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Basic Facts about Rotary Cutters and Rotary Cutter Baskets

The rotary cutter is a popular digging device that is installed on the inlet end of the suction pipe of a hydraulic dredge. It consists of a drive mechanism, a drive shaft with support bearing and the basket.

The half-spheroid shaped basket rotates to loosen material and mix it with water which can then be drawn through openings in the basket and into the suction inlet which is located inside the basket.

There are two basic types of rotary cutter baskets:

1. The Florida Machine - spiral-bladed, contractor-dredge type. This basket is commonly seen on large river and Corps of Engineer dredges as well as sand and gravel dredges, large and small. This type of basket, produced by several manufacturers, is recommended for dredges working in deposits with clay, mud, compacted, cemented and sticky materials that do not have oversize particles. The edges of the blades may be fitted with serrated edges or with a number of individual digger teeth with replaceable tips. This type of basket is designed to cut in one only one direction as part of the dredge cycle on a contractor type dredge.

2. The Twinkle Co WARTHOG sand and gravel basket. This basket is fabricated of steel plate and bars to make up a grid of openings that are sized to prevent rocks that could lodge in the dredge pump from entering the suction pipe. The basket is fitted with a number of teeth that project from the basket surface at right angles. This type of basket is designed to cut in either direction, allowing for continuous production.

CONTRACT DREDGING

The Florida Machine type bladed basket was designed to deal with the wide variety of materials the contract dredge operator encounters when deepening harbors and channels and maintaining waterways. Typically, the spiral-bladed basket is used in a manner similar to a metal milling machine. It is rotated at a relatively high speed, 50 rpm or faster, and crowded sideways into the material bank at a controlled rate. The dredge is arranged so that the cutter makes a "cut" on a radius starting at the top of the material bank. Successive passes are made proceeding incrementally downward until the desired depth has been reached. The dredge is then advanced and the procedure is repeated. In theory, the high speed cutting action enables the blades of this type of basket to slice loose a continuous stream of solids in pieces small enough to pass through the system without clogging either the basket or the dredge system.

SAND AND GRAVEL DREDGING

Sand and gravel deposits typically consist of free-caving aggregate particles with relatively little clay or other sticky materials and a significant number of particles that are too large to pass through the pump. Sand and gravel dredging procedures are different than those used in contract dredging. The sand and gravel rotary cutter is kept at the bottom of the face of the deposit rather than removing the material in layers starting at the top. The rotary cutter undermines material at the bottom of the deposit and causes cave-ins that mix the particle sizes that make up the total face of material. The goal is to continuously create a uniform mix of particle sizes for pumping to a process plant.

SAND AND GRAVEL CUTTER BASKETS

Productive sand and gravel dredging results when the digging device performs three functions:

A. Loosens material at a rate sufficient to satisfy dredge production requirements.
B. Screens out oversized particles that may lodge in the dredge pump or pipeline.
C. Diminishes the choking effects of cave-ins by partially shielding the suction inlet.

When bladed-type baskets are used in the typical sand and gravel operation they have one major shortcoming - they do not screen out oversized particles. We have seen three solutions applied to solve this deficiency.

1. Weld a grid of bars between the basket blades. The space between the bars limits the size of rock that can enter the suction pipe. The design of the bladed basket is such that when grid bars are welded between the blades a pocket is created under the leading edge of each blade. Near-sized rocks wedge in these pockets where they are protected from being knocked out. If mud is present in the deposit, rocks can become mortared into the grid openings and the basket may plug completely. Pumping must be interrupted while the operator manually cleans the basket.

2. Weld a grid of bars or a perforated plate into the backring of the basket. This is a bad idea. Theoretically, this rotating grid acts as a self-cleaning screen as it passes in front of the suction inlet and prevents oversize from entering the suction pipe. In fact, this arrangement creates many pinch points where rocks are caught between the stationary suction inlet and backplate and the rotating grid. The result is short grid life, stalling, and broken cutter shafts. Also, if a large amount of oversize collects within the basket the suction inlet can plug to the point that the pump cavitates. Production is interrupted by the need to backwash and clear the accumulated oversize rocks out of the basket.

