Chapter I

Introduction

1.1 Motivation, Objective, and Scope

At present Thai ceramic industry has been progressed to a certain level. It is now necessary that, this industrial line must be developed to a higher level to compete with leading countries. Machines and tools are high investment if imported, as well as know-how technique. However, high investment can be saved in terms of fixed-assets and cost of production,if machines, tools and know-how are invented in the country. This policy is so identified with that of practical industry and of the nation.

In ceramic production process, there are many questionable topics that are so interesting that one would desire to study and doing research with the target to end up with new invention. One interesting topic among many, is "The Production of High Alumina Bricks for Lining in Ball Mill and Other Grinding Apparatus by Extrusion Forming Method".

The theoretical interest behind the topic is:- high alumina ball mill lining functions the grinding of raw material better than the porcelain lining one.

With the Silex and porcelain lining,there are limitations of grinding competence and accuracy of the mixture: such as it´s unability to crush raw material to fine powder, insufficient hardness that will cause corrosion and contamination, the inaccuracy of the mixture, which will consequently damage the production.

In comparison, the high alumina lining has a more consistent, hardness and a higher density or more weight. These properties lead to better grinding competence to fine delicacy with less time spent in grinding which are practical industrial desire.

At present, most grinding machines used in our country, are lined with high silica, hard stoneware and porcelain. These machines take time in grinding and give inaccuracy of finished mixture, as above mentioned. If one would needs a desirable high competent and accurate grinding machine, one has to import the machine from abroad and put more investment and high expense with an expectation of high turnover.

This brings me to the interest of studying deeply in the topic of high alumina lining.If an invention of high alumina lining (app. 85% Al_2O_3) is researched and produce in Thailand, a better production and saver will be gain, not only the ceramic industry but also the other industries that need grinding machine will benefit from this invention, and an expectation of high turnover is still in the possibility. This study is aimed particularly to the high alumina material to use as lining bricks in ball mill by extrusion forming method.

1.2 Ball Mill Liners.

Ball mill is any mill in which inside of the cylinder is lined with liners, either rubber, silex, porcelain or some other non-metallic liner such as alumina liners etc.

Kinds of Liners.

- Rubber Lining ; are usually vulcanized. Natural rubber is most generally used because it provides the greatest resistance to abrasion more than synthetic rubber, like Neoprene or Hycar. The rubber linings are used only in wet grinding operations because in dry grinding, the rubber has the tendency to abrade excessively.

- Silex ; pure flint lining. it is one of the toughest lining materials available for ball mills. Because of its natural rough surface which helps prevent the charge from sliding or slipping, insures a more efficient grinding action. Belgium is the only country in the world where good quality blocks are available, the silex from other countries such as China or Korea, has lower quality.

- Porcelain Lining ; a pure white ceramic lining which has a dense, tough structure, will stand up for many years of service depending on alumina content in it.

- High Density Lining ; made with a high alumina content, it is the toughest and most abrasion resistant of the synthetic linings, together with the correct dimension designation and installation to provide the high precision, compares with the natural lining.

Ball Mill Grinding Operation.

In wet grinding ; the void volume between the grinding media, with the mill half charged, represents approximately 20% of the total volume of the mill. Fastest grinding occurs where there is just sufficient material in a batch to fill all voids and slightly cover with the grinding media. The most important element in wet grinding is the consistency, or viscosity, of the batch. Low viscosity materials permit the grinding media to move with excessive speed and this combined with the thin protective film around the media, may cause abnormal wear, contamination and heat build-up. With high viscosities free movement of the grinding media is impeded. This can cause a carrying over and "throw" of the media resulting in inefficientcy and contamination.

Based on accepted milling techniques, the avialable batch volume is 20-25% of mill volume according to the kind of balls used and these volumes should be multiplied by the specific gravity of the composition to be the batch weight. Both when too much or too little material is charged, the grinding capacity decreses. The correct ratio between the batch and the ball charge must be maintained. For uniform results not only the mill speed and the grinding time are important, also between the batch and the amount of water, leads to differences in particle size and distribution.

The quantity of water affects the grinding capacity more than other factor. In too thin a slip of particles are swept away by the water, which is put aside by the oncoming balls, and so the particles escape from the impact. A watery slip cannot form viscous film around the balls, which results in less grinding action. In too thick a slip the striking force of the balls is smorthered ; this also leads to a decreased grinding action.

Quantities of water, varying between 40-60% of the batch weight are being recommended. Whenever the percentage of clay additions is increased, some more water should be added because clay particles surround themselves with a viscous water-film and this leads to some increase of the viscosity of the slip.

