# DESIGN AND DEVELOPMENT OF FRESH SOYBEAN GRINDING AND FILTRATION MACHINE

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## ABSTRACT

Fresh soybean milk grinding and filtration machine is aimed to design and develop a machine that will minimize the production time and human effort during the extraction of soymilk by combining the grinding and separating process into a single machine. The production started by soaking the dry soybeans in water for 8-10 hours. After soaking, the soybeans were fed into the machine, the machine will starts to grind the soybean with the aid of water and the soymilk is separated from the pulp through a rotating conical filter medium. The size of the grinding stone will determine the amount of soy milk produced. The aim of this experiment is to design and develop a suitable size of grinding stone to be rotated by the electric motor of 1.5 horsepower that is used for fresh soybean milk grinding and filtration machine.

Keywords: electric motor, grinding stone, pulp remover outlet, stainless steel mesh wire.

#### 1. Introduction

Fresh soybean milk grinding and filtration machine is a combination 2 in 1 process designed to replace the use of blender to grind soybean process. This machine uses grinding stone to grind the soybean and in the same time filter the soybean milk produced. A fine stainless steel mesh wired is used to filter the soy bean milk produced. The grinded soybean pulp is channeled out on the other diffuser. In addition, it is designed to function in a locked safety condition during the process the grinding and filtration process to avoid harm to the operator (Akinnuli and Olabanji, 2013). It is also designed with a pipe valve where water is used to facilitate the grinding process. Other than, this machine is designed with two storages which are used to store soybean pulp and the soy milk. For the soy milk storage, it is built in with heating element for the purposes of heating the soy milk after the process of grind and filtering is done. The advantages of this proposed machine are it will be designed to be easily operated, portability and easily maintained to replace conventional method.

The main aim for this project is to grinding and filtrate the soybean at the same time. This concept is use to reduce the time to complete a raw soymilk. Three objectives that have to be made in order to achieve the aim:

- i) To innovate fine grinding and filtering process at the same time for the soybean;
- ii) To reduce time in producing a large amount of soybean milk;
- iii) To increase production of soybean milk; and

The machine is designed to be easily operated which there will no hard time for the operator to understand the process of the machine. In addition, the heating element is built in to the soymilk storage. It is function for the heating process for the soymilk after the grinding and filtering process is done. The simple handling designed with low maintenance is

suitable for restaurant, caterer, housewives and small industry entrepreneurship (Bennett, 2014).

#### 2. Methodology

Conceptual project only consists of hardware design. This project was inspired from the theory of fruit juice extractor where during the soft grinding where the pulp will be removed out by kinetic motion. High speed motor is used produce the kinetic motion to assist the remover of soybean pulp during the grinding process. Process flow shown in Figure 1 the soybean will enter through soybean inlet. Next, the soybean will pass through grinding stone and it will grind the soybean and at the same time the soybean pulp will be removed using pulp remover outlet. In addition, the water pipe is included in the design to assist the grinding process. The soybean pulp and soymilk are divided into two drum. Next, the soybean will be cooked using gas stove. The soymilk must be stirred during cook to avoid the soybean burnt (Ohiokpehai, 2008). After that, the soymilk is ready to drink.





### 2.1. Theoretical Research Project

The theory of the project is designed according to the theory of a fruit juice extractor where during the soft grinding where the soybean pulp will be removed out by the kinetic motion (Panda, 2013). High speed motor is used to produce the kinetic motion to assist the remover of soybean pulp during the grinding process. In addition, the soybean milk plus the remaining soybean pulp will be filtered in the same time to remove finer particles of soybean pulp. In addition, the water pipe valves are included in the design to serve the purposes to assist the grinding of soybean. The soybean milk and remaining soybean pulp is filtered in

specially designed drum in the machine. The machine also uses a conveyor belt for power transmission of the motor in order to rotate the shaft for the filter drum to filter the remaining soybean pulp mixed with soybean milk. The machine will apply the concept of the washing machine motor that uses electrical power of 240V. The main switch is also included for safety factor purpose. If the main switch is not switched on, the machine will not spin even if the timer switch is set. This switch is also used as an emergency switch. In addition, the machine is also equipped with a closing lid to enhance the safety of the operator.

# 2.2. Design Conceptual

There are few components use in the project such as electric motor, grinding stone, water pipe valve, Pulp remover Outlet, and Stainless steel mesh wire filter. The product consists of the components as listed in Table 1:

Component	Function
Electric Motor	To rotate the grinding stone to grind the soybean. The power of the motor is 1.5HP while the speed 2800/3600 RPM
Water Supply Inlet	To facilitate the grinding process
Soybean Pulp Remover	To channel the soybean pulp to the soybean pulp storage
Soybean Milk Outlet	To channel the soybean milk to soymilk storage
Grinding Stone	To provide soft grinding of soybean. The diameter of the grinding stone is 100mm
Pulp Remover Outlet	To remove soybean pulp (okra) during soft grinding
Filter	To filter the soybean pulp (okra) by using 60-80 mesh stainless steel wire mesh
Safety Protection	To protect the machine operator and safety operation
Soybean Pulp Storage	To store the soybean pulp during grinding process
Soymilk Storage	To store the soymilk during grinding process
Burner	To cook the soymilk
Size	The size of the machine is 400x470x1030mm

Table 1. Components and function description

The proposed designed of the machine features overview is shown in Figure 2.



