Optimization of Jigging Process Parameters to Beneficiate Iron Ore Fines – a Case Study of Tatasteel

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Abstract

Jigging has a very important role in mineral processing Industry. Upgrading of Iron Ore by jigging has been an emerging trend. A detailed investigation is carried out to understand the role of jig feed distribution and process parameters during jigging operation. Noamundi jig plant data shows that variation in jig feed granulometry, feed quality and operating conditions are major contributors to fluctuation in jigging performance. At Noamundi the Jig feed size (-10.0+0.5mm) fraction is used for fines jigging operation. To understand the effect of particle size distribution on jig plant performance such as yield, separation efficiency and Fe recovery. In this context The performance of jigging was evaluated by daily average data from jig operation was used to study the influence of feed distribution on jigging performance .Coarser fraction (+6mm) has a positive influence, whereas fines fraction (-0.5mm) tends to lower performance .During Jigging rearrangements of Particles takes place due to an alternate expansion and compaction of Jig Bed .These particles are arranged by increasing density from top to bottom. During the particle stratification, Jig bed physically cut at desired horizontal particle density plant to separate the desired product. Investigation shows that optimum bed height is required at different Jig feed quality to achieve desired product quality, maximum separation efficiency and Fe recovery. This Paper will illustrate role of feed distribution and process parameters control on Jigging plant performance and deals with optimization of process parameters to recover iron value from fines.

Keywords: jigging, granulometry, feed quality, bed height, yield, separation efficiency, iron separation

Introduction

Jigging is a density-separation process which is widely used to separate heavier particles from the lighter ones. It is used for beneficiation of ore minerals as well as washing of coal. In its class it is by far the simplest yet a robust mechanical device that can treat comparatively larger size feed materials at higher throughputs. The specific advantages of a jig of low operating cost and ease of operation still remain and it is for these reasons Indian industry is witnessing a recent trend of treating iron ore in jigs. Nevertheless, to keep jigging as a competitive and viable option, there has been a renewed research interest towards improving the separation efficiency. Separation efficiency of any process is intimately related to the inherent process mechanisms of the processing unit. A comparison of the process mechanisms of various gravity separation units leads one to believe that particle separation in jigging, unlike several other gravity separation processes, is a rate process. In other words, separation is achieved gradually and a final concentration product is realized after a certain time. Therefore, earlier research work on jigging was primarily focused on the kinetics of particle stratification. Later, from the process design standpoint key parameters in addition to the process kinetics was also investigated (Karantzavelos and Frangiscos, 1984; Rong and Lyman, 1991). However, these studies could not provide know-how for improving the separation efficiency.In this study effect of granulometry and bed height on jig plant performance are explained

Methodology

Effect of granulometry and bed height on jigging was studied using iron ore particles of _10.0 mm size fraction. Plant data was collected from Noamundi iron ore beneficiation plant of M/s. Tata Steel Ltd., India. In the plant, ROM is crushed and then screened at 10.0 mm. Coarser size fraction (+10.0 mm) is fed to the blast furnace and the finer size fraction is treated in a screw classifier to remove the _0.15 mm fraction. The _10.0 + 0.15 mm size fraction is fed to the sinter plant and the _0.15 mm size fraction of high alumina content is treated as a reject material. Classification process in the screw classifier reduces alumina content by only 0.2% from a feed grade of 2.7–3.5%.

Effect of granulometry on Jig Plant Yield%:

We have observed granulometry of feed plays an important role in jigging performance. We have analysed the effect of following fraction in the jig feed in the jigging performance (Yield %) and the same is plotted below

- + 6mm in Jig feed
- -3 + 0.5 mm in Jig Feed
- -0.5mm in Jig feed

From the above graphs we can conclude following facts for our operation

- Jig Plant yield increases with the increase in +6 mm in the feed.
- Jig Plant yield decreases with the increase in -3+0.5mm in the feed.
- Jig Plant yield decreases with the increase in -0.5 mm in the feed.

