VIBRORHEOLOGY: MAIN RESULTS, NEW PROBLEMS

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Summary A brief review of the results in the field of vibrational rheology developing very intensively is presented. A particular attention has been given to the latest results. Some problems unsolved as yet are also enumerated.

EXTENDED SUMMARY

During the recent years a noticeable interest of the researches is paid to the problems concerning the action of vibration on different nonlinear media such as solid bodies, granular materials, polymeric materials, concrete mixtures, suspensions, pulps, etc. The cases when the behavior of the system is essentially changed under the action of vibration are of the greatest interest both principal and applied.

For the problems stated above P. A. Rebinder suggested the name *vibrorheology*. The authors of this presentation defined vibrorheology as part of nonlinear mechanics and rheology which studies the change (caused by vibration – i.e by fast motions) of rheological properties of bodies with respect to "slow forces" and also the corresponding slow motions of bodies[1]. Vibrorheology is also part of vibrational mechanics [2] – the mechanics for the observer "who does not notice the fast forcers or fast motions" (for the observer "**V**")[2, 3].

Two essential moments should be emphasized: 1) in most cases it is expedient to speak of vibrorheological effects as of the seeming ones, which take place only for the observer "**V**"; 2) as a result of the action of vibration on the nonlinear mechanical systems, in the general case there is not only a change in the rheological characteristics or properties of the body with respect to slow actions, but there also appear either driving or shifting forces or torques.

The approaches of the vibrational mechanics, in particular the method of direct separation of motions, allow to solve the problems of the vibrorheology by the most simple and natural way. In this case it becomes possible to formulate the certain general vibrorheological regularities:

For systems with dry friction and for vibro-shock systems:

Forces of dry friction type, possibility of repetitive shock interactions	+ vibration =	slow vibrational forces of viscous friction type + additional slow vibrational forces + either random or determined vibration

For the nonlinear systems with viscous friction:

Forces of viscous friction	+ vibration =	slow forces of the transformed viscous friction + additional slow vibrational forces + random or determined vibration

The last terms in the right-hand sides of these conventional formulas point to the fact that the resultant oscillations, even under a determined action, are often of a random character, for example, due to the statistic character of the micro-properties of bodies or elements these bodies consist of. Recall that when speaking of the vibrational action, we do not necessarily mean an external effect, but also the effect of either a random or determined vibration, appearing within the autonomous system. These general regularities are clearly displayed when the considering certain problems of vibrorheology. Among such problems the paper considers:

1. Effective friction coefficients during vibration; vibrational conception of sliding friction. 2. Action of vibration on the systems with positional-viscous resistance. Effects of asynchronous suspression and excitation of self-oscillations. 3. Vibrorheology of granular materials. 4. The action of vibration on nonlinear-elastic media. 5. Vibrational hydraulics and hydrodynamics. 6. Vibrational control of rheological properties of bodies. The Indian magic rope effect. The problem of the creation of vibrational dynamic materials.

The paper contains a brief review of the researches in the enumerated directions and a main attention is given to the latest publications. Besides the investigations made by the authors the paper considers the publications by V.M. Chelomey, S.V.Chelomey, V.A.Palmov, G.I.Barenlatt, S.M.Meerkov, M.Zak, K.A.Lurie, D.M.Tolstoy, J.J.Thomsen, S.V.Sorokin, O.A.Ershova, S.V.Grishina, H. Dresig, and other scientists. Specific references to these researches are to be found in the book [3].

The authors mention among the important problems of vibrorheology (either unsolved or solved only partly) the problems of controlling the vibrorheological properties of the media as well as the construction of vibrorheological simulations of vibrational fatigue, vibroflow and vibrocreeping.

The work is carried out with the support of the Russian Foundation of the Fundamental Researches (Grant SSC 1521.2003.8).

References

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