LIGNITE TREATMENT, CHARACTERIZATION AND VALORIZATION OF THE OBTAINED OIL

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Abstract

The main objective of this research is to assess the by-products of lignite which is a carbonaceous rock. That field is little or no exploited in Madagascar. By using a dry distillation with lignite previously crushed, oil was collected. After OMNIS's laboratory (Office des Mines Nationales et des Industries Stratégiques) analysis, oils still contain sediment and water that can be used for agronomic purposes.

Keywords: Lignite, pyrolysis, valorization, liquid fertilizer, dry distillation

1. Introduction

Fossil energy production (coal, gas, oil) still represents more than 80% of total primary energy production in the world today [1]. World coal production is 3.5 billion tons to which are added 900 million tons of lignite in 2019, of which China is the leading producing country (46.7%) followed by the United-States (9.3%) and Indonesia (8.3%) occupying third place. Lignite is part of the coal family whose global reserves are estimated at the end of 2019 at 1,069.6 Gt (billion tons) [2]. Madagascar has ten deposits distributed throughout the island including the lignite deposit in Vakinankaratra with a reserve of 39,000,000 tons [3]. A resource that is little or even unexploited, yet the island is plagued by long hours of power cuts due to the drop in the water level in the reservoirs of its hydroelectric power stations. It could rely on these coal resources (lignite) to power thermal power plants [4].

This research concerns lignite treatement by applying dry distillation technology in order to valorize its by-products. This technology is improvong the separation at high temperatures of up to 900°C of the different components of the raw lignite while avoiding an explosion.

The raw lignite samples were taken from the rural commune of Soamanandrariny in Madagascar.

2. Materials and methods

2.1. Study sites

These experiments were carried out at the "Centre National de Recherches Industrielle et Technologique" (CNRIT), and the analyzes of the products obtained at "Office des Mines Nationales et des Industries Stratégiques" (OMNIS).

2.2.Preparation of raw materials and equipment

The raw materials used for the tests are carbonaceous rocks, more precisely raw lignite [5] (figure 1) which are in blocks, they were then crushed beforehand (figure 2) in order to have relatively fine particles.

Figure 1 : Raw lignite in bulk

Figure 2 : Electric Grinder

Figure 3 : Electric fan

Figure 4 : Burette

2.3.Dry Distillation

The reactor (figure 5) operates according to the dry distillation process:

- We load the fuel (charcoal) into the hearth of the stove, we light the fire;
- The previously crushed raw lignite is introduced and then closed hermetically (with clay paste to prevent the lignite from flammability once the temperature rises). Using the distillation column, we install the thermometer;
- We then place the whole thing in the stove;
- The dry distillation process is accelerated by controlled blowing using the fan (figure3) via the ventilation cone;
- We recover the distillate via the small stainless-steel pipe and burette (figure 4).

This system allows you to choose the speed of temperature rise, the level and duration of the final temperature level.

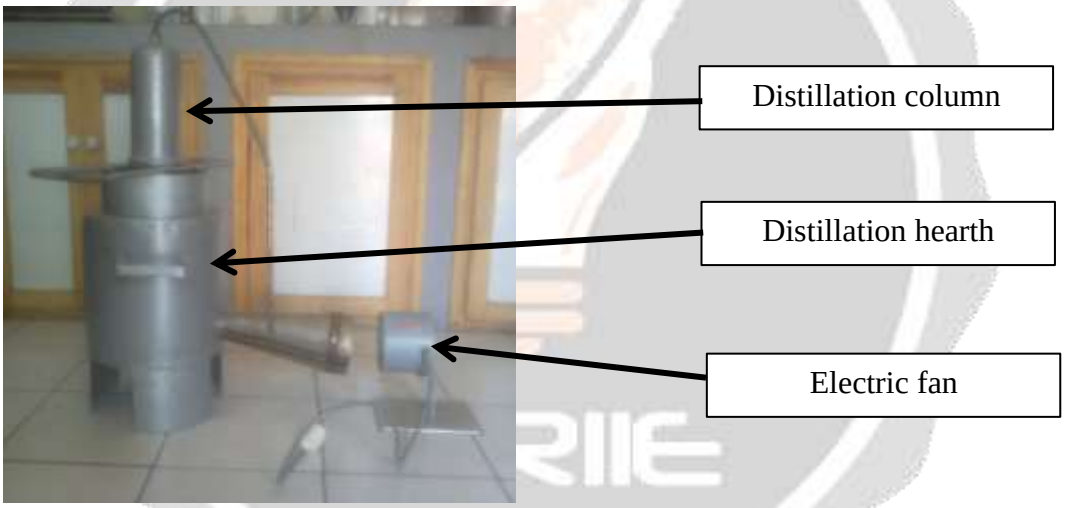

Figure 5 : Dry still

3. Results

3.1.Results within the CNRIT Laboratory

Within the CNRIT, five distillation tests are selected to determine the most influential and most promoting parameters during this research work (table 1).

