Development of a High Performance Digest Reactor

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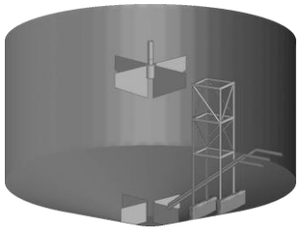


SATAKE MultiMix

Introduction

In sewage treatment plants, methane gas produced from sludge have been supplied to their facilities for power generation. For this reason, it is necessary to operate with as low power consumption as possible in this process. In this research, the RB mixing system was introduced to the digest process. And various experiments were carried out for scale-up to construct the digestion reactor then it was validated

◎ RB Mixing System

RB mixing system consists of two components, flat paddle impellers and static radial blades at the tank bottom (**Fig. 1**). Characteristics of RB mixing system are follows as:

- Strong upward flow is produced by the effect of radial blades.
- It is possible to disperse uniformly inside the tank with lower power.
- Due to the shorter shaft length and smaller shaft diameter, motor power can be reduced.

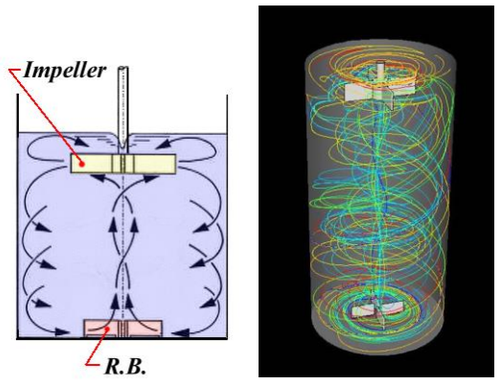
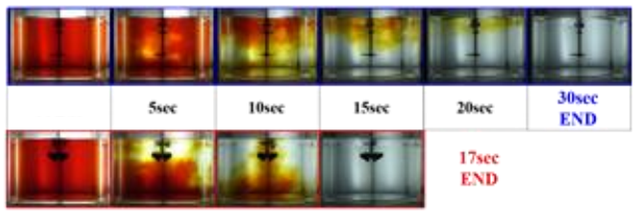


Fig. 1 Flow patterns of the RB mixing system

◎ Mixing Time

Mixing time were measured with the decoloration method by the reaction between iodine and sodium thiosulfate (**Fig. 2**). Tap water was used as fluid medium. A conventional impeller for axial flow was used for comparison. As a result, mixing time was reduced by 43 % compared with the conventional one.

(a) Conventional



(b) RB mixing system

Fig. 2 Experimental results of mixing

◎ Scale-up test

Scale-up tests were carried out with various size of the tanks (32 L, 200 L and 50 m^3). The effect of tip speed V_{tip} on the flow velocity V at the corner of the tank bottom shown in **Fig. 3**. The result was that almost data were correspond with the straight line. In case that the tip speed is 1.0m/s, flow velocity at the corner of the tank bottom can be secured by more than 0.2 m/s.

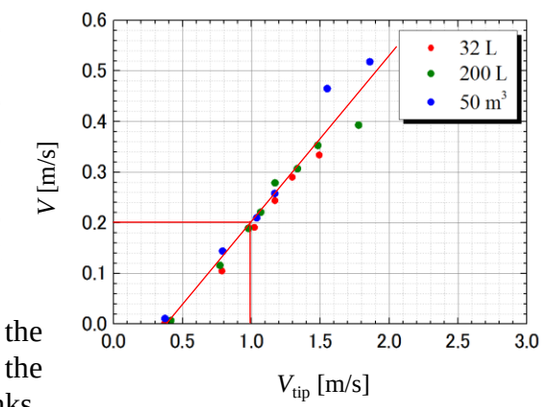
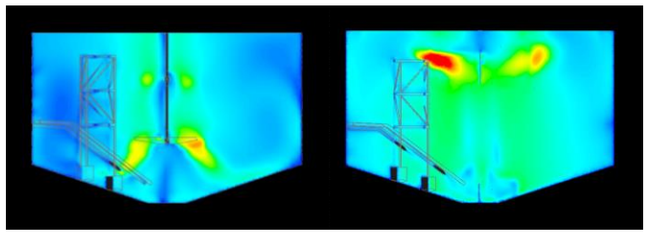


Fig. 3 The effect of tip speed on the flow velocity at the corner of the tank bottom with various scale tanks

◎ Simulation for Scale-up

The CFD simulations were carried out for the scale-up. Tank volume is 2500 m^3. As shown in **Fig. 4**, it shows that homogeneous mixing is achieved. After construction, the velocities in the tank V were measured and validated (**Fig. 5**).



(a) Conventional (b) RB system

Fig. 4 Calculation result of CFD Simulation (tank volume: 2500 m^3)

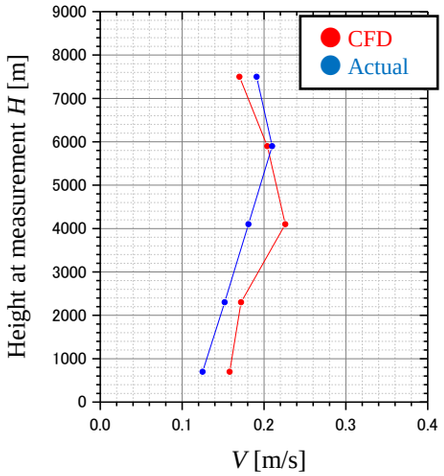


Fig. 5 Comparison of the velocity by CFD with the actual velocity

◎ Cost Evaluation

To evaluate the economical efficiency, approximate cost was estimated. Running cost was reduced by 20 % from the conventional type. In addition, the pump for defoamer is not required because the flow velocity near the liquid surface is fast and the scum is not produced.

Table 1 Comparison of this work with conventional one

		Conventional	RB system
Volume		2500 [m^3]	
Mixer	Motor	1.5 [kW]	3.7 [kW]
	Operating time	24 [hr]	24 [hr]
Defoamer	Consumption	9 [kg/day]	-
	Motor	0.2 [kW]	-
	Operating time	12 [hr]	-
Cost ratio	Initial cost	1 [-]	1 [-]
	Running cost	1 [-]	0.804 [-]

Conclusions

Through the scale-up tests and CFD simulations, we validated of this application to the digestion reactor. The digestion reactor equipped with RB mixing system has been operating satisfactorily for several years. In 2019, the President's Award of JSIM (Japan Society of Industrial Machinery) was given to this reactor as an excellent environmental equipment.