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Evaluation of the Production Process and Management of Industrial Effluents by the Congolese Refining Industry Company (SOCIR) in Muanda in Dr Congo

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Abstract:- The objective of this study is to assess the risks linked to the discharge of industrial effluents from SOCIR into the Congo River. Several physicochemical parameters were taken into account in order to characterize these effluents. The results show that the temperature remained within the standard range, above all as after treatment of the effluents either: 26.6°C for E1 before treatment and 25.8°C for E2 after treatment.

The pH remained neutral, above all as after treatment with values tending slightly towards acidity before treatment either, 6.1 for E1 and slightly towards basicity after treatment, i.e. 6.8 for E2. The solid matter (sediment) content in the effluent remains relatively low, a little low before treatment, 0.9 for E1, and very low after treatment, 0.1 for E2. Our samples have a low hydrocarbon content for E1 and a total absence of hydrocarbon after treatment for E2.

The chemical oxygen demand presents values lower than the maximum provided for by the standard, i.e. 68.0 for E1 and 26.0 for E2 at the outlet. As for the biochemical oxygen demand, this has a high value at the inlet, moderately higher than the standard which requires an almost zero value (tending to zero) for any effluent deemed potable, but this is 33.0 for E1 before treatment and decreases considerably after treatment for E2, i.e. 12.0. Thus, the DCO/DBO ratio of our samples gives values less than 3 before, as well as after treatment; either for E1: 2 < 3; and E2: 2.1< 3, hence referring to the classification according to the aptitude for biodegradation by Rodier (2009), we conclude that SOCIR effluents after treatment remain easily biodegradable and comply with the API standards in force in the company and therefore present a low risk of contamination after discharge into the Congo River. Despite these results, a series of recommendations was made to the company and the Congolese State.

Keywords:- *Assessment, Process, Management, Production, Effluent.*

I. INTRODUCTION

Discharges from industrial activities into aquatic environments are a source of global environmental and health concerns, as they are likely to significantly and sustainably degrade the quality of these environments, which constitute reserves of resources essential to human survival. (Vilagines.R, 2010)

Indeed, industrial discharges frequently contain multiple contaminants and pollutants, the hazards and risks of which must be assessed prior to their release into aquatic ecosystems.

Across the world, several developed countries have established regulations to precisely regulate the possibility of releasing these discharges into the environment. Effluents from industrial processes must meet numerous quality criteria, in particular to maintain their pollutant concentrations below threshold values set out in various international regulations. (Vilagines.R, 2010)

In developing countries, especially in Africa and more specifically in the Democratic Republic of Congo (DRC), the problem of industrial effluent management remains a major concern for the State but also for the companies themselves. It is in this perspective that our study is included in order to evaluate the method of management of industrial effluents of the Congolese Refining Company (SOCIR) and to identify the possible environmental impacts on the waters of the Congo River.

Faced with this general problem, we believe that the potential consequences of the discharge of these effluents into the environment would be determined by the conformity or not of the qualitative parameters used compared to international standards in this area, in force in the company. Thus, the objective of this study is to contribute to the problem of industrial effluent management in developing countries in general, in the Democratic Republic of Congo in particular, and in the site of the Congolese Refining Company (SOCIR) in the city of Moanda specifically. It is in this context that this study assesses the method of management of industrial effluents in this company and assesses the

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environmental impacts related to the discharge of the latter in this specific environment.

II. RESEARCH METHODOLOGY

A. Methods

We will use the mixed method, i.e. several methods combined to thoroughly conduct our research. This will involve:

- Historical method: it consists of looking at the history of the study environment by asking questions to former residents. The latter will allow us to understand the genesis of SOCIR in the city of Moanda; Comparative method: it will allow us to compare the old situation with that of today in order to identify strategies likely to lead to sustainable and rational management of SOCIR effluents;
- Experimental method: it consists of analyzing the physicochemical parameters (in and ex situ) of SOCIR effluents with a view to recommending possible sustainable management of the site taking into account the protection of the environment and human health.

