MOSS KELLEY INCORPORATED

GRIT CHARACTERIZATION IN FLORIDA WASTEWATER PLANTS

INTRODUCTION

Over the years Moss-Kelley, Inc. has pilot tested the Eutek TEACUP™, and most recently the HEADCELL™ and SLURRYCUP™ to characterize grit entering Florida treatment facilities. By using these high efficiency grit removal systems, an influent grit distribution curve has been developed for each region within Florida, therefore providing sufficient data to support the need for high efficiency grit removal at a design cutpoint of or near 100 μm. When considering grit characterization in order to accomplish high efficiency grit removal, it is important to understand two key ingredients:

- Sand Equivalent Size (SES) of the native grit defines the affect of the light grit phenomenon on grit behavior.
- Wet weather events and their impact on the grit load entering a treatment facility

SAND EQUIVALENT SIZE (SES)

When characterizing grit entering a treatment facility, it is of paramount importance to understand the ***behavioral size*** of the grit. Fats, oil, and grease can have a significant impact on the settlability of grit when they coat a grit particle. As a result, the light grit phenomenon is experienced. When this phenomenon occurs, the grease reduces the specific gravity of the particle that it coats, therefore causing it to behave like a smaller grit particle.

To determine the impact of the light grit phenomenon, it is necessary to evaluate the grit using the Wet Sieve Method to determine the SES of the grit. Traditional grit evaluation technique, referred to as Dry Sieve Analysis, does not consider the impact of grease on grit behavior and therefore provides inaccurate characterization of the behavioral size, or SES, of the grit.

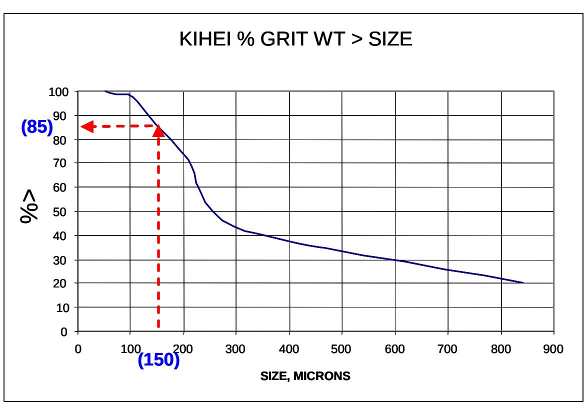
As depicted in the detailed description of the dry sieve analysis, the grit is sampled and the oil, grease and organics are then burned off. At that point, the clean, dry grit is sieved into fractions and evaluated to determine weight and physical size. This technique does not account for the affect of grease and organics on the settling characteristics of the grit particle. The Wet Sieve Method, on the other hand, evaluates both the physical size of the grit and the impact of grease and organics on the behavior of the grit particles.

DRY SIEVE METHOD	EUTEK WET SIEVE ANALYSIS
1. Burn off oil, grease, organics 2. Sieve clean dry grit into fractions by size 4. Weigh each fraction 5. Plot distribution of dry weight sand particle	1. Wet sieve grit into fractions by size 2. Measure settling velocity of each fraction 3. Establish the sand equivalent size (SES) for each fraction 4. Burn each fraction 5. Weigh each fraction 6. Plot settling characteristics of grit SES vs. Particle weight

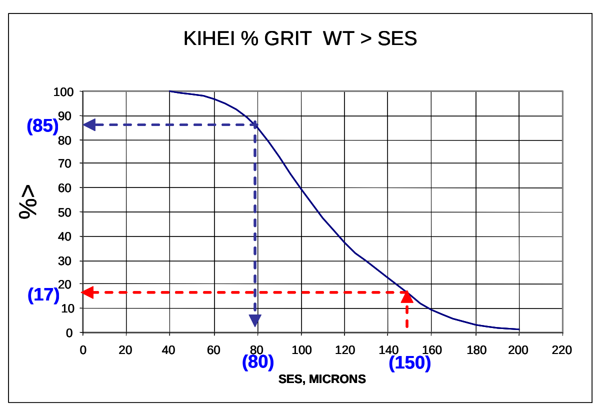
A case study that illustrates the importance of understanding SES took place at the Kihei WWTP in Maui, Hawaii. The grit was initially characterized using the dry sieve approach, at which time it was determined that 85% of the grit entering the plant was 150 μm in size or larger. The photograph below depicts the results of grit that by-passed the grit removal system following implementation of the design based on the dry sieve analysis results.

