



Extraction of Food-Grade Paraffin Oil from Light Petroleum Cuts by Using Special Iraqi Mineral Clay

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Abstract

Clay is the main raw material for many ceramic industries, especially bricks and other construction industries. In this research, the Iraqi clays which rich in iron oxides are available in the regions of Al-Rutba and Al-Qaim in the west of Iraq were used for the first time to separate aromatic compounds from light oil sections. A three cuts of petroleum sections as the C65, C150 and C216 respectively that differ from each other in viscosity were selected to prepare the medical paraffin oil with viscosities values of 46,64 and 105 at 40C respectively according to American Society for Testing and Materials ASTM 2515. A glass column of 2.5 meters in length and 5 cm in width was used, fixed on a special glass holder. The solid phase was prepared after drying the Iraqi clay at a temperature ranging from 150 to 200 degrees Celsius, then grinding it in special mills and sifting with special mechanical sieves with pore sizes mesh of 0.5 mm, 1 mm, and 1.6 mm to obtain the optimal particles for the separation process. The mobile phase was prepared using hexane as a solvent at a dilution ratio of 1:10 at a flow rate of 1.5 ml/min. It was found that the best separation of aromatic compounds and preparing medical paraffin oil when the particles of the clay with value of 1.60 mm in size. The clay was reused by calcination in a furnace at 1000°C for 2 hour which reduces the cost of the process.

Keywords: adsorption chromatography, Iraqi clay, Paraffin oil purification, petroleum refinery, reusability.

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1. Introduction

Chromatography enables the separation of compounds in a mixture by dissolving the mixture in a mobile phase and passing it over a stationary phase [1]. The chromatography is a physical method for separation, purification, and identification of compounds, where components are distributed between two phases [2, 3]. Chromatography is the most widely used separation technique in chemical laboratories, where it is utilized in analysis, isolation, and purification of several organic substances [4]. For instance, four separation techniques based on molecular characteristics and interaction type use

several mechanisms or separation such as ion exchange, surface adsorption, partition, and size exclusion[5].In addition, the chromatography techniques are based on the stationary bed, including column, thin layer, and paper chromatography[6]. In column chromatography, the stationary phase is a solid adsorbent placed in a vertical glass and the mobile phase is a liquid added to the top and flows down through the column by gravity or external press [7].The best solid phase materials in chromatography depend on the type of sample and the purpose of the analysis, such as silica, which is a commonly used material in high-performance liquid chromatography due to its large surface area and chemical stability[8]. Alumina is used in column chromatography, especially when separating non-polar compounds [9]. It has high absorption power and is used in the separation of organic compounds Especially when the molecular weight to be separated is not particularly large [10].

Oil is considered a basic raw material and an important raw material for obtaining various types of fuel, lubricating oils, and other oils, as it is refined, and from the refining process, oil sections of different specifications are obtained, each with its benefits and uses [11]. By processing this section, paraffinic liquid is obtained, which is a mixture of liquid hydrocarbons that range in specifications from light to heavy, in addition to the difference in the length of the straight chain or branching, as well as the difference in viscosity and density [12]. Medical paraffin purification involves techniques like sulfuric acid treatment, selective solvent extraction, adsorption with bleaching earth or zeolites, and micro emulsion systems to remove impurities such as olefins, and polycyclic aromatic hydrocarbons (PAHs) [13]. Methods can include thermal, mechanical, and chemical processes, with choices depending on the type of paraffin and the desired purity level [14].

And to prepare any substance, the best path must be chosen on the basis of several determinants, and from here the chromatographic separation process was chosen to prepare the medical paraffin liquid, which is of great importance for many vital industries such as the manufacture of dyes, cosmetics, and food industries such as the baking industry, fruit preservation, and others [15]. And here it was necessary to study the chemistry of the processes used in some global refineries, where it was observed that these refineries compete in terms of its purity and being colorless, odorless and chemically inert [16], and this means that any effective or unsaturated group or any colored substance must be removed or It is converted into a saturated formula, and the method used to achieve this changes according to the change of the source of crude oil, as well as the refinery [17].

The current research aims to produce medical paraffin oil from three oil cuts such as C65, C150 and C 216 using the red Iraqi clay rich in iron oxides after grinding and sifting it with special sieves of specific diameters (0.5mm,1mm and 1.6mm), could be used as a solid phase in chromatography technique as 100% local materials. The three cuts were obtained from the Middle Refineries Company/ Baiji refinery, where it is considered the basic material for preparing medical-food paraffin oil using column chromatography at room temperature. This is done using the hexane as a solvent. The solid phase is then reactivated by burning at a high temperature of up to 1000°C for 20 minute

2. Theoretical Part

It includes several steps as presented in sub-sections 2.1 and 2.2

3. practical part:

The Iraqi clays were brought from the areas of Al-Rutba and Al-Qaim. The hexane solvent was perched from Fluka Chemie GmbH and used without purification. Iraqi clays were sourced from the Rutba and Qaim regions. They are red rocks rich in iron oxides and were ground in mechanical mills before being screened using various sieve ranged from 0.6 to 1.5 mm.