Effect of Jig Feed Alumina on Jig Plant Yield%:

To understand the effect of jig feed alumina on jig plant yield % with the present type of feed mix, we have anal-

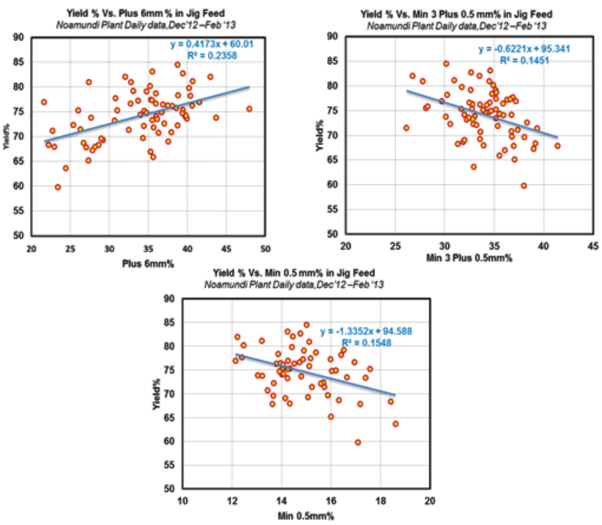

Fig. 1. Effect of granulometry on Jig plant yield
Rys. 1. Wpływ uziarnienia na uzysk w osadzarce

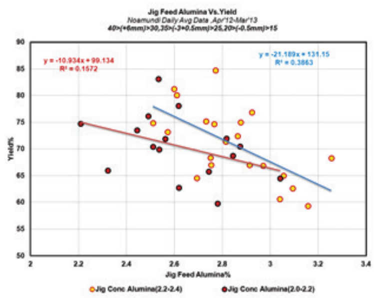

Fig. 2. Relationship between jig feed alumina and Jig yield at different jig conc.alumina level
Rys. 2. Zależność między zawartością korundu (alumina) wydajnością osadzarki

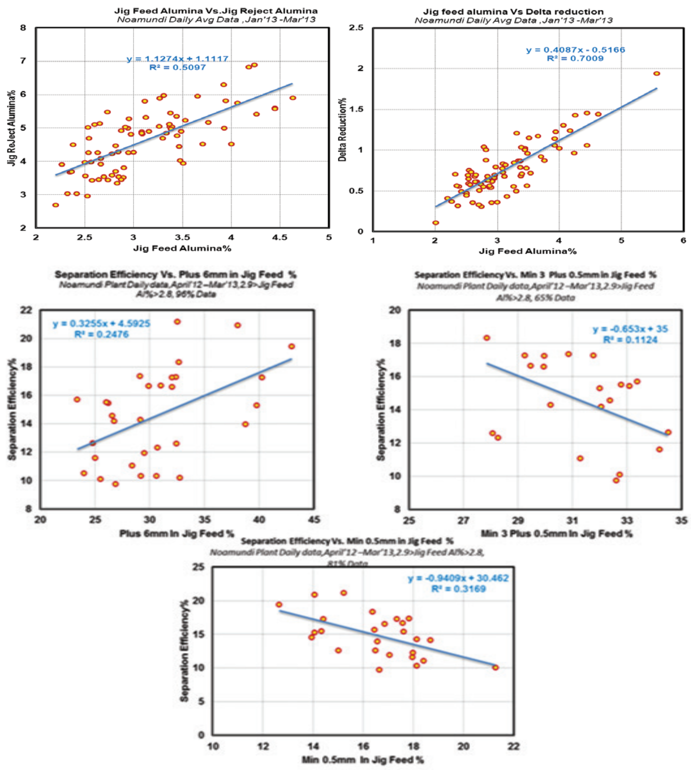

Fig. 3. Effect of granulometry on Jig plant seperation efficiency
Rys. 3. Wpływ uziarnienia na wydajność osadzarki