AERATION BASIN GRIT DEPOSITION
(after implementing 150 μm grit removal system)

Upon further evaluation using the Eutek Wet Sieve Analysis and determination of SES, it was found that only 17% of the grit entering the plant behaved like 150 μm grit or larger, and that in reality, the design cutpoint should have been 80 μm. A summary of these results is depicted below.



SAND SIZE
(DRY SIEVE ANALYSIS)

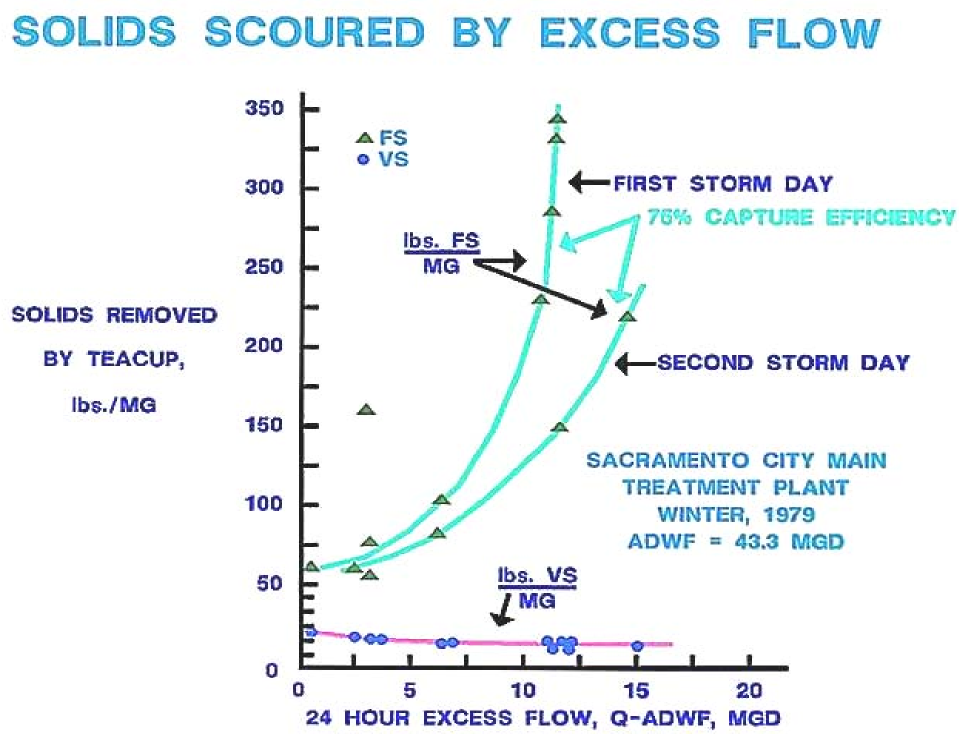


SAND EQUIVALENT SIZE (SES)
(WET SIEVE ANALYSIS)

WET WEATHER FLOW
Storm events have a significant impact on the quantity of grit entering a wastewater treatment facility.

- Infiltration and inflow (I & I) of sand into the collection system.
- Motivation of the larger ***bed load*** and scouring of the ***deposited load*** that are stationary during normal flow events.

Based on testing that has been conducted by Eutek, the solids entering a plant may increase exponentially during a storm event. Please refer to the figure below for a typical impact of a storm event from the Sacramento City Main Treatment Plant. The normal grit load entering the plant at an ADF is approximately 60 lbs. per one million gallons treated. One can expect a storm event to increase the grit load to a level of up to 10 times (or more) of the load experienced during the ADF.