B. Techniques

To carry out this study, the following techniques will be applied, namely:

- Direct Observation Technique: It consisted of going down to the field to observe and identify the effluent management process on the SOCIR site;
- Documentary Technique: It consisted of consulting the existing literature related to our subject of study;
- Sampling technique: It consisted of taking certain parameters in situ, storing and transporting the samples to the laboratory for analysis;
- Survey Technique: It consisted of bringing the various investigations to the field in order to obtain the information necessary for carrying out our study;
- Cartographic Technique: It consisted of producing and using numerous geographical maps dedicated to the location and presentation of the study environment.

III. PRESENTATION OF THE STUDY ENVIRONMENT AND STUDY SITE

A. The City of Moanda

The city of Moanda is a locality in the province of Kongo Central, in the Democratic Republic of Congo, whose area is estimated at 4,265 km2. It is the only maritime agglomeration in the country on the edge of the Atlantic Ocean but also of the Congo River, it is the only city that houses the two major oil companies in the country, namely PERENCO and SOCIR, which is also our study site.

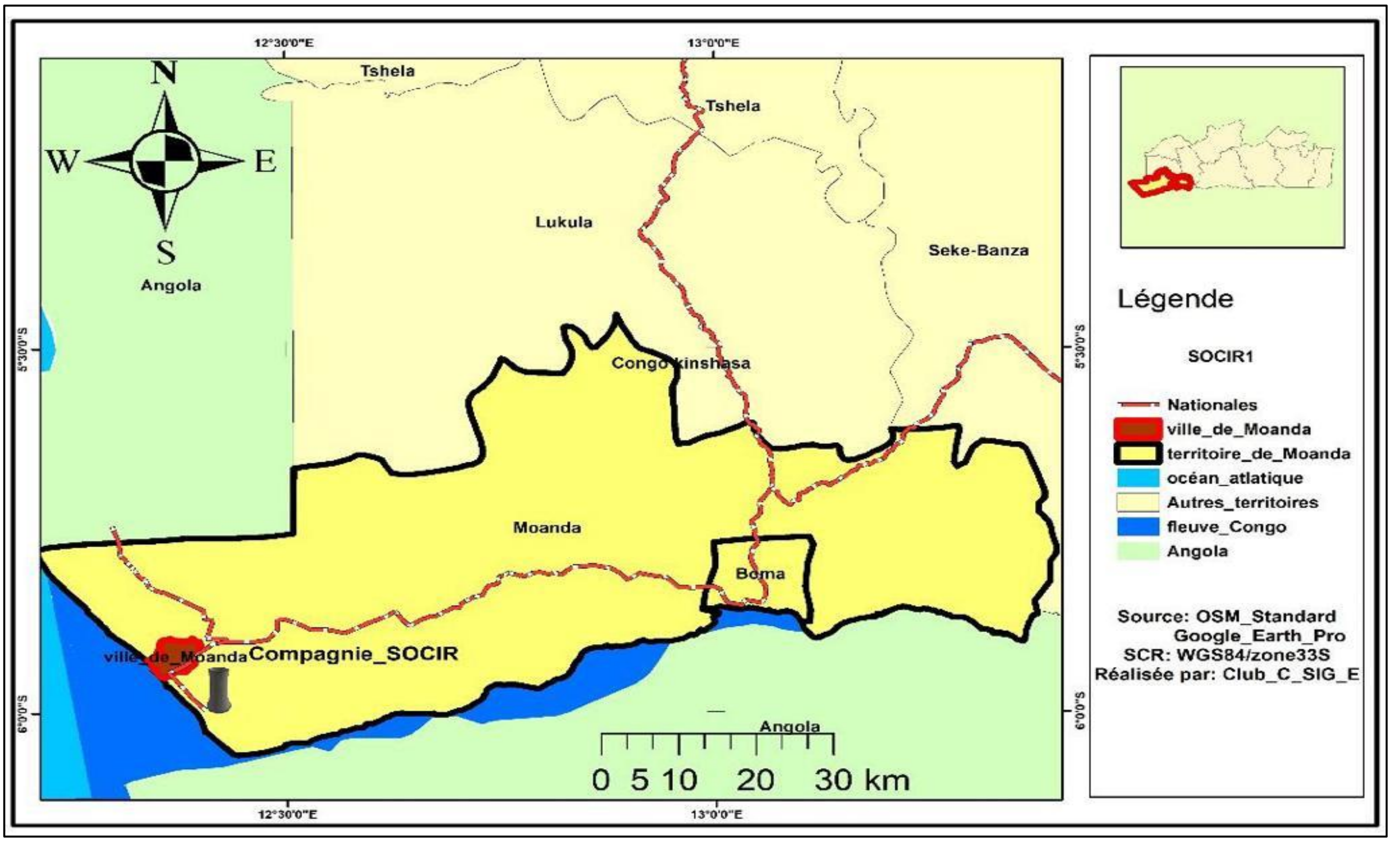

Image 1: The City of Moanda in the Territory of Moanda
Source: Daniel Mudinga, 2023

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B. The Socir Company

➢ *History*

The Congolese company of refining industries "SOCIR" is a S.A created on January 19, 1963, ordinance law number 47 of March 6, 1963. The first production of SOCIR took place on January 12, 1968.

➢ *Location*

SOCIR is located 10 km from the city of Muanda (south-east), it is established in the Kinlau group, near the village Kinimi, on a total surface area of 150 ha. The refinery itself is built on a plain that extends at the foot of the Kitona plateaus. Its head office is in Kinshasa and that of the operation in Kinlau in Moanda.

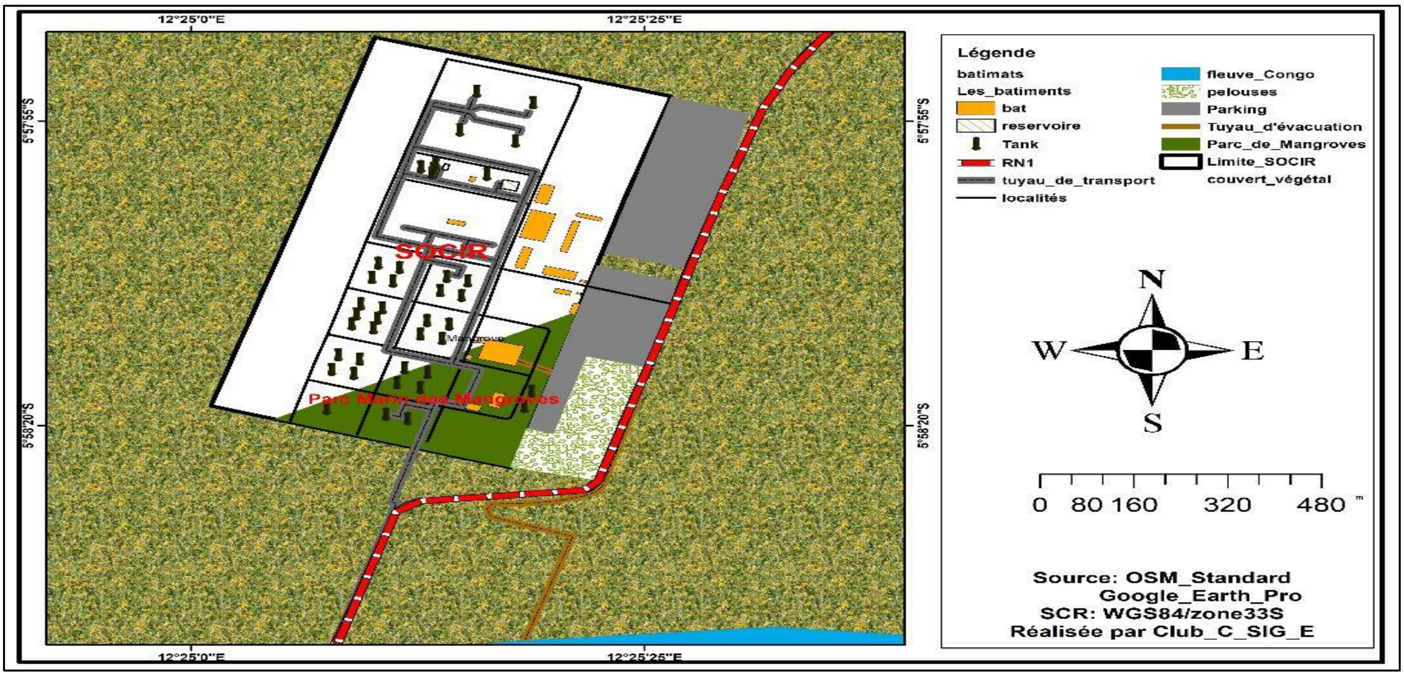

Image 2: Plan of the SOCIR Factory
Source: Image SOCIR, 2023

Image 3: Satellite Image of the SOCIR Site
Source: Image SOCIR, 2023

- *Mission of SOCIR*
  The Corporate Purpose of SOCIR is:

