# PENINGKATAN STABILITAS TEMPERATUR PADA BAK SEDIMENTASI DENGAN VEGETASI KANOPI

# IMPROVED TEMPERATURE STABILITY IN SEDIMENTATION TANK WITH VEGETATION CANOPY

**Bowo Djoko Marsono[1*)] and Sarwoko Mangkoedihardjo[1)]**
**[1)]Department of Environmental Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia**
**[*)]E-mail: bowodjok@enviro.its.ac.id**

## Abstrak

Secara alami suhu air berkorelasi dengan kepadatan dan viskositas. Perubahan temperatur karena sinar matahari mempengaruhi proses dalam pengolahan air seperti sedimentasi dan koagulasi. Efek yang merugikan adalah adanya arus densitas di permukaan pada siang hari, sehingga mengurangi efisiensi sedimentasi partikel. Vegetasi kanopi dapat diterapkan dalam bak sedimentasi untuk mengatasi perubahan temperatur di permukaan massa air. Metode ini dapat diimplementasikan dnegan menanam pohon di sekitar bak selain kain *fiberglass*. Pohon-pohon yang tinggi dan berkanopi dengan daun-daun yang besar akan menutupi area permukaan bak sedimentasi sehingga perubahan suhu air akibat sinar matahari dapat dikurangi. Untuk menerapkan teknik ini, pada saluran keluar bak sedimentasi digunakan lubang yang tercelup dan jaring di atas permukaan air.

**Kata kunci:** Bak sedimentasi, Kanopi, Pengolahan air, Pohon-pohon yang tinggi.

## *Abstract*

*Naturally the water temperature is correlated with the density and viscosity. Changes in temperature due to sunlight affect processes in water treatment such as sedimentation and coagulation. The detrimental effect is the presence of density currents on the surface during the day, thereby reducing the efficiency of particle sedimentation. Vegetation Canopy can be applied in sedimentation tanks to cope with changes in temperature on the surface of the water mass. This method can be implemented by planting trees around the tank in addition to fabric fiberglass. Tall trees and canopies with large leaves will cover the surface area of the sedimentation tank so that changes in water temperature due to sunlight can be reduced. To apply this technique, submerged orifices and a net above the water surface are used at the outlet channel of the sedimentation basin.*

***Keywords:*** *Canopy, Sedimentation tank, Tall trees, Water treatment.*

## 1. INTRODUCTION

An increase in water temperature will cause a decrease in water viscosity and a decreased water viscosity will cause an increase in the Reynolds number. Reynolds number states the level of laminar or turbulence of a water flow, laminar flow tends to have a relatively small Reynold number. Laminar flow is very important in the sedimentation process of a particle.

Water temperature in a water treatment plant, especially sedimentation tanks, tends to fluctuate with time and is segmented at each water depth. This temperature change is mainly due to the sun's rays during the day. The process of deposition of a particle is influenced by the speed of settling of the particles, the speed of settling of the particles is influenced by the viscosity of water. In other words, the temperature affects the settling speed of the particles. Temperature can also cause resuspension of pre-settled particles. (Hudson, 1972; Crittenden et al., 2012; Van Buren et al., 2000; Goodarzia et al., 2020)

Plants with leaves can shade the surface of the water from the sun. It has been widely reported that the functions of riparian vegetation to maintain river water quality include: 1) Preventing excessive evaporation of river water, 2) Maintaining river water quality, 3) Controlling aquatic weeds, and 4) Increasing fauna diversity. (Bailey, 1995; Binkley & Allen, 1999; Jones et al., 1999; Loomis et al., 2000).

The application of plants in drinking water treatment plants will provide benefits, especially reducing fluctuations in water temperature in sedimentation tanks that have a large surface area. In connection with improving the performance of the sedimentation basin with the application of riparian phytotechnology, it is necessary to review its effectiveness.

## 2. TEMPERATURE IN SEDIMENTATION TANK

The performance of the sedimentation tank is influenced by several factors, such as temperature gradients, wind effects, energy dissipation in, outflows, and equipment movement. Conventional sedimentation tanks for drinking water and wastewater treatment generally have the characteristics of a large surface area, a ratio of width to length of 1:4 and a depth of 3-4 meters. The surface area of the sedimentation tank will be in direct contact with sunlight during the day, causing temperature changes.

