

Design, manufacture the crushing equipment serving the ore mining process

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ABSTRACT

Crusher is an important equipment in the ore mining processing. However, at present, many small and medium-sized ore mining companies have difficulty in equipping crushing equipment. On the other hand, the training of Machine Manufacturing Technology is currently facing many difficulties due to the limitation of conditions to practice professional skills. The article will refer to the research and design of crushing equipment to serve small and medium-sized ore mining enterprises and to serve the training process of students in the field of machine manufacturing technology.

Keywords: Crushing equipment, ore mining, crushing technology, machine manufacturing technology.

I. INTRODUCTION

Crusher is an important equipment in the ore mining industry. There are many different types of crushers on the market such as cone crushers, disc mills, ball mills, hammer mills, etc., which are provided by domestic and foreign companies, especially from China. In the northern region, Vietnam in general and in Thai Nguyen in particular, there are many ore mining companies with large and small scales. However, many small and medium-sized ore mining companies are currently facing difficulties in equipping crushing equipment because of high equipment investment costs. These companies tend to use old Chinese equipment, so the quality of the equipment is not high, the productivity of the equipment is not suitable for the small and medium mining scale; the investment and use of equipment in the ore mining process is not really effective. Therefore, the design and manufacture of crushers for ore mining enterprises is particularly important for production practice.

On the other hand, the process of training students in Machine Manufacturing Technology needs to ensure that one of the important output

standards is the ability to apply core technical knowledge to set up technological processes, processing and manufacturing machines and equipment for practical production. In order to do that, theory needs to be closely linked to practice, learning must be associated with experience and application. Therefore, the application of the results of research, design and manufacture of crushers for ore mining process to the training process will help students approach professional practice, and improve their capacity in designing and manufacturing machine and equipment to serve practice in enterprises and improve career adaptability after graduation of the students.

II. CONTENT

2.1 Overview of ore and ore crushing process

Ore is a type of rock that contains many different minerals such as metals and gems. Ore, after being mined at large mineral mines, is taken to a processing plant (separating metal from the surface of rocks and minerals) to obtain metal ore. In metal ores, common ores include iron ores (Fe_2O_3 , $\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$, Fe_3O_4 ...), aluminum ores ($\text{Al}_2\text{O}_3 \cdot n\text{H}_2\text{O}$, Na_3AlF_6 , $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$...) and copper ores (Cu_2S , $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$, $2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$, ...).

All ore mining activities in particular and mineral extraction in general have the same main point of implementation of technical solutions to select the useful components in ore grains with the most suitable physical and mechanical properties.

An ore mining technology line usually consists of three main stages: preparation stage (large-sized ore will be crushed, crushed, sieved and graded to filter useful minerals from the soil and rock, and prepares ore grains of suitable size); ore selection stage (separation of metal particles (ore particles) from soil and impurities) and finished product stage (separation of ore particles by machine of washing, screening, stirring and magnetic separators. This study focuses on ball mills for iron ore crushing at the This study focuses

on ball mills for iron ore crushing at the preparatory stage.

2.2 Status of research on ball crushing

Ball crushing is considered a popular crushing equipment and has received a certain amount of attention from scientists. The machine has a reciprocating tubular shape, driven by an external gear and a reducer motor. The machine works on the principle of impact and grinding force. The material from the feeder through the spiral shaft is fed into the first zone of the crusher. In this area there are tapered pads and steel balls. When the machine moves, centrifugal force is generated. This force will bring the steel ball up to a certain height and then fall down and smash, crushing the material. Then coarsely ground material in the first zone, through the baffle into the second zone. This second zone also has tapered pads and smaller steel balls that will grind the material again. Powdery material is discharged through the discharge outlet [1].

