



**State Research Institute
of Organic Chemistry
and Technology
(GosNIIOKhT)**

Moscow, Russia

**DETERMINATION OF LOW CONCENTRATIONS OF
SARIN AND O-ISOPROPYLMETHYLPHOSPHONATE
(SARIN DESTRUCTION PRODUCT) IN OBJECTS OF
THE ENVIRONMENT BY THE METHOD OF
IR-FOURIER SPECTROSCOPY**

**Fokin E.A., Kondratyev V.B., Strukov O.G.,
Vlasova Z.B.,
Zavalishyna I.V., Shokin S.N.**



The extraction was carried out either by shaking up mixtures for 5-10 minutes or by using an ultrasonic bath (in both cases the results obtained were similar). Weight (volume) ratios of sample: solvent were varied from approximately 4:1 to 1:1. The extraction degree, determined by comparing spectra of the extracts and standard solutions of known concentrations, varied depending on conditions and the origin of the object within the wide limits (15-65%).

IR-spectra of the sample solutions were recorded by Nicolet Avatar- 360 FTIR spectrometer with use of cells with a path length of 0.4 mm and KBr windows.

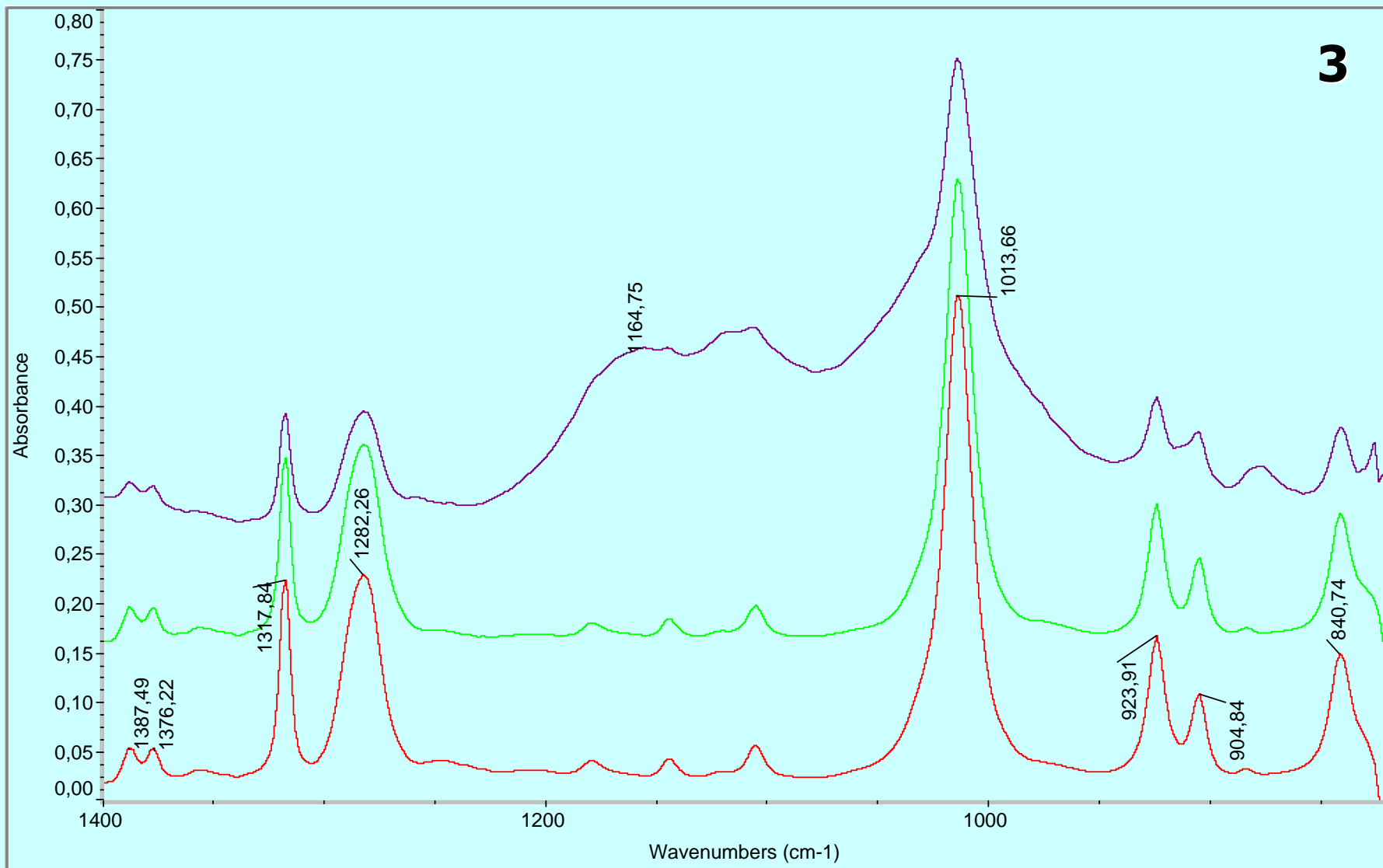


Figure 1. IR spectra of sarin (red) and its extracts from water (green) and sand (violet). Solvent and extractive was carbon tetrachloride (See Text)

