A radiotracer test performed at Howard Waste Water Treatment Plant in Panamá City, Panamá

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Abstract. This paper presents an application of Sodium Pertechnetate ($Na^{99m}Tc0_4^-$) for a better understanding of industry applications of radiotracers technology. An experiment has been carried out at Panama Pacifico Waste Water Treatment Plant (WWTP) located in the former Howard United States Air Force Base. The plant is located very close by the southern (Pacific) end of the Panama Canal. The radiotracer experiment was made in two aerated tanks due to four reasons. First, suitability of physical dimensions. Second, excellent injection point because the waste water enters in the tank in a spillway and the tracer could be released directly into the flow. Third, due to the availability of two independent systems, results can be used to compare if both tanks are operating in a similar conditions. Finally, the tracer injection procedure can be closely followed by the technical staff. Because of the significant recirculation flow existing in both tanks, the residence time distribution measurement and the mean residence time estimation were not possible. However, analyzing the detection curves, it can be conclude that the apparent mean residence time is certainly greater than the nominal value that is approximately 4 hours Waste water was totally mixed in the tank after 14 minutes of entering in the tank Dead zones were not detected.

1 INTRODUCTION

The Sanitation of Panama Bay at a cost of about $ 500 million is one of the largest infrastructure projects currently under way in Panama. This mega project is designed to be completed in two stages: the first stage began in 2003 with the design process, which finally ended in mid-2005, the second phase began in September 2005 and is expected to be completed around the first half of this decade. The sanitation project involves the installation of two water treatment plants for the purpose of improving the quality of water that ultimately flows into the Panama Bay .

Today, the Panama Bay has serious pollution problems, but for now there is no contaminant monitoring program under the Sanitation Project Bay. Without a comprehensive monitoring program, it is impossible to demonstrate the effectiveness of the measures proposed by the plan of correction (treatment plants, wastewater collectors, etc.) for contaminants.

To carry out a program to improve Panama Bay successfully, it is necessary to reduce pollution levels based on international standards of water quality, through an effective monitoring program for contaminants in treatment plants wastewater effluent and coastal marine areas.

In 2012, a Panamanian national project granted by IAEA and called, Supporting the Panama Bay Contamination Monitoring Programme started development a monitoring and analysis of organic pollutants (organochlorine pesticides and polyaromatic hydrocarbons) and inorganic (heavy metals) and implementing the use of radiotracers in plants wastewater treatment plants, for checking process efficiency and smooth functioning of the same[1].

Use of tracers has proved to be a cost-effective checking technique, providing knowledge into numerous areas of water quality, sludge performance, plant process and drain spreading. Results have enabled customers to identify areas where substantial savings in both capital and operational disbursement can be made. Economic benefit is indirectly quantified through reduced environmental impact of waste discharge. The benefits of applying tracer studies in waste water treatment facilities are operating existing plants more efficiently and providing data for the design of upcoming plants [2].

Finally, radiotracer tests may be used for in the different phases or process of the waste water treatment to investigate numerous problems [3].

2 CASE STUDY:

An experiment has been carried out at Panama Pacifico Waste Water Treatment Plant (WWTP) located in the former Howard United States Air Force Base. The plant is located very close by the southern (Pacific) end of the Panama Canal. A view can be seen in the figure 1.

Fig. 1. A view of Howard WWTP.

In this plant, like most typical WWTP, waste water undergoes a filtering process to remove objects before entering the system. After filtering, waste water is treated in two aerated tanks and two digesters where biological processes reduce organic matter and pollutants.

Before discharging the effluent to the Pacific Ocean, it is ensured that most of the oxygen is restored to avoid damages to the environment.

The experimental design consisted in selecting the tracer injection points, position of detectors, radioisotope transportation, radiological safety considerations, tracer injection, data acquisition, treatment, and interpretation.

A radiotracer experiment in the two aerated tanks was made due to four reasons. First, suitability of physical dimensions of 16.9 meters long, 7.6 meters wide and 4.5 meters deep. This represents an approximate volume of 600 m^3 with flow rate of 0.04 m^3/s in each tank. Second, excellent injection point because the waste water enters in the tank in a spillway and the tracer could be released directly in to the flow. Third, results could show if both tanks are operating in a similar conditions. Finally, the tracer injection operation can be seen by the technical staff.

We planned to inject the radiotracer directly in to the inlet flow of both tanks using one shielded syringe and locate all the six probes according to the figure 2.

Probes 1 and 3 were the main ones because detect all the radiotracer flowing out the tanks and consequently the residence time distribution. The detector position were planned to be 0.2 meter depth.

Probes 2 and 4 as well as probes 5 and 6 could determine possibly tanks malfunction for example dead or stagnant zones. The detector position were planned to be 4.0 meter depth.

All the probes must be at least 0.5 meter from any wall of the tanks just to avoid mechanical shocks that could damage the detector.

