Both experimental results and expressions (6.7) are plotted in figure 6.3.

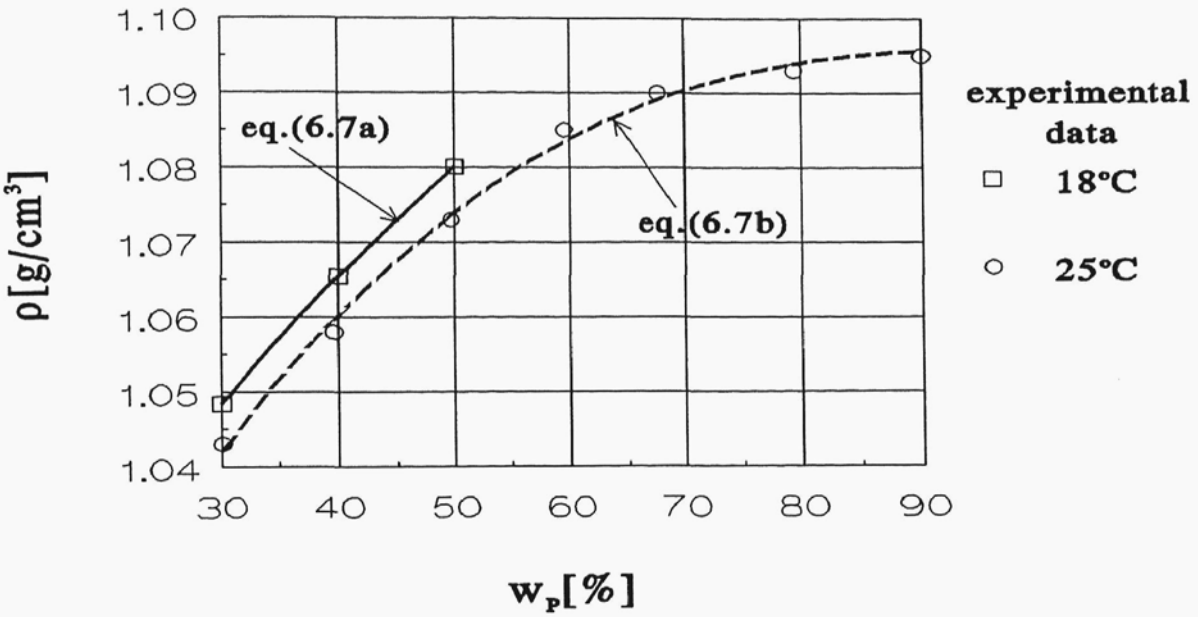

Figure 6.3. Density of the polymer aqueous solutions.

Analysis of these data indicates that even for very high contents of the polymer, density of the resulting aqueous solution increases no more than 10% of the density of pure water. It should be noted, however, that viscosity as well as density of aqueous solutions of polyethylenepolypropylene glycol may differ slightly for various batches of the same polymer.

6.2.4. Chemical Activity.

As stated earlier polyethylenepolypropylene glycol is an aliphatic polyether. This implicates its low chemical activity at normal conditions [78]. Aliphatic ethers are in general weak bases (approximately 100 times weaker than water), because of the presence of free electron pair near oxygen atom. At elevated temperatures and in presence of catalyst polyalkylene glycol may be subjected to radical reactions eg. chlorination or oxidization. In presence of very strong bases (e.g. carbanions) aliphatic ethers take part in ion reactions leading to their decomposition according to the following scheme [78]:

$$CH_3^{\ominus} + CH_3CH_2\text{-}O\text{-}CH_2CH_3 \rightarrow CH_4 + CH_3CH^{\ominus}\text{-}O\text{-}CH_2CH_3 \qquad (6.8)$$
$$CH_3CH^{\ominus}\text{-}O\text{-}CH_2CH_3 \rightarrow CH_2{=}CH_2 + CH_3CH_2O^{\ominus} .$$

Very strong acids may also cause degradation of aliphatic ethers, e.g. long heating of ether with concentrated iodic acid results in

$$CH_3CH_2\text{-}O\text{-}CH_2CH_3 + H^+ \rightarrow CH_3CH_2\text{-}O^{\oplus}(H)\text{-}CH_2CH_3$$
$$I^- + CH_3CH_2\text{-}O^{\oplus}(H)\text{-}CH_2CH_3 \rightarrow CH_3CH_2\text{-}I + CH_3CH_2OH \,. \qquad \textbf{(6.9)}$$

Experiments with the test reactions (6.1) can be carried out at room temperatures provided that the test reactants (HCl, NaOH, $CH_2ClCOOC_2H_5$) are diluted. All experimental results presented in this work were obtained at temperatures not higher than 25°C, whereas initial concentrations of the substrates were not exceeding 0.2 mol/dm^3. It was experimentally confirmed that in such conditions neither substrates nor products of the test reactions (6.1) can cause degradation of the polymer.