2.2 Devices used:

A glass separation column with a length of 2 m and a diameter of 5 cm., Mill, Drying oven, Sieves. Various glassware. The glass lobe column was filled with 5 kg of red clay after grinding and screening it so that this part would be the solid phase in the chromatography column. Iraqi clays were sourced from the Rutba and Qaim regions. They are red rocks rich in iron oxides and were ground in mechanical mills before being screened using various sieve sizes. Finally, the hexane solvent was extracted from Fluka and used without purification.

Iraqi clays were sourced from the Rutba and Qaim regions. They are red rocks rich in iron oxides and were ground in mechanical mills before being screened using various sieve sizes. Finally, the hexane solvent was returned using rotary evaporator

4. Experimental Procedure

Before starting any process, laboratory experiments must be conducted to find out the conditions for the success of the process [5]. In this research, the required raw materials were chosen. In general, the work method includes the following main stages:

a) Choosing the oil cuts. Where a number of oil sections were selected that differ from each other in the length of the paraffin chain, in viscosity, density, degree of color, etc., and it was found that this method is suitable for use for several types of oil derivatives, as the section C65, C150 and C216 were tested.

b) Choosing the solvent/the hexane solvent was chosen for its availability, cheap price, and the possibility of recovering it with high purity and low loss.

4. Results and Discussion

4.1. The preparation of red clay.

However, several operations must be performed on the clays in order to become suitable for the chromatography process, including the following:

4.1.1. Drying

The clay blocks must be dried from their water content, whose presence leads to blocking the pores inside the clay particles, which leads to a decrease in the efficiency of the separation process. The drying process takes place by heating the clay blocks in an oven at a temperature of 400-550 °C for a period of one hour.

4.1.2 Milling

The samples were tested to measure the grain size of clay deposits by a shaker machine which was used to separate the clay size of samples by using a set of standard sieves intervals (0.5, 1, 1.6 mm). The size of the prepared clay particles depends on the size of the holes in the standard sieves, so the clay particles were obtained with a size of 0.5, 1 and 1.6 mm. The Red clay can be used after the calcination process at a high temperature of 1000°C for two hours.

4.1.3 Sifting

A process of grinding clay blocks is carried out to convert them into powder to facilitate the process of filling the chromatography column. The crushed clay blocks are sieved to obtain particles of a suitable particle size for the separation process using sieves, where three particle sizes were tested: 0.5 mm, 1 mm, and 1.6 mm, and it was found that the best particle was the size of 1.60 mm depending on the physical properties of the prepared paraffin oil.

4.1.4. Reactivation

After completing the separation process by the chromatography technique, the clay (solid phase) could be reused after calcination in furnace at temperature of 1000C° for 2 hour for the removing of the contaminated aromatic compounds and impurities separated from the cuts oil.

5. Separation process The column is filled with the equivalent of 3 kg of red Iraqi clay and then the samples consisting of the oil clip and the hexane solvent are passed in a ratio of 1:10 at a flow rate of 1.2 ml/min to ensure the completion of the dissolution process and the efficiency of separation. The clay particle sizes of 1.6 were chosen based on the duration of the experiment, as these particles remained effective for 48 hours compared to 24 hours for 1 mm particles, and finally for only 8 hours for 0.5 mm particles. A medical paraffin oil was established according to the following schematic of the chromatography process.