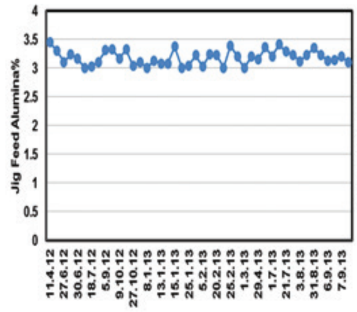

Fig. 4. Jig feed Alumina% band
Rys. 4. Wpływ zawartości korundu w nadawie na wydajność

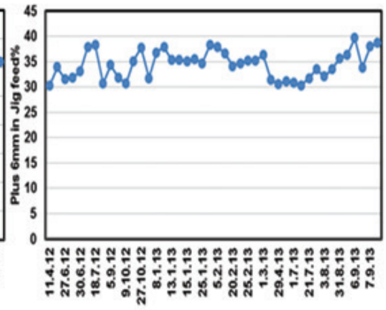

Fig. 5. Jig feed plus 6 mm fraction%
Rys. 5. Wpływ udziału klasy +6 mm w nadawie na wydajność

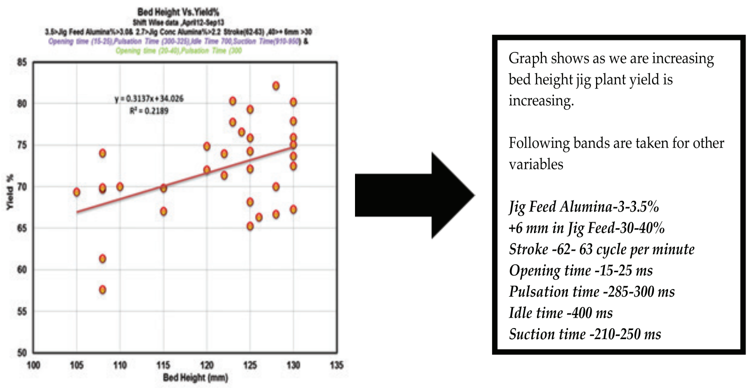

Fig. 6. Relationship between bed height and Jig yield
Rys. 6. Zależność między wysokością łoża a wydajnością osadzarki

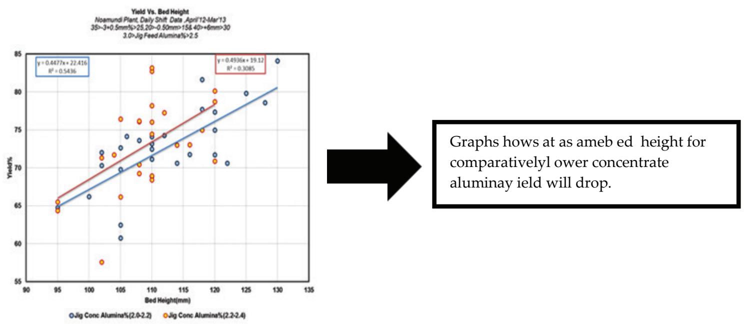

Fig. 7. Relationship between bed height and Jig yield at different jig conc.alumina level
Rys. 7. Zależność między wysokością łoża i wychodem dla różnej zawartości korundu

ysed FY13 data by fixing a fixed granulometry band and a fixed concentrate alumina band. By this exercise we wanted to avoid the effect of granulometery/conc. alumina in jigging yield.

The above graph shows if we target for lower alumina for the same jig feed alumina we will get lower yield.

Effect of granulometry on Separation Efficiency of Jig Plant:

Separation efficiency is how efficiently we are removing values from gangue. We understand delta reduction in jig plant and jig reject alumina plays an important role in jigging separation efficiency. We also understand if jig feed alumina is high we generally achieve higher delta reduction (graph shown below) and as well as higher alumina in jig rejects (graph attached) so to mitigate the effect of jig feed alumina we have plotted effect of granulometry in jig feed with a fixed band of jig feed alumina and the same are shown in Fig. 3.

