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Volodymyr Baranyak
Lviv Polytechnic National University,
Associate Professor of Criminal Law and Procedure
Educational and Scientific Institute of Law, Psychology and Innovative Education
Candidate of Chemical Sciences, Associate Professor
volodymyr.m.baraniak@lpnu.ua
ORCID ID: https://orcid.org/0000-0001-6161-7862

METHODS OF SEPARATION AT THE PREPARATORY STAGE OF CRIMINAL EXAMINATION OF MATERIAL EVIDENCE

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In expert practice, questions often arise related to the separation (separation) of research objects from a mixture of dissimilar particles of solid materials, liquids of different densities, emulsions, two-phase media. During the study, physical and chemical separation methods are used.

The choice of the separation method depends on the percentage composition and properties of the mixture and its constituent components. Expert research is carried out using various methods of separation: by mass (inertial), by size, electrical, magnetic, radiometric, photometric, etc. Chemical separation is its separate type.

Analysis of expert practice indicates that separation is mainly applied during the forensic investigation of metals and alloys (solids), drugs (solids, liquid substances) and petroleum products (liquid substances).

The article analyzes the methods of separation at the preparatory stage of the expert study of microparticles of precious metals and handicraft drugs.

Forensic investigation of metal and alloy products is one of the most difficult, since the detection and separation of microparticles of the metal under study from other metal particles and their subsequent identification require the use of both chemical and instrumental research methods.

The separation of the metal under study from the mixture of other metal particles was carried out by the method of mechanical and magnetic separation and chemical (selective dissolution) separation.

During the expert study of acetylated opium using chromatographic methods, difficulties often arise associated with the separation of components due to the presence of a large amount of ballast substances (in particular, chlorophyll) extracted from poppy straw in acetylated opium.

The use of an inertial separation method makes it possible to speed up the separation of an aqueous solution of a narcotic drug emulsion and an extracting organic solvent.

Key words: methods of separation; inertial separation; mechanical separation; magnetic separation; chemical separation; forensic examination of narcotic drugs; forensic examination of metals.

Problem statement. In expert practice, questions often arise related to the separation of research objects from a mixture of heterogeneous particles of solid materials, liquids of different densities, emulsions, and two-phase media.

Physical and chemical methods of separation are used during the study. The choice of the separation method depends on the percentage composition and properties of the mixture and its components. Separation usually takes place not only by the main feature that distinguishes the components in the mixture, but also by a number of properties. Separation processes depend on external conditions and the hardware of the separation process. Various methods of separation are used in forensic investigations: by mass (inertial), by size, electrical, magnetic, radiometric, photometric, etc. Chemical separation is a separate type of separation.

Analysis of the research problem. The analysis of expert practice shows that separation is mainly used in the forensic examination of metals and alloys (solids), narcotic drugs (solids, liquids) and oil products (liquids).

Leading scientists and practitioners have been researching the issues related to the methodology of forensic examination of metals and alloys and narcotic drugs: M. B. Wander, V. H. Honcharenko, A. V. Kofanov, V. A. Zuikov, S. O. Shymanovskyi, V. H. Savenko, M. D. Shvaikova, O. O. Davydova, D. Peters, V. P. Kramarenko, and others.

The aim of the article is to analyse the methods of separation at the preparatory stage of expert examination of material evidence. This goal allowed us to draw a conclusion about the effectiveness of the use of inertial and mechanical methods, magnetic separation and chemical (selective dissolution) separation in the examination of metals and drugs.

Presentation of the main material. The forensic examination of metal and alloy products is one of the most challenging, as establishing how the metal was processed into scrap, detecting and separating the microparticles of the metal under investigation from other metal particles and their subsequent identification require the use of both chemical and instrumental research methods.

An example of the use of different separation methods is the expert examination of platinum microparticles in the case of the theft of a platinum filter. Outerwear, a vice, a hammer and a chisel used to cut the stolen product, and samples of platinum were seized from the suspects in the theft.

This type of research addresses the issue of the presence of microparticles of this metal on carrier objects.

To detect and separate possible platinum microparticles from a mixture of other metal microparticles, mechanical and magnetic separation methods and chemical dissolution of metals are used.

The following questions were put to the expert, among others: 1) Are there any platinum particles on the items of outerwear, vice, chisel and hammer? 2) If so, are they not homogeneous with the platinum samples? [1].

At the initial stage of the investigation, an important task is to identify metal particles present on the clothing and tools used to mechanically destroy the items, as well as to separate them from other metal particles. As the practice of conducting such examinations shows, this task is often associated with considerable difficulties.

he first and most important step in the study was to detect platinum microparticles on the carrier objects and separate them from other metal microparticles for further diagnostic and identification studies.

1. Mechanical separation method

The first stage of separation consisted of mechanical separation of red and yellow metal particles from soil and mineral particles using a dissecting needle under an MBS-2 microscope with a magnification of up to 175 times. The metal particles from the surface of the vice were placed in a petri dish and washed with chloroform to remove mineral oils. The liquid was disposed of, and the metal particles were used for further research. During the study of metal particles removed from the surface of the vice, microparticles of silver-white, red and yellow colours were found.

No metal particles were found on the surface of the outerwear, hammer and chisel.

To separate possible platinum microparticles from the rest of the particles, magnetic separation and chemical metal dissolution methods were used.

