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CONE CRUSHER ATTRITION / CRUSHING MANUFACTURED SAND

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A Common Challenge:

As any aggregate producer knows, it is a rare occurrence for Mother Earth to provide natural material deposit characteristics that perfectly meet 100% of the end product mix and processing requirements driven by the business needs as it related to mix designs or product sales of products like rooming granules. There is frequently an abundance of ½ x 3/16 washed or clean sized aggregate, commonly considered a surplus material. In many regions, some producers are managing inventories consisting of several hundred thousand tons of such material.

This type of surplus material is generally in low demand and low in value and due to the continued increase in fracture requirements of fine materials and/or demand for specialty products, these same producers are often in need of higher volumes of more valuable manufactured sand.

Producers are typically faced with limited choices with regard to surplus materials. One choice is to simply stack the material and hope to sell or consume it at minimal to not profits, possibly at a loss. Inventorying such large quantities of this material can be a financial burden as well as an additional expense associated with storage and stockpile maintenance. In some cases, surplus materials also create issues when there is not adequate storage space at the facility.

An alternative is to process the material into a manufactured material is in greater demand and of greater value. The desired manufactured product to be created out of the surplus gravels is typically a manufactured sand (100% passing 3/16" with no more than 2% passing #200), and at times producers may also desire production of 3/8 x 3/16 chip.

However, the types of crushers deemed suitable for sizing this manufactured material were typically roll crushers or vertical shaft impactors (VSIs). Roll crushers are sometimes prohibitive in terms of indirect labor costs associated with maintenance, are limited by a relatively small reduction ratio and unable to meet today's particle shape requirements. Due to roll crusher constraints the market turned to the VSI which addresses reduction ratio and particle shape requirements and is known to products a sound fine aggregate.

Most producers still employ the VSI today but sometimes at a higher than desired operating cost. Gravel and glacial rock are inherently hard and abrasive, and the design of these machines in an abrasive environment equates to a high consumption of white iron and higher indirect labor costs. Some producers run the VIS only as needed and decommission it when not required. This causes a trickle down to the consumer through higher premiums of mix.

Various VSI manufactures have resolved wear issues to some degree with advancements in accelerator and shelf designs that are intended to reduce the wear by impacting material as opposed to the white iron. However, the trade off for rock-on-rock impact crushing is generally reduced efficiency. This can lead to a higher level of near size material being reintroduced into the VSI, leading also to ultra-fine material (-200M).

Before the emergence of high performance remote adjust cone crusher, producers also attempted to grind out the fines with a cone. Prior to the mid 1990's there were few models specifically designed to crush sand, but these machines were thought of as lacking adequate capacity and application flexibility. Many other operators attempted to produce sand with conventional cones and simply followed the same guidelines as they would in conventional applications. This was achieved by operating the cone at a discharge setting very close to the desired top size of the end product and new super-fine liners were developed. Many quickly found that when operating at a 3/8" or smaller discharge setting with a long parallel zone in the liners, the machine quickly consumed all available power and the result was often overload events. When a machine was able to perform, the quantity of #200's was too great and created new challenges at the wash plant or with quality control on mix designs. When these issues were coupled with relatively low production in the more expensive cone crusher, the economics were simply not in favor of the cont.

New Paradigms

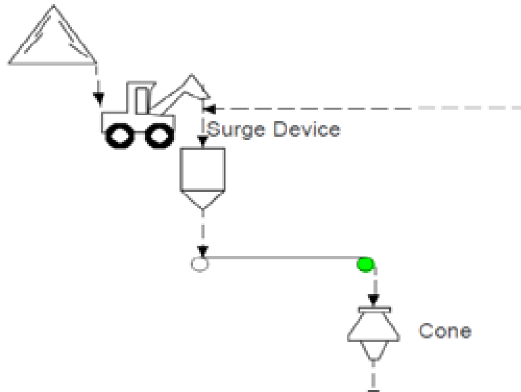
The emergence of high performance remote adjust cone crushers has brought a fresh start to the process and over the past decade more producers have been decommissioning the VSI in favor of the cone crusher for turning their surplus materials into top grade manufactured finer materials. The longer stroke, steeper geometry and opportunity for increased operating speeds that cone crushers provide is a more favorable recipe for efficiency and economical fine attrition crushing. These types of circuits are emerging in stationary, portable and even track installations. The process consists of a loading device such as a surge hopper or belt feeder, cone crusher, an inclined or horizontal vibrating screen configured specifically for efficient fine opening screening, and the transfer and stacking conveyors. Most producers employ a level sensor in the crusher to regulate the feed rate from the surge to the crusher to prevent overload.

The cone crusher is typically operated at a fairly coarse discharge setting and kept full of material (choke fed) so as to allow the inter-particle attrition to perform the majority of the crushing. This process allows the flats and corners to be crushed under compression, thereby increasing the cubicity. The manganese chamber is typically fairly coarse relative to the feed size and discharge setting (a medium chamber is often used). The RPM will typically be in a higher range to help maintain inertia that offsets amperage consumption while also helping retain material in the chamber longer to maximize efficiency.

A typical screen setup might include a 3/8" top deck opening and a 3/16 on the bottom deck, with a load-relieving center deck. Care should be taken as to not blind the 3/16 bottom deck opening. A higher screen frequency, coupled with moderate to minimal stroke, tends to yield the highest performance. This combination will help to increase material travel speed so that material band on the deck is as thin as possible, enabling fines to sift through the oversize material and get discharged to the pay pile. The use of high frequency screens has proven effective for making splits less than 4M (3/16").

Once the system has been designed and the equipment has been selected and positioned, the actual procedure itself is actually very simple, as listed below and illustrated in Figure 1:

Figure 1



1. The crusher discharge setting must be calibrated and then the initial CSS set at about 0.50”
2. Start the screen and all transfer and stacking conveyors – DO NOT START THE SURGE FEEDER YET.
3. Start the under-crusher discharge conveyor;
4. Begin feeding the system and build up a load in the surge;
5. When the surge hopper is full, turn on the surge belt feeding the cone. The purpose is to immediately choke the cone. (Note, the cone will not remain choked very long and if a diesel engine is being used it is normal to struggle. The cone may also float.)
6. Open the cone’s discharge setting until any float stops. Depending on material conditions and moisture this could be as coarse as .80” to .90”.
7. Dial in the feed rate and the discharge setting to maximize sand output and keep the cone choke fed. If feeding the plant manually vs. an automation system, this may require 10 to 15 minutes to achieve a steady balance. At this point a discharge setting of around 0.6” to 0.7” is typical.
8. A circuit that is fed dry material can provide as much as 25% higher capacity as compared to material possessing 10% moisture, thus provisions designed to protect stockpiles - such as sloped pads and/or an enclosed storage facility - will likely prove to be a good long-term capital investment.

This process can provide the desired particle shape while simultaneously producing significantly fewer undesirable fines compared to the VSI. Where a VSI often requires replacing the consumable parts on a daily basis, a set of cone liners in the same material can generally last several hundred hours between intervals. In most cases this dramatically reduces indirect, non value-added labor and maintenance costs, reduces the need to manage replacement parts inventory, and will yield a lower operating cost with a machine that is well-suited for a variety of other applications.

Figure 2

Before After