From Above relationships we can observe:

- If + 6mm in jig feed increases it will enhance the jig plant Performance in terms of Separation efficiency.
- If -3 +0.5mm % in jig feed increases separation efficiency comes down.
- If -0.5 mm % in jig feed increases separation efficiency comes down.

Effect of Bed height on Yield

Jigging is a process of particle stratification in which the particle rearrangement results from an alternate expansion and compaction of a bed of particles by a pulsating fluid flow. The rearrangement results in layers of particles that

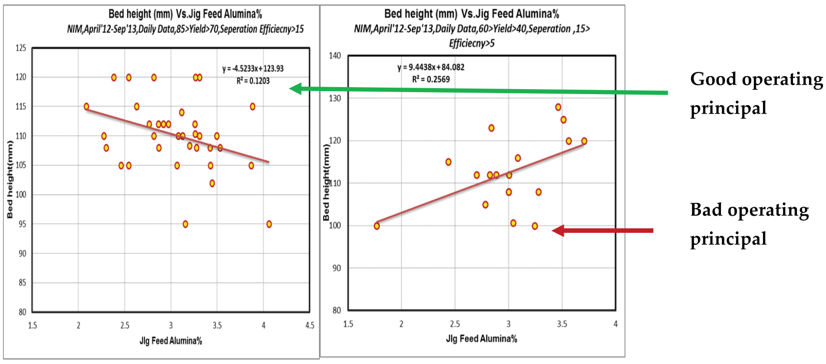

Fig. 8. Relationship between Jig Feed Alumina and bed height and comparison
Rys. 8. Związek między zawartością korundu w nadawie a wysokością łoża

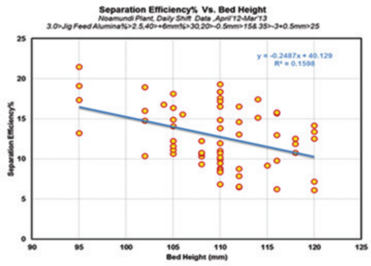

Fig. 9. Relationship between bed height and seperation efficiecny
Rys. 9. Zależność między wysokością złoża a wydajnością separacji

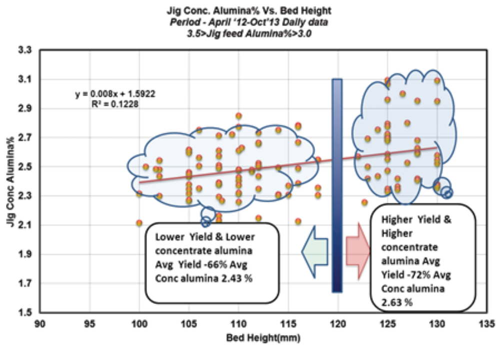

Fig. 10. Relationship between bed height and Jig conc alumina
Rys. 10. Zależność między wysokością łoża a zawartością korundu w nadawie

are arranged by increasing density from top to bottom of the bed. After particle stratification, the particle bed is physically 'cut' at a desired horizontal particle density plane (Bed height –height measured from bottom) to separate the desired product from the less dense gangue material.

To understand the effect of bed height on Jig Performance, we compiled shift wise and fixed all other known variables effecting jigging performance in fixed band except Jig bed Height.

We have stratified 44 data points in which jig feed alumina % is lying in the band of 3–3.5% and Jig feed plus 6 mm fraction between 30–40% because these parameters are having positive effect on Jig plant yield.

As discussed above we have fixed Jig feed Alumina%, Jig conc. Alumina% plus 6mm in Jig feed%. We also fixed Stroke and Pulsation time in a fixed band which we know from Jigging theory has influence jigging performance. Unfortunately we didn't get the same effect in our plant data may be due to not much variation in the said parameters. Effect of Jigging bed height on Jig plant yield is shown in Fig. 6.

We also know with a given jig feed alumina as we increase Jig Yield concentrate alumina will go up. Graph below shows in the same bed height for lower alumina output yield will drop.

