% for initially loose sand and 28% for initially dense sand).

CONCLUSIONS

A tomography system based on ECT sensor has been applied to determine solid concentration changes during granular flow in a rectangular model silo. The results were demonstrated as evolutions of the solid concentration between electrodes at the same level, both in the bin and in the hopper. Based on the raw data presented in

form of continuous 1D plots, the solid concentration changes seem to be realistic during silo flow. They depend on to initial sand density and wall roughness.

Our experiments will be continued. The reconstructed 2D images of horizontal cross-sections will be improved to obtain a satisfactory agreement in the solid concentration between the raw and reconstructed data.

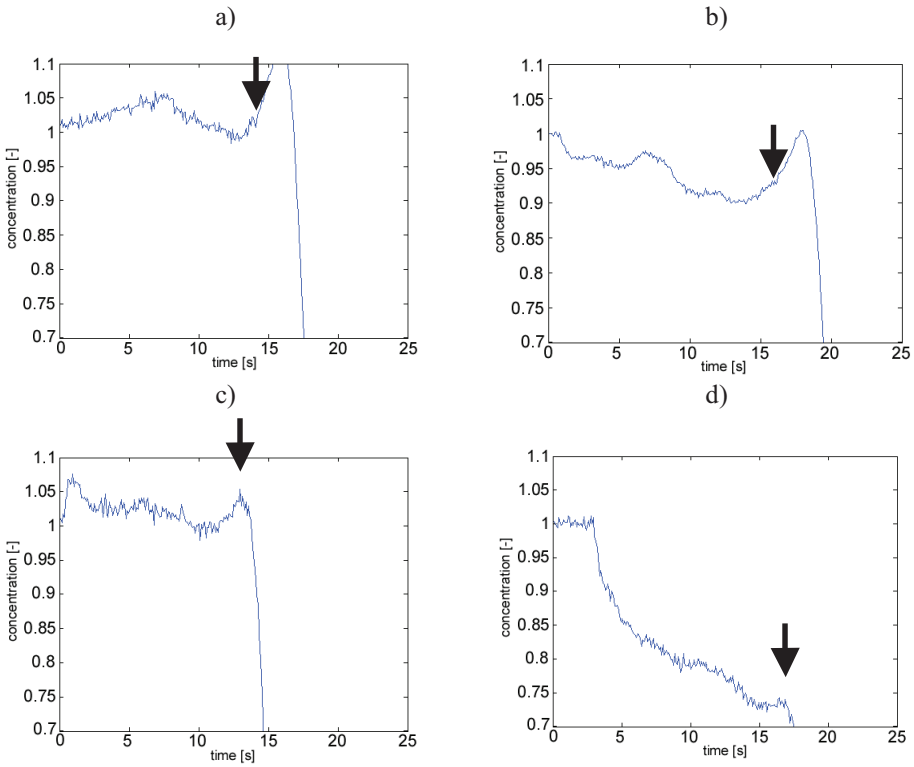

Fig. 1. Concentration changes of sand during silo emptying at height h=0.02 m above the transition between the bin and hopper: a) initially loose sand, smooth walls, b) initially dense sand, smooth walls, c) initially loose sand, very rough walls, d) initially dense sand, very rough walls

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THE TECHNICAL ASPECTS OF UTYLIZATION OF STRAW THE TOPINAMBUR ON ENERGETISTIC AIMS

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The logging with biomass the energy is the far-reaching direction of development of unconventional sources energy. The search the new technologies of processing how search with 1 hectare of plantation the species about larger efficiency of dry biomass also. Topinambur be exchanged as energetistic plant often. Recommended to direct burning the above - ground parts as substratum to production of biogas (Kościk 2003).

AIM OF WORK

The performance of possibility of utilization of straw is the aim of work topinamburu.

RANGE OF WORK

The range of work hugs:

- the investigation of usefulness the topinamburu under energetistic regard, qualification of Heating value and the Calorific value;
- the analysis of results of investigations.

METHODOLOGY OF INVESTIGATIONS

Tuberous sunflower is the object of investigations of above mentioned work (topinambur).

Samples to investigations were taken in months: November-January. The preparation of samples hugged:

- taken the crumbling the stems from plot of ground, the transportation to laboratory;
- proper measurement.

It the led investigations over qualification of Heating value and the Calorific value was executed was for help of calorimeter the kl -12, fulfilling requirement of Polish Norm.

RESULTS OF INVESTIGATIONS

It sample to investigations was intended was the topinamburu of white change and purple. Division was introduced on two kinds of samples additionally:

• stem + letter,
• stem(without lists).

