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COMPLETE RECLAMATION OF WASTEWATER AND SLUDGE

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GENERAL

Operational results of a demonstration-scale (380 m^3 day^{-1} maximum) wastewater reclamation and sludge handling plant (CCBA) are reported. In the plant process, clay is added to raw municipal sewage. The mixture is then coagulated and flocculated. Flocculated solids are gravity settled producing a secondary quality effluent (suspended solids & BOD below 30 mgl^{-1}) with total phosphorus stripped to a level of less than 1.0 mgl^{-1}. The sludge produced is readily dewatered to 45% solids concentration and then blended with dry clay to produce an extruded material having a solids concentration of approximately 80%. The extruded material is then fired in a kiln to produce an expanded lightweight aggregate with a bulk loose density between 560 and 768 kg m^{-3} (35 to 45 lbs ft^{-3}). Lightweight concrete with a unit weight of 1681 to 1825 kg m^{-3} (105 to 114 lbs ft^{-3}) and a 28 day strength in excess of 350 kg cm^{-2} (5000 lbs in^{-2}) has been made. The lightweight aggregate is valuable to the construction industry for making lightweight concrete, building blocks and roofing shingles.

PROCESS DESCRIPTION

The process designation CCBA stands for coordinate, chemical, bonding, and adsorption. The process can be broken down into three distinct steps: (1) solids/liquid separation for producing a secondary quality effluent, (2) Solids dewatering for converting the sludge produced by the solids/liquid separation stage to an acceptable feed for the production of lightweight aggregate, and (3) production of lightweight aggregate.

The solids/liquid separation process for CCBA evolves in sequence: (1) fine screening and degritting, (2) clay addition, (3) sheet mixing of chemicals, (4) decayed gradient flocculation (DGF) of the coagulated mixture to produce uniform size flocculated particles of clay and sewage solids material, and (5) gravity sedimentation to produce a secondary quality effluent (less than 30 mg/l BOD and SS).

The sludge produced in the clarifiers bears no resemblance to municipal wastewater sludge. It is a clay sludge that is contaminated with solids removed from the wastewater and compared to municipal wastewater sludge it is easy to dewater. The sludge from the clarifiers is pumped into a sludge thickening unit where it is allowed additional time to thicken by gravity settling.

The sludge from the thickener is pumped onto the sponge belt of the pressure capillary solids dewatering system where water is drawn by capillary action from the sludge into the sponge belt. The sludge is further dewatered by pressing the sponge belt against a polyvinyl chloride (PVC) belt between two

rollers. The dewatered sludge adheres to the PVC belt and is conveyed to the blender.

The sludge from the dewatering system is mixed with additional dry clay in a pugmill type blender. Sufficient clay is added to reduce the water content to approximately 20% or until a desired percent organics in the blended mix is achieved.

The mixture from the blender is deposited into an extruder where it is forced through a dye with numerous round holes. The spaghetti like extrusions are chopped into pellets.

The pellets are fed at a given rate into a rotary kiln. As the pellets move through the kiln, the temperature increases to a maximum of 1077^{o} to 1088^{o} C. (1970^{o} to 1990^{o} F.). Moisture is first driven from the pellets, then the organics burn, creating a gas pressure within the pellets. When the pellets reach a temperature where the clay becomes plastic, the internal gas pressure causes the pellets to expand.

TEST RESULTS

The plant has been operating since July 1983. The tests performed on the influent and effluent are: turbidity, SS, BOD, TDS, Ortho P, TP, TKN, NO_3 + NO_2, NH_3, and TN. At a clarifier time of approximately 45 minutes the plant has consistently reduced the SS and BOD by 86 to 90% and 82 to 86% respectively and has reduced the Ortho P and Total P by 97% and 89% respectively. Total nitrogen reduction is approximately 45% and there is little or no reduction in TDS.

The dewatering system has achieved a mean % solids of 41.4%. This is slightly less than the desired 45% however it is sufficient for the sludge to be effectively used in the aggregate production process.

No difficulty has been experienced in converting the sludge into lightweight aggregate that meets the American Society for Testing Materials (ASTM) Standards C330-80 for bulk loose density, gradation,

Structural quality concrete has been made utilizing the lightweight aggregate with a compressive strength in excess of 350 Kg cm^{-2} (5000 lbs in^{-2}) and a wet concrete unit weight of 1681 to 1825 Kg m^{-3} (105 to 114 lbs ft^{-3}).

DATA AVAILABLE

The following data and samples were available at the poster presentation:

1. Process flow diagram
2. Tables giving wastewater treatment data
3. Table on lightweight aggregate data
4. Table on concrete test data
5. Samples of lightweight aggregate

POSTER DISPLAY

1. Pictures of CCBA plant
2. Sawed concrete samples
3. Several aggregates with different characteristics