Pollution of the environment by tannery and textile waste waters in the areas of Antananarivo, Madagascar

E.O. Rasoazanany, Raoelina Andriambololona, R. Razafy Andrianarivo, L.V. Randriamanivo
Madagascar Institut National des Sciences et Techniques Nucléaires (Madagascar-INSTN)
P.O. Box 4279 - Antananarivo 101, MADAGASCAR, E-mail : instn@moov.mg
R. Raboanary
Institute of @stro - High - Energy Physics - MADAGASCAR, University of Antananarivo

Waste water pollution is a major problem throughout the world. It has affected the health and the environment in Antananarivo (capital of Madagascar). Undesirable and toxic heavy metals contained in waste water samples are measured by the technique of total reflection X-ray fluorescence. Chromium is a toxic metal for the environment associated to the tannery. Its concentration (2712.1 µg/L) is superior to the national norm (2000 µg/L). Regarding textile factories, the highest value of the conductivity (4670 µS/cm) is 23 times the national norm (200 µS/cm). The concentration of lead (251.0 µg/L) is higher than the national norm (200 µg/L) and the Belgium norm (100 µg/L). The present study illustrates the importance of the treatment of waste water of the factories before pouring them in the environment.

1. INTRODUCTION

Water is vital but it proves to be great problem for humanity. Indeed, the water of good quality is becoming rare because of human activity: discharge of chemical wastes used by industries and households in the nature. However, the public health depends especially on the water quality. The present study is devoted to determine the physical and organoleptic factors (pH, conductivity, colour, odour) of waste waters; to measure the concentrations of the undesirable metals (manganese, iron, copper, zinc), the toxic metals (chromium, nickel, arsenic, selenium, lead) and trace elements present in the waste waters collected from the rejections of the tannery and textile factories in Antananarivo on the one hand, and in waters sampled to the surroundings of the factories on the other hand; to compare the composition of the waterway upstream and downstream from the rejections of the factory and to value the harmful effects due to the discharge of the waste waters in the receiving environment of public utility (rivers, rice fields, streams).

2. METHODS

The sampling of waste waters was achieved in the discharge pipes (DP) and in the basin of decanting (BD) of tannery and textile factories of Antananarivo in order to determine the degree of pollution of their waste waters. Otherwise, the sample collections are also achieved upstream (UP) and downstream (DW) from the rejections in the receiving environment of public utility (river, lakes, rice fields.) for studying the transfer of the pollutants in this receiving environment. Two sampling campaigns were carried out in February 2003 - March 2003 and January 2004 - April 2004.

Concerning the factory of tannery (FTN), the sampling was achieved during the season of rain. FTN discharged its waste waters in the river that crosses the village. This factory has two discharge pipes of which the first discharge pipe (TNDP1) for unit of washing is upstream of the second one (TNDP2) for unit of painting.

Ten factories of textile coded FTX1 to FTX10 are chosen during the sampling campaigns. FTX2, FTX4 and FTX5 are respectively downstream from FTX1, FTX3 and FTX6 (see Figure 1).

