

where

$$v = 0.0571 \cdot \left(1 - 0.652 \cdot \frac{R_2 - R_1}{R_1} \right) + 0.00056 \cdot \left(1 - 0.652 \cdot \frac{R_2 - R_1}{R_1} \right)^{-1}. \quad (8.10)$$

In the case when $\mu=0.51$ Pa·s and $\rho=1072$ kg/m³, the critical value of the modified Reynolds number, Re_s , in the reactor equals 91.5, whereas in the experiments Re_s never exceeded 13.9. The visual observations of mixing during the experiments proved that the stratified structure created in the annular gap was not disturbed by Taylor vortices; the gradually thinning striations remained vertical.

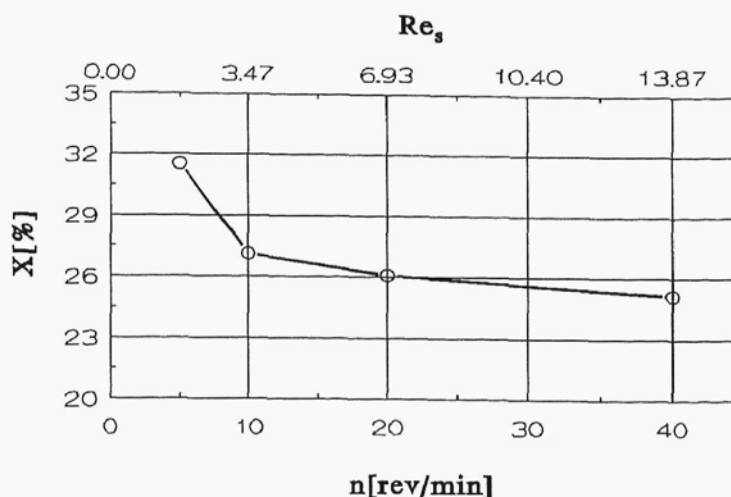


Figure 8.5. Effect of the rotational speed on the final selectivity in the batch reactor - experimental results.

It was also noticed that thinning of striations was accompanied with decolouration of phenolphthalein in the liquid initially containing sodium hydroxide. The process of decolouration was usually completed after 10 to 20 minutes from the beginning of the test; it was very difficult to determine precisely the moment of complete neutralization of NaOH.

Analysis of figure 8.5 indicates that increasing the rotational speed of the inner cylinder improves mixing in the reactor. It should be noted, however, that differences between selectivity values are very small for $n \geq 10$ rev/min, because in the Couette flow, the deformation rate for long times ($t \gg 1/G$) becomes inversely proportional to time and is not dependent on the shear rate G - equation (8.8). During the experiments G was ranging from 1.6 to 21.5 s⁻¹ so, after a few revolutions of the inner cylinder the rate of thinning was practically independent of the rotational frequency. This explains weak influence of n on the final selectivity.

8.2.2. Effect of the Initial Volume Ratio on the Product Distribution.

In the second series of tests the effect of initial volume ratio was studied for the revolution speed $n=10$ rev/min. The experiments were carried out at 18°C. Tables 8.IIabc report compositions, volumes, viscosities and densities of solutions and final selectivities

obtained in these experiments. The plot of the final selectivity versus the volume ratio $a(=V_{\text{HCl+ester}}/V_{\text{NaOH}})$ is presented in figure 8.6. This plot also contains one experimental point from the first series of tests (exp.no. 2 in tables 8.Iabc).

Table 8.IIa. Second series of tests - the acid and ester solutions; $w_p=42\%$, $n=10$ rev/min.

Exp.no.	HCl [mol/dm ³]	Ester [mol/dm ³]	V [dm ³]	ρ [g/cm ³]	μ [Pa·s]	KCl [g/kg]
1	0.01696	0.01572	1.493	1.0695	0.5154	2.801
2	0.01987	0.01975	1.232	1.0700	0.5134	1.850
3	0.02433	0.02431	1.008	1.0687	0.5283	0.0
4	0.03229	0.03286	0.7457	1.0688	0.5230	0.0
5	0.05137	0.04825	0.4652	1.0693	0.5339	0.0
6	0.1023	0.09109	0.2683	1.0710	0.5373	0.0

Table 8.IIb. Second series of tests - the base solutions; $w_p=42\%$, $n=10$ rev/min.