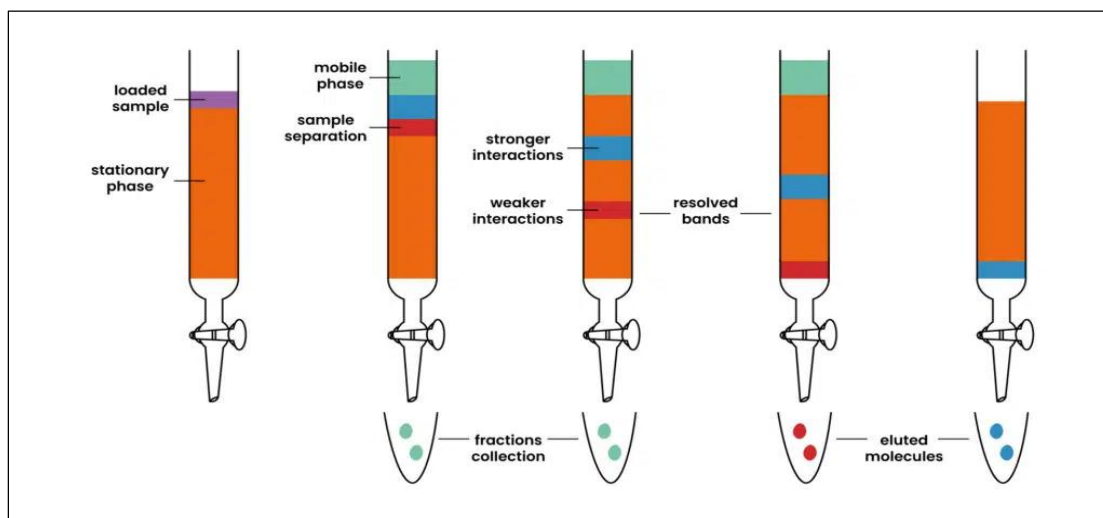


Figure 1. A figure showing the design of the chromatography system, showed the stationary phase, mobile phase, fraction collection and the eluted molecules.

Samples are withdrawn from the bottom of the column and distilled to obtain pure medical paraffin liquid in addition to hexane, which can be reused for the dissolution process evaluation. The produced paraffin oil was evaluated by measuring the viscosity, density, sulfur content, and color degree. Tables (1), (2) and (3) showed the specifications of three types of paraffin liquid used in this research depending on the type of the crude oil cuts. The physical properties of paraffin oil depend on the viscosity and physical nature of the cutting oil used.

Table 1. Physical specifications of the paraffin oil from the cut 65

Examination method	After cutting	before cutting	Measuring specification	Cut
ASTM D2515	46	58	Viscosity at 40 °C, cs	Aromatic C65
IP 196/82	0.5-0	5-2	Color	

IP 190/82	0.8461	0.8898	Density, g/cm ³
IP 336/82	0.09	1.106	S%

Table 2. Physical specifications of the paraffin oil from the cut 150

Examination method	After cutting	before cutting	Measuring specification	Cut
ASTM D2515	64	602-632	Viscosity at 40 °C, cs	Aromatic C ₁₅₀
IP 196/82	0.5-0	3	Color	
IP 190/82	0.8613	0.9214	Density g/cm ³	
IP 336/82	0.16	1.266	S%	

Table 3. Physical specifications of the paraffin oil from the cut 216

Examination method	After cutting	before cutting	Measuring specification	Cut
ASTM D2515	92	207-231	Viscosity at 40 °C, cs	Aromatic C ₂₁₆
IP 196/82	0.5	9.5	Color	
IP 190/82	0.879	0.9057	Density g/cm ³	
IP 336/82	0.1761	1.463	S%	

We note that the viscosity of the oil section used in the chromatographic separation process directly affects the separation time and the quality and the viscosity of the formed paraffin oil, for example, the density of the resulting paraffin liquid ranges between (0.84 - 0.88) grams / cm³, depending on the cut C65 of oil fraction used as a raw material. On the other hand, the viscosity of medical paraffin oil prepared from the same cut ranges from 58 to 46 cs according to the ASTM D2515. Silica gel was tested in column fillers for use as a solid phase in the column. The results showed that the silica was contaminated after a short period of time (ten minutes) from the start of the experiment, and thus was unable to separate medical paraffin under these experimental conditions. This is also what happened when using alumina as a solid phase material under these operating conditions.

5. Conclusions

In general, chromatography means the technique of separating a mixture of dissolved components on the basis of the varying transition of each component through a surface area under the influence of the mobile phase, as well as the multiple types of separation by solid liquid chromatography or adsorption chromatography. One of the components of the mixture has the ability to adsorption significantly on the surface of the solid phase more than the other component, And that the separation efficiency depends on

the surface area of the adsorbent material, in addition to its quality and the size of the particles of the adsorbed liquid on the surface of the stationary phase. The stationary phase is near the top of the column, while those with less adsorption capacity will sink slightly below the column or leave it completely

Medical paraffin liquid with specific required specifications can be obtained by selecting the oil section with the appropriate specifications, meaning that this chromatography technique can be used to produce several types of paraffin liquid, which is used to purify the oil section and separate aromatic compounds. The Iraqi clay compared to alumina and silica, as alumina loses its effectiveness very quickly and the process of reactivating it is useless, while silica is not efficient in the process of separating oil sections, in addition to that it is distinguished Iraqi clays with their ability to reduce the unwanted color in the paraffin liquid.

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