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BASIC ACOUSTIC PARAMETERS OF ORGANIC SOLVENTS USED IN ULTRASONIC CLEANING

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Sound velocities have been measured and the specific acoustic impedance calculated for the following solvents used in the process of ultrasonic cleaning (commercial technical products): trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane (Baltane), trichlorotrifluoroethane (Freon TF) and dibromotetrafluoroethane, known as freon 114B2.

The solvents preferred for use in industrial ultrasonic cleaning processes are:

1. trichloroethylene,
2. tetrachloroethylene,
3. 1,1,1-trichloroethane (trade names Chlorothene, Genklene, Baltane),
4. trichlorotrifluoroethane also known under the name of freon 113 (trade names Freon TF, Arklone P, Flugene 113).

When designing cleaning equipment intended for operation with these solvents and when developing technological processes, it is frequently necessary to make calculations involving the velocity of sound propagation, and acoustic impedance of these liquids is needed. Unfortunately, only for the first two of the above-mentioned liquids can these parameters be found in the literature. Furthermore, for tetrachloroethylene various sources cite different values of propagation velocity (e. g. L. BERGMAN — 1066 m/s, while W. SCHAAFF — 1053 m/s).

The present authors have measured the sound velocity c (by means of an interferometer) and the density ϱ (using a Mohr-Westphal hydrostatic balance) at various temperatures for all the above liquids. The coefficients $\Delta c/\Delta T$ and $\Delta \varrho/\Delta T$ and the acoustic impedances ϱc at 20°C were then determined. The liquid density ϱ was measured with an accuracy of 0.001 g/cm^3, and the sound velocity c with an accuracy of 1 m/s. Values corresponding to 20°C were read of the graphs shown in Fig. 1. Freshly distilled technical products were used for the investigations, since with such solvents we are concerned in practice. The solvents used were:

— trichloroethylene from Chemical Plant «Oświęcim» according to PN-69/C-88025,

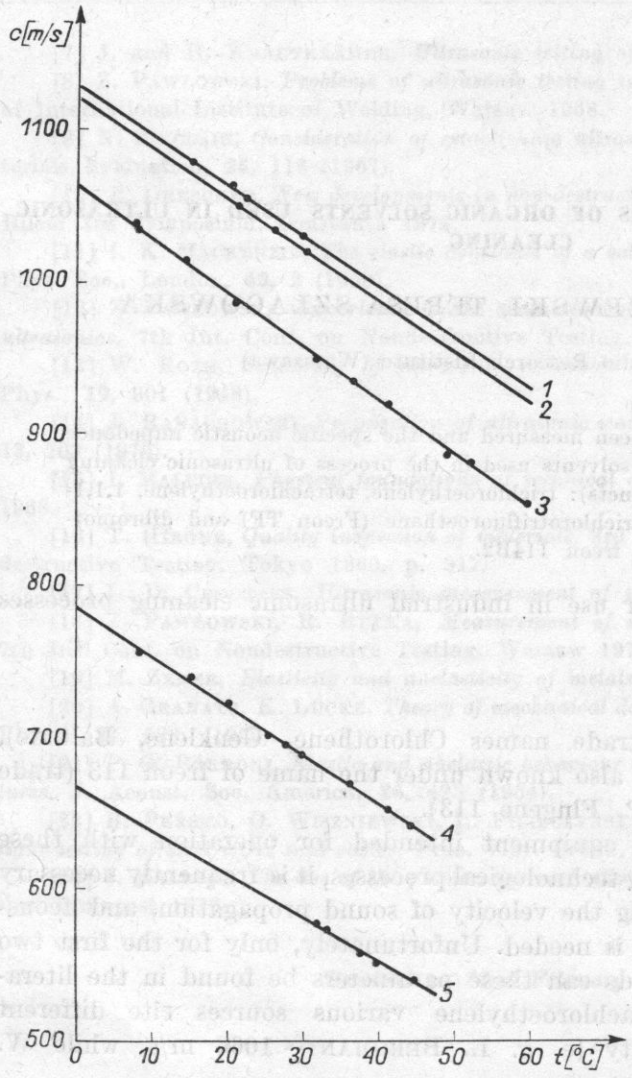

Fig. 1. The dependence of the sound propagation velocity on temperature in the five tested liquids

1 – tetrachloroethylene, *2* – trichloroethylene, *3* – 1,1,1-trichloroethane, *4* – freon 113, *5* – freon 114B2

– tetrachloroethylene from Chemical Plant «Oświęcim» according to PN-70/6026-44,

– 1,1,1-trichloroethane Baltane from Rhone Progil (France),

– trichlorotrifluoroethane Freon TF produced by the concern Du Pont.

Furthermore, the acoustic parameters of dibromotetrafluoroethane (known as freon 114 B2) produced by Nitrogen Plant «Tarnów» were also measured. Its physical properties are similar to those of trichlorotrifluoroethane (but the relevant acoustic data are also not available in the literature).

The results obtained are compared in Table 1.

It is worth pointing out that both the tested freons are remarkable in possessing sound propagation velocities amongst the lowest of the liquids tested

Table 1. Comparison of obtained results

Substance		c at 20°C $\left[\frac{\text{m}}{\text{s}}\right]$	$\Delta c/\Delta T$ $\left[\frac{\text{m}}{\text{s deg}}\right]$	ϱ_4^{20} $\left[\frac{\text{g}}{\text{cm}^3}\right]$	$\Delta\varrho/\Delta T \times 10^{-5}$ $\left[\frac{\text{g}}{\text{cm}^3\,\text{deg}}\right]$	$\varrho c \times 10^3$ at 20°C $\left[\frac{\text{g}}{\text{cm}^2\,\text{s}}\right]$
C_2Cl_4	tetrachloroethylene Cl Cl | | C=C | | Cl Cl	1063	-3.3^{30}_{15}	1.618	-169^{45}_{20}	172.0
C_2HCl_3	trichloroethylene Cl Cl | | C=C | \\ H Cl	1055	-3.5^{30}_{15}	1.464	-173^{50}_{20}	154.4
$C_2H_3Cl_3$	1,1,1-trichloro-ethane H Cl | | H–C–C–Cl | | H Cl	992	-3.56^{60}_{5}	1.333	-172^{50}_{20}	132.2
$C_2Cl_3F_3$	trichlorotrifluoro-ethane Cl Cl | | F–C–C–F | | Cl F	720	-3.23^{45}_{10}	1.576	-222^{30}_{15}	113.5
$C_2F_4Br_2$	dibromotetrafluoro-ethane F F | | Br–C–C–Br | | F F	609*)	-2.9^{45}_{30}	2.181	-319^{35}_{15}	132.8

x) Extrapolated value.

so far. In the table arranged by W. SCHAFFS containing data on 368 organic liquids only 8 have sound velocities smaller than those in freon 113 and only three smaller than in freon 114B2.

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