Exp.no.	NaOH [mol/dm ³]	V [dm ³]	ρ [g/cm ³]	μ [Pa·s]	KCl [g/kg]
1	0.04872	0.4861	1.0707	0.5590	0.0
2	0.03165	0.7294	1.0688	0.5302	0.0
3	0.02429	0.9710	1.0689	0.5969	0.0
4	0.01900	1.236	1.0694	0.5274	1.034
5	0.01539	1.506	1.0695	0.5194	2.100
6	0.01385	1.747	1.0708	0.5198	4.570

Table 8.IIc. Second series of tests - final solutions after experiment; $n=10$ rev/min.

Exp.no.	Ester [mol/dm ³]	X[%]	V [dm ³]	ρ [g/cm ³]	μ [Pa·s]
1	.009278	21.58	1.998	1.0699	0.5141
2	0.01029	18.02	1.962	1.0694	0.5141
3	0.01084	12.90	1.980	1.0683	0.5285
4	0.01171	10.03	1.983	1.0688	0.5246
5	0.01035	8.73	1.972	1.0691	0.5236
6	0.01106	8.86	2.015	1.0710	0.5138

Figure 8.6 shows that the effect of the initial volume ratio on the product distribution is strong; change of the volume ratio from 7:1 to 1:7 decreases the selectivity 3 times. This indicates that mixing in the batch reactor can be significantly improved by using larger volume of the less concentrated base solution and smaller volume of the more concentrated acid and ester solution.

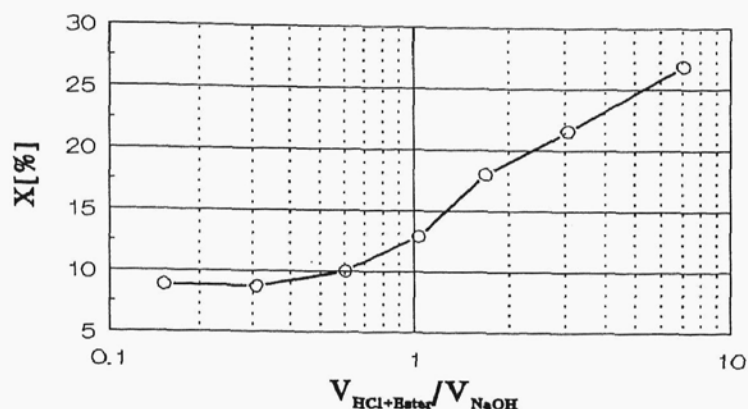


Figure 8.6. Effect of the initial volume ratio on the final selectivity in the batch reactor - experimental results.

8.2.3. Effect of the Viscosity Ratio on the Product Distribution.

The third series of the experiments was conducted to find how the difference in viscosity of mixed solutions influence the product distribution. During these experiments viscosity of the acid and ester solution was constant, whereas the viscosity of the base solution was changed from one experiment to another. The initial distribution of the solutions was identical as in the first series of tests (one eighth of the gap occupied by the base solution). In all the experiments the revolution speed was equal to 10 rev/min. The experiments were carried out at 18°C. Tables 8.IIIabc present compositions, volumes, viscosities and densities of solutions together with the final selectivities. These results are compared with the result obtained when mixing liquids of equal viscosity (exp.no. 2 in tables 8.Iabc) in figure 8.7.

Table 8.IIIa. Third series of tests - the acid and ester solutions; $w_p=42\%$, $n=10$ rev/min.

Exp.no.	HCl [mol/dm ³]	Ester [mol/dm ³]	V [dm ³]	ρ [g/cm ³]	μ [Pa·s]	KCl [g/kg]
1	0.01430	0.01324	1.734	1.0889	0.4922	32.40
2	0.01412	0.01341	1.743	1.0822	0.4873	21.83
3	0.01391	0.01413	1.735	1.0684	0.5209	0.0
4	0.01391	0.01413	1.748	1.0684	0.5209	0.0
5	0.01396	0.01329	1.738	1.0693	0.5276	0.0