Several conclusions can be drawn from these five dry distillation tests of crude lignite:
1/ to distill 1,000g of lignite, we need on average 1,500g of charcoal for an average duration of 1h56.
2/ the first drop of light-colored distillate occurs after approximately 12 minutes of the start-up time of the distillation process and this first drop only appears at a temperature of 428°C on average.
3/ the distillate then changes color (black) (figure 6) at a temperature around 667°C after 20 minutes from the appearance of the first drop;

Figure 6 : Dark colored oil

4/For 1,000 g of raw lignite, we obtain 51.4 ml of oil on average, that's to say an oil yield of 5.4%. The profitability of this technology depends on the physicochemical characteristics of this oil.

Table 1: Summary of the different appropriate parameters

Designation	Test N°1	Test N°2	Test N°3	Test N°4	Test N°5	Sum	Average	%
Date of completion	01/09/2022	08/09/2022	09/09/2022	31/10/2022	02/11/2022			
Initial weight of raw lignite [g]	1,000	1,000	1,000	1,000	1,000		1,000	100
Weight of ashes obtained [g]	338	412	330	532	568	2,180	436	43.6
Charcoal weight [g]	1,500	1,500	1,500	1,500	1,500		1,500	100
Time for first drop to appear[mn]	12	10	10	20	10	62	12.4	
First drop Temperature [°C]	436	444	464	383	414	2,141	428.2	
Oil color change time [mn]	20	15	25	20	20	100	20	
Other phase appearance Temperature [°C]	646	720	666	635	671	3,338	667.6	
Volume of the distillate [ml]	50	70	82	30	25	257	51.4	
Duration of distillation	1h58	1 h 55	1 h 55	1 h 55	1 h 55		1h56	

3.2.Results within the OMNIS Laboratory

The results summary of these analysis carried out at OMNIS of the physicochemical characteristics of the oil shows the viscosity of the oil, the density, the flash point and the flammable point, water and sediment content, water content of the oil and ash content of oil (table 2).

Table 2: Characteristics of the oil

Sample	Oil
Kinematic viscosity [Cst]	0.9357
Density	1.0041
Flash point [°C]	78
Flammable Point [°C]	91
Water and sediment content [%]	2
Water content of the oil [%]	0.5
Ash content of oil [%]	2

- We found that the value of density is 1.0041;
- These oils contain 2% water and sediment content, that is to say that the level of sediment present in the oil is very high;
- The kinematic viscosity is 0.9357 Cst, that is the viscosity values of the oil sample are very low, the oil is not viscous;
- The vapors released by the product first explode when a flame is applied at a temperature of 78°C;
- The residue remaining during combustion is 2%.

4. Discussions

The valorization of these by-products (oil) is possible, after extraction and separation of liquids and gases, the oil may be marketable with many applications in biochemistry. These oils bring together many components constituting wood. Each essence contains different chains of molecules which find outlets in the food industry, cosmetics, the chemical industry [6].

There are two mineral oils used in the cosmetics industries: synthetic mineral oils, which are perfectly pure from their production, and mineral oils from petrochemicals, which are refined. The latter are obtained after purification of materials of fossil origin such as coal, crude oil or natural gas.[7]

The various studies carried out within the framework of the valorization of carbonaceous rocks in Madagascar have shown that the valorization of these carbonaceous rocks is technically and financially feasible provided that the price of a barrel of oil on the international market rises to more than 100 Dollars. Among these studies. others have suggested that it is when the price of a barrel of oil exceeds 120 American Dollars that the exploitation of Madagascar's carbonaceous rocks is profitable.

We have previously presented that lignite is a resource that is little or even unexploited and therefore a budget for its exploitation is lacking. So, if we really want exploit these resources. the following steps must be followed:

- Search for financing to exploit lignite;
- Research of reliable technology to eliminate volatile materials in lignite;
- Know the methods of use of energy resources resulting from the valorization of lignite, whether in the form of biofuel or in the form of gas or in another form of use;
- Research of the appropriate type of equipment used downstream.

The exploitation of this oil is a start in the valorization of these carbonaceous rock resources but we must look for other outlets to make profitable investment, such as the valorization of the ashes obtained.

5. Conclusion

The methodology adopted in this research is both qualitative and quantitative. Its eventual realization requires a priori going through the chronological order of the following different activities:

- Collection of bibliographic and webographic data relating to the research work;

- Descent into the study area allowing on the one hand to discuss with local residents the potential of raw lignite and on the other hand to collect samples of these resources for experimental work at the laboratory;
- Carrying out laboratory work with samples collected on site using the appropriate technology to process or valorize raw lignite.

The results of this research showed respectively that:

- First, dry distillation technology is an appropriate processing technology for lignite valorization;
- Second, dry distillation was able to separate the solid components of the pyroligneous oil;
- Third, the first drop of light-colored distillate occurs after 12 minutes of the start time of the distillation process and this first drop only appears at a temperature of 428°C on average;
- For 1,000 g of raw lignite. we obtain 51.4 ml of oil on average, that's to say a yield of 5.14%.

Indeed. the application of dry distillation as a method of processing lignite in order to obtain valuable by-products has been achieved. The results of this research work prove the potential of lignite exploitation

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