ANALYSIS OF RESULTS OF INVESTIGATIONS

The sign the tan value and the Calorific value for straw the conducted at Institute of Chemical Alteration of Carbon in Zabrzu topinambur, they showed, that the Heating value carries out 15,93 MJ / the kg, and the Calorific value 17,19 MJ / the kg, near moisture 10% [Piskier 2006]. Got results in investigation with division on purple and white they permitted to affirm lower Heating value. Resulting with fact not redrying to equal moisture samples. it near moisture 14,2% the Heating value was received was 14 MJ / the kg and the Calorific value 15,4 MJ / the kg .

SUMMARY AND CONCLUSIONS

1. Heating Value and designed the Calorific value dependent are from moisture of material to burning.
2. purple Topinambur possesses from white topinamburu larger Heating value and the same purple topinambur to tillage on energetistic cells be indicated .
3. Occurrence in samples leaves enlarged their moisture and this was translated on fall of Heating value of studied material directly.

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AIR FLOW AND EFFICIENCY ANALYSIS IN A SOLAR DRYER

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keywords: solar energy, drying, airflow, velocity distribution, efficiency

Nowadays near pollution of environment the pollution of our body is also central concern. The modern technology of food industry and used additives induce more and more medical problems. The either important traditional, healthy method of food packing is solar drying. In this paper the effect of the solar air collector module for the physical properties of drying air was studied along with the calculation of efficiency, too. The mass flow of the drying air through the system is one of the most important factor, for that reason the velocity distribution is also presented. Finally some measuring results are discussed for drying of apple.

INTRODUCTION

As consequence of uncertain economic situation, autonomous solutions come to the front in all area of life. Responsibility for environment inspires to use just the necessary amount of energy and to cover if as much as possible from renewables. To solve the above detailed problem assists the quality reservation of our foods for good quality by solar dryer.

In this paper analytical and experimental results are detailed in reference to a modular solar dryer.

APPLIED EQUIPMENT

The studied solar dryer has three main parts: drying cabin with chimney, a PV module with an electrical fan for artificial air circulation and an air solar collector attachable to the dryer for preheating the inlet air.

RESULTS

The effect of the solar heating for the flowing air: the natural convection was investigated due to the incoming solar radiation. In the applied model the collector was considered as a simple tube and in case of the low air speed of the natural convection the air flow is considered to be stationer. The Bernoulli equation and laws of gas were used, the results in a typical summer day when the inlet air speed is about 5 cm/s due to the natural ventilation, the temperature change of the air flow 18 K and change of the pressure is negligible.

A typical relative air speed distribution based on the flow measurement data is presented in Fig. 1.

Beside the velocity distribution of the drying air some preliminary air flow distribution with flow curves was recorded with the help of a video camera. Solid CO_2 was put onto the drying trashes of the drying cabinet and a forced ventilation was started with the help of the electrical fan. The sublimating CO_2 has drawn the airflow curves with traces detectable for the camera (Fig. 2).

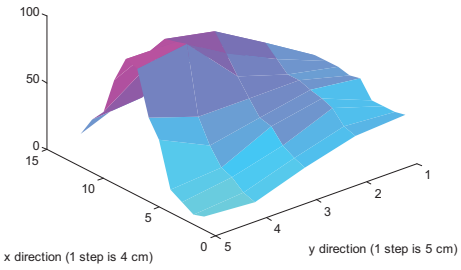

Fig. 1. Relative airflow distribution at the inlet of the dryer

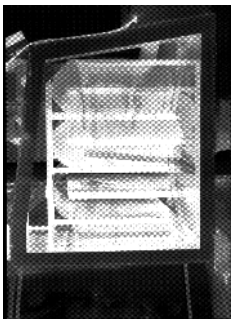

Fig. 2. Air flow experiment by sublimating CO_2

Some basic measurement was carried out with several short of fruits and vegetables. One example is shown in Fig. 3.

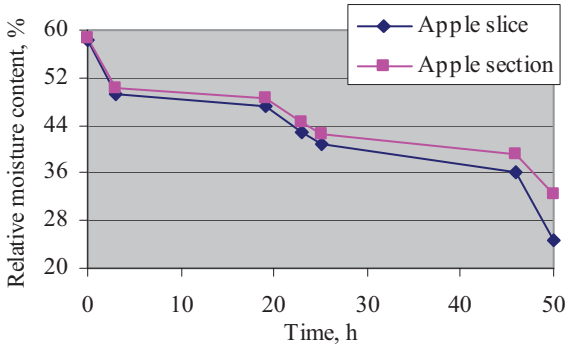

Fig. 3. Comparison of the drying curves of apple slices and sections

CONCLUSIONS

1. The governing analytical model was given for velocity, pressure and temperature change of the air flow in the solar heated collector.
2. The efficiency of solar collector during the entire measurement was determined as 35%.
3. The special measuring sensor was developed for measured the airflow distribution of the inlet of the dryer.