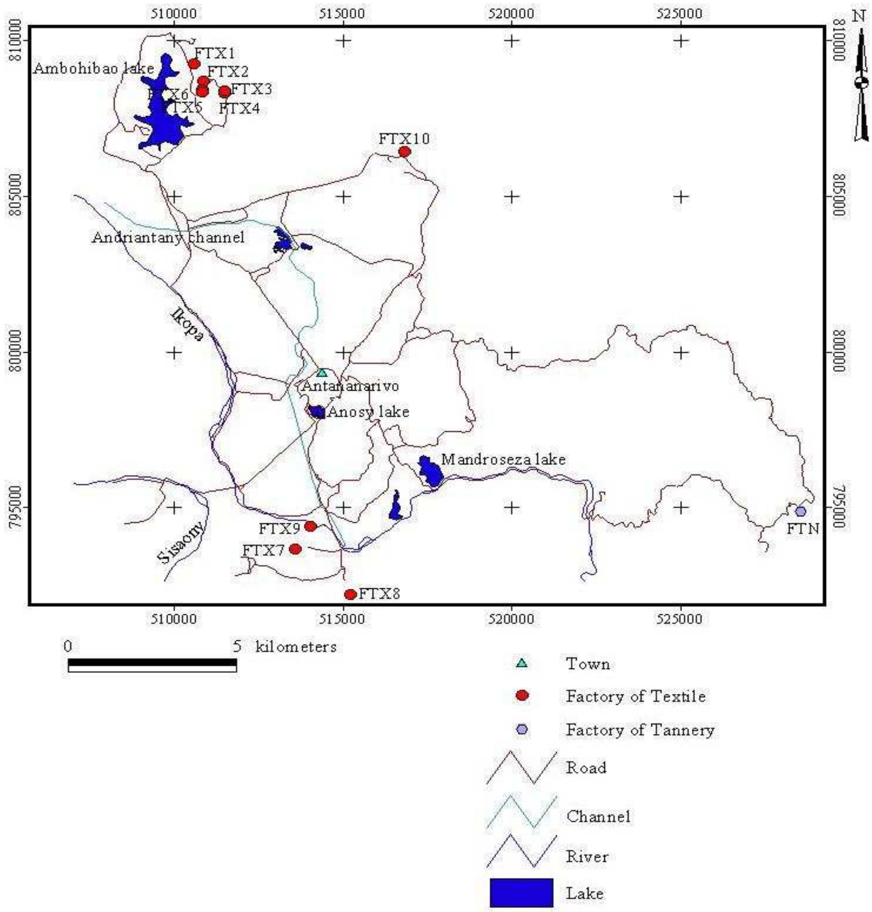

Figure 1: Localization of the discharge pipes of tannery and textile factories in Antananarivo

The analysis of the sample are done at Madagascar-INSTN. Total reflection X-ray fluorescence (TXRF) method is used for measuring the waste water samples and for determining the heavy metals and trace elements in the samples. TXRF was initially suggested as an analytical method by Yoneda and Horiuchi [1] in 1971, when they implied a pattern for the background reduction by depositing samples on an optically flat surface. Subsequently, Wobrauschek and Aiginger applied the method and clarified the physical principles [2]. This method is especially conceived for the liquid samples.

3. RESULTS AND DISCUSSION

3.1. Study of the physicochemical parameters of pollution by the waste water poured by the discharge pipes and the basin of decanting

The measurement of the physical parameters (pH, conductivity), the determination of organoleptic factors (colour, odour) and the analysis of the undesirable and toxic elements permit us to release the following observations:

- Regarding the factory of tannery, the conductivities of waste water leaved by TNDP1 exceed the national norm (200 µS/cm) [3] for the two stages of sampling. Their values are respectively of 752 µS/cm and 1410 µS/cm. The maximum value of conductivity is 7 times higher than this norm. The importance quantity of chemicals entering in the cycle of production contributes to the origin of such a charge [4]. pH do not pass the national norm (6.0 to 9.0). The colours "chestnut purple" and "gray" also do not respect the national norm (colourless).

For the first stage of sampling, the iron content of waste water leaved by the second discharge pipe of FTX2 is slightly lower than the national norm (10000 µg/L). Its value is 7760.0 µg/L. The obtaining of this value can be explained by the composition of painting. For undesirable and toxic heavy metals, the concentrations of manganese, iron, nickel, zinc, lead and arsenic are largely lower than the national norms. Besides, the waste water of leather tannery is contained also a high concentration of toxic metal chromium (2712.1 µg/L). This concentration passes the national norm of 2000 µg/L. For the health, the chromium is responsible of cancers of the devices respiratory and digestive.

- For textile factories, the waste water samples are taken in the discharge pipes of four factories (FTX1, FTX3, FTX7 and FTX8) for the first campaign. Only colour and odour of the waste water sample taken from the discharge pipe of FTX7 respect the national norms (respectively colourless and odourless) [3]. After a process of treatment, the blue colour of the waste water taken in the basin of decanting of FTX1 becomes limpid while leaved by the discharge pipe of FTX1. Lead having 251.0 µg/L of concentration in the waste water taken in this discharge pipe exceeds the national norm (200 µg/L) and the Belgium norm (100 µg/L) [5]. Almost the waste water poured by the discharge pipe of FTX has nauseous odours (prickly or bad). The concentrations of selenium are higher than the national norm (20 µg/L). The copper content (229.1 µg/L) in the waste water sampled from the discharge pipe of FTX3 passes also the Belgium norm (200 µg/L).

  For the first stage of the second campaign, the conductivity of waste water poured by the second discharge pipe of FTX10 has a maximum value of 4670 µS/cm and exceeds the national norm (200 µS/cm). The use of the chemicals necessary to the production contributes to the origin of the increase of the conductivities [4].

  Colours and odours of waste waters do not respect the national norms. During the production, the colours of waste waters poured by the textile factories depend on the use of the dyes intended for colouring of the final products of these factories.

  For the rejection of industrial effluents during the two campaigns, pH of the waste waters taken from discharge pipes vary from 6.0 to 8.5. Thus, pH having values between 6 and 7 correspond to 73% for the first stage of the second campaign and 75% for the second stage. To this effect, the textile factories seem to use some acid-based chemical products. The conductivities vary from 178.2 µS/cm to 4670 µS/cm. The majority of these conductivities exceeds the national norm of 200 µS/cm. Measured conductivities having values between the norm value (200 µS/cm) and 5 times higher than this norm represent 46% of these conductivities for the first stage of the second campaign and 57% for the second stage.

