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CONSIDERATIONS ON THE RUNNING OF THE PEAS' SEPARATOR WITH A SLOPING STRIP

Gheorghe ABRUDAN
University of Oradea, abrudan_g@hotmail.com

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Summary:
A separating device generally fulfills the separation of a mixture containing elements with different characteristics in two fragments: The main fragment, which can be made of peas, fruits, roots, etc, and secondary fragment consisting in the remainders of the mixture subject to separation.

1. The sloping strip separator's role

The slopig strip separator is clasified in the category of peeling devices, whose well functinong is grounded on friction, based on the differences between the peas' friction coefficient and the friction coefficints of the all the other particles in the mixture. [3], [4]

2. Issues concerning the kinematics and the dynamics of the friction separatig process

In the case of the friction sloping strip separator one of the fragments is stimultated through friction, by the strip and shifted in the same direction as its movement. Whereas the other fragment is repelled and shifts under the influence of gravity in the oppsite direction as the strip's movement. It is possible that the main fragment is the one that moves downstream (the peas' case), and the secondary fraction is stimulated and shifted upstream. The fragment which moves downstream can slide, roll or move by leaps. [3], [4]

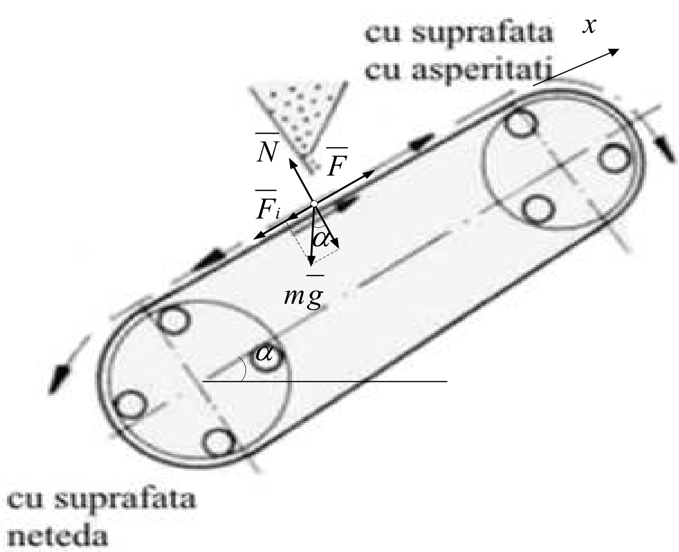

Fig. 1 Separating strip (rough surface/ smooth surface)

The equilibrium equations of the forces that work on one particle are as follows: [1]

$$F - F_i - mg\sin\alpha = 0 \qquad (1)$$

for the stimulated fragment and

$$F + Fi - mg\sin\alpha = 0 \qquad (2)$$

for the suppressed fragment

If se is denoted as $\frac{f}{tg\alpha} = \Delta$ (3)

The following cases can be distinguished:

a) When Δ> 1, which can be written as α<φ. This situation corresponds with the particles of the fragment stimulated by the strip and unloaded at the upper end.

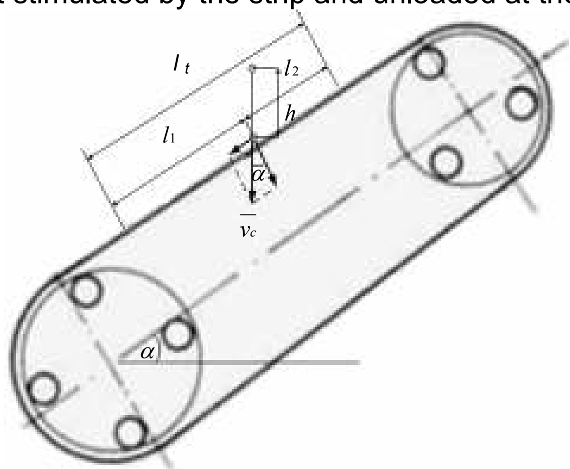

Fig. 2 Computing the length of the separation area

In the initial stage the particles shift upward on the strip, for which the time period is t_1:[1]

$$t_1 = \frac{v_c}{g(\Delta - 1)} \qquad (4)$$

and the distance of the upward movement in the period of time t_1, respectively the length l_1 are:

$$x = \frac{g}{2}\frac{v_c^2}{g^2(\Delta-1)^2}(\Delta-1)\sin\alpha - v_c\frac{v_c}{g(\Delta-1)}\sin\alpha \qquad (5)$$

$$l_1 = \frac{h\sin\alpha}{\Delta - 1} \qquad (6)$$

The influence of the h, α and Δ (respectively f) parameters on the l_1 length are shown in fig. 3, 4, 5. [2]

