DETERMINATION OF MOISTURE DEPENDANCE OF MATERIAL COEFFICIENTS FOR MACARONI DOUGH

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1. Introduction

One of the most popular human food – macaroni is produced of dough by forming and drying. The drying is the most important and the most difficult part of macaroni production. It influences sensorial, physico-mechanical and even feeding features of product. During drying the material shrinks and this could cause permanent deformations and even fracturing of macaroni. Up to now there are only few publications devoted to the mechanical behaviour of macaroni dough during drying e.g. [1-3].

During drying of macaroni dough its moisture content (dry basis) change form about 0.28-0.32 to 0.1-0.12. In that range the material is initially visco-elastic and finally brittle-elastic. The material coefficients of the material change in that range almost thousandfoldly. The aim of the work is to determine moisture dependence of some material constants of macaroni dough, in particular Young modulus, viscous equivalent of Young modulus and strength of the material. It is assumed that the material is Maxwell visco-elastic one.

2. Experiments

The experiments consisted of three parts: samples preparation, extension test and final drying. Examined material was dough appropriated to popular macaroni production [4]. Because there are no norms devoted to the extension of dough, the samples shape was similar to the normalized shape of samples made of plastic. The dough was carefully mixed. Then the samples were shaped with the use of prepared matrix. Next they were slowly dried to demanded moisture content and isolated during 24h to ensure uniform moisture content inside material. The samples were put to extension test with the 1 N/s load rate. After disruption of sample a small part of sample from the disruption region was weighed. Next the piece of sample was dried to dry mass and weighed once again to establish moisture content (dry basis) of the sample during extension test.

4. Results

Because it is assumed that the material is Maxwell visco-elastic one, the strain of the material ε is the sum of elastic strain $\varepsilon^{(e)}$ and viscous one $\varepsilon^{(v)}$

$$\varepsilon = \varepsilon^{(e)} + \varepsilon^{(v)}$$

These two strains obey Hook and Newton models

$$\varepsilon^{(e)} = \frac{\sigma}{E} \qquad \frac{d\varepsilon^{(v)}}{dt} = \frac{\sigma}{\Gamma}$$

The Young modulus E and its viscous equivalent Γ were estimated using above equations. Strength of the material is taken directly from the test (the maximal stress during test).

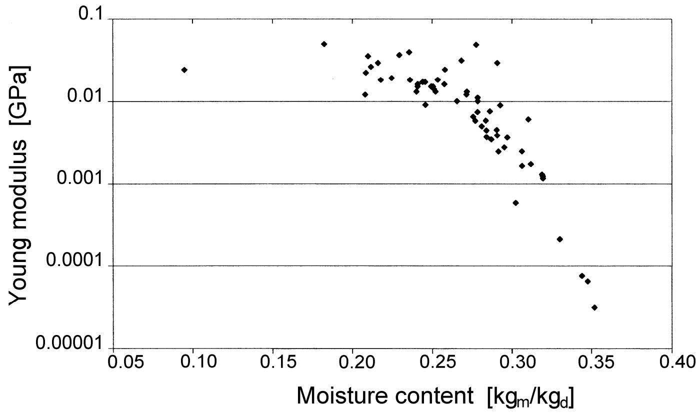

Figure 1. Young modulus versus moisture content (dry basis).

As exemplary result the Young modulus versus moisture content (dry basis) is shown on the figure 1. We obtained that the material parameter highly depends on moisture content and change its value from about 0.00003 GPa for 0.35 kg/kg moisture content to about 0.05 GPa for 0.18 kg/kg moisture content. The other two examined material parameters also highly depend on moisture content.

5. Acknowledgements

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6. References

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