AERATED SEWAGE MIXING TANKS ON SHIPS | EXCLUSIVE ARTICLE BY DR. WEI CHEN

Having a sewage mixing tank with built-in aeration upstream of a sewage treatment plant onboard ships is not just a good practice, but a strategic move that ensures the future-proofing of new ships. The benefits of this setup are not only numerous but also significant, as we'll delve into.

WHAT IS AN AERATED SEWAGE MIXING TANK?

A mixing tank, positioned upstream of a sewage treatment plant, is a crucial component in the sewage treatment process. It balances different waste streams, buffers peak flows, minimizes health and safety risks, and ensures a stable treatment process. It also helps the sewage treatment plant meet its certified hydraulic capacity and comply with existing and future rules.

A mixing tank is distinct from a designated sewage holding tank, which is approved by the authority and stipulated in a ship's International Sewage Pollution Prevention Certificate (ISPPC). The capacity of a designated sewage holding tank is determined by the Administration, taking into account the operation of the ship, the number of persons on board, and other relevant factors. Typically, a sewage holding tank provides black water a hydraulic retention time (HRT) of 8-10 days on cargo ships, and 1~3 days on large passenger ships. In comparison, a mixing tank is based on industry know-how (not by approval) and takes into account the sewage treatment plant hydraulic capacity and the daily flows of all waste streams (not just black water) to be treated. Typically, it provides a hydraulic retention time (HRT) of about 1 day on cargo ships or less when the sewage treatment plant has a higher peak flow factor or when the flows are less fluctuated.

THE SEWAGE MIXING TANK: A CATCH-ALL FOR BALANCING AND BUFFERING

One of the most crucial functions of an aerated mixing tank is managing sewage treatment plant influent flows (Qi). By capturing all sewage treatment plant influents in one place, the tank ensures that all flows and characteristics are accounted for, a fundamental aspect of effective sewage treatment.

It should be noted that gravity or vacuum (e.g. integrated ejectors) influent into a sewage treatment plant can be problematic because it is impractical to measure its flow or to take a representative sample. Likewise, on many ships, grey water is connected to the last stage of a sewage treatment plant, causing non-conformities and poor sewage treatment plant performances.

Therefore, it is a good practice to capture all waste streams in an adequately sized mixing tank to buffer the peak flow conditions and balance the different characteristics.

EXCURSION: HAMANN AG'S APPROACH TO SIZING SEWAGE MIXING TANKS

The recommended size of the sewage mixing tank cannot be calculated with a general rule. It depends on several factors, which have to be considered and weighted individually for each project. HAMANN AG takes into account the following aspects:

- Expected total volume of black water and grey water per day
- The recommended mixing ratio between black water and grey water of about 1:5
- Peak volumes, e.g. in the mornings and evenings
- Run time of the sewage treatment plant feed pump should be about 1 hour before it is stopped again to avoid excessive start/stop operation

AERATION IS ESSENTIAL

A sewage mixing tank needs to be mixed to provide a homogenous influent to the sewage treatment plant. Mixing the tank using aeration is beneficial, if not essential.

Anaerobic conditions in sewage systems can lead to the production of toxic and flammable gases. This is an unacceptable hazard within the confined boundaries of a ship. Various safety features can be incorporated into the design and operation of a sewage system. Having barriers between the sewage gases such as the water traps, ventilation of the tanks, etc., should be considered as secondary measures of protection: the prime safety feature is to prevent the production of hazardous gasses within the system in the first place. The design of a tank holding sewage may include features for maintaining an adequate oxygen level in the liquid so as to eliminate anaerobic conditions. The IMO Maritime Safety Committee issued "Guidelines for the operation, inspection and maintenance of ship sewage systems" in MSC/Circ.648 (MEPC 53/16 contains MSC/Circ. 648 and can be downloaded from the IMO Docs Archive)

In addition, septic conditions of sewage treatment plant influent, represented by low oxidation-reduction potential (ORP), can negatively impact on the optimum coagulation and flocculation process setup and the efficacy of biological treatment processes, affecting treatment stability and performance.

FEEDING A SEWAGE TREATMENT PLANT FROM A SEWAGE MIXING TANK

Having an aerated mixing tank of adequate capacity is just a start. For a sewage treatment plant to perform, its influent flow (Qi) must not exceed its designed and certified average and maximum hydraulic capacities. The feed system connecting the mixing tank and the sewage treatment plant, which consists of feed pumps, level sensors, and control logic, must be suitably designed and commissioned for each installation.

An sewage treatment plant designed to take an even influent flow (peak factor = 1) is often fed by an integrated progressive cavity pump completed with suitable control logic as part of the approved sewage treatment plant. This, albeit at a higher cost, ensures the sewage treatment plant can perform within its approved hydraulic capacity.

However, not all sewage treatment plants are designed, approved, or supplied with such considerations in mind. A centrifugal pump can deliver an instantaneous flow of 1~2 magnitudes higher than the certified maximum sewage treatment plant hydraulic capacity. A mixing tank can be turned into a sewage reservoir, flushing the sewage treatment plant with huge batches on automatic level controls. These feed regimes do not represent the type of approved conditions of the sewage treatment plants and constitute serious non-conformities that rid the sewage treatment plants of the possibility to perform.

A sewage mixing tank itself does not necessarily warrant satisfactory sewage treatment plant influent conditions. It needs technical know-how.

FUTURE-PROOFING AGAINST THE EXISTING AND NEW REQUIREMENTS

Sewage treatment plant influent flow (Qi) is essential for the compliant operation of dilution machines that are certified with a Qi/Qe <1. Likewise, influent flow (Qi) and concentrations (Ci) are essential for sewage treatment plants approved with percentage nutrient removal standards.

The current IMO guideline for sewage treatment plants, IMO MEPC.227(64), also requests that 'the sewage treatment plant influent (Qi and Ci) should be assessed without the contribution of any return liquors, wash water, or recirculates, etc., generated from the sewage treatment plant'. This means that a mixing tank should not receive sewage treatment plant sludge or wash water whenever assessments of Qi and CI are required, whether it is during a sewage treatment plant type-approval test or compliant operations.

These existing requirements are poorly implemented or enforced, leading to multiple type-approved non-conformities that are left unacknowledged or corrected. The situation might change in the near future when the IMO's MARPOL Annex IV is under revision to 'confirm the lifetime performance of the sewage treatment plants'.

An aerated mixing tank is set to become increasingly important in the compliant operation of sewage treatment plants on ships. Regulatory and technical know-how are essential to getting it right from now on.

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