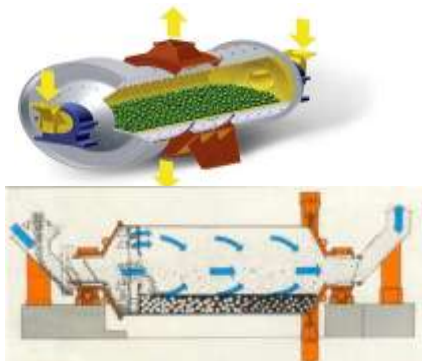


Figure 1. Model and general working principle of ball crushing

Ball crushing (ball mill) is classified into different types such as cyclic and continuous (according to working mode), dry and wet mills (according to crushing method),... rotary and tubular ball mills (according to the ratio of length/diameter of grinding cavity, L/D)... [2]. The length of the cylindrical shell is usually 1.0-1.5 times larger than the shell diameter. Crushed material can be dry, or wet (contains 20-40% water) [3]. The grinding roller is usually lined with a layer of manganese steel or rubber to reduce wear [4]. Crushers are used to crush and mix materials by using balls of different sizes. The big balls break down the raw materials, while smaller balls aid in the formation of a finer product [5]. The crushing tank contains iron balls, steel balls, stone or porcelain balls. The size of the balls depends on the crushed load [6]. The balls move in the grinding

barrel with different velocities, giving their direction and kinetic energy different and thus the impact force on the material very different. These forces are generated from the rotation of the balls and the movement of the materials in the mill and the contact area of the balls upon impact with the material [7].

From the above analysis, it can be seen that ball mill is an important equipment in the process of mining and processing of ore. However, researches on ball mills suitable for small and medium production scale have not been widely researched and published by domestic and international scientists.

2.3 The reality of using ball mills in iron ore mining and processing enterprises in Thai Nguyen, Vietnam

In Vietnam, iron ore is a popular ore with large reserves (there are more than 300 mines). In particular, Thai Nguyen province, Vietnam, has about 42 iron ore mines of all kinds with total reserves and resources of about 49 million tons. Of which, there are over 12 million tons of magnetite ore with content from 42% - 65%; 37 million tons of limonite ore and hematite ore with content of 30% - 55%, concentrated mainly in Dong Hy district and a few districts such as Dong Hy, Phu Luong, Dai Tu, Vo Nhai... Most of mined iron ore (98%) is used in the steel production process at Iron and Steel Factory of Thai Nguyen and neighboring provinces. Therefore, the issue of iron ore mining is an important content for the economic development of the province.

The crushing stage in the ore mining and processing in the mines of the province is mainly done by ball mills which are imported from China. Due to economic problems, most of the imported machines are usually old machines, so the production quality is often not high. Availability when mining and processing iron ore as well as replacement and repair are limited due to high dependence on partners. Local mechanical processing enterprises have not paid much attention to the processing of this equipment.

The crushing stage in the ore mining and processing in the mines in the province is mainly done by ball mills which are imported from China. Because of economic factors, most of the imported machines are usually old machines. Therefore, the production quality is usually not high; availability in mining and processing is not high. In addition, the replacement and repair are limited due to the high dependence on foreign partners. Moreover, local mechanical processing enterprises are not interested in processing this equipment.

The reality shows that the processing and manufacturing of ball mills has not been interested by local mechanical processing establishments, so it has not met the needs of iron ore mining and processing for the steel production process of the province and surrounding areas. Therefore, the study of crushing equipment for ore mining is still a matter of focus on research to serve as a basis for manufacturing machines for the actual ore mining process.

2.3 The reality of training students in the field of Machine Manufacturing Technology at the Thainguyen University of Technology (TNUT)

One of the most important requirements for TNUT's Machine Manufacturing Technology students is to meet the technical skills output standard.

