BIOBASIN · WASTEWATER TREATMENT & COLLECTION OPERATOR

# The Ultimate Activated Sludge Process Control Cheat Sheet

*Tape this to the inside of the lab cupboard.*

## 1 Activated Sludge Process Control

Three different ways of measuring the same population of organisms.

| QUANTITY | HOW IT IS FOUND |
|---|---|
| **F/M ratio** | Pounds BOD per day / Pounds MLVSS under aeration |
| **MCRT or SRT, days** | Pounds in aeration and clarifier / Pounds wasted and lost per day |
| **Sludge age, days** | Pounds MLSS in aeration / Pounds suspended solids applied per day |
| **Sludge volume index** | (Settled volume, mL/L x 1,000) / MLSS, mg/L |
| **Sludge density index** | 100 / SVI |
| **Return sludge flow** | (MLSS x Plant flow) / (RAS solids - MLSS) |

## 2 Usual Operating Windows

General practice ranges to judge a reading against. These are not permit limits, and your own permit governs.

| READING | USUAL RANGE | WHAT IT MEANS OUTSIDE IT |
|---|---|---|
| **Aeration dissolved oxygen** | 1.0 to 3.0 mg/L | Low invites filaments |
| **Sludge volume index** | 80 to 150 mL/g | Above 150 is bulking |
| **F/M, conventional** | 0.15 to 0.5 | Below is extended aeration |
| **MCRT, conventional** | 5 to 15 days | Longer for nitrification |
| **Return sludge rate** | 20 to 100% of plant flow | High means thin RAS |
| **Primary BOD removal** | 25 to 35% | Low means short-circuiting |
| **Secondary treatment removal** | At least 85% | Below is a permit risk |
| **Surface overflow, secondary** | 400 to 800 gpd/ft² | High means carryover |
| **Weir overflow rate** | 10,000 to 20,000 gpd/ft | High pulls floc over |
| **Volatile solids reduction** | At least 38% | Below is under-digested |
| **Gravity sewer velocity** | At least 2 ft/sec | Below, grit settles |
| **Lift station starts** | Up to about 6 per hour | More overheats motors |

## 3 Loading and Solids Inventory

Every one of these is the pounds formula with different words in front of it.

| QUANTITY | HOW IT IS FOUND |
|---|---|
| **Pounds per day** | (Flow, MGD) x (Concentration, mg/L) x 8.34 |
| **Pounds held in a tank** | (Volume, MG) x (Concentration, mg/L) x 8.34 |
| **BOD load applied** | (Flow, MGD) x (BOD, mg/L) x 8.34 |
| **Solids wasted per day** | (WAS flow, MGD) x (WAS solids, mg/L) x 8.34 |
| **Percent removal** | (In - Out) / In x 100% |
| **Population equivalent** | Pounds of BOD per day / 0.17 |

> **MCRT counts the clarifier solids on top and the effluent losses underneath; leaving either out is the commonest wrong answer. Change wasting by no more than 10 to 15 percent of the inventory a day.**

## 4 Basin and Filter Loading

Read the units in the answer and they tell you which formula was wanted.

| QUANTITY | HOW IT IS FOUND |
|---|---|
| **Detention time** | Volume / Flow, in matching units |
| **Surface overflow rate, gpd/ft²** | Flow, gpd / Surface area, ft² |
| **Weir overflow rate, gpd/ft** | Flow, gpd / Weir length, ft |
| **Solids loading rate, lb/day/ft²** | Solids applied per day / Area, ft² |
| **Hydraulic loading rate, gpd/ft²** | Total flow applied / Area, ft² |
| **Trickling filter loading** | Pounds BOD per day / (media volume in 1,000 ft³) |
| **RBC loading** | Pounds soluble BOD per day / (media area in 1,000 ft²) |
| **Recirculation ratio** | Recirculated flow / Primary effluent flow |

## 5 Digestion and Dewatering

Volatile solids reduction is the one line here that cannot be shortened into a plain percentage.

| QUANTITY | HOW IT IS FOUND |
|---|---|
| **Volatile solids reduction, %** | (VS in - VS out) / (VS in - (VS in x VS out)) x 100% |
| **Total solids, %** | (Dried - Tare) / (Wet - Tare) x 100% |
| **Volatile solids, %** | (Dry solids - Fixed solids) / Dry solids x 100% |
| **Filter yield, lb/hr/ft²** | (Solids per day x Recovery) / (Operating hours x Area) |
| **Dry solids from wet sludge** | Gallons x 8.34 x Specific gravity x % solids |
| **Specific gravity** | Weight of substance, lb/gal / 8.34 |

## 6 Pumps and Hydraulics

Water horsepower is what reaches the water. Everything else is a loss on the way there.

| QUANTITY | HOW IT IS FOUND |
|---|---|
| **Water horsepower** | (Flow, gpm x Head, ft) / 3,960 |
| **Brake horsepower** | Water hp / Pump efficiency |
| **Motor horsepower** | Brake hp / Motor efficiency |
| **Wire to water efficiency, %** | Water hp / Motor hp x 100% |
| **Flow rate** | Area x Velocity |
| **Velocity** | Flow / Area |
| **Slope, %** | Drop / Distance x 100% |
| **Wet well pump-down time** | Storage / (Pump capacity - Inflow) |

## 7 The Numbers Worth Memorising

Everything else can be looked up. These six come up so often that pausing to find them costs you time you do not have.

| VALUE | WHAT IT IS | WHAT IT IS FOR |
|---|---|---|
| **8.34** | Pounds in one gallon of water | Turns mg/L into pounds |
| **7.48** | Gallons in one cubic foot | Turns a tank volume into gallons |
| **62.4** | Pounds in one cubic foot of water | Weight from volume directly |
| **2.31** | Feet of head in one psi | Gauge reading into pump head |
| **1,440** | Minutes in a day | Daily volume into a pump rate |
| **0.17** | Pounds of BOD per person per day | Population equivalent |


## Doing this by hand on shift?

- F/M, MCRT, how much to waste and 27 more, each worked step by step
- A daily process log that checks each round against the usual windows and prints the month
- 456 operator practice questions, free in your browser, and it works offline once opened

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A study and plant aid. Your NPDES permit, your state's operator rules and the formula table your exam hands you govern; check them before you rely on any figure here.