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Application News

No.A509

Spectrophotometric Analysis

Analysis of Tapwater Contaminants by FTIR and EDX Spectroscopy

We describe an example of analysis of contaminants often encountered in plumbing using samples. Contaminants taken from locations near a tap water outlet were analyzed by FTIR and EDX spectroscopy and the source of these contaminants was identified. An FTIR spectra search was performed using the tap water contaminants library. The library contains an infrared spectra database and EDX profile database of actual collected contaminants.

Contaminant A

The head of a shower connected to a tap water supply is fitted with a water purification filter that is periodically replaced when the inside of the shower head is cleaned. Contaminant A found when replacing the filter is shown in Fig. 1. The contaminant was attached to the part of the shower head indicated by the red circle, was black in color, and around 1 mm in size.

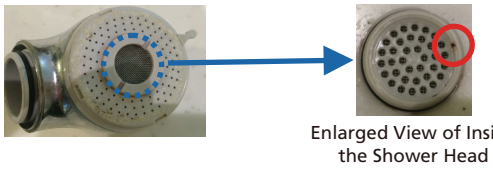
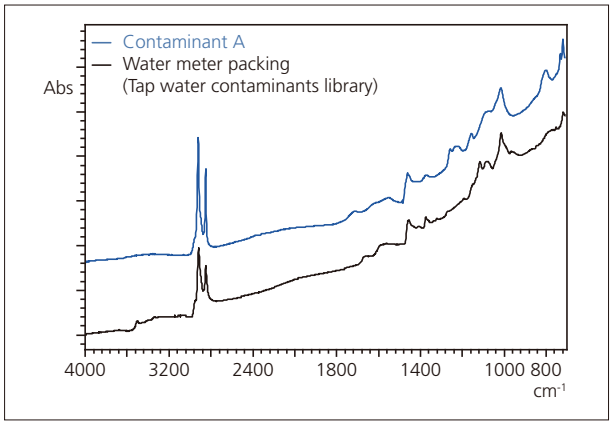


Fig. 1 Images of Contaminant A

FTIR Analysis

The contaminant was collected and examined by single-reflection attenuated total reflection (ATR) measurement. The ATR spectrum we obtained and spectra search results are shown in Fig. 2. The ATR spectra matches an entry in the tap water contaminant library, based on which the contaminant is inferred to be an ethylene propylene diene rubber (EPDM) with additives that include talc and kaolin.



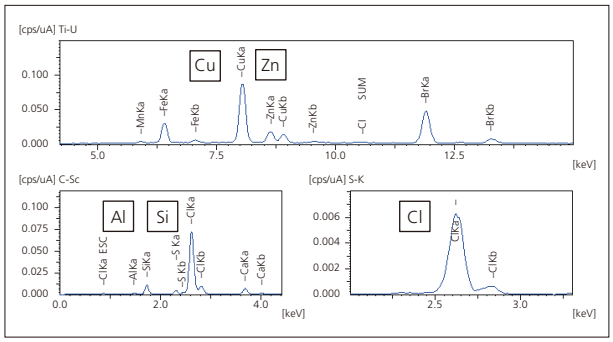
Library Information for Water Meter Packing

Materials: Ethylene propylene diene rubber (EPDM), magnesium silicate (TALC), aluminum silicate (KAOLIN).
Major elements: Si, Mg Color: Black Shape: Rubber/fragment
Hardness: Soft Metallic luster: No Technique: ATR (Ge)

Fig. 2 ATR Spectra of Contaminant A and Spectra Search Result

EDX Analysis

Results of qualitative and quantitative analysis of $_{6}C$-$_{92}U$ are shown in Fig. 3. Based on the results of FTIR analysis, EPDM (C_5H_{10}) was used as the balance[1]. Si and Al come from talc and kaolin, which corroborates the data obtained by FTIR analysis. Cl is present in chlorine used in tap water, and metallic elements such as Cu and Zn are presumed to come from elution and deposition of water supply parts.



Constituent	Cl	Si	Al	Ca	S	Cu
Quantitative value (%)	1.48	0.57	0.19	0.10	0.070	0.021

Constituent	Fe	Br	Zn	Mn	C_5H_{10}
Quantitative value (%)	0.013	0.007	0.003	0.001	97.6

Fig. 3 Qualitative and Quantitative Results for Contaminant A Obtained by EDX Analysis

Identification of Source

The shower head was disassembled further and the filter and other parts analyzed by FTIR spectroscopy. The spectra obtained for Contaminant A showed similarities to the spectra obtained from a rubber gasket. The ATR spectra obtained are shown in Fig. 4. Contaminant A was identified as a fragment of this rubber gasket that had attached itself to the inside of the shower head.

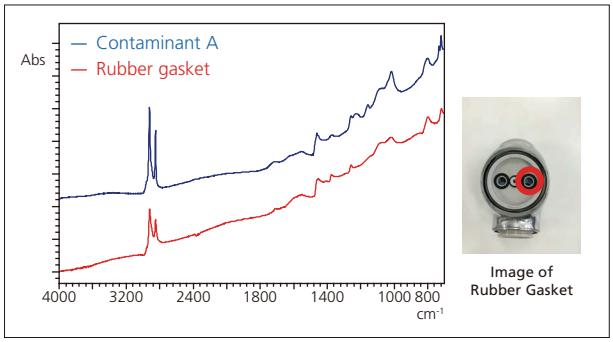


Fig. 4 ATR Spectra of Contaminant A and Rubber Gasket

Contaminant B

Contaminant B was trapped by a tap water outlet filter, and was discovered during routine cleaning. Images of Contaminant B are shown in Fig. 5. Contaminant B is a white material around 2 mm in size.