To meet this output standard, the students have been equipped with a relatively complete system of technical knowledge (about 51%). However, practical activities and internships (about 14%) mainly focus on training skills in processing specific details. The content of practice related to the research, design and manufacture of a detailed assembly or a whole device has not been focused. Therefore, technical skills are still relatively fragmented; To meet this output standard, students have been equipped with a relatively complete system of technical knowledge (about 51%). However, practical activities and internships (about 14%) mainly focus on training skills in processing specific details. The content of practice, practice related to the research, design and manufacture of a detailed assembly or a whole device has not been focused. Therefore, technical skills are still relatively fragmented; Systematicity, practicality and completeness need to continue to improve.

Therefore, the research, design, processing and manufacturing of ball mills will make a favorable environment for students of Machine Manufacturing Technology to improve their cognitive ability, form design thinking, linking theory with practice, linking learning and production... so this activity will contribute to improve the technical capacity of students.

2.4 Design, manufacture and testing of ball mill equipment

a. Design and manufacture of ball mill for iron ore crushing

Ball mills are designed and manufactured with a cylindrical grinding roller mounted on a horizontal support. The mill is moved by a system consisting of a motor and a load carrier. The material from the feeder passes through the spiral

shaft into the grinding roller. The ore is continuously crushed and has a moisture content of less than 3%. When the machine moves, centrifugal force is generated, bringing the steel ball up to a certain height, falling, smashing and crushing the ore. The ore after being crushed will be released through the outlet.

Some main parts of the crusher are designed to meet small and medium-sized production, including: Motor base (12,996kg), pulley 1 (4,112 Kg), pulley 2 (21,105 Kg), V-belt (0.396 kg), SKF6312 (1,653 kg), intermediate gear opening cover (2,005 kg), Spur Gear 1 (64,791 kg), Spur Gear 2 (143,526 kg), spacer (0,503 kg), intermediate shaft (6,371 kg), load carrier (64,416 kg), intermediate support (32,783 kg), support plate (39,016 kg), mill body (3121,408 kg), foot frame (584,868 kg).

The mill body consists of the grinding roller (689.569 kg), the seat ring (147,883 kg), the curved liner (51.668 kg), the door (20,390 kg), the outlet liner 1 (10,175 kg), the outlet liner 2 (19,222 kg) and outlet pad 4 (19,222 kg).

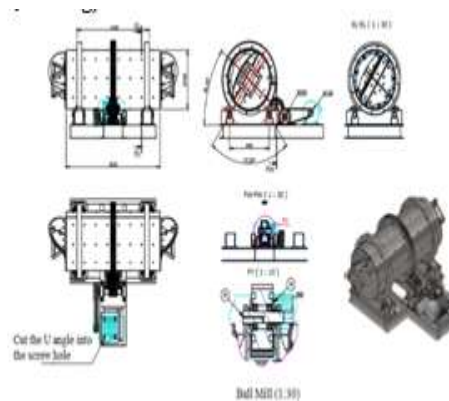


Figure 2. Design the ball mill

The designed ball mill has been delivered to the factory. Some of the main machine details and the ball mill manufactured and fully assembled are shown in detail as follows:



Figure 3. Some details and finishing crushing

b. Experimental results

The crusher, after being manufactured, tested and used in crushing iron ore, has ensured the required features. Iron ore, after being crushed by a crusher, has ensured its small size, meeting the requirements of the next stages. Iron ore before crushing and after crushing is shown as follows:



Figure 4. Iron ore before crushing



Figure 5. Iron ore is crushed by ball mill

III. CONCLUSIONS

Ball crushing is an important equipment in the mining and ore processing industry in general and in Thai Nguyen province, Vietnam in particular. The results of the research, design and manufacture of ball mills of the subject have met the small and medium production scale, of the local production scale. So the local mechanical enterprises can conveniently process and manufacture for the supply, operation and repair of equipment, ensuring the initiative and investment in machinery and equipment of enterprises to ensure economic efficiency. Besides, the research results are a practical basis in orienting students of Machine Manufacturing Technology to apply specialized knowledge in practice, meet the industry's output standards and improve their adaptive capacity to enter the professional world after graduation.

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