3.2. Effects of discharge of waste water upstream and downstream from the rejections of tannery and textile factories

- Concerning the tannery factory, the water samples taken along the river for the first campaign, notably upstream and downstream from the rejections, permit to make a study in absence of activities of the factory. The waters taken upstream of the first and the second discharge pipes do not have odours while those taken downstream from the rejections are nauseous. Thus, the nature of the receiving surrounding itself contributes to this phenomenon. The presence of chromium downstream from the rejection is observed. About 150 m and 200 m after the rejections, the concentrations of chromium are respectively of 581.9 µg/L and 785.0 µg/L.

At the time of the first stage of second campaign, the values of conductivities of the water sampled downstream from the rejections decrease up to 32.2 µS/cm (see Figure 2) because of the strong dilution along the river [6]. About 350 m downstream from the rejections, the increase of conductivity of 54.7 µS/cm can be explained by the contribution of the nature of the receiving surrounding itself.

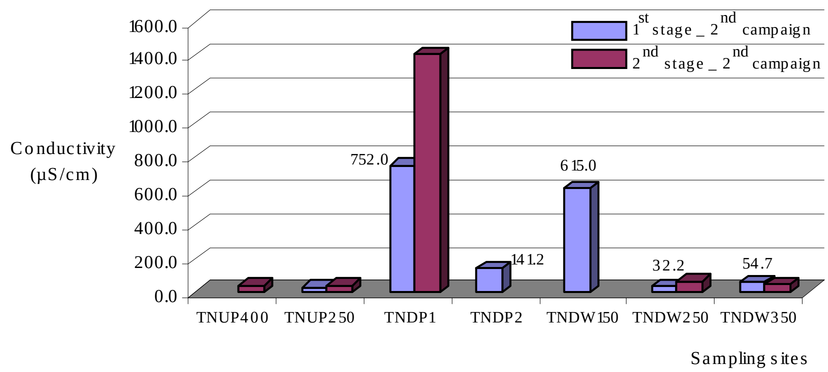

Figure 2 : Variation of conductivity of the waters upstream and downstream from the rejections of tannery factory

- Regarding the factories of textile, because of the discharge of waste water leaved by FTX2 in the river, the inhabitants complained about the nauseous odour in the neighbourhoods of this river. However, the farmers also use this river for the watering of their cultures (leaves, salads, ...). Indeed, they felt this nauseous odour at the time of the cooking of these cultures and their tastes prove to be unpleasant. A specific treatment of the waste water before the rejection makes it possible to solve the problem of the residents. Thus, the analyses of Oxygen Chemical Demand (OCD), Oxygen Biochemical Demand after 5 days (OBD5) and the ions prove to be necessary to be able to complete this present work and to study the organic substances in order to know the existing phenomenon in the watery life.

  During the discussion with the farmer who is owner of the vegetable gardens and the rice field being directly after the rejection of FTX4, he complained about the discharge of the waste water. During several years, the river downstream from rejection is used to watering its vegetable gardens and to satisfy the needs for its rice field. At that time, the output of production of rice was 0%. Actually, he found the solutions by replacing the waste water by spring water and the output approaches the 100%. In addition, about 200 m downstream from the rejection, the influence of the "whitish" colour and the "prickly" odour of waste water is observed. The strong presence of manganese, zinc, strontium and lead is also noted. At this place, the leaves of vegetation of the kitchen gardens present burns. For this purpose, the question arises: "from which pollution comes in this river?". The deepen analyses would make it possible to know the origin of such phenomenon.

4. CONCLUSION

For the factory of tannery, the concentration of chromium of 2712.1 µg/L passes the national norm (2000 µg/L). The presence of the chromium downstream from the rejections is also observed. So therefore, to study the pollution by waste waters of such an industry, it is sufficient to determine the element chromium like pollutant.

Concerning the textile factories in Antananarivo, pH of waste waters vary from 6.0 to 8.5. The conductivities vary from 178.2 µS/cm to 4670 µS/cm. The important use of a quantity of chemical products in the cycle of production can contribute to the origin of this increase of the conductivities. Colours of waste waters coming out of the discharge pipes and the basin of decanting depend on the dyes used by the factories. Downstream from the rejections, a lot of complaints are issued by the inhabitants because of the nauseous odours. To this effect, the elimination of these odours also requires a deepened study. Lead having a maximum concentration of 251.0 µg/L passes the national norm of 200 µg/L and the Belgium norm (100 µg/L).

To conclude, the purification of the waste waters is a decisive stage to preserve our environment. The treatment of the waste waters will permit to preserve the quality of our environment, in particular the one of the surface and underground waters waters.

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