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ECOLOGY AND WORK QUALITY OF FAN FLAT NOZZLES

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keywords: wear nozzle, drop tracks, flow rate

INTRODUCTION

The quality of spraying machine work is affected by several technological, technical and climatic factors, the most important of which include the type of machine, choice of nozzles, appropriate spray parameters, temperature and humidity as well as following the instructions of plant protection agents producers. (Sawa *et al.* 2003). It should be noted that nozzle wear degree has a decisive effect on spray quality. Speed wear nozzle depends on their outlet size and nozzle material as well as working time (Wargocki 1995). The consequence of nozzle wear is increase in drops mean diameter. Nozzle wear influences merging degree of drops, which causes drops to flow off the surface of protected plants. Consequently, plant protection agents permeate into underground water and contaminate environment (Biziuk *et al.* 2001).

MATERIAL AND METHOD

Laboratory nozzle wear tests were conducted in the Department of Machinery Exploitation and Management in Agricultural Engineering, University of Life Sciences in Lublin.

New nozzles (LECHLER 110-03; plastic) of nominal flow rate 1,17 l/min were destroyed by 3 bar pressure. The nozzles were destroyed to reach 10% wear rates, which was calculated by comparing changes in liquid flow rate from each nozzle to nominal flow rate. Water solution of kaolin was used for destroying nozzles. 9,8 kg of kaolin was added into 150 l of water (Ozkan *et al.* 1992).

Drop track diameter and spray coverage degree were calculated using the computer programme Image Pro+ made by Media Cybernetics.

RESULTS

Analyzing the test results (Table 1) it was found that with the nominal flow rate nozzles produce drop track which can be qualified as small drop spray and medium drop spray. Increase in flow rate changes classifications of spray drop track. After achieving 10% of nozzle wear degree, nozzles produce drop track which can be qualified as large drop spray. Increase in flow rate and drop spectra have influence on dripping of plant protection agents off plant surfaces, which causes pesticide to permeate into soil and underground water. Also excessive number of drops on plant surface causes drop merging, which deteriorates spray quality and incurs economic loss.

Rise in working pressure increases coverage degree. The explanation to this fact is that large pressure causes nozzles to produce small drops in spite of their wear. As a result, worn out nozzles dose large volumes of liquid and consequently, coverage degree also increases.

Table 1. Choose investigations results

Detail	Units of measurement	New nozzle	Nozzle after 10% wear rates
Working pressure	MPa	0,3	0,3
Working speed	km h^{-1}	7	7
Flow rate	l min^{-1}	1,17	1,29
Change of drop track	ø µm, %	165,02 100	306,24 189
Change in coverage degree	%	46,01	58,87

CONCLUSIONS

The investigation confirmed the influence of nozzle wear on spray ecological characteristics. Increase in nozzle wear degree causes changes in track size left on spray surface. In this case it must be taken into consideration that large drop spray has limited effectiveness, for example in relation to fungi diseases, and at the same time drops flow off protected plant onto ground surface. Increase in nozzle wear causes rise in coverage degree. This relation results from generating drops by worn nozzles which leave tracks with larger diameter. Increase in working speed causes decrease in coverage degree. These results can be used in practice, because the conducted experiment explained that nozzle wear degree has influence on ecological characteristics of agricultural spray.

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THE MEASURE OF THE ACCUMULATOR'S VOLTAGE IN THE OFF-GRID PV SYSTEMS

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INTRODUCTION

The photovoltaic (PV) is clear and perspective source of removable electrical energy. The installation of PV power plant is on the increase yearly. The PV energy source is important in remote places. The other form of energy supply is difficult or impossible here. The research of grid PV system and off-grid PV system is in progress in the CULS in Prague, department of physics.

One of problems in the off-grid PV system is accumulator's voltage. The accumulator is a part with high level of risk in real condition work. For long-term operation with satisfactory efficiency is necessary precision measure of accumulator's terminal voltage. Because this voltage is measured during the charge process, this data isn't correct. The charge current is regulated with PWM method. The potential on the terminal voltage contain voltage's ripple. The method which is describe below, sketch the one of method unsinkable in practice, how is possible make the measure of accumulator's voltage.

MEASURING METHOD

If the Pulse-width modulation (PWM) is used for charge current's regulation, the voltage on the accumulator's terminal hasn't constant value. There is voltage ripple, as showed in fig. 1. This voltage's ripple make difficult for measure of exact accumulator's voltage. So we need this voltage as a pointer for an assessment of accumulator's state. If we measuring upper value as the real, the effectively of energy accumulation is decreasing. On the contrary, the lower value results in a charge with gassing in electrolyte, and accumulator's lifetime in autonomy system is decreasing.