- The refining of crude oil for the production of fuels, bitumens and liquefied gases intended to meet a priori the needs of the Congolese domestic market.
- The sale of finished products and by-products of SOCIR as well as the export of surplus products.
- The transport and storage of crude oil and finished products. This activity consists of the reception of imported cargoes, the storage of products unloaded in the refinery tanks and their transport to ANGO-ANGO/MATADI in the SEP CONGO depot.
- NB: The refinery has been shut down since 1967 due to certain technical problems, which means that SOCIR is no longer able to satisfy its first two missions, since 1967 until today, it has made the third mission its main activity. Following the oil chain, SOCIR works on 4 links:
- ✓ Transport and storage
- ✓ Distribution and marketing

- *Means*

SOCIR has adequately equipped itself to achieve its objectives and fulfill its mission.

- *Storage Tanks*

- ✓ Gasoline: 56,343 tons
- ✓ Jet A1: 29,663 tons
- ✓ Diesel: 39,207 tons
- ✓ FMI: 19,293 tons
- ✓ Cumulative: 144,506 tons

This capacity allows SOCIR to receive 60,000-tonne tankers, a size thus limited by the CVM which requires the tanker to have a length of 200 m and a draft of 1.8 m.

SOCIR has 6 tugs and 5 boats which all bear the names of villages to ensure the transport of products by sea.

- *The Chemistry Laboratory*

The chemistry laboratory controls the quality of all products (crude oil, finished products, lubricants and other reagents).

The products are analyzed according to national standards at the entrance, during storage and before shipment to SEP CONGO (ANGO-ANGO).

The SOCIR chemistry laboratory has modern equipment and for its evaluation, the SOCIR chemistry laboratory participates in the correlation competition organized by the South African SABS/MAP.

- *Thermoelectric Power Plant*

SOCIR is not powered by the SNEL network and to cover its energy needs, it operates a 4500 KVA thermoelectric power plant, 1000 KVA of which are produced by two generators.

- *Water Treatment Plant*

As for electricity, SOCIR is not dependent on REGIDESO; it treats its water itself. SOCIR can therefore treat water at a rate of 50 per hour. Apart from the need for drinking water, SOCIR needs cooling water, service water and (soft) water treated to achieve a quality suitable for steam production.

The water catchment location is located 2 kilometres north of the refinery and the raw water, which can reach 300 m3/h, feeds a fire-fighting network that covers all the facilities.

- *Maintenance and Engineering Services*

To ensure the efficiency of many different equipment, SOCIR uses its maintenance services.

IV. RESULTS AND DISCUSSION

A. Process Of Production And Management Of Effluents At Socir

The oily waters come mostly from the drainage of tanks, cleaning of barges tanks, maintenance deck of vehicles, oil residues of chemistry laboratory, etc. All the oily waters are collected and take underground pipes through closed sewers to the de-oiling basin (api-separator). It is a concrete tank with a length of 32m, a width of 4.2m and a height of 1.4m.

The settling basin is divided into two sections by the partitions with a capacity of 400m cubic lies in the difference in density of oily materials and water. It is equipped with a skimmer mill, the oils thus recovered are pumped into SLOP tanks, before possible analyses in the chemistry laboratory.

The purified water is discharged into the Congo River via a 600m long concrete pipe equipped with sumps with siphon. Once a week, samples are taken at the spillway and analyzed in the Laboratory as part of monitoring the quality of liquid effluent discharges from the refinery.