**Table. The main bands of IR-spectra of molecules CH₃P(O)(OC₃H₇)_iX (cm⁻¹).
Solvent is CCl₄.**

X=F - sarin	X=OH - IPMP	X=C1 - IPMCP
2983	2979	2983
2938	2934	2935
2878	2873	2873
	2640	
	2320	
	1680	
1467	1467	1464
1455	1453	1453
1417	1417	1418
1387	1386	1387
1376	1375	1374
1318	1312	1307
1282	1202	1269
1179	1179	1180
1140	1142	1142
1105	1109	1104
1014	1009	990
	987	
924		912
905	908	889
841		
		524
508		
480	485	4736

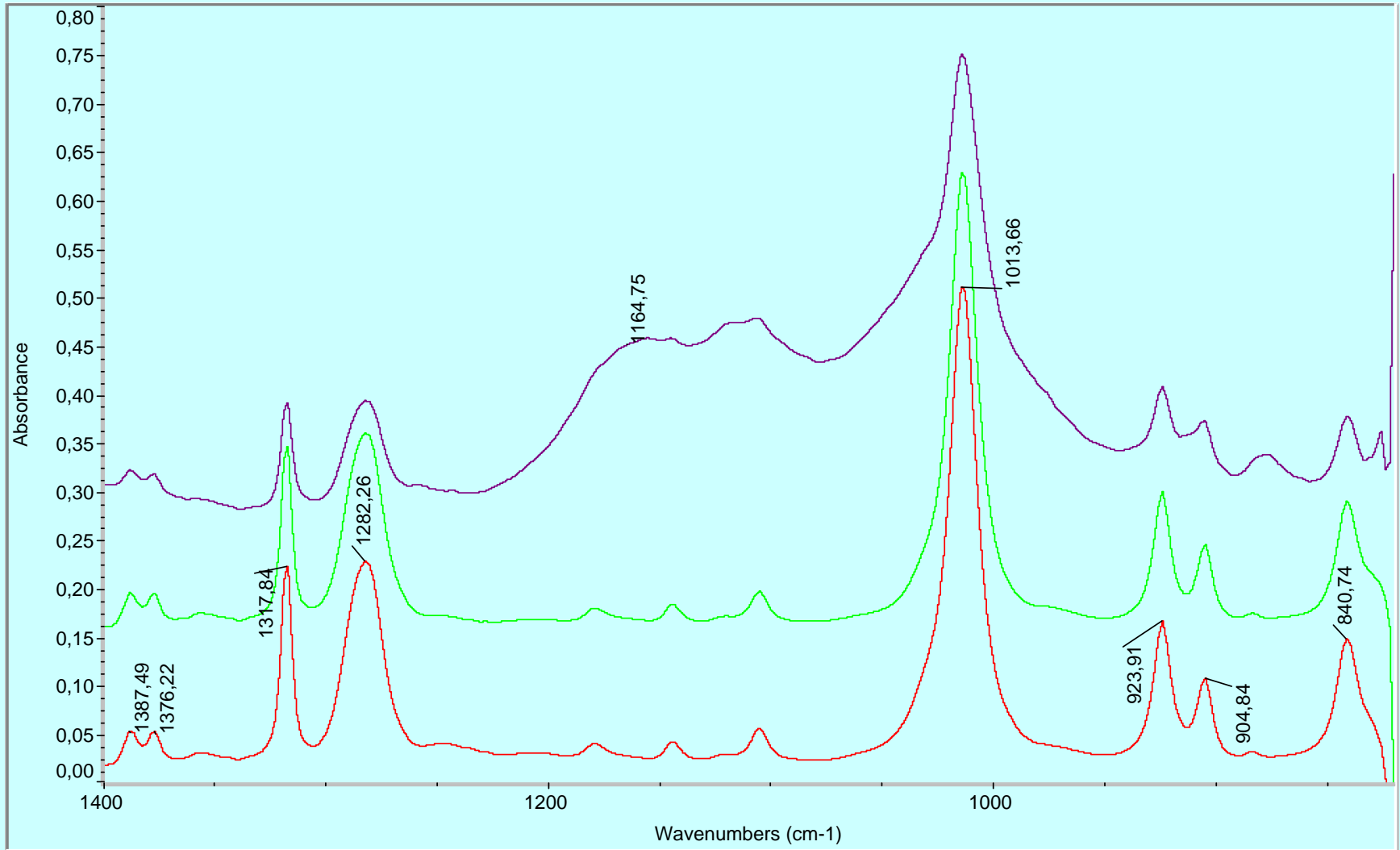


Figure 2. IR-spectra of O-isopropylmethylphosphonate (C= 0.01 %) (red) and its extracts from water (violet), sand (blue) and from the surface (green). Solvent and extractive was carbon tetrachloride.

