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Research Article

Study of design and manufacture for one-line rice color sorting machine

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ABSTRACT

Vietnam is one of the major paddy producers in the world in which the rice processing to pass the international quality standards is one of the huge problems need to be solved. One of these problems is how to separating the different color rice during the processing that plays an important role to improve the quality of rice for export. Therefore, "Rice color separation machine" is an important equipment of the rice harvested processing line. During the study to solve these problems at the LAMICO Company, a big company in the field of rice processing in Vietnam, we have designed, tested, and manufactured a machine for rice color separating by using the camera successful. This device helps classify finished rice and whereby, export value of Vietnam rice also increases. After checking and experimental investigation the working of the machine directly in some rice processing factories in the Mekong River Delta, the results indicate that the machine works very efficiency and separate all different color rice mix in the processing line. This paper presents the mechanical design solutions for the adjust slide and spraying equipment position structural of the rice color separation machines. Slides, spraying equipment and feeder are main structures in the mechanical cluster of the rice color separation machine and their relative positions are important parameters in deciding the accuracy and response ability of the spraying equipment as well as identifying rice lines of the cameras. This paper proposes the design calculation determining parameters of the relative distance for a standard working mode and make the gap adjustment mechanism for the color rice separator machine can best respond the part of the image recognition camera control.

Key words: Rice color separator machine, Rice trough adjustment structure, rice processing line

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INTRODUCTION

In the internal Vietnam economy, agriculture is the most spread sector with high connectivity with many other economic sectors.

Particularly within the food processing industry, the processed rice exports industry accounted for 15% of the country's export turnover of $ 3.7 billion in 2012. So as to achieve the above results, the automation problem in the rice processing chain is strategic and that is a matter of Government concern and development. Rice color separator machine is a device in the modern production line in the finished products (**Figure 1**), so that it is highly determinant in the automatic processing line for exported rice.

RESEARCH METHODS

In this study, we used the theoretical analysis to calculate the parameters of machine. The modeling method also is used for designing the machine. Rice color separator machine is designed based on the principle of image recognition and processing by real-time high speed CCD camera in suitable light environment. In order to perform color separation, there are three basic elements: image processing algorithms, lighting methods to recognize object and mechanical frames. In this, the mechanical system is responsible for feeding rice during the operation to ensure the productivity and separation rice when the control signal is appeared. Accurate and precise separation of the rice is critical requirement to the machine's performance. In actual practice, the relative position between the feeder, spraying equipment and the camera angle is critical effect to the accuracy of the separation.

Calculation and design process

(Machine Specification)

- Input capacity: 9 tons/hour.
- Accuracy: 98%.
- Maximum power consumption: 6kW, regularly 4 kW.
- Power supply: 220V/50Hz.
- Air compressor power: 10 Hp.

Based on the model and the calculation sequence of the parameters (**Figure 2**), the following is the calcu-

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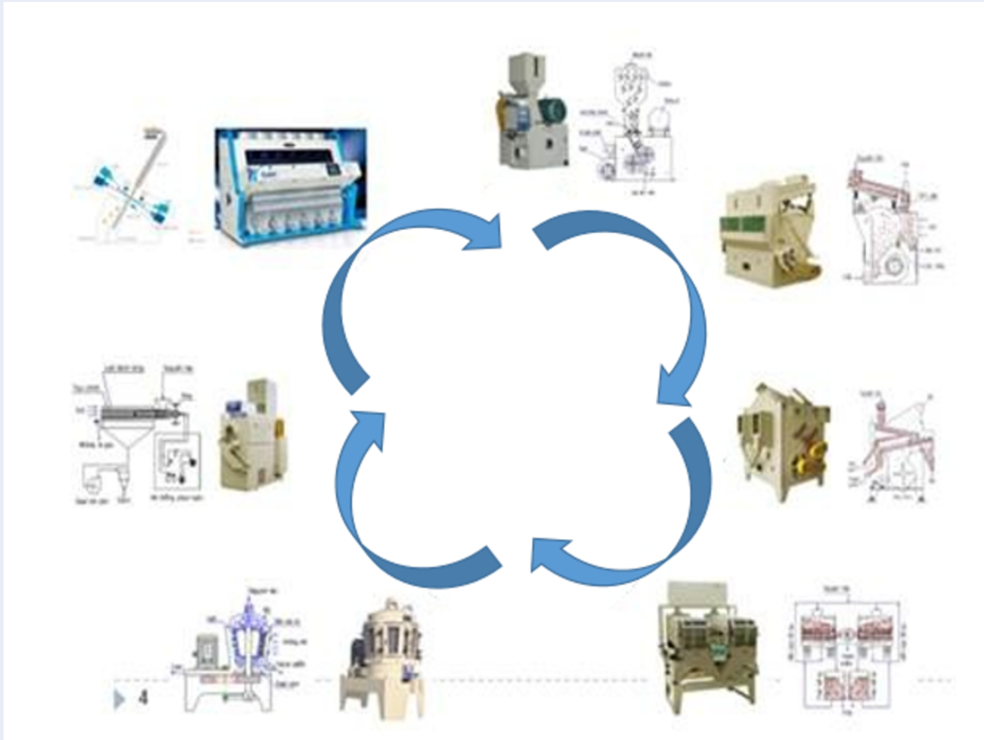

