pISSN:2349-5707 Volume:13,Issue 6, June -2026 eISSN:2349-5715

UDK 636.089:615.9

THE ROLE OF THERMAL DESORPTION SURFACE IONIZATION SPECTROMETRY (TDSIS) IN CHEMICAL ANALYSIS

Tashkent Branch, Samarkand State University of Veterinary Medicine,
Animal Husbandry and Biotechnology, Alfraganus University
Safarov M.B., Eshmatov G'. Kh., Jalilov F.S.
e-mail: safarovmadad@gmail.com
https://orcid.org/0009-0000-0875-2897 f.jalilov@afu.uz

Annotation This review presents Thermal Desorption Surface Ionization spectrometry (TDSIS) for analyzing nitrogen-containing pesticides in complex matrices. The "Iskovich" spectrometer offers a detection limit of 10^{-10}–10^{-11} g and a linear range of 2,5–4,5 orders. TDSIS demonstrates high selectivity for nitrogenous compounds. Practical applications in honey and plant extracts are discussed, along with limitations including matrix effects and emitter poisoning.

Keywords TDSIS, surface ionization, "Iskovich" spectrometer, pesticides, nitrogen-containing compounds, detection limit

Annotatsiya Ushbu sharhda murakkab matritsalarda kimyoviy moddalarni tahlil qilish uchun termodesorbsion sirt ionlashuv spektroskopiyasi (TDSIS) usuli keltirilgan. “Iskovich” spektrometri 10^{-10}–10^{-11} g aniqlash chegarasi va 2,5–4,5 tartibli chiziqli diapazonga ega. TDSIS azotli birikmalarga nisbatan yuqori selektivlik ko‘rsatadi. Asal va o‘simlik ekstraktlarida qo‘llanilish misollari hamda matritsa ta’siri va emitter zaharlanishi kabi cheklovlar muhokama qilingan.

Kalit so‘zlar TDSIS, sirt ionlanishi, “Iskovich” spektrometri, pestitsidlar, azot saqlovchi birikmalar, aniqlash chegarasi

Thermal Desorption Surface Ionization Spectrometry (TDSIS) is a physicochemical analysis method that has gained significant importance in recent decades, particularly in fields requiring high selectivity and sensitivity for the detection of nitrogen-containing organic compounds in complex matrices. The operating principle and analytical capabilities of the TDSIS method have been detailed in numerous scientific and practical studies. A review of the literature systematically includes research on the developmental stages of this method, the design and metrological characteristics of the "Iskovich" spectrometer, as well as its application in the detection of chemical substances.

TDSIS is based on the ionization process of chemical substances on a heated metal surface. The theoretical foundations of the method were elaborated in detail by Rasulev and Zandberg (1988). The authors explain the phenomenon of surface ionization through the relationship between the ionization potential (E_i) and the work function (φ) of the emitter material. Calculations indicate that for nitrogen-containing compounds with an ionization potential approximately in the range of 7–9 eV, an oxidized molybdenum (Mo) emitter with a work function around 6–7 eV is considered the most optimal choice.

Researchers have quantitatively expressed the selectivity of the TDSIS method. The ionization coefficient for nitrogen-containing compounds is typically in the range of 0.2–0.5, whereas for hydrocarbons and oxygen-containing compounds, this value is observed to be below 10^(-4). These fundamental findings were later highlighted by Rasulev, Khasanov, and Palitcin (2000), who discussed prospects for using devices based on surface ionization for the indication and identification of nitrogen-containing substances [7].

A significant milestone in the practical implementation of the TDSIS method was the development of the "Iskovich" spectrometer. A paper published by Iskhakova, Mikhaylin, Rasulev, Sagatov, and Khasanov (2004) detailed the instrument's structure and operating principle. The authors identified the main components of the instrument – a desorber (evaporator), a surface ionization detector (SID), an airflow system, and a microprocessor

pISSN:2349-5707 Volume:13,Issue 6, June -2026 eISSN:2349-5715

control unit. The operational procedure involves evaporating the sample at a programmed temperature, transporting the resulting molecules via an air stream to the heated emitter surface, ionization, and recording the ion current [1].

Key indicators for a TDSIS spectrum include the maximum temperature (T_{max}), the peak maximum height (I_{max}), and the peak area (S). These parameters are crucial not only for qualitative identification of substances but also for their quantitative assessment. The metrological characteristics of the device are clearly defined from both scientific and practical standpoints. The absolute detection limit of the TDSIS method ranges from 10^{-10} to 10^{-11} g, with a linear dynamic range spanning 2.5–4.5 orders of magnitude [1]. Subsequently, Iskhakova (2012), in her candidate dissertation, provided an in-depth analysis of the operating principles of the "Iskovich" spectrometer, including the influence of solvents on the spectrum and issues related to emitter surface "poisoning" [2]. The research demonstrated that the selectivity, sensitivity, and effectiveness of the TDSIS method in analyzing real objects are directly dependent on the instrument design, emitter material, and operating parameters [2].

