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THE EXPERIMENTAL STUDY OF STRUCTURAL VISCOUSITY WHICH CHARACTERIZED THE NON – NEWTONIAN FOOD MIXTURES

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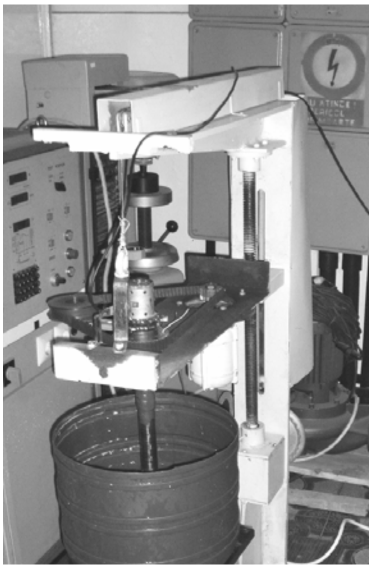
ABSTRACT

In the food industry we call non-Newtonian food mixtures, those mixtures that have a flow resistance which is changing with change of application speed of shearing force, generating the irregular flow of them. From this point of view, in food industry, we meet: non-Newtonian mixtures with viscosity independent on time (grease, suet, ground meat, the water and powder systems etc); the mixtures with viscosity dependent on time (mashed fruits, the mayonnaise etc); the viscoelastic mixtures (the meat).
This paper content the study of correlation between the torsion moment produced by mixing device which is in rotary motion with the value of structural viscosity created into the non-Newtonian mixture, propriety (the structural viscosity) which characterized the degree of homogenization and power consumption needed to result the mixture. The experiments was realized for an mixture with average consistence, S-L type, with solid phase participation (meat) in 50% proportion and liquid phase participation (water) in 50 % proportion for an constant revolution (n=120 rot/min) and fill degree of mixing tank by 25 % proportion. The experimental determination was realized by an stall which allow the obtaining of non-Newtonian mixtures in laboratory conditions .This stall was conceptions and realized in Ph.D. of the first author of this paper. The experimental determination for revolution moment produced by the shafts mixer, it realized by measuring with electrosensitives traductors rosette type 1-XK 11 E – 3/350.

Key words: non-Newtonian mixture, structural viscosity, moment of torsion, average consistence

1. THE EXPERIMENTAL TECHNIQUE

For getting the experimental researches, it was concepted and made an experimental stand which alloys the creation of the non-Newtonian mixtures in laboratory conditions. On the same stand it could be put on more mixing device. The experimental stand (figure 1.) with discontinuous motion is formed by the mixing tank 12, put on the supporting plate 1, the movement of the mixing device 11 it is made from the asynchronous engine 13, by a frequenced static converter. On the stand it was put a measure installation which can put together data about technological parameters of mixing process. The power transmission from the asynchronous electric engine to the mixing device shaft was realized by the flat cogged transmission belts 9.The using of flat cogged transmission belts presents a high performance, it doesn't have the elastic slipping phenomenon, it doesn't need high stretching and obviously it doesn't load the shaft and doesn't need usual adjustment between axes. The transmission report is 2:1.In the case of non-Newtonian mixtures formed with crust, for avoiding the stickiness to the tank lateral surfaces, the tank will be projected with a coat, crossed by a thermical agent. The mixing tank with flat or convex bottom is realized by clear plexiglas for visualization during mixing process. The mixer shaft has a full circular reaction and it is built by an strainless steel semi-fabricated. The designing of the shaft and calculation from rigidity point of view, it was remembered the bending deflection mear by the belt wheel to be lower than 0,10 – 0,03 from normal module of belt wheel. The variation of the mixer shaft position regarding the mixing tank is realized by an adjustment 14, moved by gear 15. For the device silent function of the mixing device it is necessary a superior bearing. This will take the radial and axial loads (the heaviness of the shaft and of the mixer) which put the pressure on the mixing device. The superior bearing is formed by two radial-axial coned roles bearings. The assembling of the belt wheels to the shaft and to the electric engine as the fixation of the working element is made by the parallel keys assembly. For the working of the stand it is used an asynchronous engine with variable speed, with the next parameters: normal power: P = 0,15kW; rated tension: U = 380V; rated current: In = 4,8A; normal revolution : n_n = 2850 rot/min; normal frequency f_u = 50 Hz.