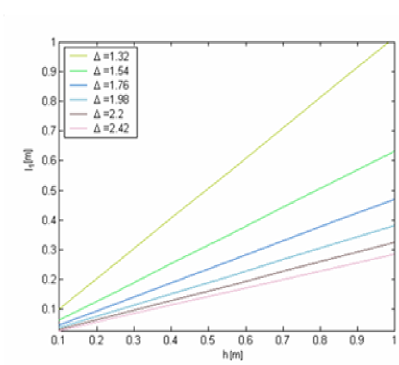

Fig. 3. The variation of the upward shifting length l_1 regarding the h_1 falling height, for various values of the proportion Δ

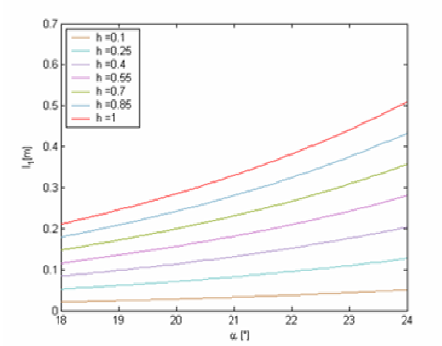

Fig. 4. The variation of the l_1 length regarding the α sloping angle of the strip, for various values of the height h

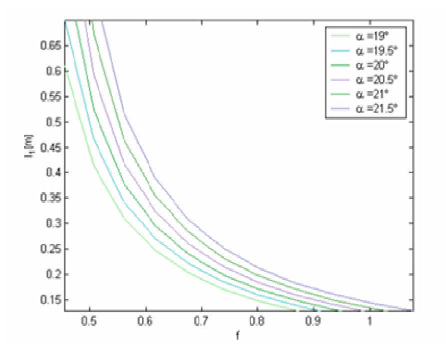

Fig. 5. The variation of the l_1 length regarding the friction coefficient f, for various values of the angle α

At the l_1 length`s limit the particle is drawn in an upward monotonous accelerated movement. The time of movement caused by particle friction on the distance l_1 is: [1]

$$t_{1s} = \sqrt{\frac{2l_1}{g(\Delta - 1)\sin\alpha}} \qquad (7)$$

The downstream movement of the stimulated fragment induces the growth of the material layer's thickness. The actual thickness of the material layer when passing near the inferior margin of the supply area will be:

$$q_t = q\left(1 + \frac{2}{\Delta - 1}\sqrt{\frac{2h}{g}}\right) \qquad (8)$$

The thickness growth coefficient for the material layer, which consists of the stimulated fraction $\psi = \frac{q_t}{q}$ because of the downstream sliding and then the stimulating through friction is given by the following relation:

$$\psi = 1 + \frac{2}{\Delta - 1}\sqrt{\frac{2h}{g}} \qquad (9)$$

The diagrams from fig. 6, 7, 8 show the variations of the ψ coefficient regarding the parameters h, Δ, α and f, [2]

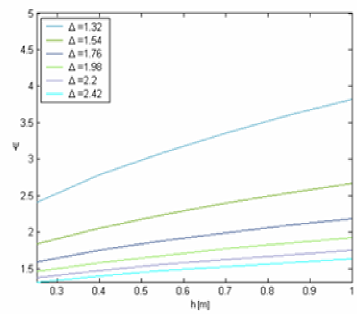

Fig. 6. The variation of the material thickness coefficient ψ, regarding the falling height h, for variuos values of the proportion Δ

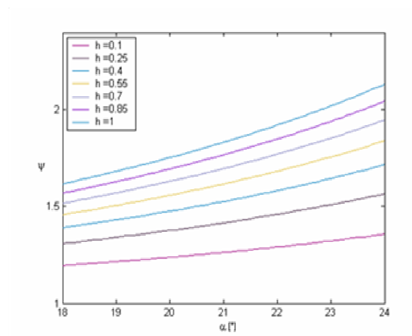

Fig. 7. The variation of the material thickness coefficient ψ, regarding the strip's sloping angle α, for various values of the falling height h.

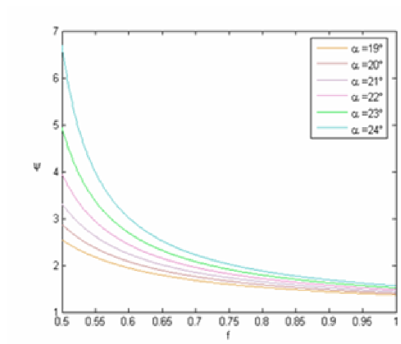

Fig. 8. The variation of the material thickness coefficient ψ, regarding the friction coefficient f, for various values of the angle α

In the second stage the particle is stimulated through friction from the limit l_1, its speed grows until it reaches the linear speed of the strip, until it enters a stable movement regime.