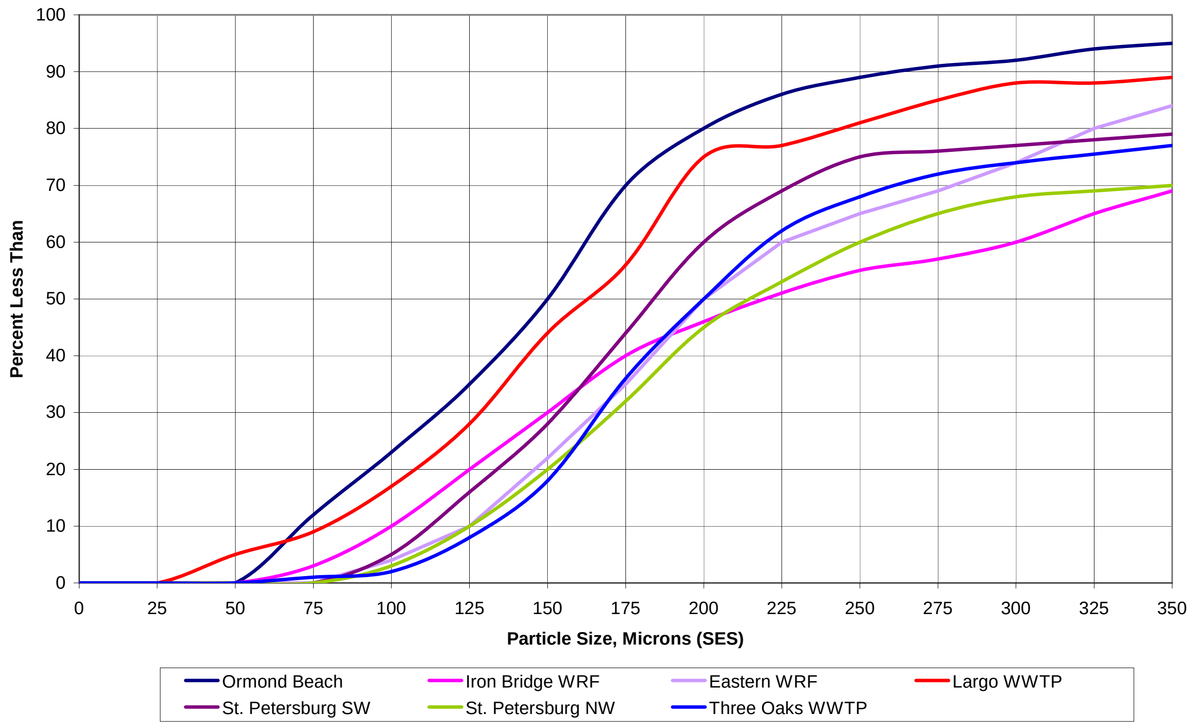


Although the figure represents the actual results of a storm event outside of Florida, the affect of the storm event on grit quantity is typical for every region. A dramatic increase in load will be experienced and, without consideration during design, will impact the plant performance through reduction of process volume, wear on plant equipment, and abrasion on piping and biosolids handling equipment such as centrifuges.

SIZE DISTRIBUTION AND CHARACTERIZATION OF GRIT

Moss Kelley and Eutek have characterized grit throughout many regions of Florida by conducting pilot tests. These locations offer a good balance of coastal and inland plants that can be used as a basis of comparison for all Florida systems. Graph 1 below depicts the distribution of grit based on Sand Equivalent Size (SES) that entered the treatment plants during these pilot tests.

GRAPH 1 - FLORIDA GRIT DISTRIBUTION CURVES



As depicted within the attached selection of grit characterization curves, the typical grit that enters a Florida WWTP ranges in size from 50 μm to over 350 μm. Up to 50% of the grit entering a WWTP may be 150 μm or smaller. Based on the rough estimation of a mean characterization curve from the representative curves, it can be concluded that 80% of the grit entering the treatment facility is 275 μm or less, 60% of the grit entering the facility is 200 μm or less, and between 30 and 40% of the grit is 150 μm or less. A design grit system cutpoint of 100 μm will ensure that somewhere between 75 to 95% of the grit within the representative curves is captured, with approximately 90% of the mean characterization captured at 100 μm. Based on the testing and full-scale installation experience of Moss Kelley, Inc. and Eutek, we believe that a practical and economical basis of design for high efficiency grit removal systems is 100 μm.

Conventional grit removal technologies (i.e. Pista Grit, Grit King, Jones Attwood, Fluidyne Systems, etc.) offer a typical performance claim as defined below:

95% removal of grit 50 mesh (300 micron) in size and greater
85% removal of grit greater than 70 mesh (200 micron), but less than 50 mesh
65% removal of grit greater than 100 mesh (150 micron), but less than 70 mesh

The problem with this low efficiency performance is two fold; 1) the performance claim listed above is incremental, and; 2) this level of treatment does not remove fine grit (>100 micron).

