# Dewatering Machine – dataset

The document describes the dataset of a dewatering machine used in sludge dewatering process. The dewatering machine can be consideread a Cyber-Physical System (CPS) since different sensor are used to monitor, optimize and control the machine.

The different projects are about the analysis of athe CPS data using Big Data Technologies.

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# 1. Cyber Physical System characteristics

The dewatering machine is a CPS is an industrial decanter centrifuge, a centrifugal separator used for dewatering sludge from both purification processes and industrial processes. Decanters are equipment used in various sectors, including ecology, general industry, chemical and petrochemical sectors, food processing, and animal husbandry. These machines can be used for applications such as sludge dewatering, recovery and extraction of used oils and refinery materials, wastewater treatment, and the treatment of sludges from food industry processes.

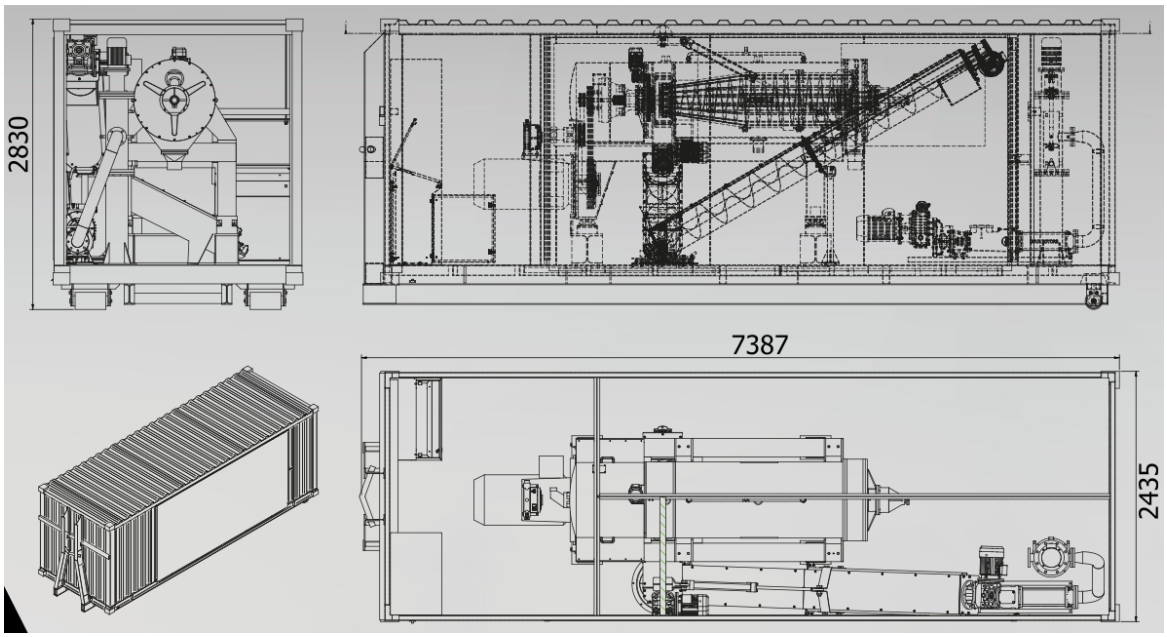


*Figure 1: Dewatering machine*

The parts of the machine that come into contact with the product are made of stainless steel AISI 304 or 316L, while the drum is made of duplex stainless steel to ensure mechanical resistance to abrasion and strong chemical resistance to corrosion. The components most exposed to the erosive action of the sludge are protected with a thick

tungsten carbide coating. Additionally, the discharge holes for the dehydrated sludge are protected with ceramic material, which provides a very high surface hardness and ensures superior durability.

These decanters can be equipped with a hydraulic system that automatically and continuously adjusts the differential speed of the internal screw, adapting the centrifuge operation to the immediate feed conditions. This system is designed to achieve maximum efficiency and the minimum consumption of polyelectrolyte and energy, compatible with the instantaneous load input. The hydraulic system provides high torque, regardless of the required rotational speed, making the system one of the most efficient on the market for achieving high concentrations of suspended solids in the dehydrated sludge.

## 1.1. Sensors

The Figure 2 shows the detailed diagram of the machine and the output (input for the optimization system) and actuation (output for the optimization system) quantities.

