Department of Environmental Engineering
Middle East Technical University
Spring 2023
EnvE 422 Treatment and Disposal of Water and Wastewater Sludges

HOMEWORK # 2

Assigned: May 12, 2023
Due on: May 22, 2023, 17:00
Submission to Res. Assistant Esin Yandımata

Question 1 (25 pts.). Size the aerobic digester serving a 6 m^3/day of sludge flow rate and working to stabilize a 500 kg VSS/day of inflow sludge loading. Required reduction in VSS is 50 % and the decay constant for the aerobic microorganisms is 0.1 day^{-1}.

Question 2 (25 pts.). The Ankara Materials Recovery Facility receives 120 metric tons of dewatered wastewater treatment sludge per day. The sludge has a solids content of 30% and a bulk density of 1009 kg/m^3. Assuming the composting curing area is equal to the size of the composting area and that access roads, turn-arounds, and runoff collection require approximately 60% of the total area of the facility, estimate the minimum area required. Additionally, preliminary tests have indicated that the volumetric ratio of bulking agent (e.g. woodchips) to sludge required for adequate composting using a 1.8 m aerated static pile system is 3:1. By assuming a reasonable composting period, what is the minimum total area required for the composting operation? (Hint: Remember that the total area is composed of composting, curing and roads etc.)

Question 3. (25 pts.). By plotting their shear stress versus shear rate relationship graphs, comment on what kind of rheological property do these 3 sludges exhibit.

Sludge 1		**Sludge 2**		**Sludge 3**	
Shear Stress (N/m^2)	Shear Rate (sec^{-1})	Shear Stress (N/m^2)	Shear Rate (sec^{-1})	Shear Stress (N/m^2)	Shear Rate (sec^{-1})
3.8	1.8	1.7	1.8	15.4	1.8
5.4	3.7	3.6	3.7	17.3	3.7
9.0	7.3	7.5	7.3	21.3	7.3
14.1	14.7	15.0	14.7	28.7	14.7
23.1	36.7	36.9	36.7	50.6	36.7
35.7	73.4	74.2	73.4	87.9	73.4

Question 4 (25 pts). Raw primary sludge is to be pumped for 6 km against a static head of 26 m. Specify the required head and the pipe diameter.