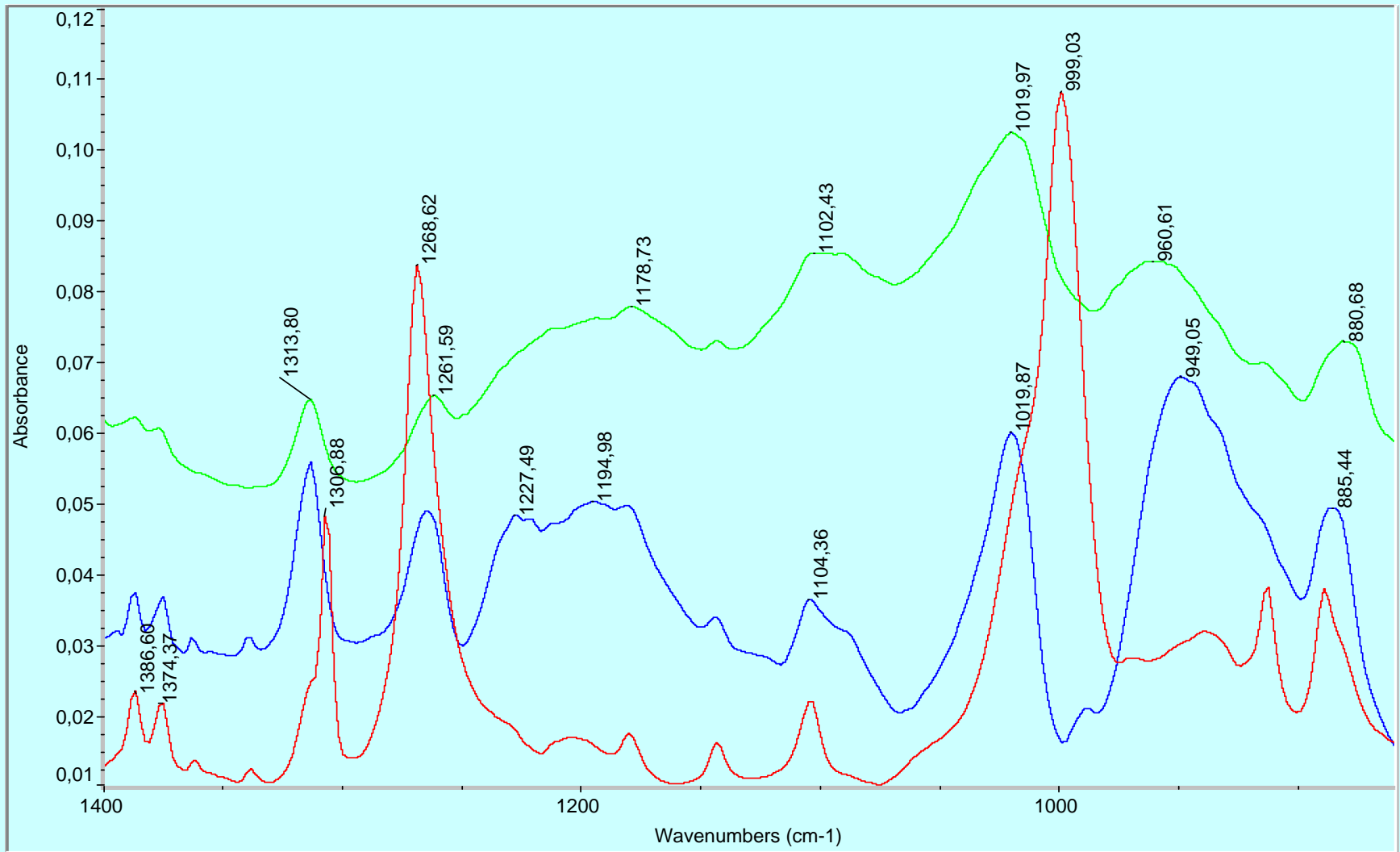


Figure 3. IR-spectra of O-isopropylmethylchlorophosphonate (red) and its extracts from water (blue) and sand (green). Solvent and extractive was carbon tetrachloride.

