# Design of Roller mechanism and Conveyor in Sulfur granulation systems


- **Nguyen Thien Binh**
- **Le Thanh Son**
- **Nguyen Thanh Nam**

DCSELAB, University of Technology, VNU-HCM


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**ABSTRACTS:**

*Roller mechanism and conveyor are important components in sulfur granulation system. This paper presents the method to design roller mechanism to apply two goals: create a continuous pressure for a regular granulation on steel conveyor. There are also granulation mechanism and maintain temperature not to stuck and solidify of sulfur in the supplying pile. Moreover, this paper shows the solution to design steel conveyor and filtering system including with temperature sensor which ensure the decreasing of temperature over the length of steel bell. This will help the granulation of sulfur with the right size and shape.*


***Keywords:*** *rotor-former, cooling steel bell, sulfur granulation system…*

## 1. INTRODUCTION

The sulfur granulation system is one of the most important components in sulfur processing. The system includes many elements and components. This paper presents how to design a granulation drum in consideration of two factors: stability of product and method to maintain constant temperature on the conveyor. Temperature sensorsare also integrated along with the length of steel-bell helping to control temperature of product decreasing over a predefined process.

The granulation system consists of two main components: the granulation drum *Roller mechanism*) and the conveyor.

## 2. PRINCIPLES OF SULFUR RANULATION PROCESS

### 2.1. Description of process

Liquid of Sulfur from tank (1) is pumped through heating pipe to filter (3) before lead to granulation component (4). Pipe, filter and liquid sulfur tank have to be heated by water stream (or by heating resistors) to maintain the temperature of the sulfur flow about 130 to 150 Celsius degrees. (Figure 1).

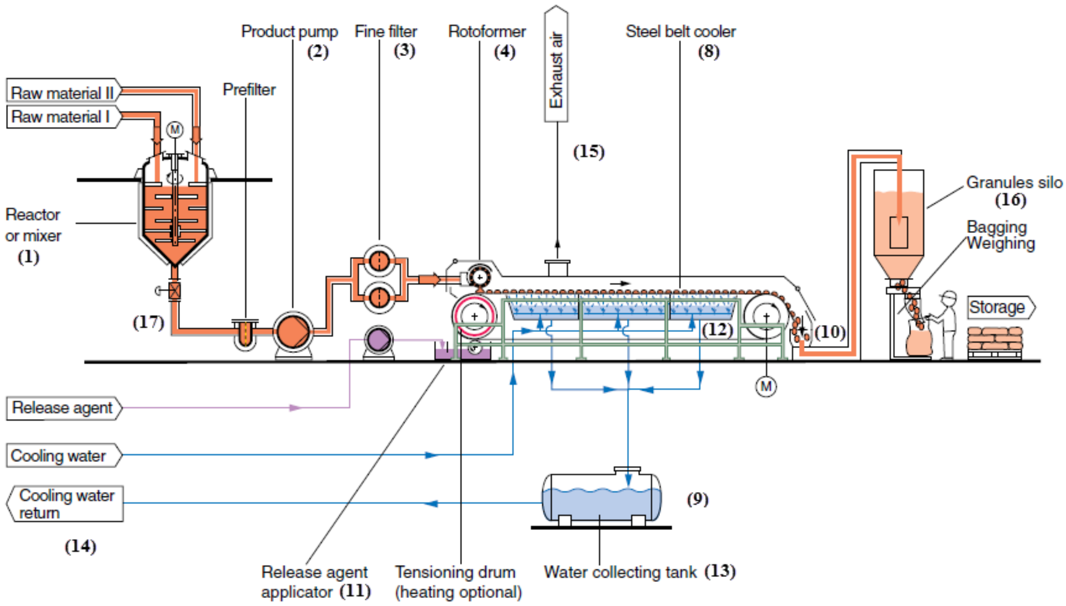


**Figure 1.**Principle of system working process.[2]

Heat out from solidifying and cooling process is transferred by steel-bell to cooling water tank (9). This cooling process is done by spraying cool stream water at the bottom of the bell. It will return to the tank and continue to be pumped to the cooling water tank. In this period, there is no contact between cooling water and sulfur. After cooling process is finished, granulated sulfur is taken off from the steel bell by a steel knife (10). A standard separating agent (Silicon: 97%, water and Tegopren: 3%) is sprayed on the steel bell forming a thin firm to ensure not to effect to the granulated sulfur (11).

Cooling water (under the steel bell) fall to collection tank (12) below the bell. Under the effect of gravity, water flow to tank (13) and pumped back to cooling water tanks (14) to continue the cooling process.