Figure 1: Location of the rice color separation machine in rice production line [1,2]

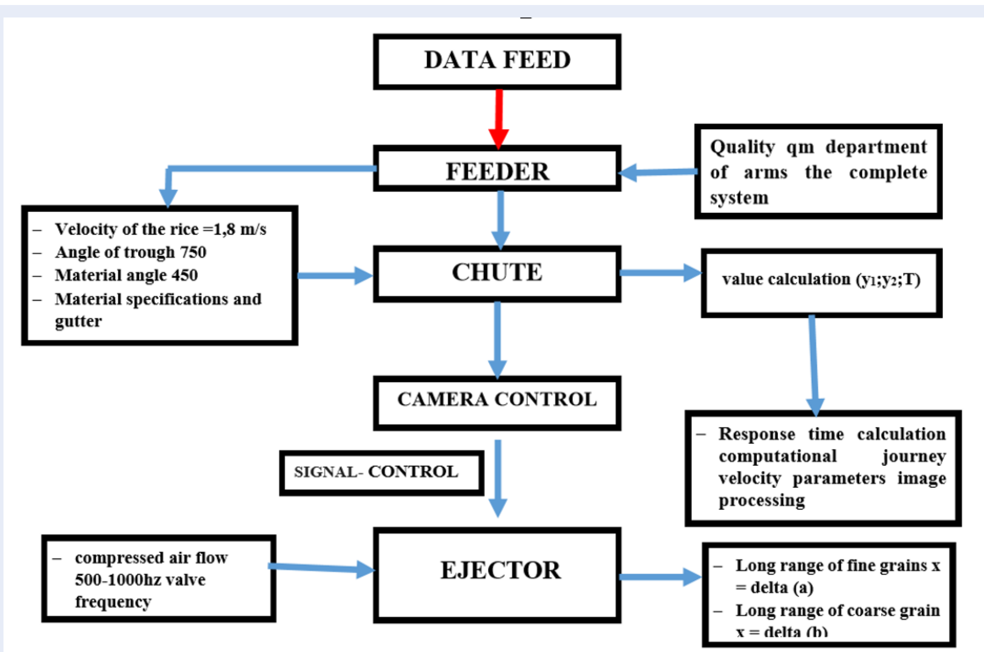

Figure 2: Calculation and design process [3,4]