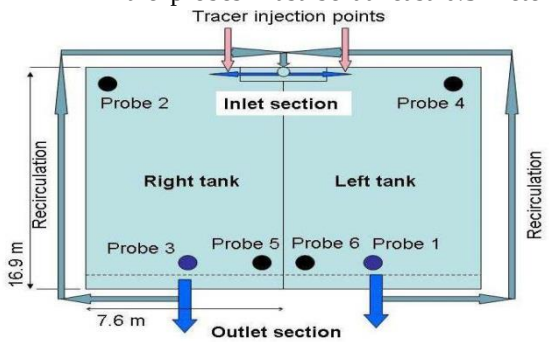

Fig. 2. Howard WWTP: Inlet and outlet sections, recirculation and all six probes position.

The sodium pertechnetate (Na99mTc04) solution that was used as a radiotracer in the experience is normally used in nuclear medicine as a scintigraphic agent for viewing images of internal human organs. The 99mTc has half-life of 6 hours, decays by isomeric transition emitting photons of energy 140 keV (87.5%). The total radioactivity of the radioisotope sodium pertechnetate was was aproximately 0.9 GBq (24 mCi) at the injection time. The initial volume of the radioisotope solution was estimated in less than 1 ml in a 10 ml syringe. In order to facilitate the handling during injection procedure we prepared a new 8 ml solution diluting the initial volume in 7 ml of clear water.

Background radiation was measured for all six probes (figure 3) of the gamma spectrometer. Probes are 2" NaI(Tl) from Altaix Systems and the data acquisition from Caesar 12 Software.

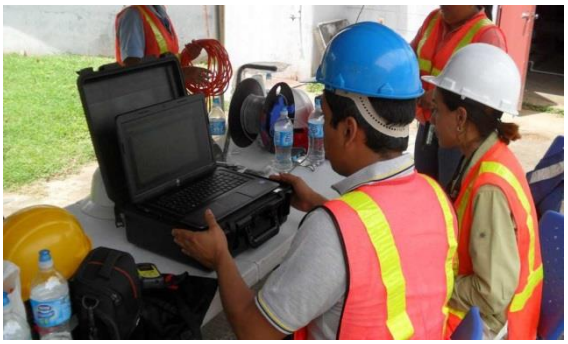

Fig. 3. Portable field gamma spectrometer

The time between each record was fixed in 60 seconds and recorded count was shown in counts per second (cps). We fixed in 30 minutes the period for background count as being enough for a good average value. We injected the radiotracer at 12:02 PM (figures 4 and 5), about 0.45 GBq (12 mCi) in each tank.

Fig. 4. Radiotracer injection in the left tank

Fig. 5. Radiotracer injection in the right tank

The detection was carried out until02:45 PM because we found that the recirculation was much more important than previously thought. Our decision also was based on the shape of detection curve that was almost horizontal meaning that we were detecting in a tank with stagnated flow or no flow rate to the outside of the tanks(figures 6 and 7).

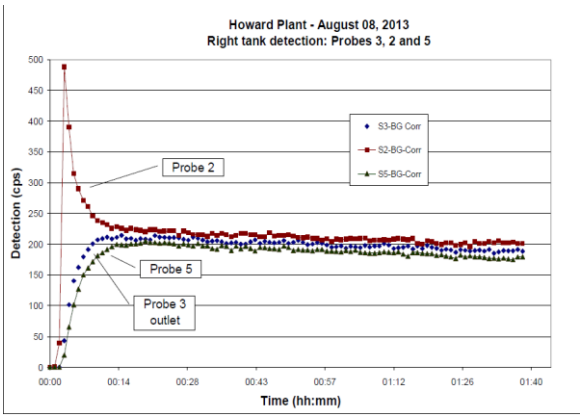

Fig. 6. Radiotracer detection in the right tank

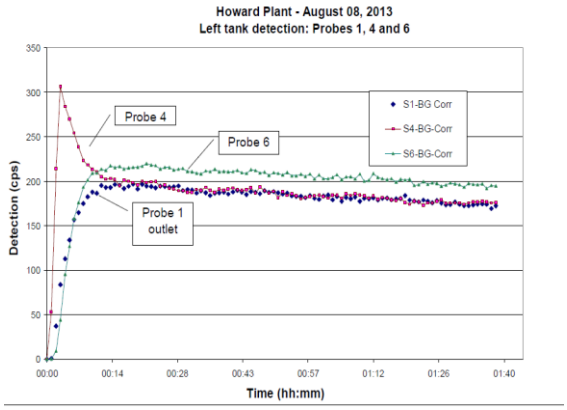

Fig. 7. Radiotracer detection in the left tank

3 GENERAL CONCLUSIONS

Because of the significant recirculation flow existing in both tanks the residence time distribution measurement and the mean residence time estimation were not possible. However, analyzing the detection curves, it can be conclude that:

1. The apparent mean residence time is certainly greater than the nominal value that is approximately 4 hours,
2. Waste water was totally mixed in the tank after 14 minutes of entering in the tank; and
3. There were no dead zones.

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