The rotor-former is equipped with a gas exhaust. There is a cone pipe (15) above the rotor-former and steel bell assembled with a fan.

The granulated sulfur which is separated from cooling bell will be carry to packing zone. (16)

## 2.2. Property of sulfur granulated

Property of sulfur granulated is used as input factors to design the system. These are some properties of sulfur material:

Purity: $\geq$ 99,9% of total mass.

Temperater input: 125-1350C

Pressure input: 3.5 bar g ± 0.1 bar g

Density : 1800 kg/m3 ở 130 0C

Viscosity: 11 cp at 130 0C

Humidity : $\leq$ 0.1%

Shape: hemisphere

Size: 2 – 4 mm

Angle of respond: 28o

Input temperature and pressure

In these informations, the temperature, output pressure of the materials are important parameters to calculate the granulator roller.

### 2.3. System requirements

The designed sulfur granulation system has technical requirements that need to be responded. The technical requirements will be addressed so that the design for granulatingand roller conveyors can be the best respond. [1]

**Table 1.**The technical requirements applied on the designed sulfur granulation system

| ***Parameters*** | ***Input technical requirements*** | ***Unit*** |
|---|---|---|
| Productivity | 800-1000 | Kg/hour |
| The purityof the raw materials | $\geq$ 99.9 | % wt |
| Input temperature of raw material stream | 125 – 135 | $^0$C |
| The pressure of input raw material stream | 3.5 ± 0.1 (h=19,6m) | Bar |
| Diameter of sulfurparticle | 2 – 4 | mm |
| The level of granulation | $\geq$ 98 | % |
| Product temperature after separation from the conveyor | < 70 | $^0$C |

## 3. DESIGN PROPOSAL

The design proposal isto maintain a constant temperature at the inlet of the steel conveyor. Sulfur particles go thorugh the cooling steel conveyor in which temperature is controlled to decrease gradually making uniform sulfur particles.

Based on these requirements, the sulfur granulation roller includes: heating system, cylindrical stator (6) and perforated shell (7)which turns concentric with the stator . Sulfur droplet deposit, fall down through the holes and evenly spread over the width of the conveyor (8). During the falling, sulfur forms droplet on the conveyor surface, nondeformation and then solidified, finally forms sulfur particles in hemisphere shape. Rotoformer rotation speed is synchronized with the speed the cold conveyor.

Sulfur granulation roller is an important part ingranulation process. This decides quality of particle including shape and size of sulfur particles.

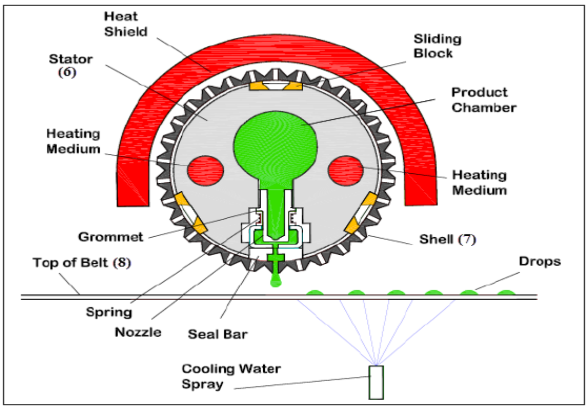


**Figure 2.**Principles and structure of rotor-former [2]

To maintain a constant temperature while sulfur is forming, sulfur mixture is heated to around 125 - 135oC . This is the temperature at which the sulfur is maintained in the dough state and can be the best well-formed.

If the temperature is lower, sulfur will gradually return solid form and choke at the pipes and forming-holes. However, the higher temperaturewill causes the mixture becomes liquidand wastes energy.

To solve this problem, the sulfur granulation roller is designed with insulation-pipeline inside. Heated oil is led into the roller by two pipe-lines, heatingand maintaining the chamber temperature. In additionto control the temperature of the chamber, each 500 mm length of internal the sulfur granulation roller, a pair of sensors is integrated in external case of the chamber .

Task of the roller chamber is to ensure a constantpressure on sulfur mixture. Two ports of the roller also havesulfurpipelines to thechamber.The sulfur pumped into the chamber is the product of the previous mixing-component that includes tanks and paddles. Chamber component has many considerable factors and the most important thingsis the stiffness of spring and gush-nozzle corecalculation.

Along with the pressure of chamber p, pressure from the spring with stiffness k directly affectsparticle diameter d and granulating capacity of the system Q. Chambercomponentis designed so that the chamber pressure will push extraction pressure spring andtherefore,willpush products go through each nozzle every time there is a difference in presure at the time injection holes on the roller matches with theconstantnozzles.