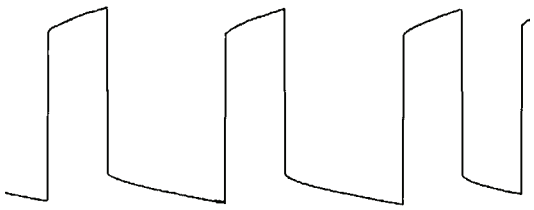

Fig. 1. The voltage's ripple on the accumulator's terminal

The voltage's ripple is caused by the electrolyte ion diffusion during the charge process.

This process can be described by formula:

$$j_D = -L_{DD}\nabla c$$

In the one-dimensional space (the direction of diffusion in the electrolyte is perpendicular to accumulator's desks):

$$\Re^3 \rightarrow \Re^1 \qquad J_x = -D_{DD}\frac{dn_a}{dx}$$

We can change this linear differential equation. The suitable equation is integrating element equation. The fact, that that equation is acceptable, is long-term course (Fig. 2) of accumulator's terminal voltage after unit step on accumulator's terminal.

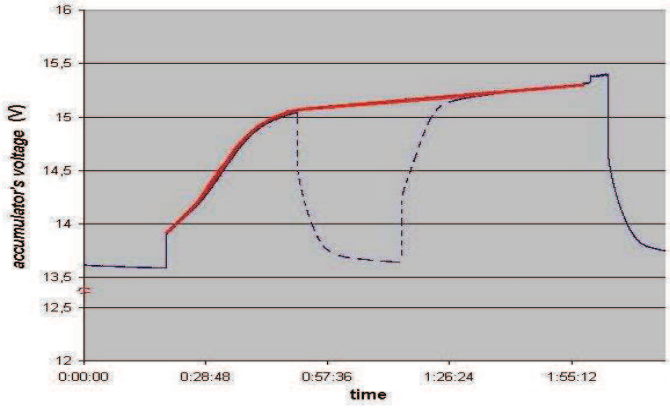

Fig. 2. The long-term record of accumulator's terminal voltage

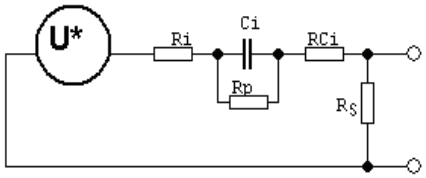

Fig. 3. The spare scheme of accumulator during the charge proces

So we have the spare scheme during the charging process (fig. 3). The general solution of the problem will be:

$$y(t) = y(0+).e^{\frac{-t}{\tau}}$$

We need the time-constant (τ) for solving of equation mented above. This constant can be measured as the part of control algorithm. The time constant is measured after finishing of the charge process. The time-constant is measured if the load is supplied from PV collector entirely.

CONCLUSION

The determinate of the accumulation state is the essential and difficult problem for a solar regulator in the autonomy PV systems.
The method mention above is an effective method for increase of the energy accumulation in the autonomy off-grid PV system. This method is possible implement in to a control algorithm.

PRESSURE DROP MEASUREMENT THROUGH WILLOW CHIPS AND CHUNKS

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keywords: drying, porosity, pressure drop, energy wood

An important type of the biomass is the energy forest, where the drying needs more energy and time than in other cases (e.g. grass). For the drying the airflow is an important factor as it takes out the moisture from the surface of the wood. During the research the pressure drop causing airflow through packed bed of willow chips and chunks was investigated. The relationship between the pressure drop and the air volume flow is presented, along with the used measuring method.

INTRODUCTION

Among the various possible methods for using alternative energy sources one possible solution is the energy forest, as it is a closed circle for the CO_2. In the developing of this energy source there is an important question. The moisture content of the fresh harvested wood is too high (approximately 100% on dry base) for the immediate use so is has to be dried first. The speed of the process and the energy need of the forced drying is depending very much on the volume flow of the drying air. In this study, the circumstances of the airflow through a layer of willow chips and chunks are presented. The investigation of the air volume flow as a function of the pressure difference was carried out.