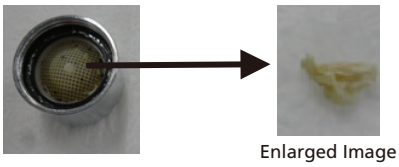
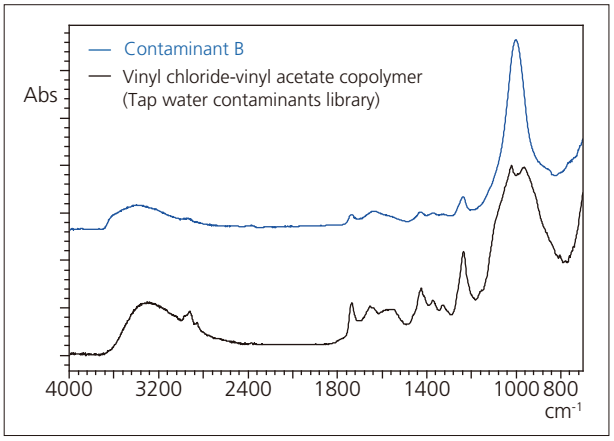


Fig. 5 Images of Contaminant B

FTIR Analysis

The contaminant was collected and examined by single-reflection attenuated total reflection (ATR) measurement. The ATR spectrum we obtained and spectra search results are shown in Fig. 6. The ATR spectrum matched the tap water contaminants library data entry, and based on this was presumed to be a vinyl chloride-vinyl acetate copolymer.



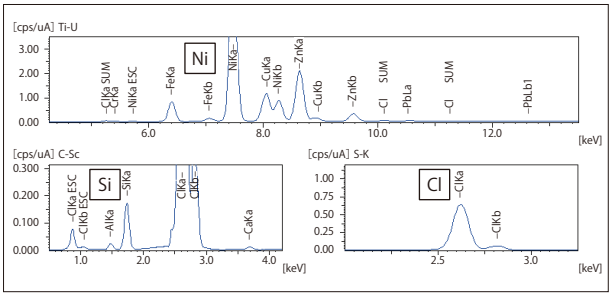
Library Information for Vinyl Chloride-Vinyl Acetate Copolymer

Materials: Vinyl chloride-vinyl acetate copolymer
Major elements: Cl, Fe Color: Brown Shape: Splinter
Hardness: Soft Metallic luster: No Technique: ATR (Ge)

Fig. 6 ATR Spectra of Contaminant B and Spectra Search Result

EDX Analysis

Results of qualitative and quantitative analysis of $_{6}C$-$_{92}U$ are shown in Fig. 7. Based on the results of FTIR analysis, vinyl acetate ($C_4H_6O_2$) was chosen as the balance, the Cl detected was considered to be from vinyl chloride (C_2H_3Cl), and other elements were quantified as metals. Ni was presumed to come from elution and deposition of metal plating inside the tap water outlet over a long period of time, while other elements came from supply piping and other components or from water scale.



Constituent	C_2H_3Cl	Si	Ni	Al	Zn	Fe
Quantitative value (%)	56.4	1.63	1.22	0.43	0.34	0.23

Constituent	Cu	Ca	Cr	Pb	$C_4H_6O_2$
Quantitative value (%)	0.20	0.13	0.010	0.006	39.4

Fig. 7 Qualitative and Quantitative Results for Contaminant B Obtained by EDX Analysis

Identification of Source

Water supply pipes are made from vinyl chloride, while vinyl chloride-vinyl acetate copolymers are commonly used as seal materials at connection points. Contaminant B is presumed to be a piece of this seal material that has flaked off into the water due to degradation occurring over time. No parts around the tap water outlet were found that matched the constituents of Contaminant B.

Conclusion

When contaminants are found, it is important to quickly investigate the cause and take measures to handle the problem. We obtained useful analytical data both quickly and simply using both FTIR and EDX analytical instruments. We also identified the source of contamination by analyzing parts close to where contamination was found, and comparing the data obtained.

[References]
1) Shimadzu Application News No.X255

Table 1 Instruments and Analytical Conditions

[FTIR]

Instruments	: IRAffinity-1S, MIRacle10 (Germanium prism)
Resolution	: 4 cm^{-1}
Accumulation	: 40
Apodization	: Happ-Genzel
Detector	: DLATGS

[EDX]

Instrument	: EDX-8000
X-ray Tube	: Rh target
Voltage / Current	: 15 kV (C-Sc, S-K), 50 kV (Ti-U) / Auto
Atmosphere	: Vacuum
Measurement Diameter	: 1 mm ϕ / 3 mm ϕ (Contaminant A / B)
Integration Time	: 100 sec/ch
Sample Support Film	: Polypropylene 5 µm

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