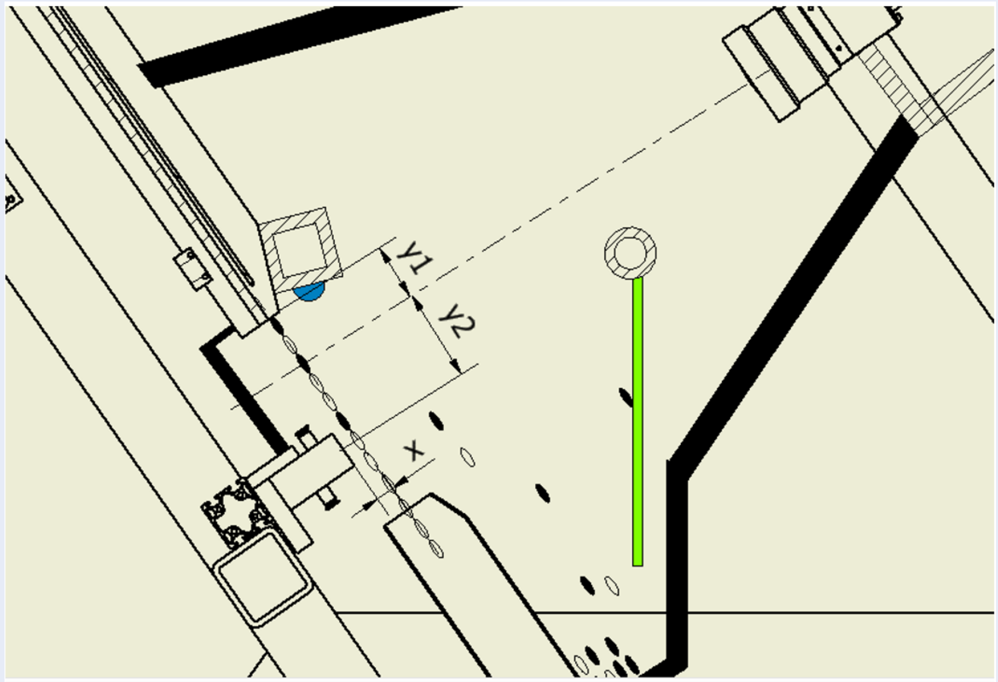

Figure 3: Relative positionof camera and sprinklers

lation of important parameters of the rice color separator machine.

Calculate the velocity of the rice as Figure 3 shown, when coming out of the feeder vibrating at the required flow rate as follows:

$$v_{mtb} = \frac{Q_m}{F\gamma\psi} \quad (1)$$

Insides, the density of rice (γ), fill factor (ψ), the cutting charge of the material line in leaning feeder (Figure 4), and the required flow rate for are (Q_m). The suitable capacity of rice for a feeder are:

Calculated value: $v_{mtb} = 1.8\ m/s$

Calculate the output velocity of the rice at the end of the leaning feeder and the time parameters for the critical positions.

Rice speed at the end of leaning feeder.

$$v_{ck} = \sqrt{v_{mtb}^2 + 2gL\left[\sin\alpha - f\frac{\cos\alpha}{\cos\frac{\delta}{2}}\right]} \quad (2)$$

Therefore, the angle of the spraying equipment α, the opening angle δ, the length of the feeder L, the coefficient of friction of the spraying equipment with rice f.

Calculation value $v_{ck} = 4.376\ m/s$

Calculate the orbit of the rice in space. In this section the, determination of the distance between the spraying equipment and the camera to meet image processing speed limit and response capacity of the actuator is pneumatic valve frequency 500~1.000 Hz.

Calculate the amount of time's the grain falls from the feeder move to the camera.

$$t_c = \frac{-v_{ck}\sin\alpha + \sqrt{v_{ck}^2\sin^2\alpha + 2gy_c}}{g} \quad (3)$$

Calculate the amount of time the rice falls from the feeder to the spraying equipment t_p and y_p. Calculate the time of movement from the camera to the spraying equipment.

$$\triangle t = t_p - t_c \quad (4)$$

Calculate the falling coordinates of finished rice.

$$y = xtg\alpha + \frac{g}{2v_{ck}^2\cos^2\alpha}x^2 \quad (5)$$

Given y = h (1.020 mm), the value given in the high-selective design for the rice color separator machine. Solving the equation (5), we calculate the long range value from which the basis of choice is the width of the feeder, x = Δa = 223 mm.

