STRUCTURAL MATERIALS IN SHIPBUILDING
AND NATIONAL ECONOMY

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ABSTRACT

There is a strong tendency in modern shipbuilding toward polymerbased materials (PBM) expansion, which creates fundamentally new opportunities for development of new technique.

The state of developments and the areas of application have been considered for glass-plastics, carbon plastics, sphere plastics, damping layer materials and boronaluminium.

The features of polymer-based structural materials application in shipbuilding are as follows.
- heavy-zired structures (in many cases with heavy thicknesses) are being developed in shipbuilding as compared to products for air-space systems,
- a necessity to ensure physico-mechanical properties stability to eliminate the degradation of material in the course of long-term service in a rather aggressive medium like sea water, deep-water technical devices are operating at compression which leads to more stringent requirements to materials rigidity and to structures stability as a whole.

In this paper we are going to consider some examples to illustrate the prospects of structural materials application in shipbuilding and national economy.

In 1964, the world largest (for that period) non-magnetic ship was constructed in the USSR. She had 340 tonnes displacement and a hull made in oligoestrermaleinatracrilate-based polyester resin reinforced by glassfabric.

All these years (a quarter of a century) the developments based on this resin have been continued. As a result, the content of toxic monometre-styrol has been sharply reduced. The
full elimination of styrol in volatile substance composition for the manufacturing technology of ship hulls in glassplastic is ensured by cobalt accelerator implantation in resin directly. Incorporation of phosphorus-containing antppyren and metal organic catalyst in resin give an order of magnitude reduction of colorimetre factor (from 8,5 to 0,5).

Utilisation of non-toxic, environmentally pure binder (without styrol precipitation) with elevated fire protective properties and the development of structures heat treatment conditions aimed to reduce the precipitation of volatile substances in air of habitual rooms up to the required level, allow to use the polyester glassplastic not only for ship hulls but for yachts and boats.

Reinforcing materials hybridization is the best way to enhance the serviceability of non-metallic hull of a ship. (Table 1).

<table>
<thead>
<tr>
<th>Reinforcing material and filler in hybrid PSM planking</th>
<th>Density g/sm$^3$</th>
<th>Elastic modulus MPa $10^{-4}$</th>
<th>Ultimate tensile strength $\sigma_p$ $\sigma_r$ $\sigma_m$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glassfabric</td>
<td>1.6</td>
<td>1.7</td>
<td>430</td>
</tr>
<tr>
<td>Glassfabric, hollow microspheres</td>
<td>1.0</td>
<td>1.0</td>
<td>190</td>
</tr>
<tr>
<td>High-modulus glassfabric, carbon strip</td>
<td>1.5</td>
<td>3.1</td>
<td>400</td>
</tr>
<tr>
<td>Glassorganofabric, hollow microspheres</td>
<td>0.85</td>
<td>0.8</td>
<td>120</td>
</tr>
</tbody>
</table>

Hybride materials, combining reinforcing components of different chemical nature (glass, carbon fibers, hollow non-organic microspheres) not only increase the service-ability of the ship hull but sharply reduce the strengthening elements of hull planking, reduce the hull mass due to "three-layer" structure of material: Carrier layers are manufactured using high-modulus carbon and organic fibers in order to achieve high-strength and rigidity of structure. High bending rigidity at low integral density (0.85 g/sm$^3$) is achieved due to application of light microdispersion filler in the middle layer. The increase of material impact strength is ensured due to efficient combining of material as to thickness, creating layer structure which absorb the energy of impact load.

The suggested multilayer hybride materials can be applied as a shell of hulls and ships of the displacement of 1000 t, and also for non-outfit fairwater of hydroacoustic stations of fish ships.

To get over mass inhomogeneity of structure is the most serious task of material science of composites. It can be demonstrated having in mind the development of sphere plastics—light high strength composite with hollow microspheres in structure. The sphereplastic provides the buoyancy of deep water en-