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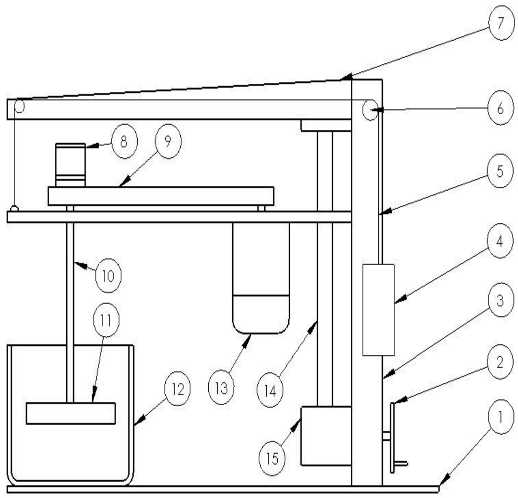

b

Figure. 1.a) The experimental stand
b)The components element of stand
1 the supporting plate;9 the flat cogged transmission belts; 10 the mixer shaft; 11 the mixing device; 12 the mixing tank; 13 the asynchronous engine 14 the adjustment ; 15 moved by gear

2. THE MEASUREMENT METHODS

One of the studied parameters - the apparent viscousity – could be determined in an indirect way by measuring the torsion moment of mixer shaft.

For the torsion moment determinations transmitted by the mixer shaft with electro resistive traductors (TER) into a shaft section applies in two exactly opposite to the points, two electro resistive traductors by each point, arranged at 45°.The four electro resistive traductors are bond in a complete bridge, which transformed the resistance variation of the transductors into a proportional variation of the tension The electro resistive traductors are 1- XK11E – 3/380 types and are designed to measure the deformations produced in the shaft after the torsion and to take with this the value of the torsion moment that made this deformations (fig. 2).To eliminate the parasites signals that can interfere into the using of the configuration from figure 3.

Figure. 2. The mixer shaft with electro resistive traductors

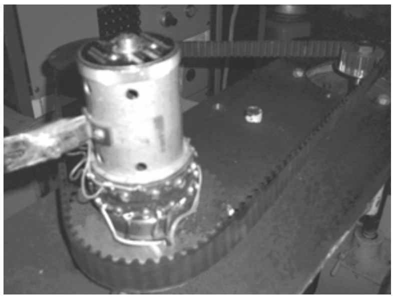

Figure. 3 The collector sing

For a quality transmition of electric signals by the rotated shaft it is used the mobile contact by shape of a collector sing with many brushes (with holders designed to allow the take off from contact during the time that will be no measuring. The collector sing with brushes is put on the free extremity of the shaft which presents an internal opening, through which are passing the connection cables from tensometric mark to mobile contacts. The measuring scheme it is presentation in figure no.4

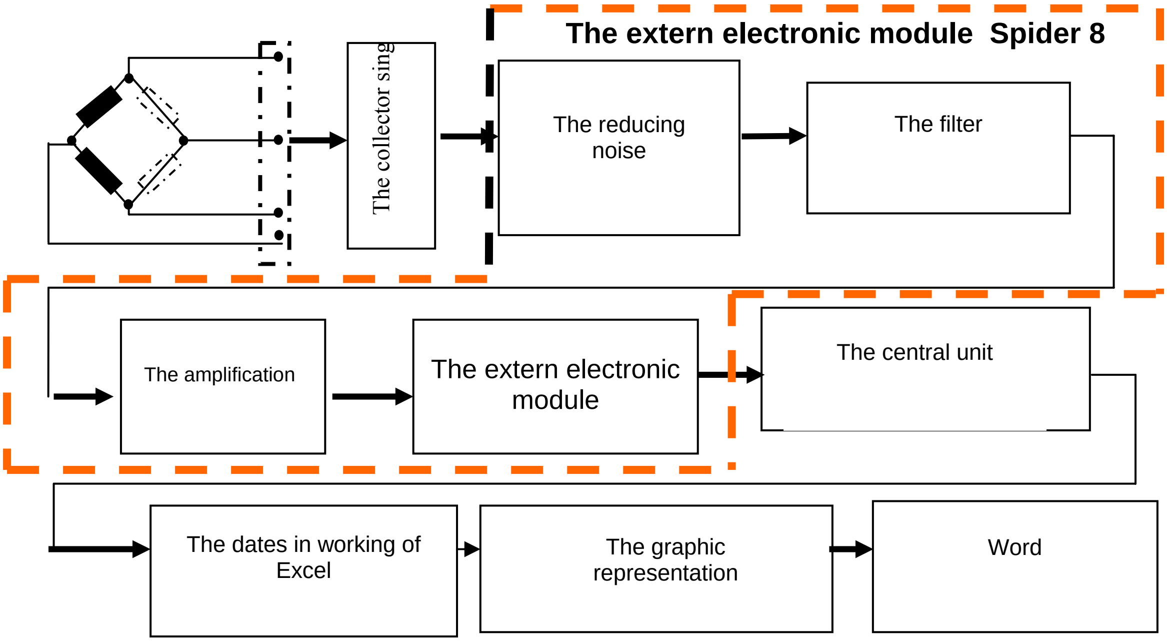

Figure. 4 The schem of measuring

3. OBTAINING RESULTS

The variation mode of torsion moment depending on time for an mixture with average consistence (50% meal participation and 50% water participation), for constant revolution n = 120 rot/min and 25% filling degree is presented in figure 5