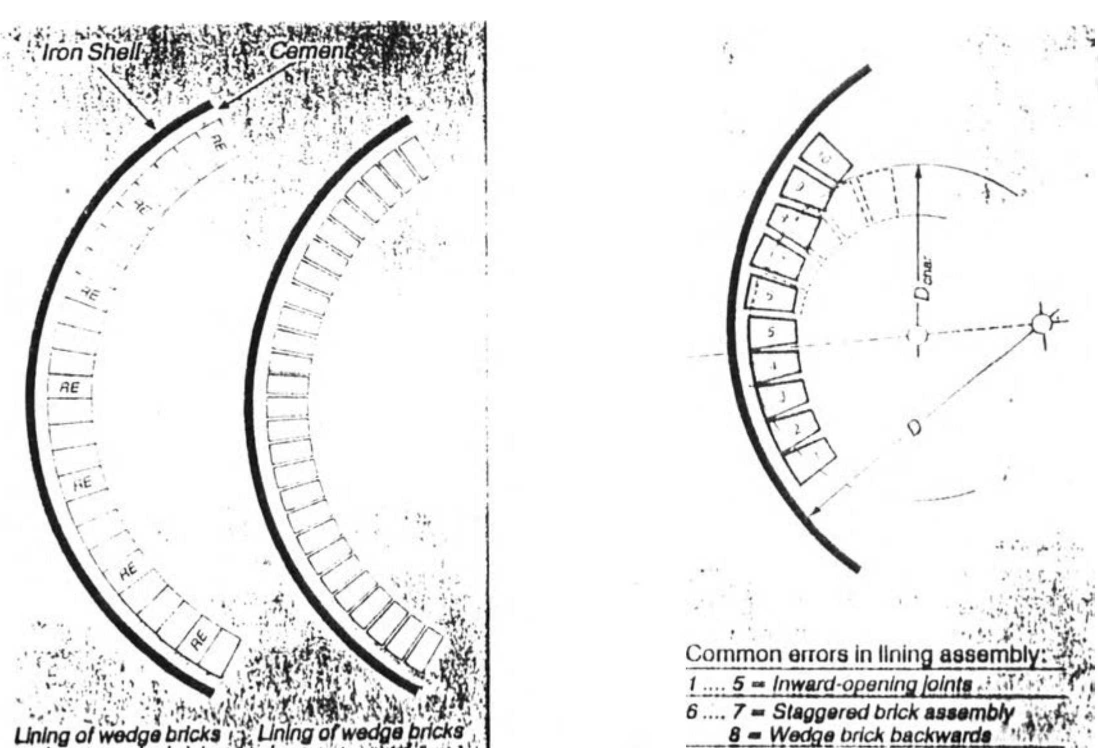
Lining Installation

Before begining work on the lining, any brick or cement residues shall be removed from the inside surface. Smooth area shall be roughened and, if the iron shell is considerably worn, it shall be strengthened by electric welding.

The lining process is usually started on the head surface, when the bricks are installed on the flat surfaces, with the upper brick overlapping the joint between the two lower bricks. Narrow joints measuring approximatly 1 mm. should be made.

The cylindrical face of the shell is usually lined with rows of wedge bricks interspersed with rows of rectangular bricks at certain interval. If the diameter of the shell is the same as the characteristic diameter of the wedge bricks, only wedge bricks alone shall be used.

Fig.1 Lining installation



1.3 Literature Survey.

1.3.1 From the product data sheet of liners, The forming method was isostatic pressing. But in this research,the extrusion method was considered to make the equivalence product with the lower cost.

Table 1 Typical physical characteristics of high-alumina lining products from various companies.

Trade name Country	Alubit.90 Italy	CTI. Spain	Arlcite. France
Forming method	=== Isostatic pressing ===		
% Al_2O_3 content	90	90	84
Density [gm./cm.^{3}]	3.57	3.60	3.40
Hardness [Moh scale]	9	9	9
[Rocwell 45N]	78	75-79	-
Flexural strength [kg./cm.^{2}]	3,200	3,200	2,740
% Water absorption	0	0	0
Impact strength [kpcm/cm.^{2}]	-	8	-
Color	white	white	white

1.3.2 Surdeanu, Tudor Gheorghe; Rom, 65,807,30 Oct.1978.

Bricks for Lining Ball Mill and Grinding Apparatus. The title bricks were extruded from a high alumina composition containing calcined Al_2O_3 84%, crude kaolin [thixotropic index 1.2] 5.5%, steatite [contg.>30% MgO] 4% , Na_2O-bentonite 5%, and tech.-grade $CaCO_3$ [contg.>97% $CaCO_3$] 1.5% were ground in the presence of water to give a slurry, which was used for vacuum extrusion of bricks. The bricks after firing at 1550-1570 c. had Moh.hardness 9,density 3.45-3.58 gm./cm.^{3},and water absorption 0%.