Density, viscosity, transparency and refractive index of aqueous solutions of polyethylene-polypropylene glycol are slightly affected by hydrochloric acid provided that concentration of acid does not exceed 0.2 mol/dm^3. For concentrations of HCl close to 1 mol/dm^3, viscosity of the polymer solutions falls approximately 10% below values computed from expression (6.5) and the solution smells during preparation.

When treated with sodium hydroxide aqueous solutions of the polymer may form colloidal suspension. The process is reversible; dilution of colloidal suspension with water recovers transparency. Table 6.IV presents limiting values of concentrations of NaOH, which, when exceeded, result in formation of colloidal suspension. These values were obtained through dilution of colloidal suspensions until complete transparency was regained.

Table 6.IV. Limiting NaOH concentrations in the polymer aqueous solutions at 25°C.

w_P[%]	4.85	8.41	10.73	13.51	15.41	18.16	25.32
c_{NaOH}[mol/kg]	0.867	0.766	0.716	0.651	0.627	0.576	0.430

w_P[%]	28.26	37.21	45.36	50.22	55.75	58.50
c_{NaOH}[mol/kg]	0.376	0.268	0.162	0.149	0.129	0.097

Experimental data reported in table 6.IV and approximating expression

$$c_{NaOH} = 2.11 \cdot w_P^2 - 2.74 \cdot w_P + 0.99 \qquad \textbf{(6.10)}$$

are plotted in figure 6.4.

Density, viscosity and refractive index of transparent solutions were found to be no more than

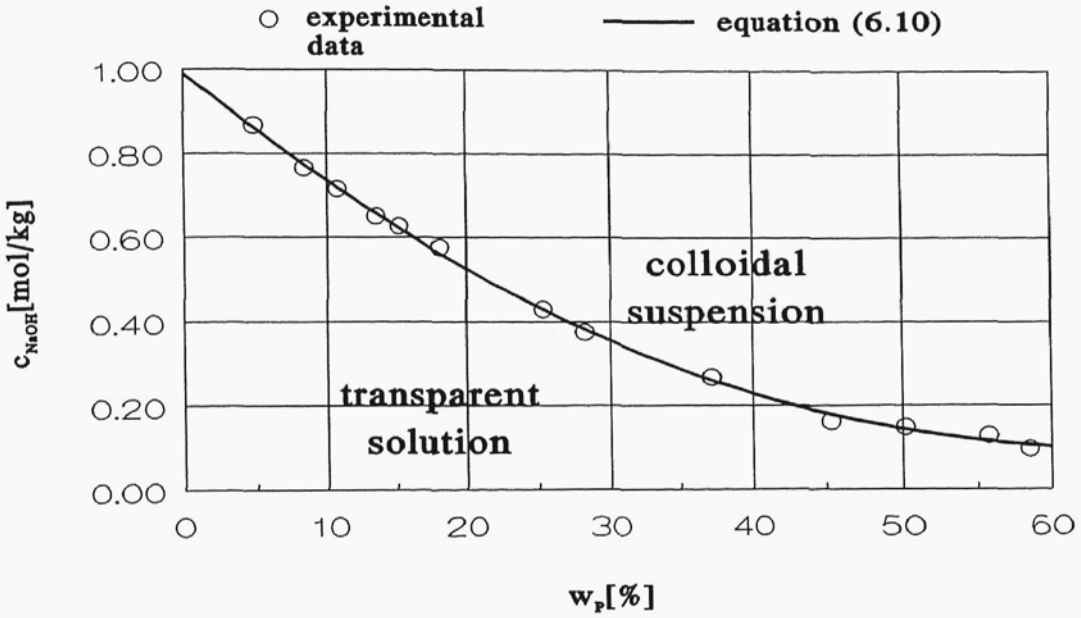

Figure 6.4. Limiting NaOH concentrations in aqueous solutions of polyethylene-polypropylene glycol at 25°C.

a few percents different from the values obtained for solutions without NaOH but containing the same amount of the polymer.

Density, viscosity of the solutions were thus measured before and after each experiment. pH-titrations of aqueous solutions of the viscosity increasing agent containing up to 1 mol/dm^3 of either HCl or NaOH showed that falls in hydrogen and hydroxide ions concentration are practically undetectable after 24 hours since preparation of solution.

Similarly as in the case of HCl and NaOH, concentration of ethyl chloroacetate in aqueous solutions of the polymer is slightly decreased after 24 hours. Additionally, it was found that polyethylenepolypropylene glycol considerably increases solubility of ethyl chloroacetate as well as solubility of other aliphatic esters in water.

6.2.5. Alkalinity of Aqueous Solutions.

Aqueous solutions of the viscosity increasing agent have alkaline reaction. pH-titration of solution containing 9.1 weight percents of the polymer was performed to determine alkalinity of this substance. Titration was conducted by means of 0.1N HCl, whereas pH values were determined with a standard, combined, pH electrode. Figure 6.5 shows titration curve obtained in this test. An equilibrium point can be found close to pH=7, which confirms the presence of 9.7 mmol of base per kilogram of the polymer. A theoretical pH-titration