$$v_{px} = v_{ck}\cos\alpha \quad (6)$$

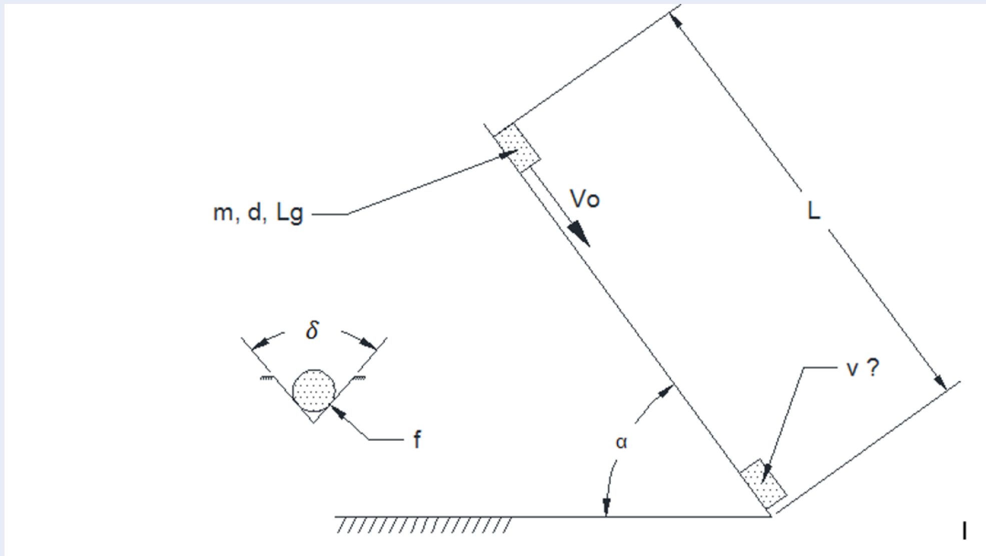

Figure 4: Modeling calculations using rice movement on leaning feeder which has a ditch.

$$v_{py} = -\sqrt{v_{ck}^2 \sin^2\alpha + 2gy_p} \quad (7)$$

The velocity of injection spraying equipment on the rice by the spray force F, the calculated value of the force is based on the spraying equipment pressure at the 15 mm section.

F=ma

$dv = \frac{F}{m}dt$

Integral for two equations, with selective time t being the response time of the spraying equipment. We get the velocity value acting on the rice.

$$v = 0.1Fm \quad (8)$$

The total velocity of rice at the starting point of air injection with the angle $\beta = 90^o - \alpha$

$v_{px} = v_{ck}\cos\alpha \; + \; 0.01 \; Fm\cos\beta$

$v_{py} = -\sqrt{v_{ck}^2 \sin^2\alpha + 2gy_p} + 0.01Fm\sin\beta$

The orbital equation of the rice is separated

$$Y = \frac{0.1Fm\sin\beta - \sqrt{v_{ck}^2\sin^2\alpha + 2gy_p}}{v_{ck}\cos\alpha + 0.1Fm\cos\beta}x - \frac{g}{2(v_{ck}\cos\alpha + 0.1Fm\cos\beta)^2} \quad (9)$$

Solving the equation (9) with y = 0 (Fig 5) results in the calculation of the longest range of classified rice x = Δb = 535 mm; calculating the value of the raw material feeder in the design.

Investigate the relationship and choose the appropriate altitude

The time response factor is the factor that affects the relative position of the image and pneumatic center spray point, which determines the accuracy of the rice classify process. Therefore, in the design needs to calculate a pair of values (y1; y2; t) accordingly.

The image processing time is 1 ms, the signal transmission time is 0.2 ms, the response time of the compressed air valve is 1ms, so we can calculate the total response time as fast as possible is: t_{du}=2.2 ms.

Based on the control time response, the results of the computation showed that the appropriate pairs value were selected (Table 1).

$(y_1;y_2;t)=(4;11;2.5)$

DEMONSTRATION - RESULT-DISCUSSION

The gas law in the top of the spraying equipment is so complex that it is difficult to conduct a pressure profile survey at any cross section to select the most suitable distance of the spraying equipment to the orbit of rice, so the simulation will take less time and consistent with the problem of complex fluid[3–5]. Furthermore, the convergence problem at the cross section will determine the accuracy as well as the color separation of rice. The results of the calculation are presented at the center of the pneumatic hole located at the l5mm line of rice (Figure 6).