At that time, the elastic force of the spring equals to the differential pressure sum of the system [3]:

Flx = k.Δl = (Pextractionchamber– Pnozzle).Ahole

- Δliscompression of the spring, determined by the limit internal size of the component (5-10 mm).

- k is the stiffness of the spring.

- Aholeis the area of the hole that can be adjust the aperture of the hole-πr2

Also, particle diameter can be calculated as follows : [1]

$$D = \frac{Q.A}{Pnozzel}$$

So thatthe necessary stiffnessof the spring holding thenozzles value is:

$$k = \frac{\Delta P.D.Pnozzel}{Q\ \Delta l}$$

In addition, the aperture size and shape of the nozzles on the extraction holecanbe adjusted. This helps toincreasethe diversity of sizeandshapeofparticleproducts.

## 4 .THE CONVEYOR DESIGNING

Conveyor is located after the sulfur granulation roller component. Steel conveyor task is to maintain a decreasing steadily temperature from the beginning to the end of the conveyor that makes the sulfur turns into solid before packing.

To do this, the steel conveyor is designed many cooling spray nozzels with cold water in vertical and horizontal position.Cooling sprinkler system spraygushs by dispersal method, the cold water particles are not in contact with conveyor at a constant area, they are sprayed on the bottom surface of the conveyor. This helps avoid warping sulfur particles when the temperature the bottom of the conveyor is not uniform. [4]

The t1 = 70oC particle temperature decreasing necessary according to calculation requirement and heat processing with the lost heat in each meter conveyor is :

$$q = \frac{(t0 - t1).Cn}{L}$$

- T0 is the temperature at the output of the making particle roller.

- Cs is the specific heat of sulfur.

- L is the length of the conveyor.

- q is the heattranfer out of the conveyor per meter.

Sothe necessary temperatureof cooling water for each meter of calculation conveyoris:

$$qn = q = (ton - tn).Cn$$

$$\rightarrow tn = ton - q/Cn = ton - \frac{(t0 - t1)}{L}$$

Basedon water temperatures that steadily decreases per meter of conveyor and the normal temperature of cooling water is15oC, we can calculate the pump capacityand the chiller in each specific work mode.

## 5. CONCLUSION

This paper points out the need-to-solve-problems and design options apply to two important structures of the sulfur extraction system are: the sulfur roller mechanism and the steel conveyor. The sulfur roller mechanism performs two tasks: creates continuous and constant pressure; creates constant temperature to avoid congestion and solidified sulfur in the pipe-lines. In addition, this paper also provides the designing solutions for the variable heat steel conveyor systemand theimpurities filter system with thermal sensors on the conveyor that ensures temperature will regularly reduce along the length and the width of the conveyor. The design parameters of the these COMPONENTS can be input terminals for the other

COMPONENTS, such as: material supplying and mixing system and insulation pipes.

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# Tính toán thiết kế cơ cấu con lăn tạo hạt và băng tải thép biến nhiệt trong dây chuyền sản xuất hạt lưu huỳnh

- **Nguyễn Thiên Bình**
- **Lê Thanh Sơn**
- **Nguyễn Thanh Nam**

DCSELAB, Trường Đại học Bách Khoa, ĐHQG-HCM

**TÓM TẮT:**

*Cơ cấu con lăn và băng tải thép là các thiết bị quan trọng trong dây chuyền sản xuất hạt lưu huỳnh trong công nghiệp. Con lăn tạo hạt ngoài nhiệm vụ tạo áp liên tục để rải hạt trên băng tải thép thông qua cơ cấu chiết còn cần phải duy trì nhiệt độ không đổi để tránh nghẹt và đông đặc lưu huỳnh trong đường ống cấp. Bài báo giới thiệu phương án thiết kế cần thiết cho băng tải thép biến nhiệt và hệ thống lưới lọc tạp chất. Cảm biến nhiệt độ trên băng tải thép đảm bảo cho nhiệt độ giảm đều trên chiều dài băng tải và đồng nhiệt độ trên băng tải theo chiều rộng. Điều này sẽ giúp cho hạt lưu huỳnh tạo ra phẳng và giữ đúng kích thước hình dạng yêu cầu. Ngoài ra, bài báo cũng đề xuất các phương án và đầu vào cần thiết cho hệ thống này hoạt động tốt.*

***Từ khóa:*** *con lăn tạo hạt, băng tải biến nhiệt, hệ thống chiết sulfur…*

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