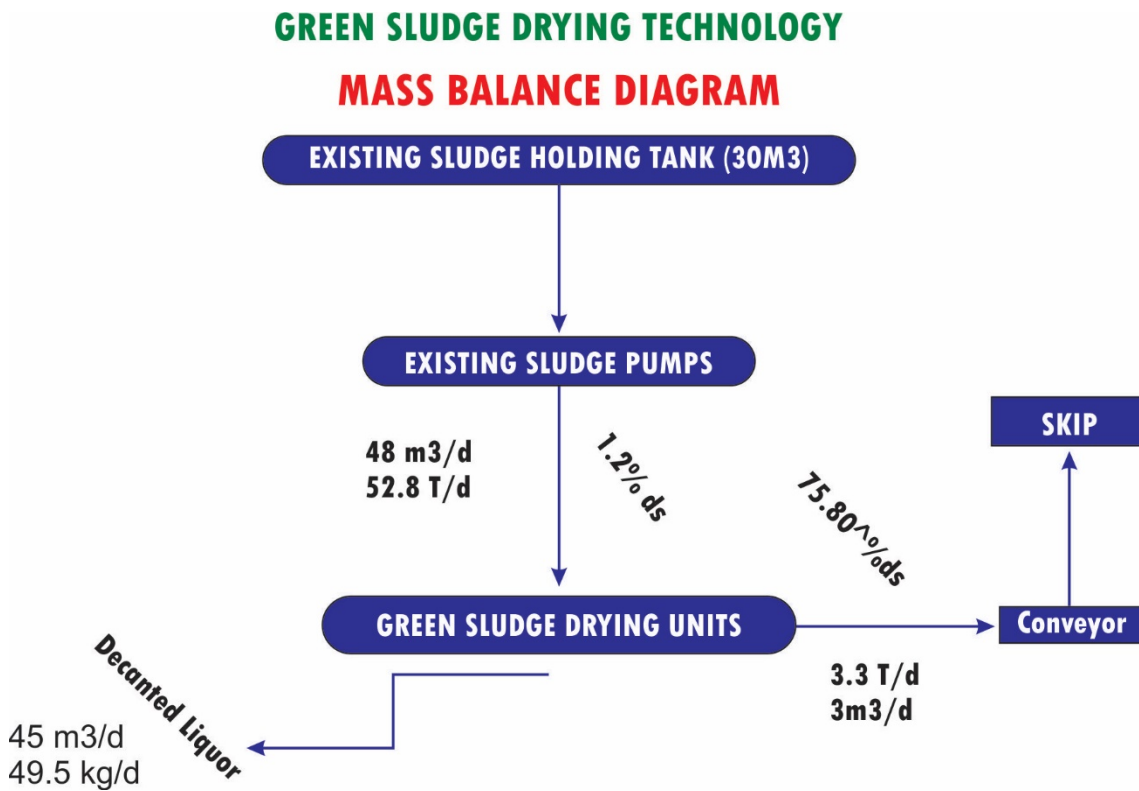


PROCESS DESIGN, MASS BALANCE, AND CONTROL PHILOSOPHY

This section provides technical information on the Green Sludge Drying Technology (GSDT) including its design and operation. GSDT is a batch process for thickening and drying municipal and industrial mixed sludges.

See the following example based on a customer in the Middle East with hot climatic conditions.

Mass Balance Diagram



Process Description

In this example a target dry solid content of over 60% is required based on the above daily volumes. In this situation a system would consist of six (6) longitudinal units operating in parallel.

Surplus activated sludge is transferred from an existing Sludge Storage Tank using a pumping arrangement to the Green Sludge Drying Units (GSDU). The flow to the GSDU is measured by an inline flowmeter and controlled by individual electrically actuated valves at the inlet to each unit.

Each unit is equipped with surface level scrapers to extract the sludge which migrates to the top of the units and discharge it to a conveyor. A single belt conveyor is designed to transport the discharged sludge from each of the six units. The scraper drive is automatic with variable speed to optimize best solution depending on site location. Once enabled, it typically runs for 15 minutes (adjustable). A water lubrication system is provided to lubricate the scraper chains. It is fed by solenoid valve connected to a service water line.

