Ch.S. Laidabon, B.B. Damdinov[1], Yu.S. Alekseev, B.B. Badmaev[1]

INVESTIGATION OF VISCOELASTIC PROPERTIES OF IMPREGNATE SOLUTIONS

East-Siberian State Technological University
Russia, 670013, Ulan-Ude, Klyuchevskaya st., 40à
Phone:(3012)379344; Fax:(3012)333706

[1] Buryat Scientific Center SD of RAS,
Russia, 670047, Ulan-Ude, Sakhyanovoy st., 8
Phone:(3012)33-2282; Fax:(3012)330238;
E-mail: ofp@bsc.buryatia.ru

For increase of service life of a product from wood usually subject to antiseptics. But the wood has low moisture permeability and its impregnation represents complex technological process. Cavitation-pulse technology of impregnation of wood now is developed, for intensification of which the electromagnetic field is applied. Viscoelastic properties of impregnate solutions (creosote, BBK) have been investigated by resonance method with using piezoquartz resonator. The temperature research in a range 20 - 90°C has been carried out. It is shown that in this range of temperatures the complex behavior of tangent of mechanical loss angle is observed. It speaks that in impregnate solutions there is a whole spectrum of relaxation frequencies. On the basis of the received data the characteristics of an electromagnetic field used at impregnation are made. The tests have shown efficiency EMF at impregnation of wood.

With the purpose of reception of new qualities the porous-capillary bodies subject to impregnation by special solutions. It first of all concerns to building materials. So with the purpose of

with special solutions. But the wood has low permeability [1] and its impregnation represents complex technological process: previously them “pin” on the certain depth, then subject to vacuumation with the subsequent endurance in impregnate solution at superfluous pressure. Other building materials meet with the same problems at impregnation: durability of concrete designs which are taking place in damp environment (for example, bed plates in a ground) are exposed to intensive corrosion, but traditional technology of impregnation of concrete [2] does not satisfy to the modern requirements neither on quality, nor at cost. By development of technology of impregnation the phenomena of carry in impregnate solutions being the determining factors in the majority of technological processes were taken into account only interaction of a liquid with walls of a capillary earlier, transportation phenomena in impregnate solutions, which is main factor in most technological processes were not considered. But the speed of warm -, masstransportation in impregnate solution depends on its condition.

For an estimation of a structure and the definition of resonant frequency investigations of viscoelastic properties of impregnate solutions (BBK (borax technical and boric acid), bitumen and PEK in diesel fuel, and also, creosote) of various building materials. Earlier [3] was shown, that various liquids is not dependent on viscosity and polarity have measurable value of the shear modulus G' at frequency 74 kHz. The investigations of shear properties of liquids were carried out by a resonance method [4] with using the piezoquartz resonator. The essence of the given method, in brief, consists in the following. The piezoquartz crystal oscillating on the basic resonance frequency, contacts by the horizontal surface to a layer of a liquid covered by a solid cover-plate. The solid cover-plate with a layer of a liquid is on one end of piezoquartz. The layer of a liquid tests shear deformations and in it the standing shear waves should be established. Depending on thickness of a layer of a liquid the parameters of a resonance curve of piezoquartz are change. The theory of a method gives the following expression for complex shift of resonance frequency of oscillatory system [3]:

$$\Delta f^* = \frac{S\chi G^*}{4\pi^2 M f_0} \cdot \frac{1+\cos(2\chi^* H - \varphi^*)}{\sin(2\chi^* H - \varphi^*)}, \qquad (1)$$

where G*=G’+iG’’ - complex shear modulus of a liquid, S - area of the basis of cover-plate, χ^* - complex wave number, H - thickness of a liquid layer, f_o - resonant frequency, φ^* - complex shift of a phase at reflection of a wave from liquid - cover-plate interface.

The expression (1) limiting becomes simple for a case, when thickness of a film of a liquid it is a lot of less than length of a shear wave, and when cover-plate practically is in rest. In this case settlement formula of shear elasticity has a kind:

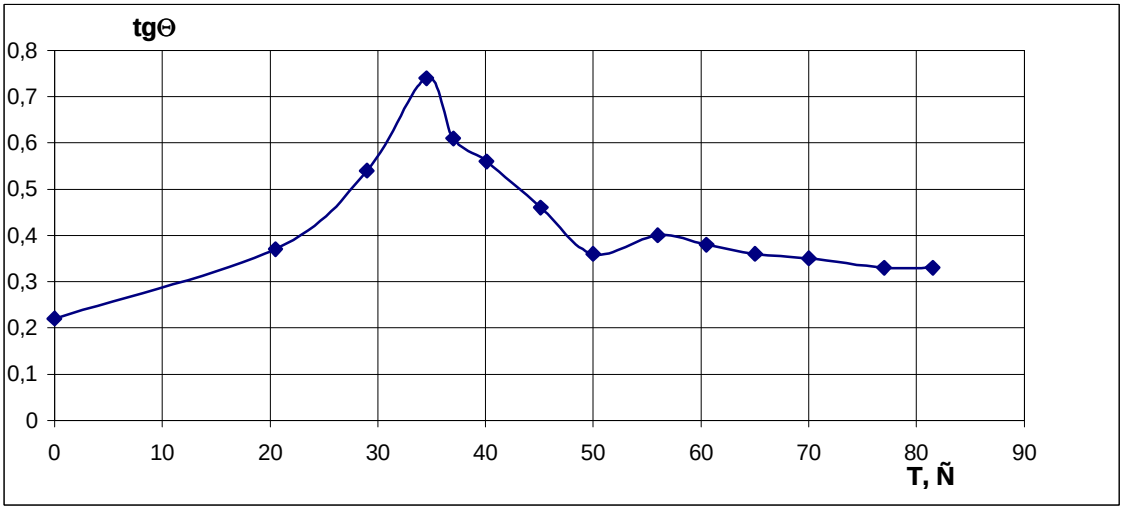
$$G' = \frac{4\pi^2 M f_0 \Delta f' H}{S}, \qquad (2)$$