When considering the grit characterization curves, ignoring the actual inefficiencies of the conventional classifying and dewatering equipment, the amount of grit that will by-pass the conventional system based on a mean characteristic curve is calculated as follows:

Assumptions:

1. Based on the approximate mean of the grit characterization curves, 25% of the grit is 300 μm or larger, 15% of the grit is larger than 200 μm but less than 300 μm, 25% of the grit is greater than 150 μm but less than 200 μm, and 35% of the grit is 150 μm or less.

300 μm and greater:	(0.95)(25%)	=	23.75%
Greater than 200 μm but less than 300 μm:	(0.85)(15%)	=	12.75%
Greater than 150 μm but less than 200 μm:	(0.65)(25%)	=	16.25%
150 μm or less:	(0.00)(35%)	=	0.00%
TOTAL			52.75%

Therefore, the very highest level of grit removal that could be expected from a conventional bulk flow swirl concentrator is 52.75%. This performance is attributed to the bulk flow device only and does not include the classifier efficiency, which is significantly less.

In comparison, the Eutek typical guarantee for a Headcell, SlurryCup and Grit Snail System is:

95% removal of grit 100 micron and larger with < 20% attached organics

Organic Content: A secondary issue with removed grit is attached organics and the impact on odor and vector attraction. After a conventional bulk flow grit removal unit collects the grit as underflow, the underflow is pumped into a hydrocyclone/screw system for separating the grit from the liquid and discharging it into a dumpster. A hydrocyclone can separate fine grit from the flow stream; however it does not differentiate grit from organics. Therefore, a cyclone will discharge up to 75% volatile organics along with the grit. Secondly, once the cyclone discharges the grit slurry into the screw classifier, turbulence caused by the turning screw will cause grit to remain suspended in the liquid and carry it over the effluent weir and back into the process, therefore "short-circuiting" the grit separation system.

Visual Comparison: Please observe the difference in the two samples that were collected during a pilot test performed in February, 2003 at the City of Largo WWTP as shown on the next page. Notice the fine grit quotient in the Eutek sample when compared to the sample discharged into the dumpster from the existing grit removal system. Additionally, please notice the lack of organics within the Eutek sample and the effect that this reduction will have on vector attraction.

Existing Grit System

Eutek Headcell Pilot Unit

ESTIMATED GRIT LOAD AND WET WEATHER AFFECT ON GRIT LOAD

Grit Load: The table below shows the average grit quantities collected from three of the grit removal systems where the Eutek Headcell pilot was tested over the exact same period of time. The significance of Table 1 is that the Eutek pilot system removed many times the unit volume when compared to the existing grit removal system (3x at Three Oaks; 6x at Largo; 24x at St. Pete SW). All of these plants have the same thing in common; they are incapable of removing fine grit. It should be noted that this problem is exacerbated during a wet weather event, since the quantity of grit that enters a treatment plant increases significantly during wet weather. Secondly, since most of the existing grit systems discharge grit with 3x greater attached organics, the difference in grit capture between the two systems, in terms of fixed grit, is even greater.

Comparison of Grit Volumes Collected During Pilot Test Existing Systems vs. Eutek Headcell Pilot System	Existing System (cf/mg)	Eutek Headcell Pilot (cf/mg)	Difference (cf/mg)	lbs of grit bypassed into process (lbs/mg)
City of Largo	2.05	12.53	10.48	524
City of St. Petersburg, SW	0.51	12.27	11.76	588
City of St. Petersburg, NW	0.04	8.30	8.26	413
Three Oaks, Lee County	1.11	3.56	2.45	122

*Assume 1 cu yd of grit is equivalent to 1350 lbs of fixed solids

CONCLUSION

Understanding the characteristics of grit is the first step to solving a treatment facility's grit challenge. Light grit and wet weather flow are the main culprits for the distribution of grit within headworks, activated sludge basins and digesters. Recognizing that grit does not behave based on physical size, but must be characterized based on Sand Equivalent Size (SES) is one piece of the puzzle. Infrequent peak wet weather events cause collection pipes to be scoured, bringing the majority of the grit load into the treatment plant in massive slugs. Therefore, if grit removal is important to the successful operation of a treatment plant, both fine grit and peak wet weather events must be the basis of design.