The Use of Graphite ore Concentrate from the Taskazgan Deposit as a Lubricant

Azamjon Tursunov[1,*], and *Umid* Turdialiyev[2]

[1]Institute Chemical Technology of Tashkent, Tashkent, Uzbekistan
[2]Andijan Machine-Building Institute, Andijan, Uzbekistan

Abstract. Graphite ore from the Taskazgan area in the Bukhara region of the Republic of Uzbekistan was enriched by flotation and a graphite concentrate was obtained. This article describes how the resulting concentrate was used in the production of lubricants.

1 Introduction

Graphite is a natural mineral belonging to the class of local elements and is an allotropic modification of carbon.

Graphite is a dark gray crystalline substance with a metallic sheen that feels oily to the touch. For this reason, graphite breaks up into thin coins, but the crystals are still very strong, and when rubbed against the surface of an object, it leaves a mark on itself due to the particles that come from its crystal. For this reason, the word "graphite" comes from the Greek word meaning "to write".

Since graphite is a common and inexpensive raw material in nature, it is used as a raw material in the manufacture of pencil cores, in the manufacture of electrolysis electrodes in industry. It is also widely used in nuclear reactors as a neutron moderator and, in addition to technical oils, as a lubricant. It still has good electrical conductivity, so graphite rods are used in conventional batteries.

In connection with the rapid development of all industries and engineering in the Republic of Uzbekistan, it is important to comprehensively study and develop effective technologies for the enrichment and processing of graphite ores to obtain high quality graphite materials. Graphite ores of the Takazgan deposit in the Bukhara region are of great interest as a raw material base.

There is no production for beneficiation of graphite ores in our country, so we studied the ways of beneficiation of graphite ores using the example of mineral industries in other countries. World experience shows that the most optimal way of beneficiation of graphite ores today is the flotation method, which is carried out by the foam-air method [1].

* Corresponding author: turcunov-farpi@mail.ru

2 Methods

Graphite ore of the Takkazgan deposit was enriched in a flotation apparatus to obtain a concentrate of up to 90%. The resulting concentrate is a black or dark gray powder. The degree of crushing is 005 mm. Universal graphite foaming agent (UGFA) obtained from local waste was used as a foaming agent. Can be used in combination with all types of technical oils. Widely used in mechanical engineering, chemical industry, power generation and drilling. When operating mechanisms under heavy load and under the influence of shocks, oil seeps through the groove between the parts, and graphite ensures the formation of a thin film on the surface of the part. It is used to lubricate automobile springs, various cables, screw gears (for example, jacks), open gears and mechanisms operating under heavy loads with low sliding speeds. They can be used at temperatures from minus 200C to 800C [2, 3, 9].

Graphite is a plastic product with a density of less than five, volatile matter content of 1%, pH neutral, very low coefficient of friction, easy to grind, good binding properties. It has an ash content of 5%, a moisture content of 1%, and a sulfur content of 0.2%. Graphite is a gray, smooth, soft and shiny hexagonal crystalline substance with a specific gravity of 2.17 to 2.3 g/cm3. In this case, carbon atoms are located at the ends of a regular hexagon, standing in parallel planes. The distance between atoms in a hexagon is 1.42A°, and the distance between parallel planes is 3.35A°. Carbon atoms in one plane are covalent, and carbon atoms in different planes are connected to each other by a metallic bond. That is, the strength of graphite varies in different directions and has a mechanical anisotropic property. Graphite is difficult to burn when heated in air, but burns at 8900C in an oxygen flow with the formation of CO2. Graphite is widely used in various lubricating oils as a filler and anti-friction additive. In the preparation of plastic lubricating oils, only the gray type is used, which are obtained by beneficiation of graphite ore [4, 5].

Lubricating oil protects the friction surface from various aggressive liquids, gases, vapors and various abrasive materials (dust, dirt, etc.). Almost all lubricating oils protect the surface of parts from corrosion. When creating base lubricating oils and adding various additives to their composition, the decisive factors in the performance of lubricating oils are the following:

a) resistance to irritation, abrasion and oxidation, high rheological properties (temperature dependence of viscosity) are required;
b) the created lubricating oils should protect the surface of the parts from abrasion and wear.
c) must reduce friction energy;
d) it must reduce noise and vibration in gears and withstand shock loads [6].

Lubricants are divided into 4 main groups according to their composition.