Effect of Bed height on Separation Efficiency with variable Jig Feed Alumina

With the increase in Jig Feed alumina to achieve good separation efficiency from Jig Plant we have to reduce bed height failing which there will be misplacement means concentrate reporting in jig rejects or jig rejects reporting in jig concentrate.

Effect of Bed height on Separation Efficiency with fixed Jig Feed Alumina in showed in Fig. 9.

Effect of Bed height on Jig Concentrate alumina with the fixed band of jig feed alumina

In the fixed band of Jig feed alumina if we increase bed height we will get higher yield but concentrate alumina will increase. Graph shown below. So we can change concentrate alumina as desired by changing bed height.

Conclusion

We would like to draw following conclusion.

- Feed granulometry play important role in jigging yield and separation efficiency and the effect of unfavourable granulometry can be mitigated by treating ore in closed size range e.g -8+3 mm and -3+1 mm. In this range testing conducted at Mintek South Africa and we could find substantial improvement in yield compare to -8+1 mm as a whole.
- With the increase in feed alumina yield drops for a fixed band of jig concentrate alumina and with the same jig feed alumina if we target for lower concentrate alumina we will get less yield.
- If we increase friable ore in the feed -0.5 mm in jig feed increases which is detrimental to jigging performance and the same can be controlled in the present plant condition by replacing present de-watering screen panel with 0.6 mm size screening media. In the beneficiation practice it is proposed to treat +1mm size which is ideal for jigging process.
- When jig feed alumina is increasing to maintain concentrate alumina in a fixed band and also to achieve good sepration efficency, we need to operate at lower bed height. Yield may vary.

Acknowledgements

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Optymalizacja parametrów procesu wzbogacania w osadzarce drobnouziarnionej rudy żelaza – studium przypadku Tatasteel

Wzbogacanie w osadzarce odgrywa bardzo ważną rolę w przemyśle przetwórstwa minerałów. Wzbogacanie rudy żelaza w osadzarkach jest nowym kierunkiem badań nad wzbogacalnością. Przeprowadzono szczegółowe badania w celu określenia wpływu uziarnienia nadawy i parametrów procesu na efektywność procesu. Dane dotyczące wzbogacania w zakładzie Noamundi pokazują, że zróżnicowanie składu ziarnowego nadawy i warunki procesu są głównymi czynnikami wpływającymi na wahania wydajności osadzarki. W Zakładzie Noamundi do wzbogacania w osadzarce kierowana jest klasa ziarnowa (10,0–0,5 mm). Zbadano wpływ rozkładu wielkości cząstek na wydajność osadzarki, taką jak wydajność, skuteczność rozdziału i odzysk żelaza. Wydajność osadzarki oceniono na podstawie średnich dziennych danych z osadzarki przemysłowej, które wykorzystano do zbadania wpływu parametrów nadawy na wydajność. Udział grubszych ziaren (+6 mm) ma pozytywny wpływ, podczas gdy drobnych ziaren (-0,5 mm) ma tendencję do obniżania wydajności. W procesie osadzania następują

zmiany gęstości łoża. Zmiana gęstości łoża następuje od góry (najniższa) do dołu (największa). Podczas stratyfikacji ziaren warstwa materiału jest rozdzielana na określonym poziomie, tak aby uzyskać produkt o pożądanej charakterystyce. Badanie wykazało, że optymalna wysokość łoża osadzarki jest różna dla różnej charakterystyki nadawy tak aby osiągnąć pożądaną jakość produktu, maksymalną wydajność separacji i odzysk Fe. W niniejszym artykule zilustrowano rolę jakości nadawy i kontroli parametrów procesu dla uzyskania wydajności osadzarki, oraz przedstawiono optymalizację parametrów procesu w celu maksymalizacji uzysku żelaza.

Słowa kluczowe: osadzarka, granulometria, jakość nadawy, wysokość łoża osadzarki, wydajność, wydajność separacji, wzbogacanie żelaza