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Image 4: De-Oiling Basin (Api-Separator)
Source: Daniel Mudinga, 2023

Image 5: Point of Discharge of SOCIR Effluents into the Congo River
Source: Daniel Mudinga, 2023

Image 6: Concrete spillway for Treated Effluent from SOCIR into the Congo River
Source: Daniel Mudinga, 2023

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B. Analysis Results

Two samples named E1 and E2 respectively were taken just at the inlet of the settling basin for E1 and at the outlet of the spillway to the river for E2 in order to verify the effectiveness of the treatment process of these effluents by SOCIR and compliance with international standards issued by the API (American Petroleum Institute) and validated by the Congolese Ministry of the Environment. The results of these surveys are shown in the table below:

Table 1: Results of Analyses of SOCIR.SA Effluents

Settings	**Values obtained (E1)**	**Values Obtained (E2)**	**Standards**
Ph	6,1	6,8	5 ,5 - 9,0
Temperature	26,6	25,8	30C max
Solids /sediments	0,9	0,10	1mL/100 ml max
Hydrocarbons	Traces	Abs	20 ppm max
DCO	68,0	26,0	150 ppm max
DBO5	33,0	12,0	N/A

Source: Daniel Mudinga, (SOCIR.SA Chemistry Laboratory)

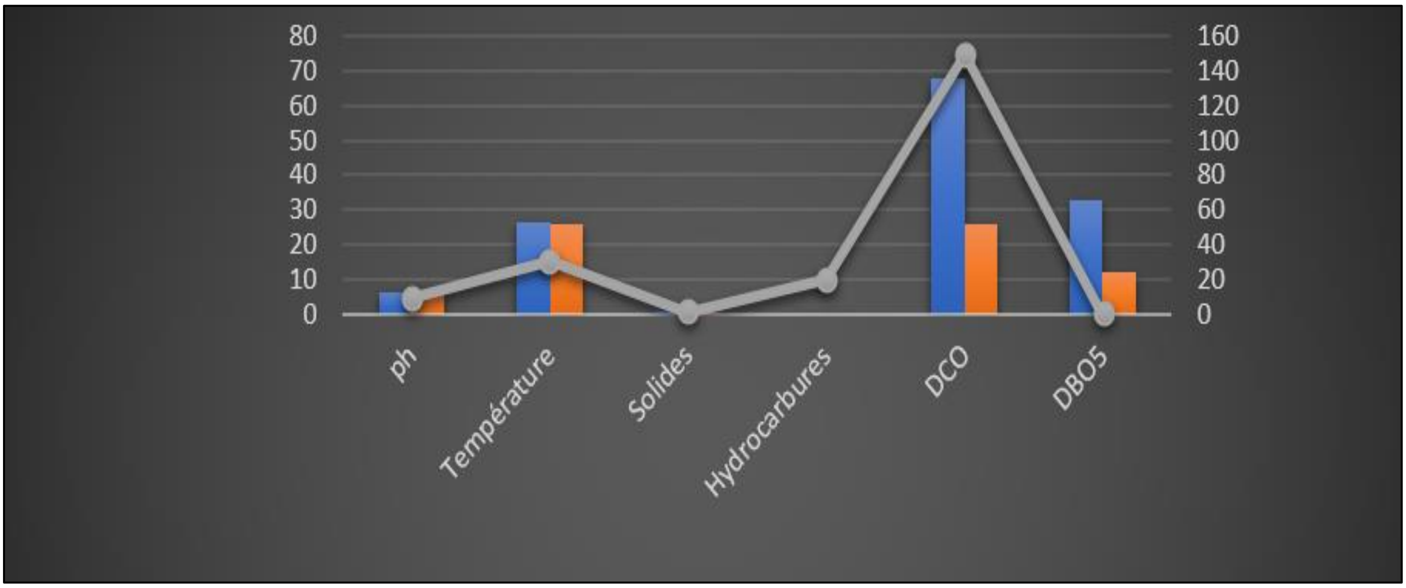

Image 7: Histogram of Results of Analyses of SOCIR.SA Effluents
Source: Daniel Mudinga,2023