The practical significance of the TDSIS method is particularly evident in the qualitative and quantitative determination of psychotropic substances and other biologically active compounds. Khasanov, Rasulev, Iskhakova, and Usmanov (2006) systematically studied the TDSIS spectral parameters of various classes of substances. In subsequent research, Khasanov, Rasulev, Usmanov, Iskhakova, Lehotay, and Amirav (2008), in ASMS conference proceedings, demonstrated the effectiveness of the TDSIS method in detecting pesticide residues in real objects – honey, cucumber, and white pepper extracts. The authors noted that the detection limits were significantly lower than the maximum residue limits (MRLs). For example, the detection limit for amitraz in honey was approximately 200 ng/g, while the MRL is 1.5 μg/g [5]. This demonstrates the potential for effectively applying the TDSIS method in monitoring studies and assessing food and environmental safety.

The role of the TDSIS method in chemical-toxicological analysis was extensively covered by Zhailov (2021) in his doctoral dissertation. The reliability of results obtained by the TDSIS method was assessed using several indicators: degree of linearity $r^2 \geq 0.995$, relative error not exceeding 3–5%, and result repeatability (RSD) maintained within 5–7%. The duration of a single analysis is only 3–5 minutes, confirming the practical convenience of the method [8].

At the same time, certain limitations of the TDSIS method have also drawn researchers' attention. Iskhakova, Rasulev, and Khasanov (2009), in the UzPEC-5 conference proceedings, studied the influence of solvents on TDSIS spectra and found that in some cases, solvent molecules can form clathrate compounds, leading to a shift in T_{max} [3]. The authors recommended optimizing solvent choice and sample preparation conditions to minimize this effect [3]. Furthermore, studies conducted by Iskhakova in 2012 noted that "poisoning" can occur when more than 10^{-7} g of organic substances deposit on the emitter surface, significantly reducing ionization efficiency [2]. Therefore, regular instrument cleaning, operating the emitter surface under optimal conditions, and careful selection of analysis parameters are of crucial importance.

The analysis of the literature indicates that the TDSIS method and the "Iskovich" spectrometer represent a scientific and methodological tool enabling rapid, sensitive, and selective detection of substances in complex matrices. The theoretical foundations of the method are fundamentally developed [6, 7], the instrument design and metrological characteristics have been thoroughly studied [1, 2], and the potential for application in environmental objects and biological samples has been confirmed [4, 5]. Consequently, expanding the application possibilities of this method for the analysis of pesticides (e.g., neonicotinoids), minimizing the influence of solvent substances, and developing scientifically based proposals to overcome the problem of emitter surface "poisoning" are relevant tasks. Such an approach serves to further enhance the practical significance of the TDSIS method in modern pesticide monitoring and chemical-toxicological analysis.

pISSN:2349-5707 Volume:13,Issue 6, June -2026 eISSN:2349-5715

FOYDALANILGAN ADABIYOTLAR

1. Iskhakova S.S., Mikhaylin A.V., Rasulev U.Kh., Sagatov Ya.R., Khasanov U. Termodesorbtsionnyy poverkhnostno-ionizatsionnyy indikator narkotikov i drugikh lekarstvennykh preparatov // Zhurnal analiticheskoy khimii. – Moskva, 2004. – №1. – S. 58-63.

2. Iskhakova Saida Sunnatovna. Termodesorbtsionnaya poverkhnostno-ionizatsionnaya spektrometriya fiziologicheski aktivnykh azotistykh osnovaniy: avtoref. diss. ... kand. fiz.-mat. nauk. – Tashkent, 2012. – 20 s.

3. Iskhakova S.S., Rasulev U.Kh., Khasanov U. O vliyanii prirody rastvoriteley na termodesorbtsionnye poverkhnostno-ionizatsionnye spektry lekarstvennykh preparatov // UzPEC-5 – konf. po fizicheskoy elektronike 28-30 oktyabrya 2009. – Tashkent: Institut elektroniki im. U.A. Arifova, 2009. – S. 161.

4. Khasanov U., Rasulev U.Kh., Iskhakova S.S., Usmanov D.T. Detection and analysis of nitrogen-containing pesticides in environment by surface ionization methods // Journal of Surface and Interface Analysis. – Surrey: John Wiley & Sons, 2006. – Vol. 38. – P. 309-312.

5. Khasanov U., Rasulev U., Usmanov D., Iskhakova S., Lehotay S., Amirav A. Detection and analysis of nitrogen-containing pesticides residues in food and the environment by surface ionization methods // ASMS Conference. – Denver, Colorado, USA, 2008. – P. 187.

6. Rasulev U., Zandberg E. Surface ionization of organic compounds and its application // Progress in Surface Science. – Elsevier, 1988. – Vol. 28, No. 3/4. – P. 181-412.

7. Rasulev U.Kh., Khasanov U., Palitcin W. Surface-ionization methods and devices of indication and identification of nitrogen-containing base molecules // Journal of Chromatography A. – Elsevier, 2000. – Vol. 896. – P. 3–18.