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A Review On Production Of Lightweight Aggregate By Pelletization Process

KEYWORDS: Pelletization, Lightweight Aggregate, Artificial Aggregate.

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ABSTRACT A pelletization process is a well-known technique in the production of artificial aggregates. The production of concrete requires aggregate as an inert filler to provide bulk volume as well as stiffness to concrete. Natural crushed aggregates are commonly used in concrete which can be depleting the natural resources and necessitates an alternative building material. This led to widespread research to produce artificial aggregate. A review studies have been reported on different factors which can be affecting the pelletization process such as speed of pelletizer disc, time duration, and angle of disc, moisture content and types of binder to produce fly ash lightweight aggregates. These factors affect efficiency of pelletization of light weight aggregate and properties of light weight aggregate.

I. INTRODUCTION

Presently in India the power sector depends on coal based thermal power stations which produces a huge amount of fly ash and estimated to be around 110 million tonnes annually. This fly ash can be utilized by producing lightweight aggregate. The utilization of fly ash is about 30% as various engineering properties requirements that is for low technical applications such as in construction of fills and embankments, backfills, pavement base and sub base course; intermediate technical application such as in producing blended cement, concrete pipes, precast/ prestressed products materials, lightweight concrete bricks/blocks, autoclaved aerated concrete and lightweight aggregate (Baykal and Doven, 2000). Lightweight concrete can be produce by aerated cellular concrete and lightweight aggregate concrete. The uses of structural grade lightweight concrete reduce considerably the self-load of a structure and permit larger precast units to be handled. For example the Autoclaved cellular concrete (ACC), is a lightweight concrete material, which can be manufactured using 60 to 75% fly ash by weight (Ahmaruzzaman, 2010).

Earlier studies showed that the performance of pelletization is a function of mechanical process parameters such as the angle of the balling drum and the revolution speed and properties of the raw material, namely, size of particles, and their distribution, with the intrinsic specific surface area and shape; wettability of particles and moisture content (Baykal and Doven, 2000; Jaroslav and Ruzickova, 1998).

One of common technique to produce lightweight aggregate is agglomeration (pelletization). In agglomeration technique the pellet is formed in two ways either by agitation granulation and compaction. The agitation method is not taking any external force rather than rotating force. With increase in the dosage of water in the binder the cohesive force of the particles increase. Sintering, autoclaving and cold bonding are three different processes to harden the green pellet (Bijen, 1986). The partial replacement of normal weight aggregate is 20 to 40% by the volume of lightweight aggregate with difference of the compressive strength as 1% only (Behera et al., 2004). This paper is review on the factors affecting production of lightweight aggregate and crushing strength of lightweight aggregate by different binder.

PELLETIZING PROCESS

The desired grain size distribution of aggregates may be provided either by crushing of rock or by the agglomeration of fines that has cementitious property either by themselves and/or by blending them with mineral additives. Pelletization process is the agglomeration of moisturized fines in a rotating drum or disc. Binder addition may also be made to the fines during or prior to process. The product at the end of the process is called as 'fresh pellet'. The crushing strength of the fresh pellet must be enough for hauling and stockpiling purposes. The pellets may also be sintered during a specified interval of time after production depending on few concerns like the properties of the fines used in pelletization process, the purpose of use and the rate of increment in engineering performance of the pellets.

In the granulation technique pellets formed without any compacting forces other than tumbling force. As a result of this tumbling force and as well as capillary force fly ash come together and fly ash ball formed. This required wetting of fly ash particles. Usually water is added as bonding agent but sometimes material like glass powder, cement, slag, metakaoline, clay binders etc. used as biding agent. This all required to increase efficiency of pelletization of producing lightweight aggregate.

The different types of pelletizer machine were used to make the pellet such as disc or pan type, drum type, cone type and mixer type. With disc type pelletizer the pellet size distribution is easier to control than drum type pelletizer. With mixer type pelletizer, the small grains are formed

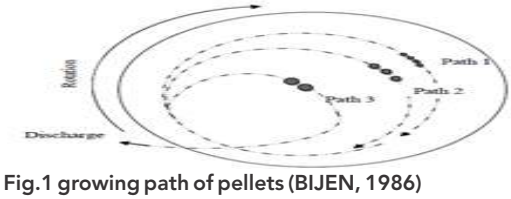

Fig.1 growing path of pellets (BIJEN, 1986)

Volume - 5 | Issue - 1 | Jan Special Issue - 2015 | ISSN - 2249-555X

Initially and are subsequently increased in particle size by disc type pelletization shown in Figure 1 (Bijen, 1986).



Fig.2 disc pelletizer machine (Manikandan and Ramamurthy, 2007)

The disc pelletizer size is 570 mm diameter and side depth of the disc as 250 mm, it is fixed in a flexible frame with adjusting the angle of the disc as 35 to 55° and to control for the rotate disc in vertically manner should varying speed as 35 to 55 rpm shown in Figure 2 (Manikandan and Ramamurthy, 2007).

FACTORS AFFECTING PELLETIZATION PROCESS

This review paper focused on only pelletization process and factors affecting pelletization process. Now from earlier studies there were mainly two types of factor one is physical factors and mechanical factors which can affecting the pelletization process.