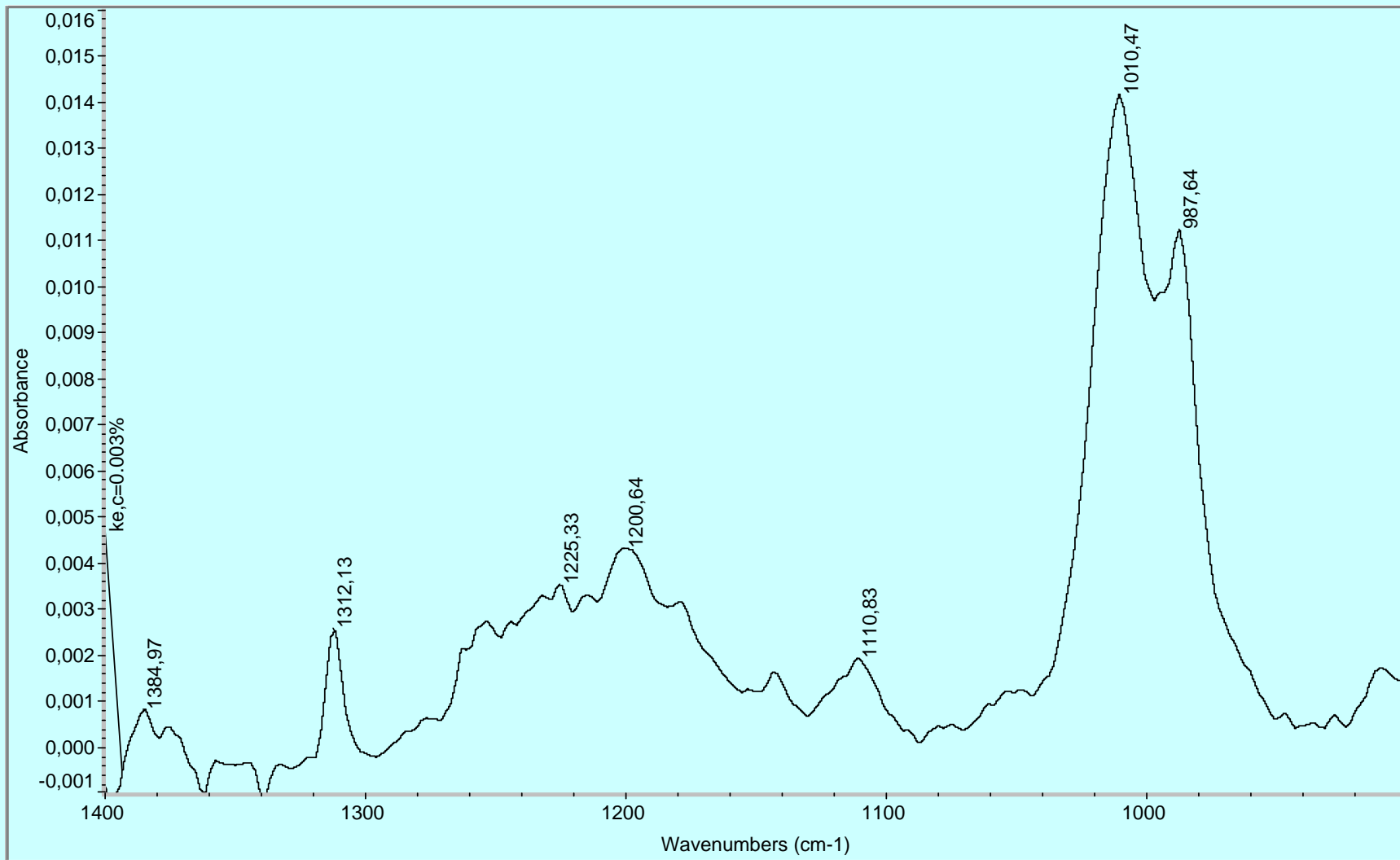


Figure 4. IR-spectra of O-isopropylmethylphosphonate in carbon tetrachloride, (C= 0.003 %)

The study conducted showed that the IR-spectroscopy method may be applied successfully for identification of toxic chemicals and their destruction products in the environment. The method is characterized by high selectivity, and the presented variant differs by quick response as well: operations connected with sample preparation and spectrum recording takes less than half an hour. The method is characterized by high sensitivity as well. Detection limits for sarin and IPMP in the system substance/sand was about 0.1 mg/g, and for the system substance/water was about 2 mg/ml. On the surface this substance may be detected at the level of about 0.2 mg/cm².

The above stated detection limits correspond to the concentration of toxic chemical in extracts not less than 0.03 %. All analytical bands are located within the interval of optical density from 0.02 to 0.14. However, these bands may be reliably identified even at concentration of the substance in carbon tetrachloride at the level of 0.003% (Fig.4). This fact allows supposing that sensitivity of determination of substances in the environment objects by the method of IR-spectroscopy may be increased in some times.