THEORY

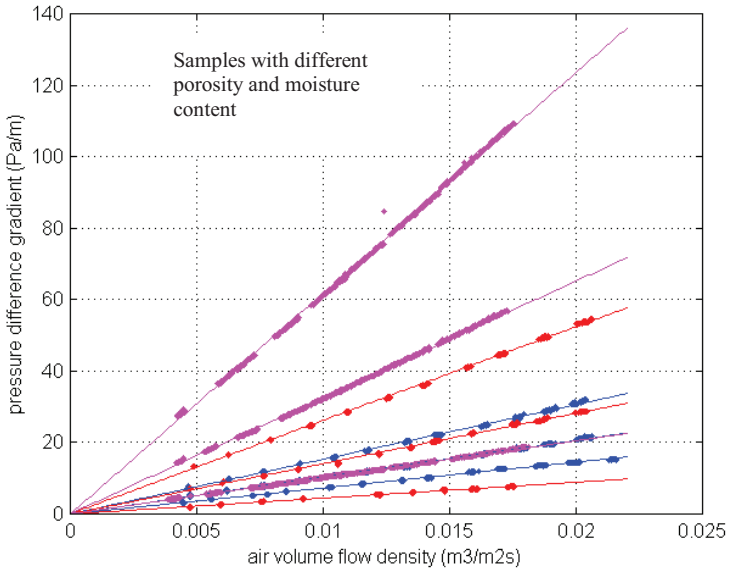
With the help of the physical theory of laminar flow the modified Reynolds number for porous media. For flows of homogenous incompressible fluids with small Reynolds numbers through a porous media the Darcy's law can be applied say in the form for one dimension case. Forcheimer introduced a 'developed Darcy's law' by introducing higher order parts to the original Darcy's law as:

$$-\frac{dp}{dx} = \alpha \cdot v_x + \beta \cdot v_x^2 \cdot$$

MEASUREMENTS

For the low range air speed measurement a special experimental equipment was used which was developed and built in the Wageningen University. The main parts of the system is the two water tanks, the pump, the flow rate meter (volume-current meter), the air route changer valve and the pipes. The idea of the measurement, that water is coming down in controlled rate from an upper water tank to a lower one, and the air inlet of the upper tank is connected to the drying cabinet. In this way the air volume current is equal to the water volume current, what can be measured more exactly because of its higher density.

Size, density, moisture content and porosity measurements were also elaborated. With the equipment the air volume flow as a function of the pressure difference on the two sides of the chunk layer can be determined.



RESULTS

For low air volume flow (<1,2 liter/s) a linear change can be predicted between the volume flow current and the pressure gradient through chips or hunks layers, but for higher volume flow (1,2-3,0 liter/s) second order polynomial fitting necessary for getting a reasonable fit.

On the base of the theory with the help of the tortuosity the first order coefficient of the fit can be calculated.

The change of the moisture content gives much bigger differences then the change in the porosity for chips.

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TEMPERATURE EFFECT ON BIOSPECKLE DYNAMICS

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Surface of most materials are extremely rough on a scale of an optical wavelength. When laser light is scattered from such a surface, the optical wave consists of many components or wavelets, each arising from a microscopic element of the surface. An interference of the coherent wavelets differing in phase results in a granular pattern of intensity that is called speckle.

When the laser light impinges on the surface of a biological sample it will pass through one or more layers (air space, skin, cell walls) each of them will act as a stationary diffuser. Particles within the material are thus illuminated by the laser beam and will scatter the laser light back out through the air space. If these particles are in motion, the speckle reveals temporal fluctuations and is said to "boil" or "twinkle". This phenomenon had been referred to as "biospeckle" (Braga Jr *et al.* 2003).

Speckle technique has been used for measuring blood flow in the retina or skin, detection of the aging of a botanical sample, determination of bruising in fruits, assessment of seed viability and as a tool to control many processes such as drying of paints or ice cream melting. So the scattered intensity distribution along time can be used to characterize the degree of activity in respective process.

The aim of this work is presenting temperature effect on the biospeckle dynamics in relation to biological material.

In the experiment apples were illuminated by source of coherent light (low power He-Ne laser with λ = 632,8 nm), the scattered light was detected by the charge-couple device (CCD) camera connected to host computer and the successive images were registered and stored.

Two methods were employed in order to evaluate the activity of the dynamic speckle patterns. In the first method 20 grayscale bitmap images, having a resolution of 640x480 pixels were recorded with 1s intervals between two adjacent frames. Next cross-correlation coefficients $C^{k\tau}$ were calculated using equation (1):

$$C^{k\tau} = \left| \frac{\left\langle \left(S_{ij}^{\tau_0} - \left\langle S_{ij}^{\tau_0} \right\rangle \right) \left(S_{ij}^{\tau_0 + k\tau} - \left\langle S_{ij}^{\tau_0 + k\tau} \right\rangle \right) \right\rangle}{\sigma_{ij}^{\tau_0} \cdot \sigma_{ij}^{\tau_0 + k\tau}} \right| \tag{1}$$

Where: *i,j* is the pixel number, S_{ij} – the pixel intensity, τ-time interval, *k* - frame number and σ is the variance (Zdunek *et al.* 2007).

The second method is based on the measurement of the spread of the number of intensity levels variations in time in the spatial temporal speckle pattern. In this step 512 successive images were recorded (15 frame per second) and moment of inertia of co–occurrence matrix was calculated according to equation (2):

$$IM = \sum_{ij} M_{ij} (i - j)^2 \tag{2}$$

Where M_{ij} is normalized co-occurrence matrix:

$$M_{ij} = \frac{N_{ij}}{\sum_j N_{ij}} \tag{3}$$

Where N_{ij} is the number of occurrences of gray level *i* followed by a grey level *j* in the spatial temporal speckle pattern (Arizaga *et al*. 1999).