Short circuiting due to density current in sedimentation tanks has long been observed. Temperature differences between the water in the basin and the water entering, cause currents and short-circuiting, again with poor settling efficiency and too much floc carried over to filters. If incoming water is much colder or warmer, it short-circuits along the bottom or top of the basin. Sudden increases in turbidity also increase the specific weight of the flocculated water, causing it to short-circuit along the bottom of the basin (Camp, 1946; Harleman, 1961; Kao, 1977). There are several methods to reduce the effect of density currents, including improving the inlet and outlet systems and recirculation (Hudson, 1972; Camp, 1946; Harleman, 1961; Kao, 1977; Fitch & Lutz, 1960; Sank, 1978).

Studies were conducted by using a 1:25 scale model with dynamic similitude following the Froude law. Temperatures in the tank and the feed flow were kept constant with the feed flow about $0.3^0$C lower than the water in the tank. Without diffuser walls in the tank, the density current flowed along the bottom of the tank at a relatively shallow depth and took less time to reach the outlet. Under these conditions, the top two-thirds of the tank depth was not used effectively. To improve the hydraulic efficiency, diffuser walls with approximately 7 percent net opening were added. With the modified diffuser walls, head losses created at the diffuser walls forced the retardation and mixing of the density current with the ambient water, improving the flow distribution in the tank and the efficiency of hydraulic performance. The next study also reported density flow velocities of 0.8 to 1.8 m/min in the bottom of sedimentation tanks as compared to design velocity of 0.4 m/min. These density flow velocities were observed during the day when the surface temperature was 0.2 to 0.5°C warmer than the influent raw water (Kawamura, 1981; Kawamura, 2000).

When conducting tracer tests in pilot plant investigations, Tekippe & Cleasby, (1968), found that minor temperature differences greatly reduced the reproducibility of experiments and overshadowed minor differences in inlet and outlet design variables. The performance of sedimentation tanks that are constructed with metallic walls and exposed to sunlight may also be unpredictable. The heat transmitted through the wall on the sunny side of the basin tends to warm the water, making it less dense than water on the warm water in turn rises, forming a density current that, if sufficiently severe, can invert the contents of the basin (Tekippe &

Cleasby, 1968).

Research shows that the temperature profile in the water will reduce about 16% of the hydraulic retention time, temperature variations need to be considered in the design and operation of sedimentation tanks. Proper design will result in a better potential for reduced chemical consumption and turbidity (Goodarzia et al., 2020).

## 3. RIPARIAN VEGETATION

Riparian vegetation is vegetation that grows on the banks of rivers. This vegetation has many functions, including maintaining river water quality, wildlife habitat, preventing landslides and regulating the growth of aquatic flora at both high and low levels. Riparian vegetation is very useful in regulating water temperature and controlling the entry of sunlight into rivers (Loomis et al., 2000; Mitsch & Gooselink, 1993).

The incoming light will increase the surface temperature of the river water. This is very dangerous for aquatic life that has adapted to low temperatures. If the river water temperature increases, then only a few animals only can live. An increase in water temperature will reduce the diversity of aquatic biota species. Sunlight is needed by aquatic plants and algae for photosynthesis. The presence of riparian vegetation can reduce light enter the river. Light is a limiting factor for the growth of these photosynthetic organisms. If the light is lacking due to the presence of riparian vegetation, then the growth of photosynthetic organisms can be controlled. However, if the light is too much then the growth of the organism will be very fast (Loomis et al., 2000).

Research in the Sematang Borang River which is part of the Musi River Basin shows that environmental temperature, Dissolved Oxygen levels and salinity are strongly correlated with riparian distribution patterns, while river water temperature has a moderate correlation (Hastiana, 2014).

Role of riparian vegetation at surface water are: 1) Canopy density, river orientation and water velocity interact to affect water temperature, 2) Channel orientation and water velocity should determine the optimal planting strategy, and 3) Sparse riparian canopy can provide spatially extensive cold water protection (Hastiana, 2014; Garner et al., 2017).

Wilkerson et al., (2006), reported a 2.5–2.8$^o$ C increase in mean weekly water temperature after logging, with maximum temperatures increasing by up to 4$^o$C. Webb and Crisp, (2006) found that coniferous riparian forests reduced mean water temperature by around 0.5$^o$ C, with summer mean maxima reduced by 5$^o$C. The results from the Girnock are broadly consistent with these findings: the largest differences between open and woodland sections related to maximum temperature values, with differences of up to 8$^o$C being recorded. As emphasised elsewhere, riparian planting offers great potential for mitigating higher temperatures and protecting stream habitat conditions (Wilkerson et al., 2006; Malcolm et al., 2008; Webb & Crisp, 2006).