2. Magnetic separation method

Platinum is a paramagnetic (weakly magnetic) metal. To separate platinum microparticles from metal particles with strong magnetic properties, a magnetic separation method using a permanent magnet was used. Most of the silver-white particles were attracted to the magnet, which made it difficult to separate platinum microparticles. As a result of using this method, it was possible to partially purify the object of study.

3. Chemical method

Under normal conditions, platinum is insoluble in common mineral acids, except for "tsarist vodka" (a mixture of 1 volume of concentrated nitric acid with 3 volumes of concentrated hydrochloric acid) [2].

To completely separate the platinum microparticles from the residues of other metal particles, the mixture to be separated was treated with concentrated hydrochloric acid for 15 hours. The object was examined under a microscope and the metal particles that did not dissolve in the hydrochloric acid were selected.

The separated metal particles were subjected to diagnostic and identification testing by emission spectral analysis (ESA).

Another example from expert practice. Today, acetylated opium is the most widespread among artisanally produced drugs of plant origin in Ukraine.

During the expert examination of acetylated opium using chromatographic methods, difficulties often arise with the separation of components due to the presence of a large amount of ballast substances extracted from poppy straw (in particular, chlorophyll) in acetylated opium.

In such cases, the sample of acetylated opium is pre-purified by successive extraction from slightly acidic and slightly alkaline solutions with equal volumes of chloroform, which extracts approximately 28–30 % of morphine from alkaline aqueous solutions [3]. The mixtures are shaken, the aqueous layer is separated, and the resulting chloroform extract is applied to a chromatographic plate [4].

Due to the low solubility of chloroform in water (1 g in 100 ml at 15 °C), a stable emulsion forms during shaking, which can be separated by either settling or centrifugation. In the case of settling, the emulsion separation is a long process. The most common and fastest way to separate emulsions is by centrifugation. Under the influence of centrifugal force, the components of the emulsion are separated according to their density: an outer layer of liquid with a higher density and an inner layer of lighter liquid.

Centrifugation is therefore essentially a process of settling in a field of centrifugal forces. The centrifugal forces that occur during centrifugation are stronger than gravity and pressure forces on the liquid system. Therefore, centrifugation is a much more efficient method of mechanical separation of heterogeneous liquid systems than settling [5].

To accelerate the separation process, the water-chloroform emulsion was centrifuged at 800 rpm. As a result of centrifugation, due to the difference in the density of chloroform and water, the heavier (relative density of 1,488 g/cm^3 at 20 °C) chloroform layer was placed above the lighter (density of 1,000 g/cm^3 at 4 °C) water layer. The chloroform extract was then separated and analysed according to conventional methods.

Conclusions. Thus, the use of various separation methods at the preparatory stage of forensic examination of metals and drugs allows to separate the metal under investigation from a mixture of metal particles, as well as to speed up the process of separating the emulsion of an aqueous solution of a drug and an organic solvent used for its extraction.

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Володимир Бараняк
Національний університет “Львівська політехніка”,
доцент кафедри
кримінального права і процесу
Навчально-наукового інституту
права, психології та інноваційної освіти,
кандидат хімічних наук, доцент
volodymyr.m.baraniak@lpnu.ua
ORCID ID: https://orcid.org/0000-0001-6161-7862

СПОСОБИ СЕПАРАЦІЇ НА ПІДГОТОВЧІЙ СТАДІЇ ПРОВЕДЕННЯ КРИМІНАЛІСТИЧНОЇ ЕКСПЕРТИЗИ РЕЧОВИХ ДОКАЗІВ

У статті на прикладах з експертної практики розглянута методика застосування інерційного, механічного, магнітного способів сепарації і хімічного розділення суміші під час проведення криміналістичної експертизи наркотичних засобів і металів. Застосування інерційного способу сепарації дозволяє пришвидшити процес розділення емульсії водного розчину наркотичного засобу й екстрагуючого органічного розчинника. Відокремлення досліджуваного металу від суміші інших металічних частинок проводилося способом механічної і магнітної сепарації та хімічного (селективне розчинення) розділення.

Аналіз експертної практики вказує на те, що сепарація здебільшого застосовується під час криміналістичного дослідження металів і сплавів (тверді речовини), наркотичних засобів (тверді, рідкі речовини) та нафтопродуктів (рідкі речовини).

У статті проведено аналіз способів сепарації на підготовчому етапі експертного дослідження мікрочастинок дорогоцінних металів і наркотичних засобів кустарного виготовлення.

Криміналістичне дослідження виробів з металів і сплавів належить до найскладніших, оскільки виявлення та відокремлення мікрочастинок досліджуваного металу від інших металевих часток та їхня подальша ідентифікація потребують використання як хімічних, так і інструментальних методів дослідження.

Відокремлення досліджуваного металу від суміші інших металевих частинок проводилося способом механічної та магнітної сепарації та хімічного (селективне розчинення) розділення.

Під час експертного дослідження ацетильованого опію з використанням хроматографічних методів часто виникають труднощі, пов'язані з розділенням компонентів, через наявність в ацетильованому опії великої кількості екстрагованих з макової соломи баластних речовин (зокрема, хлорофілу).

Застосування інерційного способу сепарації дає змогу прискорити процес розділення емульсії водного розчину наркотичного засобу та екстрагуючого органічного розчинника.

Ключові слова: способи сепарації; інерційна сепарація; механічна сепарація; магнітна сепарація; хімічне розділення; криміналістична експертиза наркотичних засобів; криміналістична експертиза металів.