Biospeckle measurements were carried out for different temperatures of samples, from -20°C to room temperature. In this range of temperature cross-correlation coefficients and *IM* values were determined to find dependency between obtained parameters and sample state.

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THE INFLUENCE OF SOIL SURFACE SLOPE ON RAINDROP DETACHMENT IN A LABORATORY EXPERIMENTS

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INTRODUCTION

The process of erosion by water consist of four phases: the detachment of soil particles from the soil by raindrop impact, detachment by runoff, the transport of the detached particles by raindrop impact, and transport by runoff. Through its ability to detach soil particles, raindrop impact is the first stage in the soil erosion process. The purpose of the studies was evaluation of the effect of soil surface slope on raindrop detachment during rainfalls with constant intensity and initially air-dry soil.

MATERIAL AND METHOD

Studies were conducted on silt loam soil developed from loess characterised by 17% of sand, 76% of silt, 7% of clay, and pH 4.5 of KCl. Soil samples were placed in a small box (25x36x14 cm) under 4, 12 or 25% slope and exposed to simulated rainfall with the intensity of 54 mm h^{-1} (cumulative rainfall 54 mm). Short box was used to eliminate ability of runoff to detach soil particles. In consequence the influence of soil surface slope on raindrop detachment was possible to measurement. The same initial soil moisture (air-dry, 1.6% vol.) and soil bulk density (1.26 g cm^{-3} measured at the depth of 0-5 cm) were used. During each rainfall simulation runoff, soil loss and splash detachment was collected in 5 minute intervals. Additionally splash detachment was collected in 3 independent directions relative to slope: down, up and crosswise. Studies were conducted in 3 replications.

RESULTS

Laboratory experiments showed that rainfall on surface with 4, 12 and 25% of slope caused initiation of surface runoff after 10, 7 and 3 mm of cumulative rainfall, respectively (Fig. 1). Analysis of obtained results showed that runoff achieved comparable steady-state level in all slopes of measurements. Steady-state level of soil wash and its volume increment indicated bigger diversity for used slopes. Under maximum slope (25%) steady-state level of wash was 4 times

higher than under minimal slope (4%). It must be noticed, that in spite of similar surface runoff the different curves of wash (raindrop detachment) were obtained. Final soil moisture content measured at the depth of 3 cm was about 29% vol. regardless of surface slope. The obtained data indicate that increase of soil surface slope exposed to simulated rainfall contributed to increase of soil splash, which ranged from 6 to 35%.

CONCLUSIONS

Studies based on rainfall simulations showed, among other things, that susceptibility to raindrop detachment increased rapidly with soil surface slope increasing. Therefore conducted laboratory experiments indicated that silt loam soil developed from loess was very susceptible to sheet or interrill erosion.

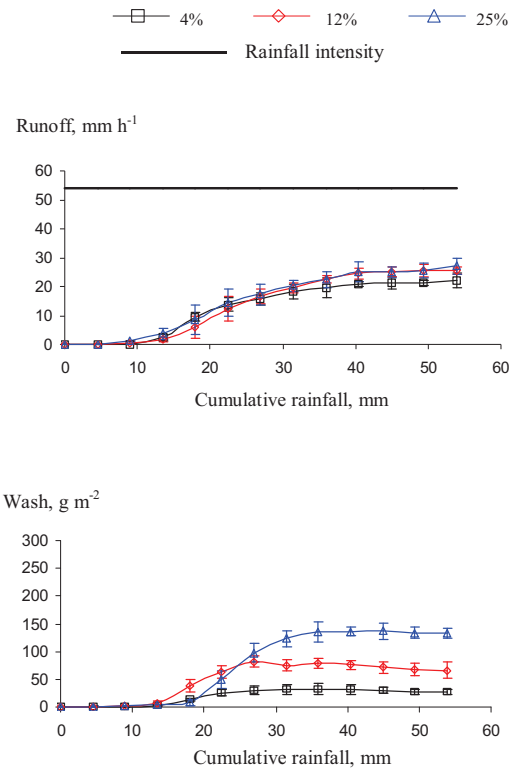

Fig. 1. Trends in runoff and soil wash (raindrop detachment) during the rainfall simulation for each slope gradient: 4, 12 and 25%

ELECTRICAL PROPERTIES OF DRIED FRUITS

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keywords: electrical properties, capacitance, impedance, LCR meter

Electrical properties of materials are utilized in many areas of human activities and most frequently are applied at the moisture content measurements. Electrical properties of porous materials are influenced by the characteristics of the air, which is trapped in the pores, most especially its relative humidity and temperature. Among the influential factors for porous materials, the following can be named: size and distribution of pores, porosity and bulk density. Further factors are temperature of the material, but the most significant is the influence of the presence of water, its uneven deployment in the material, different binding energy in each water bond in the material and sorption properties (Hlaváčová, 1994).

