

## Correlation and Prediction of Biodiesel Density

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**Abstract :** The knowledge of biodiesel density over large ranges of temperature and pressure is important for predicting the behavior of fuel injection and combustion systems in diesel engines, and for the optimization of such systems. In this study, cottonseed oil was transesterified into biodiesel and its density was measured at temperatures between 288 K and 358 K and pressures between 0.1 MPa and 30 MPa, with expanded uncertainty estimated as  $\pm 1.6 \text{ kg}\cdot\text{m}^{-3}$ . Experimental pressure-volume-temperature (pVT) cottonseed data was used along with literature data relative to other 18 biodiesels, in order to build a database used to test the correlation of density with temperature and pressure using the Goharshadi-Morsali-Abbaspour equation of state (GMA EoS). To our knowledge, this is the first that density measurements are presented for cottonseed biodiesel under such high pressures, and the GMA EoS used to model biodiesel density. The new tested EoS allowed correlations within  $0.2 \text{ kg}\cdot\text{m}^{-3}$  corresponding to average relative deviations within 0.02%. The built database was used to develop and test a new full predictive model derived from the observed linear relation between density and degree of unsaturation (DU), which depended from biodiesel FAMES profile. The average density deviation of this method was only about  $3 \text{ kg}\cdot\text{m}^{-3}$  within the temperature and pressure limits of application. These results represent appreciable improvements in the context of density prediction at high pressure when compared with other equations of state.

**Keywords :** biodiesel density, correlation, equation of state, prediction

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