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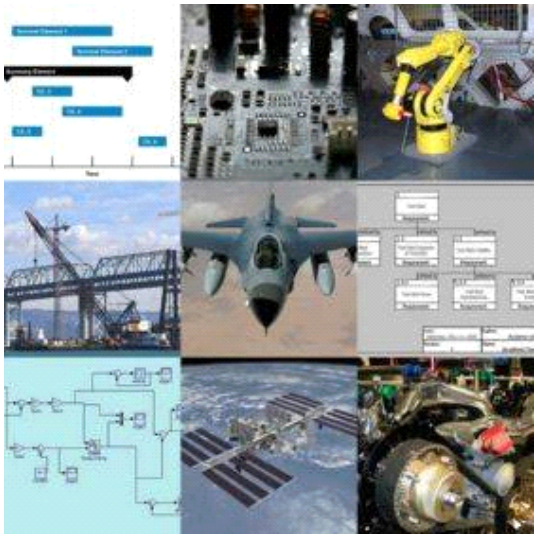

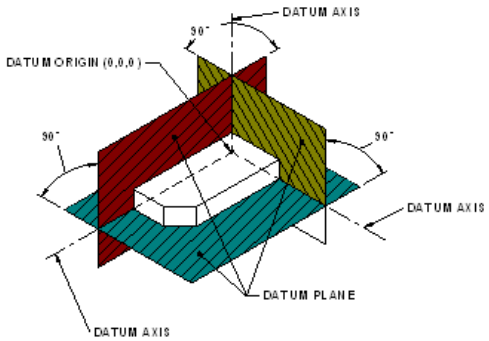

An Introduction to Sludge Handling, Treatment and Disposal

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1. GENERAL CONSIDERATIONS. Sludge, or residual solids, is the end product of wastewater treatment, whether biological or physical/chemical treatment. Primary sludge is from 3 to 6 percent solids. Treatment objectives are reduction of the sludge and volume, rendering it suitable for ultimate disposal. Secondary objectives are to utilize the generated gas if anaerobic digestion is selected as part of the sludge management strategy. In addition, an attempt should be made to sell/utilize the sludge as a soil conditioner rather than paying to dispose of it.

2. SLUDGE PUMPING. Sludges with less than 10 percent solids can be pumped through force mains. Sludges with solids contents less than 2 percent have hydraulic characteristics similar to water. For solids contents greater than 2 percent, however, friction losses are from 1-½ to 4 times the friction losses for water. Both head losses and friction increase with decreasing temperature. Velocities must be kept above 2 feet per second. Grease content can cause serious clogging, and grit will adversely affect flow characteristics as well. Adequate clean-outs and long sweep turns will be used when designing facilities of these types.

2.1 PIPING. Sludge withdrawal piping will not be less than 6 inches in diameter. Minimum diameters for pump discharge lines are 4 inches for plants less than 0.5 million gallons per day and 8 inches for plants larger than 1.0 million gallons per day. Short and straight pipe runs are preferred, and sharp bends and high points are to be avoided. Blank flanges and valves should be provided for flushing purposes.

2.2 PUMPS. Sludge pumps will be either plunger, progressing-cavity, torque-flow, or open-propeller centrifugal types. Plunger and progressing-cavity pumps generally should be used for pumping primary sludges; centrifugal pumps are more suitable for the lighter secondary sludges. Centrifugal and torque-flow pumps are used for

transporting digested sludge in most cases; plunger and progressing-cavity pumps are used when a suction lift is involved. Plunger pumps are also well suited to sludge elutriation. Standby pumps are required for primary and secondary sludge pumps as well as for sludge elutriation pumps. The pump information provided is for guidance only and does not represent design criteria.

2.2.1 PLUNGER. The advantages of plunger pumps may be listed as follows:

- Pulsating action tends to concentrate the sludge in the hoppers ahead of the pumps.
- They are suitable for suction lifts of up to 10 feet and are self-priming.
- Low pumping rates can be used with large port openings.
- Positive delivery is provided unless some object prevents the ball check valves from seating.
- They have constant but adjustable capacity regardless of large variations in pumping head.
- Large discharge heads may be provided for.
- Heavy-solids concentrations may be pumped if the equipment is designed for the load conditions.

Plunger pumps come in simplex, duplex, triplex models with capacities of 40 to 60 gallons per minute per plunger, and larger models are available. Pump speeds will be between 40 and 50 revolutions per minute, and the pumps will be designed for a minimum head of 80 feet since grease accumulations in sludge lines cause a progressive increase in head with use. Capacity is decreased by shortening the stroke of the plunger; however, the pumps seem to operate more satisfactorily at, or near, full stroke. For this reason, many pumps will be provided with variable-pitch, vee-belt drives for speed control of capacity.