where M - mass of piezoquartz, Δf ' - real shift of frequency. Tangent of mechanical loss angle

$$\mathrm{tg}\theta = \frac{G''}{G'} = \frac{\Delta f''}{\Delta f'} \qquad (3)$$

where the imaginary shift of resonance frequency Δf" is equal, by definition, half of change of width of a resonant curve. Experimentally measurable values were: thickness of a layer of a liquid, shift of resonance frequency and change of width of a resonance curve of piezoquartz. On the found values, under the formulas (2) and (3), basic viscoelastic properties of liquids (the dynamic shear modulus G' and the tangent of mechanical loss angle tgθ, equal to the ratio of the imaginary modulus G" to real G') have been calculated. G" is a measure of that part of energy of elastic fluctuations, which turns to heat, i.e. G" characterizes dissipation of energy of fluctuations in viscoelastic body.

The results of investigations for creosote are submitted on Fig.1. It is visible, that the modulus of elasticity of creosote decreases exponentially depending on temperature. The dependence tangent of mechanical loss angle has two maxima,



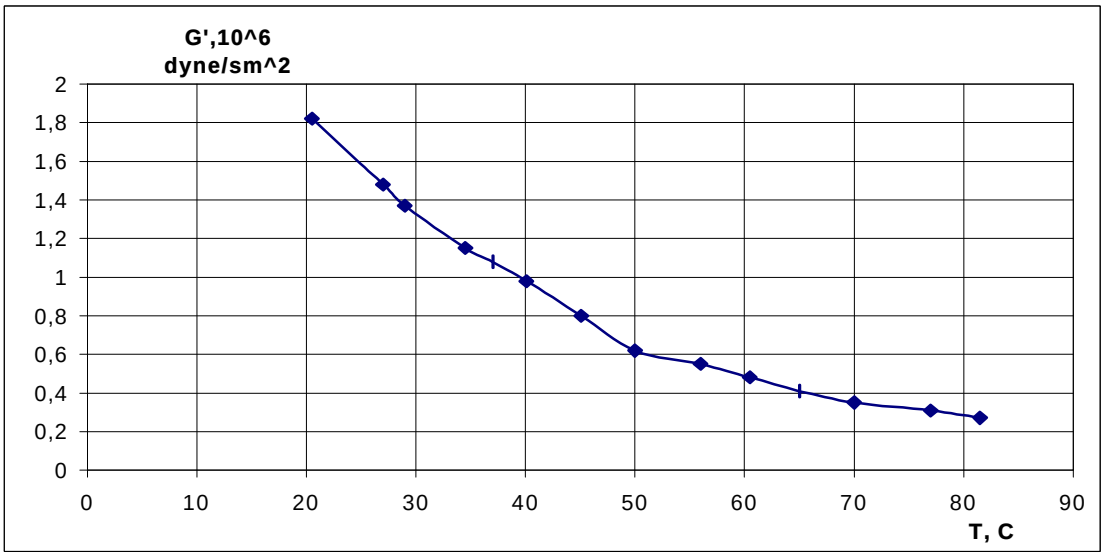


Fig.1.

that speaks, probably, about presence two relaxation frequencies connected to two kinds relaxation in creosote. The dependence of imaginary shift on temperature passes through a maximum, that speaks that at this temperature the maximum of absorption is observed.

Concentration dependence of viscoelastic properties of a solution of bitumen with diesel fuel at temperature of the order 20°Ñ.

Liquid	G', 10^6, dyne/sm^2	G'', 10^6, dyne/sm^2	tgθ	f_{rel}, kHz
Bitumen 20 %	1,36	0,66	0,486	35,57
Bitumen 10 %	0,58	0,152	0,262	19,2
Bitumen 5 %	0,56	0,072	0,12	8,78
Bitumen 0%	0,45	0,067	0,15	10,98

Concentration dependence of viscoelastic properties of a solution PEK with diesel fuel at temperature of the order 19°Ñ.

Liquid	G', 10^6, dyne/sm^2	G'', 10^6, dyne/sm^2	tgθ	f_{rel}, kHz
PEK 50 %	0,56	0,13	0,23	16,84
PEK 40 %	0,58	0,25	0,43	31,5
PEK 25 %	0,25	0,13	0,52	37,99
PEK 12,5 %	0,43	0,125	0,291	21,3
PEK 0%	0,45	0,067	0,15	10,98

Thus, investigation of viscoelastic properties of impregnate solutions:

- shown, that all investigated solutions have low-frequency elasticity, that testifies to structure of a liquid,
- have allowed to calculate resonant frequencies.

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