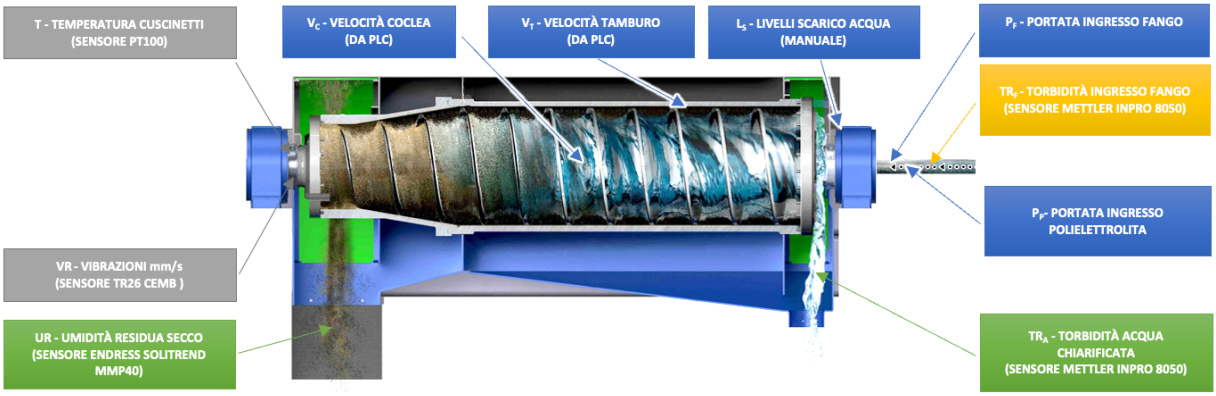


*Figure 2: Detailed diagram of the machine and the input/output quantities.*

The figure lists various types of data collected and monitored by the system, including:

- **Input Data**: Sludge inlet turbidity, sludge inlet flow rate, and polyelectrolyte flow rate, with specific operating ranges.
- **Process Data**: Includes drum and screw speed, water discharge levels, and other technical specifications vital for the proper functioning of the system.
- **Machine Status Data**: Bearing temperature and vibrations, with optimal operating ranges to ensure the safety and efficiency of the machine.
- **Output Data**: Clarified water turbidity and residual dry moisture, crucial indicators of treatment quality and dewatering efficiency.

The machine is intrinsically complex, with operational parameters acquired from various sensors, in addition to the ability for remote control of input variables that can be effectively applied in a monitoring and optimization context for the sludge treatment process.

## 1.2. Description of the Different Parameters for Monitoring and Optimization

Below a description of the sensors which equip the CPS:

- **Temperature Sensor**: Monitors the temperature of the bearings inside the machine. Monitoring bearing temperature (using PT100 sensors) ensures the system operates within safety and efficiency limits. Bearings that operate within an optimal temperature range have a longer lifespan, contributing to greater system reliability.
- **Vibration Sensor**: Measures the vibrations of the machine, which is critical in monitoring the mechanical condition and operational efficiency of industrial systems.

Vibration sensors such as the TR26 are essential for real-time monitoring of machine conditions.

- **Moisture Sensor**: Measures the residual moisture percentage in the material after the dewatering process. This is a key indicator of the effectiveness of the separation process, particularly in applications like sludge treatment.
- **Screw Speed Sensor**: Refers to the rotation speed of the screw inside the machine, which is crucial for optimizing the separation efficiency of solids from liquids.
- **Drum Speed Sensor**: Refers to the rotation speed of the drum, responsible for separating solids from liquids through centrifugal force.
- **Water Discharge Level**: Monitors the water discharge levels in the industrial purification process.
- **Sludge Inlet Flow**: Measures the quantity of sludge entering the machine per unit of time.
- **Sludge Inlet Turbidity**: Measures the turbidity (the quantity of suspended particles) in the sludge entering the treatment system.
- **Polyelectrolyte Inlet Flow**: Measures the flow rate of polyelectrolyte entering the treatment process.
- **Clarified Water Turbidity**: Measures the clarity of the treated water after it has passed through the purification process.

## 1.3. Operating Mode

The treatment process for sludge via the decanter focuses on the effective separation of solid matter (soil) from water. The primary goal of this machine is to extrude water from

the sludge mixtures, thus improving the separation between the solid and liquid components. The amount of residual soil, with a low moisture percentage, indicates the quality of the treated sludge.

The decanter operates by adjusting the rotational speed and the dosing of polyelectrolyte, a flocculant polymer that helps aggregate solid particles in the sludge, aiding in their separation from water. The solid product (dry) is measured in kilograms, while water purity is assessed in terms of quality.