The temperature and moisture content have important role at the selection of suitable regime of the storage. These are the most important parameters that influence physical and physiological processes which run in the stored plant products. Dried fruits with very low moisture content have good assumptions for the long storage.

Samples of dried fruits were delivered twice by Faculty of Agriculture of University in Novi Sad. First samples were with very low moisture content. Second samples were apricots variety of, Novosadska rodna. These apricots were dried in osmotic drier on the beginning and in convective drier after it.

LCR meters are the most suitable devices for measuring these electrical properties of biological materials. Electrical properties (impedance, electrical capacity) were measured by LCR meter GoodWill LCR-821. We measured resistance, impedance and capacitance of these materials. Measurements had been realized at frequencies from 50 Hz to 200 kHz. The measured values were loaded by PC. Each electrical property was measured at all frequencies three times. Average value has been computed from these ones. Frequency dependencies of the electrical properties at various moisture contents were constructed.

The regression equation has the shape of decreasing power function. These regression equations have high coefficients of determination. We can deduce that the method of drying ensured the same properties of all fruit pieces.

BIOGAS – PRODUCTION AND USE

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keywords: biogas, anaerobic digestion, liquid manure

In the year 2008 the European Commission has accepted the Renewable Energy Directive, which among other things sets a goal of reaching the minimum of 20% energy to be produced from renewable resources by the year 2020. One of such resources is biogas. It is a mixture of methane and carbon dioxide produced from organic matter in a process of anaerobic digestion. This process consists of three phases: hydrolysis of input material, acidic fermentation and methane fermentation. Biogas can contain 55-80% of methane and 20-45% of carbon dioxide. Other gases that the mixture comprises are: hydrogen sulfide (0,08-5,5%), hydrogen (0-2,1%), nitrogen (0,6-7,5%), oxygen (0-1%). [Institut für Energetik und Umwelt gGmbH]. Biogas can emerge naturally on swamps, landfills, in sewage sludge or can be produced as a result of expedient human activity in biogas plants [Podkówka 2006].

The calorific value of biogas depends on the amount of methane that it comprises. Biogas that contains 65% of methane has a calorific value of 23 $MJ \cdot m^{-3}$. Compared to traditional energy sources biogas seems to be a good substitute. As an example one cubic meter of biogas with calorific value of 26 $MJ \cdot m^{-3}$ can replace 0,77 m^3 of natural gas, 1,1 kg of hard carbon or 2 kg of wood [Oniszek-Popławska et al. 2003].

As a substrate for biogas production we can use almost any type of organic matter. In agricultural biogas plants manure and liquid manure are the main sources of biomass. Liquid manure is not the ideal feedstock for biogas plants because its C:N ratio is 6,8:1 whereas the ideal C:N ratio for biogas production is 20-30:1 (Czuba et al. 1996). Because of that the most efficient way of producing biogas is codigestion of liquid manure with other types of biodegradable material. Some technologies like the German NaWaRo (from German Nachwachsende Rochstoffe = Renewable Resources) use as the main substrate biomass from crops (e.g. maize), and liquid manure is only an additional substrate.

There are several factors that influence the process of anaerobic digestion.

One of the most important is temperature in which the digestion occurs. It influences efficiency and speed of the process and should be adjusted to the type of bacteria. Oniszek-Popławska *et al*. [2003] distinguish three ranges of temperatures used in biogas plants: psychrophilic (10-25˚C), mesophilic (30-35˚C) and thermophilic (52-55˚C). In mesophilic conditions the digestion process takes 12-36 days,

whereas in thermophilic its duration is shortened to 12-14 days [Oniszek-Popławska et al. 2003].

Another factor is the time of retention. It is established from the ratio of feedstock input to the digesters capacity. It should be tuned not to wash out bacteria out of the digester and to enable the full digestion of the used type of feedstock.

In order for the digestion process to run with maximum efficiency the pH In the digester should range from 7,0 and 7,2 [Uzar 1993]. During the acidic fermentation stage the pH decreases to values of 6,2-6,5. To prevent that from happening fresh feedstock or lime can be added into the digester [Oniszek-Popławska *et al*. 2003].

To keep homogenic conditions in the digester and to allow the bacteria equal access to biodegradable substances, the feedstock should be crashed before insertion and constantly mixed inside the digester.