Vegetation (large trees) as a 10 m wide buffer on the riverbank is the most effective and has provided a wider buffer. Likewise, that the length of the buffer with large tree vegetation is essential to prevent continuous heating in unshaded reaches (Kail et al., 2021). The combination of vegetation and non-vegetated canopy can be applied to water treatment plants to get tank surface coverage. Metal tank surface covers can be useful for inspection and preventing vegetation leaves from falling onto the water surface, see Figure 1.

**Figure 1.** Canopy steel and trees on the wastewater treatment

## 4. DISSCUSSION

In general, large drinking water treatment plants are built openly where the water surface is directly exposed to sunlight, such as the sedimentation unit, flocculation unit and filter. As a result of this exposure, temperature fluctuations arise, especially on the surface during the day and night. Changes in temperature will result in changes in the density of water which results in current density. To overcome this problem, it is generally done by installing a canopy made of metal or plastic. Disadvantages of this method are the limited lifespan of the canopy, corrosion, prone to damage if blown by strong winds, and high cost. The advantage is that the canopy coverage can optimally cover the entire surface of the water and minimal maintenance, there is no garbage on the surface of the water so it is cleaner.

The riparian method is an alternative to overcome the problem of current density, especially in sedimentation tanks. The advantages of a riparian canopy that is applied next to a sedimentation tank include low cost, more sustainable because it has a long life, creates a green building for oxygen supply, is more environmentally friendly. This approach is supported by results of similar studies Samudro & Mangkoedihardjo, (2021) and Samudro, (2020) regarding the benefits of vegetation on temperature stability. The drawback is that it requires cleaning of leaves that fall on the water surface, tree maintenance, if the width of the building is large enough it will be difficult to be covered by tree leaves and arrangements so as to achieve better coverage.

However, to overcome these shortcomings, it can be done by installing a grill or net above the water surface so that the leaves that fall on the surface of the tub can be restrained, planting broad-leaved conditioning trees, trees with branches that form a canopy and do not bear fruit and combine it with a metal canopy placed in the middle of the tub as in Figure 2.


**Figure 2.** Riparian Sedimentation

Changes in temperature that can be reduced to 5 $^{o}$C, is very significant to overcome the current density in the sedimentation tank. It is important to note that the sedimentation basin is the design of the outlet channel or launders. Riparian application around the sedimentation tank causes leaves to fall to the surface of the water in the sedimentation tank, which can then enter the outlet channel until it enters the filter unit. The escape of leaves into the outlet channel can also cause blockage of the channel or pipe that interferes with the processing process. To prevent this, it is not recommended to install weir launders but use submerged orifices see Figure 3. Bar screens also need to be installed at the inlet and outlet of the tank.

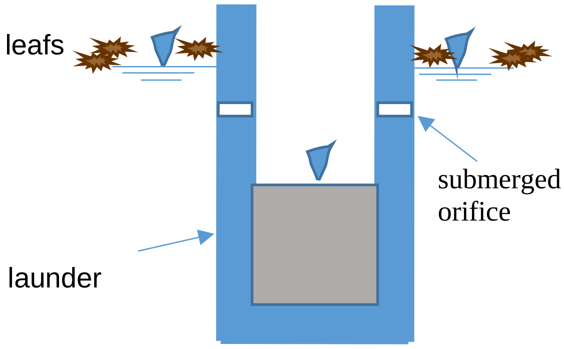


**Figure 3.** Design Launder

## 5. CONCLUSION

Temperature fluctuations in drinking water treatment buildings, especially sedimentation tanks, can be minimized by riparian, namely planting trees around the sedimentation tanks so that the water surface can be covered with trees. The combination of a tree and a canopy made of metal or plastic/fiber can be applied to large tubs that cannot be reached by the tree canopy. Specifications of trees that are suitable to be applied as riparian include; A conditioning tree with broad leaves, not bearing fruit and forming a canopy. To prevent tree parts from falling into the water, a net can be installed and select outlet channels with submerged orifices.

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