

How to look for the keys to success of van der Waals type equations of state

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The van der Waals (vdW) equation—one of the symbols of physics—is 150 years old. Equations of state (EOSs) of the vdW type are represented by cubic equations, which even today remain of interest for fundamental science. For example, how to explain that an insignificant modification improves by an order of magnitude calculation results. Probably, the keys to the reasons for the success of cubic EOSs should be sought not only from mathematicians. This work continues the “cognitive” search at the micro level and can be considered as another proposal to look at the issues that exist for vdW-type EOS from a new angle. The results we obtained for the model of interacting point centers, including two analytical expressions for the critical compressibility factor (CCF), served as the basis for remotely joining the scientific controversy regarding an expression for the CCF obtained by JH Vera, one of the enthusiasts of EOS problems. Thus, we did not just pay tribute to one “interesting” expression for the CCF obtained independently at different times—2015 (Vera), 2010 (Petrik), 1985 (Laval), 1980 (Shmidt–Wenzel)—but and emphasized the possibilities of the new model, within the framework of which the resulting relationships were filled with physical meaning, determined by the manifestation of the attraction and repulsion forces and their relationship. The significance of the new expression for the CCF is determined by the fact that it relates two parameters from the hierarchy of factors that shape the properties of the two models—interacting point centers and spherical shells.