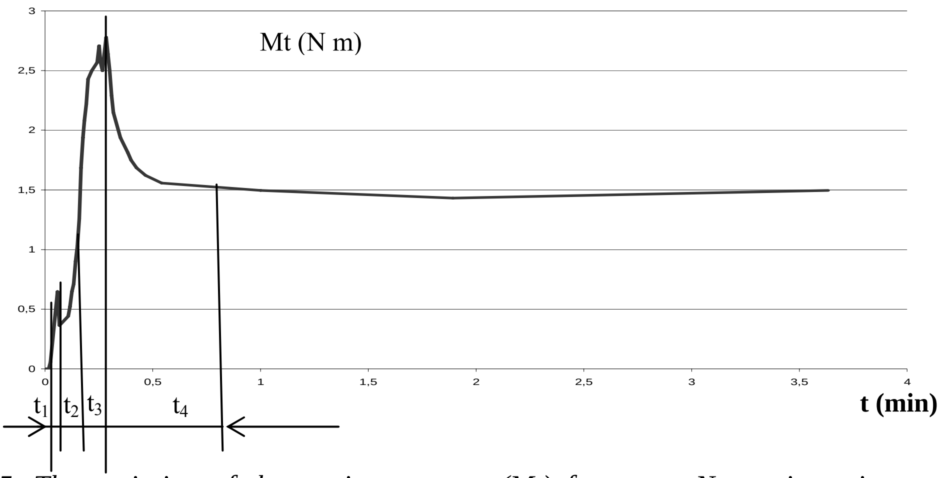

Figure 5. The variation of the torsion moment (Mt) for a non-Newtonian mixtures with average consistence depending on mixing time (t), at the constant revolution; t_1 – mixing time when in the mixing tank is only solid phase, min;t_2 – mixing time when in the mixing tank was put the liquid phase, min; t3 – mixing time for borning the viscous mixture, min; t_4 – the homogenization time, on the maximum point it is considered maxim homogenous degree because the torsion moment become constant, so, constant viscosity

The variation mode of the structural viscosity for the mixture with average consistence, depending on torsion moment for a mixing device revolution n = 120 rot/min is presented in figure no. 6

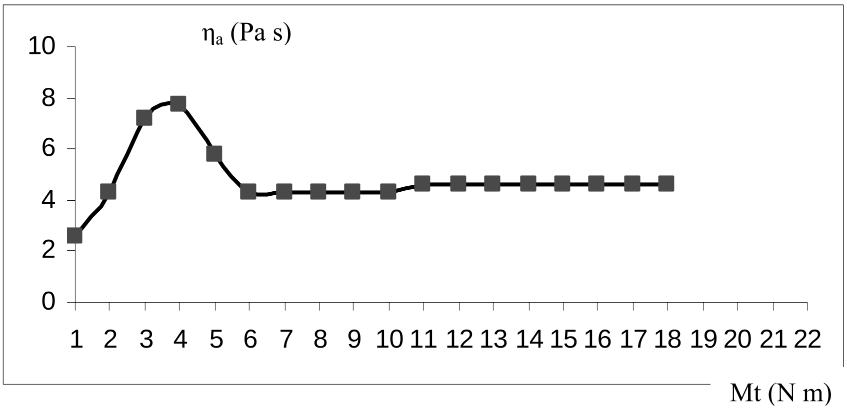

Figure. 6. The variation of the torsion moment (Mt) for a non-Newtonian mixture with average consistence depending on mixing time (t), at the constant revolution

4. CONCLUSIONS

The elaboration of the measuring method for the torsion moment was concepted in according with idea to measuring of has measures during the studies. We can consider that the maximum homogenization degree is corresponding with time which the torsion moment constant. The values of viscosity determinates by the torsion moment are bigger in comparation with the values of viscosity determinated by measuring the density. This work error is determinated by the organoleptic elements from the structure of the experimental stand, but by measuring the torsion moment it obtains dynamic values.

5. REFERENCES

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