1. Soap lubricants - used as thickeners of salts of higher fatty acids.
2. Inorganic lubricating thickeners. Inorganic thickeners added to lubricants must have a highly dispersed, thermally stable and strong specific surface area. These include silica gel (Si), bentonite (Bn), graphite (C) and others. Graphite imparts both thickening and lubricating properties to lubricants.
3. Organic lubricant thickeners. It uses organic substances with high thermal stability and high specific surface dispersion as a thickener. This group of lubricants includes pigmented, polymeric, polyurea, structured lubricants.
4. Hydrocarbon lubricants: thickeners include hydrocarbons that liquefy at high temperatures. This group of lubricants includes lubricants with natural and synthetic wax, ozocerite, paraffin, petralatum, and ceresin [7, 8].

3 Results and Discussion

10 g of graphite concentrates were tested on the gears of the devices for 1 hour, the results obtained by visual observation are shown in the Table 1.

Table 1. Results obtained by visual observation

Properties	**70% concentrate**	**80% concentrate**	**90% concentrate**
Adhesion	It spilled	Partially collapsed	Almost not spilled out
Lubrication	Not	Average	Good
Creating a protective layer	layer is not formed	A thin layer formed	Sufficient layer formed

Since a 90% concentrate in a powdered state showed good results, a lubricant was obtained from this concentrate by mixing I-20 brand engine oil in various proportions until a homogeneous state was obtained. The samples were operated for 1.5-2 hours on rolling bearings in the 1M-65, SUV-5 and AGL-125 installations.

Table 2. The properties of the grease prepared in the ratios of 1:1 and 2:1 meet the requirements for lubricants currently used in the industry

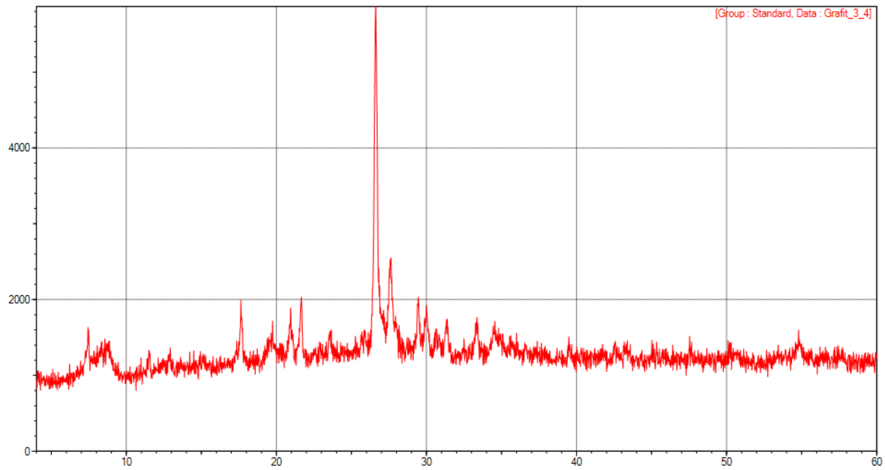
Graphite: engine oil	**1:2**	**1:1**	**2:1**
Functions:			
Adhesion	Good	Good	Good
Fluidity	Fast	Average	Empty
Lubrication	Good	Good	Good
High temperature resistance	Unbearable	Endurable	Endurable

Based on the results shown in the table, the properties of the grease prepared in the ratios of 1:1 and 2:1 meet the requirements for lubricants currently used in the industry.

X-ray phase analysis of graphite samples

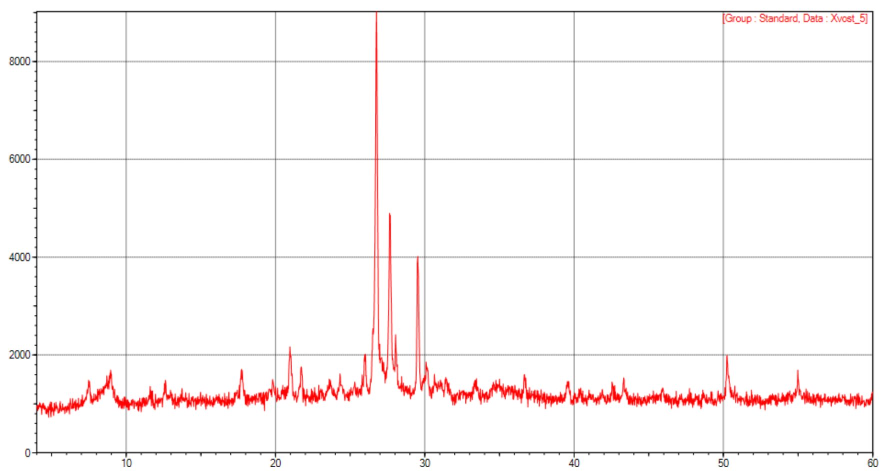
Samples of graphite enrichment and tailings were analyzed using X-ray phase analysis, and their X-ray diagrams are presented in Fig. 1-2.