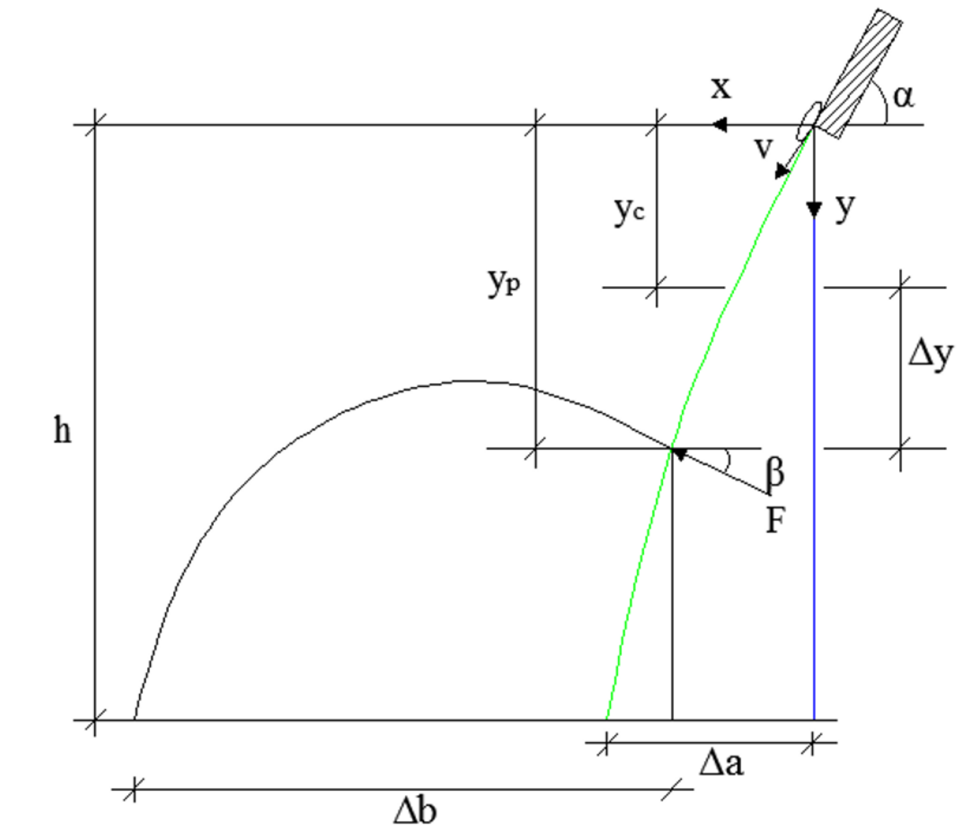

Figure 5: Model of falling position of rice when the force acting from the spraying equipment [5]

Table 1: The parameters about calculation and bias of correspondence

Response time t (ms)	y_c	y_p	y_1	y_2
2.045	5.800	8.689	6.000	9.000
2.159	5.310	9.179	5.500	9.500
2.272	4.830	9.659	5.000	10.500
2.387	4.350	10.139	4.500	11.000
2.500	3.860	10.629	4.000	11.500
2.614	3.380	11.109	3.500	12.000
2.729	2.900	11.589	3.000	12.500
2.843	2.410	12.079	2.500	13.000
2.957	1.930	12.559	2.000	13.500