1. PHYSICAL FACTORS

1.1 Binders content and its type
1.2 Moisture content
2 MECHANICAL FACTORS
2.1 Angle of disc
2.2 Speed of pelletizer
2.3 Time duration

1. PHYSICAL FACTOR

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BINDERS CONTENT AND ITS TYPE

The binders are one of the very important materials for production of lightweight aggregate. There are different types of binder available in market but for efficiency of process we have to define best of them. Here some results of efficiency of pelletization with different type and content of binders are shown.

In one paper, author used ordinary Portland cement; Na–bentonite and powdered limestone were used as binders in 10%, 20%, and 30% by weight of fly ash for pelletization. As a result they found 20% of sodium bentonite resulted in optimal strength and minimum water absorption (K. Ramamurthy, K.I. Harikrishnan 2004).

In this paper, author used bentonite and kaolinite as different type of binder and at a dosage of 14% of bentonite they got maximum efficiency of pelletization is 98% than 14% of kaolinite. This result obtains because of different plasticity index of different binders when plasticity index is more than efficiency is good at optimum dosage of binders (R. Manikandan, K. Ramamurthy 2007). From above result we can understand type of binder and its content has major role in efficiency of pelletization process.

MOISTURE CONTENT

When a fine-grained material is moisturized, there forms a thin liquid film on the surface of the grains, which forms meniscus between the grains, structures like bridges. In case the particles are rotated in a balling drum or disc, then they form ball shape structures with enhanced bonding forces between grains due centrifugal and gravitational forces. But when moisture content is more than optimum value then muddy pellets crate with uneven shape and its strength is less than handling strength.

2. MECHANICAL FACTORS

ANGLE OF DISC

As shown in fig.2 pelletizer is to set an optimum angle to create pellets but pelletizer disc is also rotating with some speed so there are pellets in the disc have to withstand with two forces one is rotating force and other is gravitational force when this two force are at their compatibility level pellet formation will be good. So by this it can be seen angle and speed both are also its compatibility level.

Based on the trial and error the efficiency of production was higher and perfect shape of the pellet, when the disc were kept at an angle 36° and speed as 55 rpm the mixture was pelletized to a disc pelletizer to make the aggregate perfect spheres. On the other hand angle of pelletizer lower than 35° or greater than 45° can result in the fly ash aggregate could not made a higher strength pellets (P.Gomathi And A.Sivakumar,2013).

SPEED OF PELLETIZER

A pelletizer disc is rotating with some speed to form pellets. As from above we know angle and speed both have to its optimum value to form pellets. For low revolution speed the movement of pellets is governed by gravitational force and for high speeds the movement is governed by the centrifugal force. If one of these forces becomes dominant, then either pellets formed have loose structure or formation is totally ceased, especially if it is for the centrifugal force, where all the particles are stuck to the side walls of the disc by means of adherence created by moisture. So speed of pelletizer disc will be optimum. (Baykal, G., Doven, A.G., 2000). A high level speed is used to maximize strength of aggregate (K.I. Harikrishnan, K. Ramamurthy,2007).

TIME DURATION

The efficiency, size and shape of aggregate were affected by the duration of pelletization, as it was observed that during the first 10 minutes the pellets were formed with perfect shape and subsequently turns into irregular shape. Also, with the increase in the duration of pelletization the compaction pressure increases with the formation of larger size. The further increase in duration beyond 20 minutes resulted in the formation of muddy fly ash balls with uneven size. Hence it can be concluded that an optimized interval of 10 to 15 minutes leads to a more stable formation of pellets with uniform size and higher strength index (K.I. Harikrishnan, K. Ramamurthy,2007).

The overall efficiency of pelletization with cement binder with alkali showed 94.38% as compared to that of geo-polymer based fly ash aggregate Containing lime binder with alkali showed 36.88%. However the fly ash aggregates containing cement and 12M NaoH were found to exhibit higher efficiency compared to the other type of aggregate. The result shown in Table.3 with different time duration (P. Gomathi and A. Sivakumar 2012).

Volume - 5 | Issue - 1 | Jan Special Issue - 2015 | ISSN - 2249-555X

CONCLUSION

From above studied, it is concluded that

- If fineness of fly ash is less than 257 m2/kg, efficiency of pelletization is very low.so we required binders to increase the efficiency of pelletization.
- The dosage of binders' content required based on its plasticity index and different binders have different effect as 14% of bentonite gives better efficiency than kaolinite of same dosage.
- Angle and speed both are its compatibility level. At an angle of 35° to 55° and speed as 35rpm to 55 rpm, the disc pelletizer makes the aggregate good spheres shape and efficiency.
- The Pelletizer lower than 35° or greater than 55° can result in the fly ash aggregate could not made a higher strength pellets.
- Most favourable time duration for pelletization is 10 to 25 minutes.

These mechanical factors such as angle of disc, speed of pelletizer, and time duration affect pelletization process. This all parameters have to be at its optimum value for increasing efficiency of pelletization. Angle of disc and speed both are related to each other and this two are relevant to moisture content. By this study we can understand about factors affecting pelletization and further use it in practical to overcome the problem related to this factor. And we know that there is major part of aggregate in concrete. We increase efficiency and quality of lightweight aggregate produced by pelletization so that we can maximize use of it.

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