 https://doi.org/10.1051/e3sconf/202344906012



Theta-2Theta (deg)

Fig. 1. X-ray pattern of graphite enrichment



Theta-2Theta (deg)

Fig. 2. Tail x-ray

The results of X-ray phase analysis of these graphite enrichment samples and tailings showed that no phase transitions were observed in these graphite samples and their intensity was significantly lower than that of other graphite products in graphite enrichment samples and tailings, it turned out to be 5000 and 9000, respectively. The X-ray diffraction patterns of these substances were compared using the corresponding programs and it was found that no new phase was formed (Fig. 3).

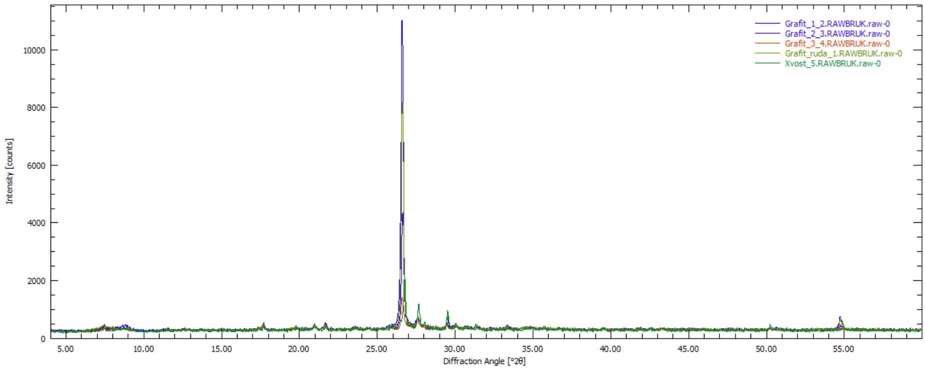


Fig. 3. Comparison of X-ray patterns of graphite samples

An in-depth analysis of a sample of graphite enrichment from these substances by the Rietveld method showed that the substance consists of 2 polymorphic modifications of graphite. Of these polymorphs, it was observed on the x-ray pattern of graphite-2H that at 2θ = 26.440º and 54.615º the distance between two planes in the crystal was d = 3.368 Å and 1.679 Å, and the intensity was I = 9397 163 and 697 613, respectively. X-ray diffraction analysis of graphite-3P showed that at 2θ = 26.607º and 27.553º the distance between two planes in the crystal was d = 3.348 and 3.235 Å, and the intensity I = 2194.614 and 669.368, respectively. (Fig. 3). Table 3 shows the % of these polymorphs

Table 3. % Content of graphite polymorphs

Substance	**%**
Graphite -2H	80.60
Graphite -3R	19.40
Total:	100

These results were theoretically 9.34%, and their experimental value was 5.38%. This Fig. indicates a low relative error.

IR Spectroscopic Analysis of Graphite Material

The results of IR spectroscopic analysis of this sample of graphite enrichment showed that these substances consist of graphite and graphite oxide, while a sharp change in the absorption bands in the spectrum of vibrations of a group of atoms in these graphite samples was not observed (Fig. 4).

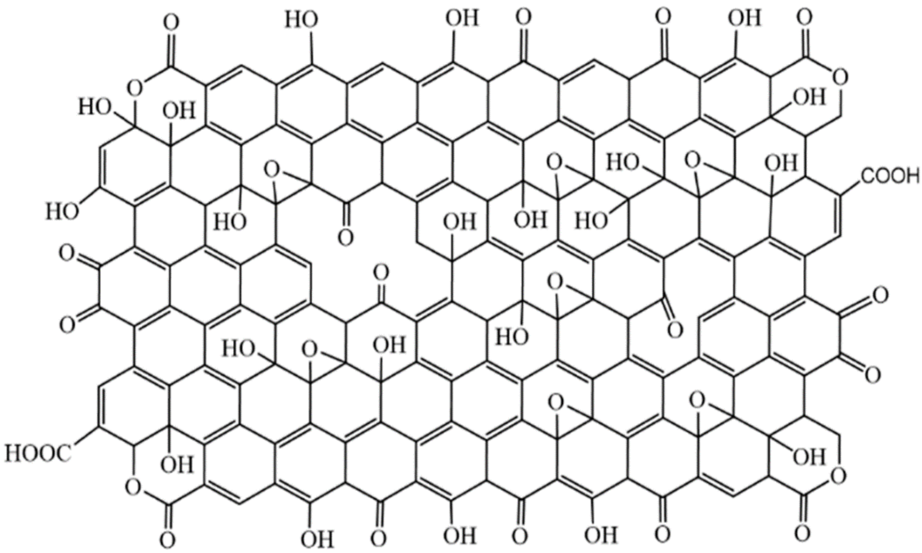
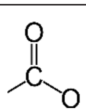
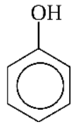
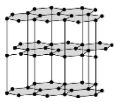


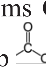
Fig. 4. Graphite oxide

The results of IR spectroscopic analysis are presented in Table. 4, which gives general information about the role of absorption bands in the spectrum of vibrations of groups of atoms of graphite ore, enrichment of graphite and tail samples.