The period of time t_2 of the particle's movement is: [1]

$$t_2 = \frac{v_b + v_c \sin\alpha}{g(\Delta - 1)\sin\alpha} \qquad (10)$$

The stimulation area of the particle in the transition movement being given by the following:

$$l_t = \frac{(v_b + v_c \sin\alpha)^2}{2g(\Delta - 1)\sin\alpha} \qquad (11)$$

Then the distance that the particle crosses until the end of the transitory movement, when $v_x = v_b$ is:

$$l_2 = l_t - l_1 \qquad (12)$$

and so:

$$l_2 = \frac{v_b(v_b + 2\sqrt{2gh}\sin\alpha)}{2g(\Delta - 1)\sin\alpha} \qquad (13)$$

The influence the parameters: v_b, h, f, α, have on the stimulation length l_2 is represented in fig. 9, 10, 11, 12. [2]

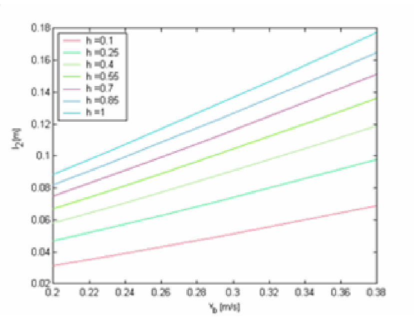

Fig. 9. The variation of the l_2 length, regarding the strip's speed v_b, for various values of the falling height h

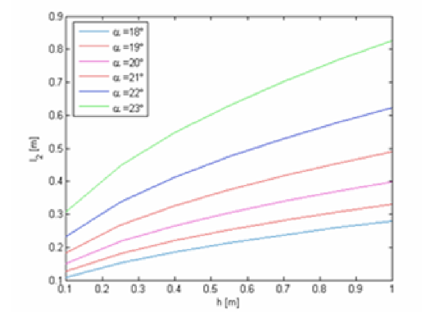

Fig. 10. The variation of the l_2 length, regarding the falling height h, for various values of the α angle

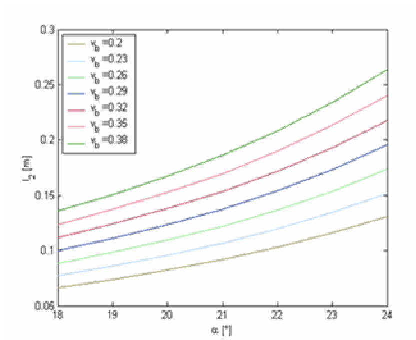

Fig. 11. The variation of the l_2 length, regarding the strip's sloping angle α, for various values of the strip's speed v_b

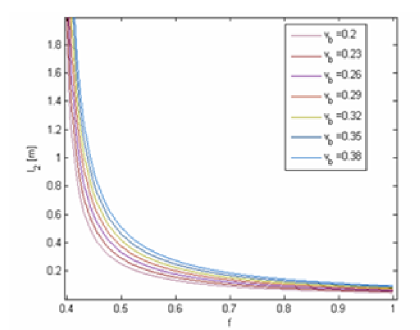

Fig. 12 The variation of the l_2 length, regarding the friction coefficient f, for various values of the strip's speed v_b

b) If Δ=1, which means α = φ

This situation does not separate the constituent fractions of the mixture and is not in any way useful for the technologic process. In the practical application, this situation is avoided by counterbalancing and adjusting the angle α, which represents the slope between the strip and the horizontal axis.

c) If Δ<1, which means α>φ, the particles shift downstream.

In this situation the shifting has a continuous growth, and the particles are suppressed to the lower end of the strip.

The area which the particle has crossed at the moment of time t, moving in a contrary direction than the strip, can be computed using the equation:

$$x = -\frac{gt^2}{2}(\Delta - 1)\sin\alpha - \sqrt{2gh}t\sin\alpha \qquad (14)$$

3. CONCLUSIONS

. Within the framework of the doctor's degree thesis the influence of the constructive and functional parameters on the particles separation process has been studied, concluding that these are:

- the downstream movement length l_1, the upward particle stimulating length l_2, as well as the material layer's thickness on the strip.

Taking into consideration these dimensions, the upper and lower limits of unloading the material on the division strip can be computed.

The studies show that for obtaining optimum values for l_1 of at most 0,2m, l_2 of at most 0,4m and ψ of at most 2.5, an unloading height h between 0,5 – 0,7 m, a strip's sloping angle α between 20-23˚, a strip material that can ensure a friction coefficient f for the particles between 0,6 and 0,95 and a strip's speed between the limits 0,3 and 0,4 m/s should be used.

For any friction coefficient's value lower than 0,5 the particles will roll downstream on the division strip.

4. BIBLIOGRAPHY

[1] Abrudan, G.,- Contribuții teoretice şi experimentale privind aplicarea şocurilor în procesul de lucru al separatorului cu bandă, Teză de doctotat, Universitatea "Politehnica" Timişoara, 2007.
[2] Abrudan, G.,- Dinamica separatorului cu bandă oscilantă, Editura Politehnica Timişoara, 2007.
[3] Dănilă, I., Neculăiasă,V., - Maşini agricole de recoltat, vol.III, Institutul Politehnic Timişoara, 1987.
[4] Neculăiasă,V., Dănilă, I., - Procesul de lucru şi maşini agricole de recoltat, Ed. A92, Iaşi 1995.