Substances like antibiotics, detergents, plant protection chemicals or heavy metals can be lethal to the bacteria which conduct the digestion process. That is why these substances should be prevented from the feedstock.

Usually the technological chain of an agricultural biogas plant consists of the following elements: feedstock container, digester (bioreaktor), heating unit, digested manure tank, biogas purification installation, cogeneration unit, sterilization chamber, composting site [Oniszek-Popławska i In. 2003].

Biogas production is a clean and environmentally friendly process [Uzar 1993]. Because biogas is produced from organic matter its energetic application is considered to have a zero level of carbon dioxide emission. Biogas plants can decrees The European Union's dependence on natural gas import from Russia and other outside sources. Keeping that in mind it is safe to say that Poland should follow the lead of countries such as Germany, France or The Netherlands and harness the great potential for biogas production.

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MONITORING OF SOIL RESPIRATION: APPLICATION OF OXITOP CONTROL SYSTEM

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keywords: OxiTop Control System, microbial soil respiration

INTRODUCTION

The soil microorganisms living in intimate contact with soil environment are sensitive indicators of the soil quality, especially for assessment of soil pollution [1].Presently, there are a lot of methods for monitoring of soil biological activity. One of them is the soil respiration measurement by OxiTop Control System. The OxiTop Control System complies with conditions of ISO 16072:2002 [2]. This metod has a wide application for matrix with a high microbial activity (e.g. sludges) [3], however, using OxiTop Control System for determination of the soil respiration is not very popular.

The aim of this study was application OxiTop Control System for the measurement of soil respiration.

MATERIALS AND METHODS

The soil sample (Os-1) was a heavy loamy sand and derived from top level A (0-20 cm) of soil from typical agricultural area (Lublin district, Poland). The soil was air dried and sieved (2mm). The basic properties of the soil were: content of fraction ø<0,02mm - 16%; OM (Tiurin method) - 1,36 %; pH_{KCl} - 5,40; WHC - 28%, respiration (determination of CO_2 release by titration ISO 16072:2002 [2]) R_{CO2} 1,45 $\mu gCO_2/g*h$.

The moist soil samples were placed in the OxiTop System vessel (1L) and incubated for a period 168 h. The vessel contained a vial with 50 mL caustic soda solution (1M) for absorbing CO_2 and measuring sensor (the date were transmitted to the PC).

The three parameters were optimized: quantity of the sample (100g and 300g), humidity of the soil (40%, 50% and 60% WHC) and incubation temperature (25°C and 30°C). 360 measured values were recorded at equidistant time intervals (28 min.) during 168 h experimented time. The OxiTop System without soil was used as a control.

The soil respiration (BA) was calculated as follows:

$$BA = \frac{32000}{RT} * \frac{V_{fr}}{m_{Sd}} * (\Delta p - \Delta p_0)$$

where:
BA – soil respiration (mg O_2/ kg_{dm}), 32000 – molar mass of oxygen (mg/mol), V_{fr} – free gas volume (L) – determinated according to ISO 16072: 2002[4], Δp – measured reduction in presser in a sample (hPa), Δp_0 – measured reduction in presser in a control (hPa), R – general gas constant: 83,14 hPa mol^{-1} K^{-1}, T – temperature (˚K),m_{Sd} – mass of dry soil substance (kg).

RESULTS AND DISCUSSION

The regression lines were calculated for each BA/time relationship (Fig. 1and Fig. 2) and the differences between the levels of the investigated factors (OxiTop conditions) were assessed on the base of the regression slope differences (ANOVA, Tukey test, $\alpha \leq 0,05$). There were no statistically significant differences between the applied temperature conditions (25°C and 30°C). The most effective conditions were: 60 %WHC (statistically different from 40 %WHC) and soil sample weight of 300g (statistically different from 100g).

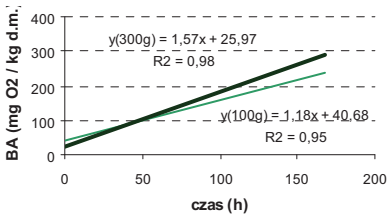

Fig. 1. Relation of BA/Time for different quantity of soil OS-1

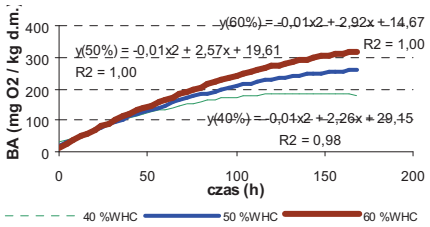

Fig. 2. Relation of BA/Time for different humidity of soil OS-1

CONCLUSIONS

The OxiTop Control System can be applied for determination of the microbial respiration of low active soil. For soil OS-1 the most advantageous parameters were: temperature 25°C - 30°C, sample weight 300g and humidity 60%WHC.

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