Table 4. General information about the role of absorption bands in the spectrum of vibrations of groups of atoms of graphite ore, enrichment of graphite and tail samples.

Group of atoms	**Absorption in the spectrum of fibrations of groups of atoms lane arrangement *V*, cm^{-1}**		**Formula Connections**
	Valence vibration	Deformation vibration	
-OH	597.93	439.78	Graphite oxide
-OH	1591.27	2351.23	Graphite oxide
C=C	1645.28	690.52	Graphite oxide
C=O	1996.32	2112.05	Graphite oxide
C-H	2852.72	2926.01	Graphite oxide
	2086.98	1774.51	Graphite oxide

	3757,33	3612,67	Graphite oxide
	989,48	601,79	Graphite
-C-H	869,80	769,60	UGFA (aromatic cycle)

According to the results of IR spectroscopy, the -OH- ion belonging to graphite oxide in graphite ore, graphite concentrate and tailings samples has a valence in the regions of 597.93 and 1591.27 cm^{-1}, and a deformation in the regions of 439.78 and 2351.23 cm^{-1}, respectively, no fluctuations were observed. The group of atoms C=C, belonging to graphite oxide, is located in the regions of 1645.28 and 690.52 cm^{-1}, respectively; The group of atoms C=O is located in the regions of 1996.32 and 2112.05 cm^{-1}; A group of atoms C-H 2852.72 and 2926.01 cm^{-1} by area; groups of atoms belonging to the carboxyl group  in the regions of 2086.98 and 774.51 cm^{-1}; The -OH- ion in the phenolic state in graphite oxide exhibited stretching and bending vibrations in the regions of 3757.33 and 3612.67 cm^{-1}, respectively. Groups -C-C-, which form the basis of graphite, observed stretching and deformation vibrations in the regions of 989.48 and 601.79 cm^{-1}, respectively; in addition, the added substance - a group of atoms -C-H, which is the basis of the aromatic ring that forms the UGFA - showed absorption frequencies in the regions of 869.80 and 769.60 cm^{-1}.

4 Conclusion

According to the test results, 90% graphite powder obtained from local raw materials and a graphite lubricant obtained from it can be recommended as a material. Graphite powder obtained from local raw materials makes it possible to replace imports. Adding 50-65% of local graphite powder to lubricants allows saving technical oil without deterioration of physical and mechanical properties. The performance characteristics of graphite lubricant have shown that it can also be used to lubricate bearings and other rotating parts of industrial lathes.

References

1. Djalol Kamolovich, Adylov, Shakhnoza Djurakulovna Kuylieva, and Azamjon Salimjon Ogli Tursunov, An International Multidisciplinary Research Journal, **11.5**, 1305-1313 (2021)
2. IAP 2019 0369- Graphite ore beneficiation method, Official newsletter of the Intellectual Property Agency of the Republic of Uzbekistan. Tashkent, **3(239),** 16 (2021)
3. M.Yu. Ismailov, B.N. Khamidov, V.I. Ivanov, Uzb.kimyo.j. **6,** 77-78 (2001)
4. M.Yu. Ismailov, B.N. Khamidov, *Improving the quality of lubricants based on vegetable oils. Urgent problems of chemical processing of mineral raw materials in Uzbekistan,* Resp. scientific — practical. conf. fast. ball. (Tashkent, 2003) 42-43.
5. L. M. Kazakova, S.E. Kreyn, *Fiziko-ximicheskie osnovi proizvodstva neftyanix masel,* (M.: Ximiya, 1978) 320.

6. A. S. Tursunov et al., Universum: texnicheskie nauki, **10-2 (67)** (2019)
7. Mineral resources of Uzbekistan (Tashkent*,* Fan, 1977), **553**, 101-104.
8. V.I. Bragin, I.I. Baksheev, Scientific and technical journal "Mining Information and Analytical Bulletin", 9, 133-137 (2012)
9. GOST 17817 - 78. Graphite. Methods of sampling and preparation of samples for testing.