2.2.2 PROGRESSING-CAVITY. The progressing-cavity pump can be used successfully, particularly on concentrated sludge. The pump is composed of a single-

threaded rotor that operates with a minimum of clearance in a double-threaded helix of rubber. It is self-priming at suction lifts up to 28 feet, is available in capacities up to 350 gallons per minute, and will pass solids up to 1.125 inches in diameter.

2.2.3 CENTRIFUGAL. With centrifugal pumps, the objective is to obtain a large enough pump to pass solids without clogging but with a small enough capacity to avoid pumping a sludge diluted by large quantities of the overlying sewage. Centrifugal pumps of special design can be used for pumping primary sludge in large plants (greater than 2 million gallons per day). Since the capacity of a centrifugal pump varies with the head, which is usually specified great enough so that the pumps may assist in dewatering the tanks, the pumps have considerable excess capacity under normal conditions. Throttling the discharge to reduce the capacity is impractical because of frequent stoppages, hence it is absolutely essential that these pumps be equipped with variable-speed drives. Centrifugal pumps of the bladeless impeller type have been used to some extent and in some cases have been deemed preferable to either the plunger or screw-feed types of pumps. Bladeless pumps have approximately one-half the capacity of conventional non-clog pumps of the same nominal size and consequently approach the hydraulic requirements more closely. The design of the pump makes clogging at the suction of the impeller almost impossible.

2.2.4 TORQUE-FLOW. This type of pump, which uses a fully recessed impeller, is very effective in conveying sludge. The size of the particles that can be handled is limited only by the diameter of the suction or discharge valves. The rotating impeller develops a vortex in the sludge so that the main propulsive force is the liquid itself.

2.2.5 PUMP APPLICATION. Types of sludge that will be pumped include primary, chemical, trickling-filter and activated, elutriated, thickened, and concentrated. Scum that accumulates at various points in a treatment plant must also be pumped.

2.2.6 PRIMARY SLUDGE. Ordinarily, it is desirable to obtain as concentrated a sludge as practicable from primary tanks. The character of primary raw sludge will vary

considerably depending on the characteristics of the solids in the wastewater, the types of units and their efficiency, and, where biological treatment follows, the quantity of solids added from the following:

- Overflow liquors from digestion tanks;
- Waste activated sludge;
- Humus sludge from settling tanks following trickling filters; and
- Overflow liquors from sludge elutriation tanks.

The character of primary sludge is such that conventional non-clog pumps will not be used. Plunger pumps may be used on primary sludge. Centrifugal pumps of the screw-feed and bladeless type, and torque-flow pumps may also be used.

2.2.7 CHEMICAL PRECIPITATION SLUDGE. Sludge from chemical precipitation processes can usually be handled in the same manner as primary sludge.

2.2.8 TRICKLING-FILTER AND ACTIVATED SLUDGE. Sludge from trickling filters is usually of such homogeneous character that it can be easily pumped with either plunger or non-clog centrifugal pumps. Return activated sludge is dilute and contains only fine solids so that it may be pumped readily with non-clog centrifugal pumps which must operate at slow speed to help prevent the flocculent character of the sludge from being broken up.

2.2.9 ELUTRIATED, THICKENED, AND CONCENTRATED SLUDGE. Plunger pumps may be used for concentrated sludge to accommodate the high friction head losses in pump discharge lines. The progressing-cavity type of positive displacement pump also may be used for dense sludges containing up to 20 percent solids. Because these pumps have limited clearances, it is necessary to reduce all solids to small size.

2.2.10 SCUM PUMPING. Screw-feed pumps, plunger pumps, and pneumatic ejectors may be used for pumping scum. Bladeless or torque-flow centrifugal pumps may also be used for this service.

2.3 CONTROLS. The pumping of sludges often requires operation at less than the required d engineer will evalua on-off operation. ld be investigat

3. SLUD sludge. Two basic nuous or batch proc ut mechanic oduce solids con .2 percent for activat n primary settling ta

3.1 GRAV s of hydraulic he same as those f ndex (SVI) require lo lytes) also allows hig me divided by sludge udge blanket) is d for designing

3.2 FLOT rise to the surface where they are collected. This is accomplished by using a dissolved air flotation process. The process is best suited to activated sludge treatment where solids contents