Figure 2. Machine features overview

The electric motor shown in Figure 3 which is been used in the project. The electric motor must been followed by appropriate specification to the machine. In this project, the machine will apply to the concept of washing machine motor that uses electrical power of 240V. This 1.5 horsepower electric motor is the most suitable type to actuate the movement of the grinding stone in the work of grinding the soybean. This machine come with a grinding function, comprising an upper body and a lower body including a driving device therein, the upper body including a housing, an upper lid and a concentric pair of rotor and stator installed vertically within the housing. The main function of the grinding stone is to provide soft grinding of the soybean shown in Figure 4. The diameter of the grinding stone is 100mm which is the perfect size to complete the action grinding the 20-45 kg of soybean per hour. The water pipe valves shown in Figure 5 are required here to facilitate the grinding process of the machine. The friction made between two grinding stone without the water will produce a clique pulp that will lead to cloqged in the filtering process. Pulp remover outlet shown in Figure 6. This component is installed to remove soybean pulp during soft grinding. The soybean pulp is not necessary for soymilk because the soymilk need to be smoothly and clean from pulp for the drinker. Although the pulp is filtered out, it is also can be used for cooking benefit and as a bakeries recipe (Ludvigsen, 2011).



Figure 3 . Electric motor



Figure 4. Grinding stone



Figure 5. Water pipe valve



Figure 6. Pulp remover outlet

Stainless steel mesh wire shown in Figure 7 is the action of filtering the soybean pulp, we are using a 60 - 80 mesh stainless steel wire mesh which is the suitable mesh to filtrate the exact size of the pulp that will produced and made a clean milk for human consumption.



Figure 7. Stainless steel mesh wire

Soymilk and soybean pulp storage shown in Figure 8 is the output of this machine is soymilk and soybean pulp. Both of each output will goes to each storage which is already installed a plastic wheel so that is portable to move. Under the soymilk storage, it is a heating element connecting with a gas hose. After the soymilk already filled up the storage, it will be moveable to the gas tank and being heated the same way as the kitchen stove. In the same situation, if the soybean pulp is already filled up the storage, the content will be expelled to the certain place.



Figure 8. Soymilk and pulp storage

### 3. Result and Discussion

The idea of fresh soybean milk grinding and filtration machine, a new kind of soymilk process has put the users at ease where the users not only could produce soymilk conveniently in terms of portability, this machine also build in with heating element to gain easy heating procedure after the soymilk has been produce hence the time required to produce a complete soymilk could be reduced. This product could also be potentially commercialized as it has potential to be marketed in the business industry because of its function and convenience towards the Small Industry Entrepreneurs (SME). While the function is almost the same as an electric blender, fresh soybean milk grinding and filtration machine has a special feature where in it could filtrate the soymilk at the same time the soybean been grinded. A comparison between the conventional grinder, electric blender and the designed portable machine is shown in Table 2.

Machine/ Characteristic	Stone Grinder	Soybean Electric Blender	Soybean Grinding and Filtration Machine
Operating Type	Manual	Electric	Electric
Filtration	None	None	Stainless steel mesh wire
Time taken	Slow	Normal	Fast
Production rate	Low	Normal	High
Size of machine	Large	Small	Small and portable
Type of Grinding	Corundum	Corundum	Corundum
Stone			

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This product also potentially be made as further researches in order to increase the production of fresh soybean milk. Machine itself could reduce the time as two process which is grinding and filtering is going through at one time, thus increasing the likelihood of this product being commercialized successfully in the marketing industry. Last but not least, fresh soybean milk grinding and filtration machine is an environmental friendly product and it plays a very important role in order to achieve a large amount of soymilk per day. The finalized machine is shown in Figure 9.



Figure 9. The completed machine

The difference diameter of grinding stone affected the time taken during grinding process because the grinding stone receive the same amount of force produce by the electric motor, the smaller diameter of grinding stone will have a greater acceleration than the larger diameter of grinding stone since the smaller grinding stone will have the least amount of inertia ('laziness') and thus require the least amount of force to get it going. It will affect the time taken during the grinding process.

The horsepower of electric motor is increased onto the machine provided the different horsepower of electric motor that used to the machine can be utilized. Higher horsepower consume higher electrical energy and will produce much more noise disturbance to the surrounding.

#### 4. Conclusion

This machine is a new design which facilitates the complete processing of soymilk in one machine thereby saving time and complexity of operation. The effectiveness of fresh soybean milk grinding and filtration machine it is designed to function in a locked safety condition during the process the grinding and filtration process to avoid harm to the operator. In order to produce more soymilk, it is useful to choose the suitable grinding stone size to be installed into the machine. This to ensure the machine work properly without harming the operator. The safety procedure is taken to ensure the machine can be marketed comparable to other product.

This machine could also be potentially commercialized as it has the potential to be marketed in the business industry because of its function and convenience towards the food and beverages industries. The increase of production rate could overcome the "labor force rate" issue, thus increasing the likelihood of this product being commercialized successfully in the food and beverages industries.

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