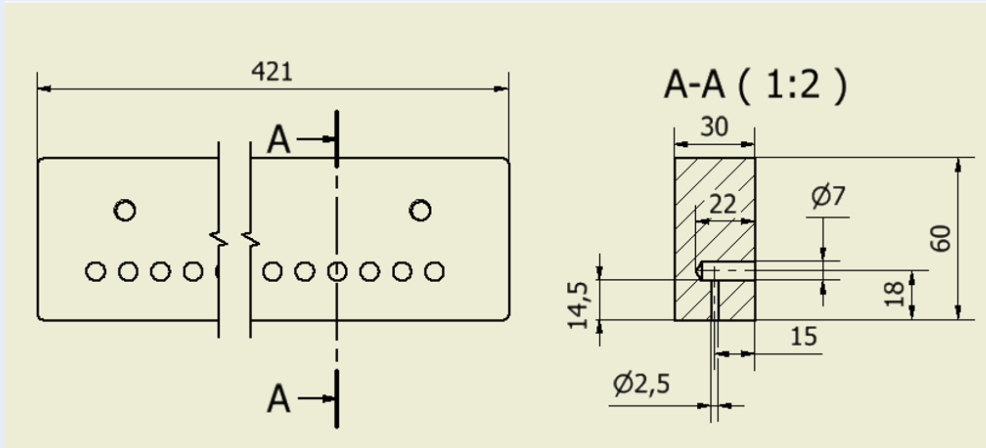

Figure 6: Model of the top of spraying equipment cross-section pneumatic is used to demonstrated simulation model

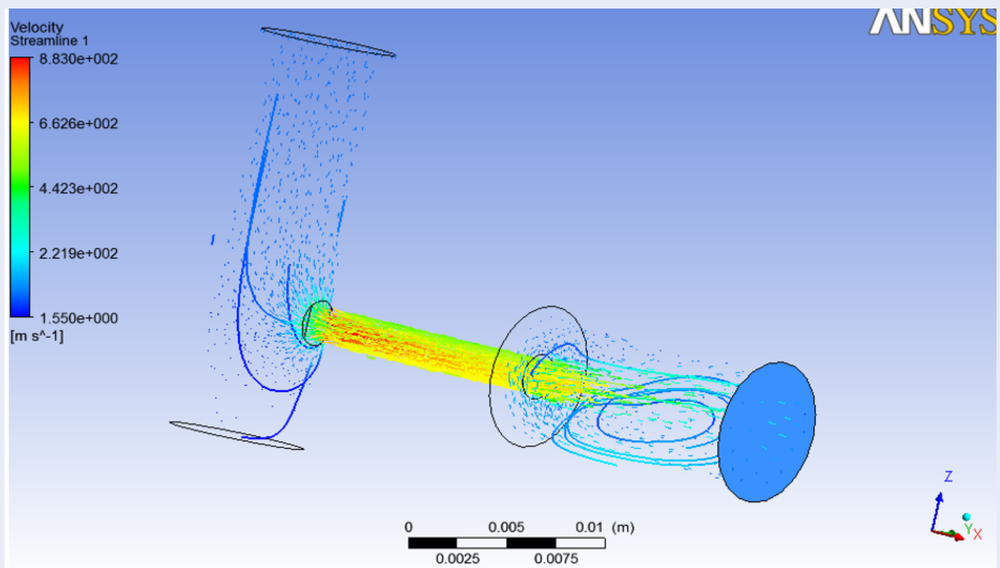

Figure 7: The result of velocity simulation at 15 mm of section

According to the simulation results presented in Figures 7, 8 and 9, the relative pressure at the spraying equipment and the gas velocity at the 15 mm section are respectively

$p=10^3$ Pa

v=200 m/s

The value of the top of the spraying equipment force applied to the rice at the time of firing is calculated by the following formula:

F=pA

Herein:

- The area of the rice like width and long of rice[6] is affected by the force of the air stream according to the formula:

$A = \frac{\pi}{4} d^2$

(with d = 2.5 mm is the diameter of the injection hole).