3. Weld a bar or bars across the suction inlet mouth inside the basket to keep oversize rocks from entering the suction pipe. This is a another very bad idea because there is absolutely no mechanical action available to move the rocks away from the suction inlet. The suction inlet plugs as oversized rocks wedge in the two or three openings created by the bars. Production is interrupted every time the system is backwashed to dislodge the oversize rocks stuck in the suction inlet. The cycle repeats over and over with consequent poor production - just like a plain-suction dredge.

TWINKLE CO SAND AND GRAVEL CUTTER BASKETS

The Twinkle Co type of basket (WARTHOG) was developed to solve these problems by keeping oversized rocks outside the basket without plugging. Twinkle Co basket openings are sized to prevent dredge pump plugging, so the opening on a 12" dredge basket will be larger than those on an 8" dredge basket. The unique design of the Twinkle basket is such that the smallest part of each opening is located at the surface of the basket. This feature causes rocks that can not pass through the opening to project above the surface of the basket where they are jostled loose as the basket rotates. The basket is self-cleaning. Moderate amounts of clay and mud will pass through the openings without plugging.

Numerous (30) bucket teeth with easy-to-replace, fully hardened tips give the Twinkle Co basket an aggressive digging capability. The large number of inexpensive teeth reduces wear on the hard-surfaced body of the basket.

There is no one rotary cutter basket design that is suitable for all dredging applications, however, the Twinkle Co WARTHOG basket has proven effective in many sand and gravel deposits. It has been installed as a replacement for bladed baskets on many dredges with excellent results.

ROTARY CUTTER DRIVES

The rotary cutter drive output torque capability must be sufficient to prevent excessive stalling in the deposit in which it is working. When comparing rotary cutter drives, compare the rated output torque of the drives and the outside diameter of the cutter baskets. Do not compare horsepower ratings because they relate to speed, which is not usually a big factor in sand and gravel dredging. Basket speeds of 10 to 15 rpm are usually sufficient to supply capacity production and reduce wear, however, difficult digging conditions may require basket speeds of up to 50 rpm.

Torque and the basket diameter determine how much digging force can be applied by the basket's teeth to loosen impacted rocks and cut through tough material. For instance, a cutter drive with a rated torque of 75,000 lb. in. driving a 30 inch diameter basket can exert a force of 5,000 lb. at its rim. (75,000 lb. in. divided by the radius, 30/2, of the basket). If a 36 inch diameter basket were to be installed on this drive the digging force at its rim would decrease to 4,170 lb. A 48 inch diameter basket could exert a digging force of only 3,125 lb. The digging force available at the basket rim is a measure of how effective the basket teeth will be in loosening impacted rocks or cemented material. Bigger is usually not better.

The cutter basket diameter needs only to be large enough to cover the suction inlet mouth. Typically, an 8 inch dredge would have a rotary cutter basket with an outside diameter of 30 inches or less. Ten and 12 inch dredges require baskets with an outside diameter of no more than 36 inches. An oversized basket offers no advantages and actually detracts from rotary cutter performance.

The teeth on Twinkle Co baskets are approximately 4 inches long and wear back to about 2.5 inches before needing replacement. Longer teeth are available, however, they have the same effect as a larger diameter basket-they decrease digging force and stalling will occur more frequently.

TWINKLE CO ROTARY CUTTER DRIVES

When comparing rotary cutter drives, find out where the seal is located that retains the lubricating oil in the drive gearbox. Several drives on the market today have this seal located near the end of the drive shaft next to the basket hub. It is difficult to create a more hostile environment for an oil seal. The constant bath of silt and sand and gravel can lead to frequent failure. In contrast, Twinkle Co puts this seal on the gearbox output shaft, a location that is several feet removed from the blast of abrasive particles found next to the suction inlet.

ROTARY CUTTER LIMITATIONS

Regardless of basket design, rotary cutter performance will be severely limited if there is a large percentage of oversize material in the deposit. As the sand and gravel dredge mines the bank of material the accumulation of oversized rocks form a "blanket" on the bottom of the deposit. If the basket attempts to dig deeper, gravity assures that the rocks fall into the hole where they will further hamper operation of the cutter. When too many oversized rocks are present, production will be reduced.

Symptoms of this condition are frequent stalling, inability to loosen material in quantities sufficient to maintain production and/or the inability to dig deeper.

Increasing the rotary cutter drive torque output capability, changing basket styles and increasing basket speed may help somewhat, however, these changes will probably not solve the problem.

The sure cure solution is to replace the rotary cutter with a Twinkle Co Linear Cutter.