Laboratory experiments of heated wastewater discharge from the power plant using thermo-color dyes

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Several power plants located along the east coast of Korea discharge heated water used as a coolant. To reduce its thermal pollution impact to the surrounding coastal regions near the power plants, the behavior of heated wastewater should be monitored and predicted. However, lots of difficulties exist not only in surveying the coastal regions around the power plants but also in maintaining in-situ monitoring systems there. In this study we demonstrate a novel method for estimating the thermal diffusivity of heated wastewater from the power plant using thermocolor dyes which can visualize temperature changes by color transition in the solution. The solution shows violet, green, and yellow colors when the water temperature ranges < 18˚C, 18–21˚C, and > 21˚C, respectively. Salt water in the tank is set to 17˚C and warmer solution, considered hot wastewater, is discharged through submerged tube at the bottom. Behavior of the warmer solution is recorded by digital camera, and eye-catching colors are converted to HSV-color coordinate (Hue, Saturation, Value) to determine the absolute color. Thermal diffusivity is estimated by analyzing spreading extent of warmer solution from HSV-color images and by solving the advection-diffusion equation. Our novel approach has following two advantages: 1) Any sensors (like thermometer) are unnecessary, and hence any disturbances by sensors on fluids are prevented, 2) Converting video images to HSV-color provides absolute color so that we can determine the temperature changes quantitatively using the images taken at a certain angle and brightness. The estimated thermal diffusivity shows a reasonable value compared to that from a numerical simulation. Therefore, our method using thermocolor dye solution and converting HSV color coordinate can be applied in reproducing and predicting the movement of heated wastewater. It also can be applied for conventional experimental studies of heat transfer in fluids like turbulent mixing.