In view of the above results, we note first of all that the Universal parameters used for the characterization of wastewater pollution have indeed been respected, namely: temperature, pH, hydrocarbon and solid matter (sediment) content, chemical oxygen demand and biochemical oxygen demand. The results show a temperature within the standard range, before and after effluent treatment, i.e.: 26.6°C for E1 before treatment and 25.8°C for E2 after treatment. The pH remained neutral, before and after treatment, with values tending slightly towards acidity before treatment, i.e. 6.1 for E1 and slightly towards basicity after treatment, i.e. 6.8 for E2. The solid matter (sediment) content in the effluent remains relatively low, i.e. a little low before treatment, 0.9 for E1, and very low after treatment, i.e. 0.1 for E2. The hydrocarbon content is expressed in ppm and is set at 20 ppm max by the standard, the ppm (part per million) equivalent to one millionth is often expressed in science to represent a mass fraction where 1 ppm = 1 mg/kg. Our samples have a low hydrocarbon content in the form of trace elements for E1 and a total absence of hydrocarbon after treatment for E2.

The chemical oxygen demand has values lower than the maximum provided for by the standard, i.e. 68.0 for E1 and 26.0 for E2 at the outlet. As for the biochemical oxygen demand, it has a high value at the inlet, moderately higher than the standard which requires an almost zero value (tending to zero) for any effluent deemed potable, but it is worth 33.0 for E1 before treatment and decreases considerably after treatment for E2, i.e. 12.0.

Since these are industrial effluents from a refinery, which may contain a significant fraction of non-biodegradable compounds, the biodegradability of these effluents can be considered according to the COD/BOD5 ratio. Thus, our samples give values lower than 3 before, as well as after treatment; that is, for E1: COD/BOD5= 68.0/33.0 = 2 < 3; and E2: COD/BOD5= 26.0/12.0= 2.1< 3, hence referring to the classification according to the biodegradation aptitude by Rodier (2009), we conclude that the SOCIR effluents after treatment remain easily biodegradable and compliant with the API standards in force in the company and therefore present low risks of contamination after discharge into the environment in general and into the Congo River in particular.

V. GENERAL CONCLUSION AND RECOMMENDATIONS

In view of the above, we note with satisfaction that the Congolese Refining Company SOCIR scrupulously takes into account the aspects related to quality control and the environment in its site and this involves a reinforced implementation of PPE (Personal Protective Equipment) and the implementation of strict compliance with international standards of the API (American Petroleum Institute) validated at the national level by the Ministry of the Environment and Sustainable Development throughout its refining process up to the management of its industrial effluents. It is in this more or less particular context that the company has equipped itself with qualified personnel and the necessary infrastructure (laboratories, buildings, pipelines, settling basins, modern electronic and electrical devices, etc.) in order to achieve all its objectives, both economic, technical, social and environmental. At our level and in view of the objectives pursued by this study, we can clearly conclude that SOCIR manages its industrial effluents responsibly and in compliance with the strictest standards in this area, hence its management model can constitute a reference and contribute essentially to the general problem of the management of industrial effluents in the southern country in general and in the Democratic Republic of Congo in particular. But beyond the results obtained by this study, we also ask the State, through its control services, to continue what we have started in order to perpetuate the sustainable management of industrial effluents in our country and thus minimize the environmental risks linked to the environmental dissemination of toxic elements linked to industrial activities in the Democratic Republic of Congo in general and to the Congolese oil industries in particular. May this experience also continue in other industries in the country in order to protect our natural environments.

Despite this satisfactory situation at the SOCIR level, concern still persists at the national level around this problem, hence we propose the following:

A. To SOCIR:

- To further strengthen its quality and environmental control system by providing its staff, although qualified, with capacity building training in order to always be up to date in the field of environmental risk management;
- To set up an environmental monitoring system in order to closely monitor the evolution of the water quality of the Congo River downstream of the discharge;
- To increase contacts and actions for the benefit of local populations who are not beneficiaries of SOCIR services, but who out of love and hospitality have welcomed the company with open arms on their land.

B. To the Congolese State:

- To increase surveys in all industries in the country in order to verify compliance with environmental standards at different stages of the operation of these industries;
- To redefine the environmental standards used by these industries with a view to integrating a local dimension, adapted to our local realities; - To create a framework for permanent exchange with these industries with a view to jointly defining a common policy for environmental protection by companies operating in the DRC, sector by sector.

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