- The pressure at the 15mm cross section is simulated $p=10^3$ Pa

Result F=1.96 N

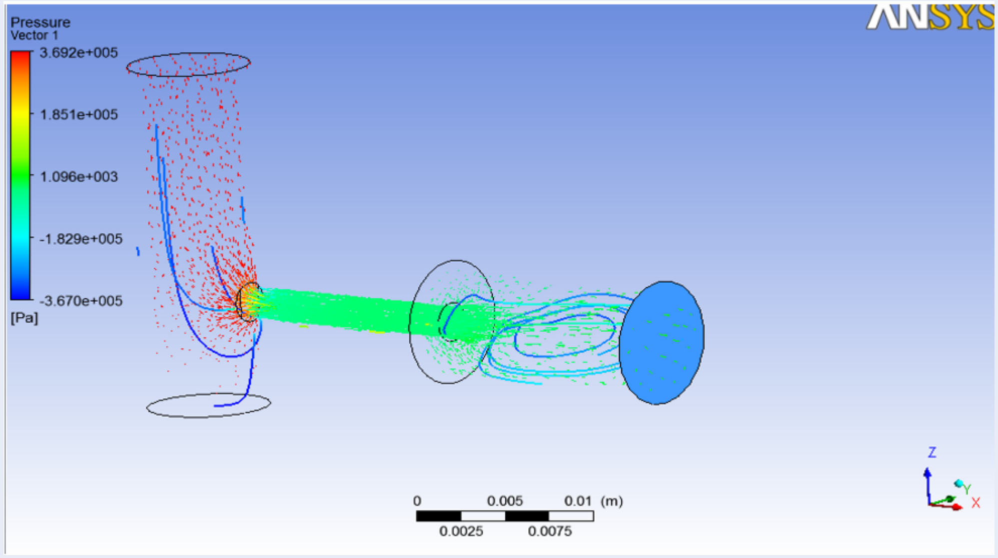

Figure 8: Results of pressure simulation at 15 mm of section

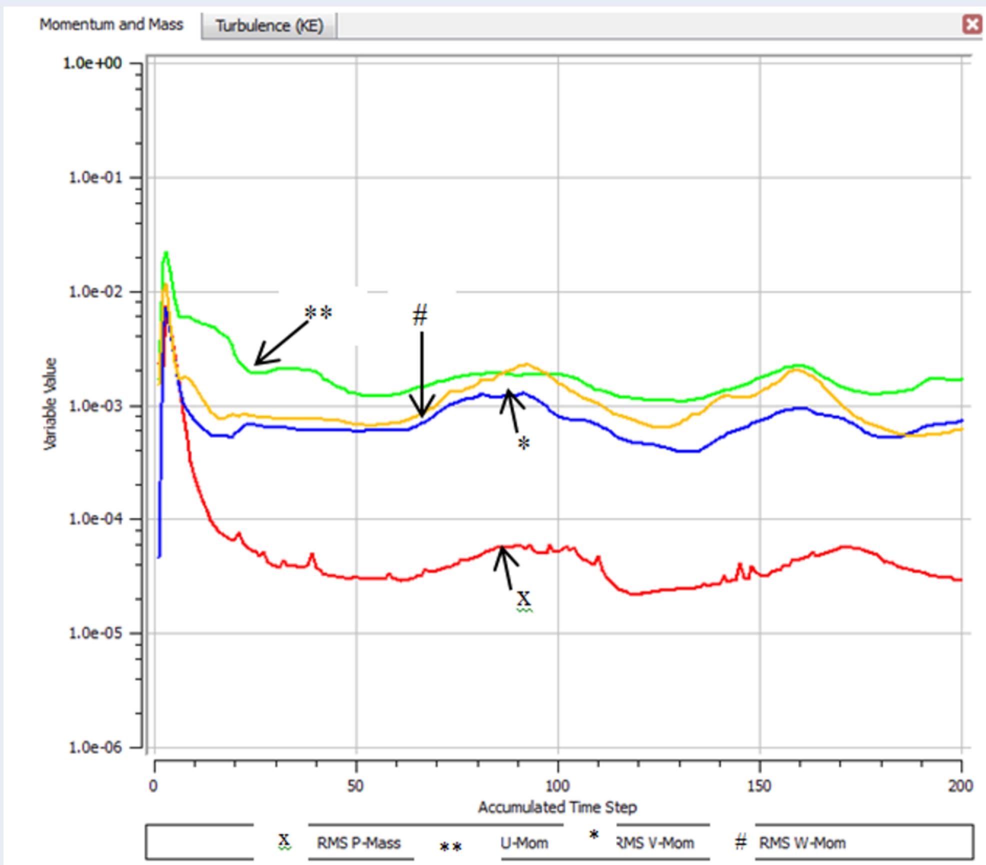

Figure 9: Integrated graph of output velocity in three axes in space

CONCLUSION - EVELOPMENT DIRECTION

Conclusion

The following conclusions can be drawn from the research and experimental operation of the device:
- ANSYS software results show that the design of the spraying equipment is focused and that the pressure parameters at any cross section determine the position of the spraying equipment with the orbit of the rice which is suitable for classification. The calculation of the above parameters will be very complicated and sometimes not possible due to the large volume of calculations.
- Accurate calculations of the relative position between leaning feeder, cameras and spraying equipment are very important parameters, it determine the classification performance of the machine when combined with the image recognition system.
- Basing on this calculation, we can use to design the operation mechanism of the rice color separator machine.