The GSDU is also provided with a clear liquid draw-off facility which consists of a slotted baffle and motorized penstock. The draw-off system drains the residual water after every thickening batch. A CIP system is provided at the baffles --i.e., a spray nozzle and a ball valve -- to clean the baffles from sludge flocs after draining. The flushing valve is an automated solenoid valve. The unit level is monitored by a hydrostatic level sensor for the finer control of sequencing. The GSDU are protected with GRP covers and an inspection hatch is provided.

In summary, in this example the GSDU consists of:

- Sludge Feeding Line from the existing sludge holding tank
- A Flowmeter in the common header
- 6 Longitudinal Units (8m x 3m x 1m high)
- 6 Longitudinal Surface level Scrapers (2 shaft type)
- 6 inductive proximity sensors for scraper jam/breakage detection
- 6 actuated inlet valves to control feeding operation
- 6 baffles for draw-off
- 6 penstocks with motorized actuators with inbuilt open/close local control unit
- Service Water line of continuous pressure of 5 bar.
- 6 no. of solenoid valves to control water supply for chain lubrication.
- 6 no. of solenoid valves to control flushing of draw-off baffles
- 6 hydrostatic level sensors

The thickened sludge from each scraper is discharged to a common conveyor belt which transports it to a collection skip. The following is provided for sludge conveyance:

- Conveyor belt
- Skip
- Radar level Switch for Skip

Image 403 – Sectional Plan of Green Sludge Drying Units

GSDU – Control Philosophy

A complete PLC system with a 9-inch HMI is implemented to realize the fully automated system for thickening and drying.

GSDU are used in sequence by the PLC for the batch operation. While a single tank is available for the feeding system, the rest of the tanks could be either in settling stage, decanting stage or standby. This ensures the 24x7 availability of the whole thickening/drying system to receive surplus activated sludge from the CETRP. A “Start Feed” relay output is provided on the PLC to transfer the demand (to start feeding) to the remote Surplus Activated Sludge (SAS) pumping station control system.

Four operational triggers will be available in the HMI:

1. Start - Start or Restart with a fresh batch from current GSDU in feeding cycle
2. Stop – Stop the process and pause everything for further instruction.
3. Abort – Abort the current process and empty the current filling tank.
4. Resume -Resume operations from where it stopped.

Once initiated, PLC automatically drives every GSDU tank through the following cycles and cascade the batches of all tanks superficially.

- Sludge feeding
- Sludge Thickening
- Scraper chain lubrication
- Sludge Scraping
- Draw-off of the Filtrate/excess water
- Water clean of draw-off baffle

Once the operator initiates the operation from HMI, a cycle is started for a GSDU tank. If the tank is opted out of operation, automatically next GSDU goes to filling mode. All the valves are closed automatically, and scraper drives are switched off by the PLC at the start of the automatic operation.

1. Feeding valve is opened.
2. The sludge feeding (relay output) is enabled which in turn starts the remote SAS pumps.
3. The sludge feeding continues till the GSDU tank reaches high level by monitoring the level sensor
4. The pump is stopped, and the feeding valve is closed at high level.
5. The GSDU is allowed to thicken/dry (adjustable period 6 to 24 hours)
6. The operation of the respective scraper is enabled by the PLC. It runs for 15 minutes. The scraper operates only if the conveyor is put into auto mode.
7. The conveyor operates whenever any of the 6 scraper is running and stops with a delay of 1 minute to ensure the belt is empty.
8. During the thickening/drying phase, filling is enabled for the next GSDU tank in que and filling continues automatically for the next GSDU tank if the demand persists for receiving the sludge.
9. The scraper and conveyor system operation stops in case of a high level detected in the sludge skip. The operation can continue only if the skip level reduces.
10. The draw-off penstock is opened and it is closed when minimum level is reached
11. The baffle plates are cleaned for a short period by the solenoid valve.
12. Now the batch is finished for the particular GSDU tank and it has to wait for its turn for next batch which starts with a new feeding.