Development direction

- Rice color separator machine is a device in the modern rice processing line, which is integrating with the whole rice processing chain is a matter of concern.
- In addition, the built-in modular design makes easy maintenance and replacement.
- The mechanical solution helps to improve the color separation of the machine, reducing the proportion of bad rice in the best product.

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CONFLICT OF INTEREST

this study is done by our self and there have not any results in this paper come from other sources.

AUTHOR'S CONTRIBUTION

All authors contribute to this study are as the same.

REFERENCES

1. Gorial B, O'Callaghan J. Separation of grain/straw mixtures in a horizontal airstream. Journal of Agricultural Engineering Research. 1991;Available from: https://doi.org/10.1016/0021-8634(91)80008-3.
2. Tangpinijkul N. Rice Milling System. "Rice Post Harvest Technology" IDRC. 2008;.
3. BUHLER. Destoner MTSC for an Efficient Cleaning. 2016;.
4. Husking_apparatus. US Patent US5678477;.
5. Aghaghazvini H, Afzal A, Soltanabadi M, Malek S, Mollabashi L. Determining percentage of broken rice by using image analysis, Iran. 2014;.
6. Daniel MJ, Marks BP, Siebenmorgen TJ, Mcnew RW, Meullenet JF. Effects of long-grain rough rice storage history on end-use quality. JFood Sci. 1998;63(5):832–835. Available from: https://doi.org/10.1111/j.1365-2621.1998.tb17910.x.

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Bài Nghiên cứu

Nghiên cứu thiết kế cơ cấu điều chỉnh vị trí máng trượt và đầu phun trong máy tách màu gạo

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TÓM TẮT
Việt Nam là một trong những quốc gia sản xuất lúa gạo lớn trên thế giới trong đó việc chế biến gạo đạt tiêu chuẩn quốc tế là một trong những vấn đề lớn cần giải quyết. Một trong những vấn đề đó là làm sao tách các hạt gạo khác màu trong quá trình chế biến đóng vai trò quan trọng trong nâng cao chất lượng gạo xuất khẩu. Máy tách màu gạo là một thiết bị quan trọng trong dây chuyền chế biến gạo sau thu hoạch. Trong quá trình nghiên cứu tại công ty LAMICO công ty chuyên về máy chế biến lúa ga5oo73 Việt Nam, chúng tôi đã thiết kế, thực nghiệm và chế tạo thành công máy phân loại màu gạo dùng camera.Thiết bị này giúp phân loại gạo thành phẩm và theo đó giá trị xuất khẩu của hạt gạo Việt Nam cũng tăng lên. Sau khi thực nghiệm, kết quả chỉ ra rằng máy hoạt động tốt và hiệu quả,đã phân loại được gạo khác màu trong dây chuyền chế biến lúa gạo. Bài báo trình bày giải pháp thiết kế cơ khí cho cơ cấu hiệu chỉnh vị trí máng trượt và đầu phun trong máy tách màu gạo. Máng trượt, đầu phun và máng hứng liệu là một trong các cơ cấu cơ khí chủ đạo trong cụm phân loại của máy tách màu gạo và vị trí tương đối của chúng là một thông số quan trọng quyết định tính chính xác và khả năng đáp ứng của đầu phun cũng như của camera nhận dạng dòng gạo. Bài báo đề xuất phương án tính toán thiết kế các thông số quyết định khoảng cách tương đối này cho một chế độ làm việc chuẩn và đưa ra các cơ cấu hiệu chỉnh khoảng cách để máy tách màu gạo có thể đáp ứng tốt nhất cho phần điều khiển nhận dạng ảnh của camera.
Từ khoá: Máy tách màu gạo, Cơ cấu điều chỉnh máng gạo, chế biến lúa gạo

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