sodium hydroxide and N_{NaOH} is the number of moles of base added to the reactor and consumed in reaction with acid and ester.

7.2. Experimental Results.

7.2.1. Effect of the Feeding Time on the Product Distribution.

The feeding time can influence the product distribution in two ways. Very fast feeding can produce high concentration gradients on the macroscopic scale (comparable with the reactor size). Inhomogeneity on the macroscale retards mixing on the molecular scale (high diffusion times) and consequently elevates the final selectivity. On the other hand, in the case of very slow feeding the initial size of the inlet stream can be very small. This results in faster diffusional mixing, which decreases the final selectivity. As it can be seen, it may be impossible, even in the case of very slow feeding, to avoid influence of the feeding time on the product distribution.

Two series of experiments were conducted in the semi-batch reactor to determine the effect of the feeding rate on the final selectivity. In the first series the agitation speed was equal to 100 rev/min, whereas in the second series the agitation speed was equal to 400 rev/min. The viscosities and densities of mixed solutions were kept constant and almost equal to each other. The initial volume ratio $a=V_{HCl+ester}/V_{NaOH}$ was equal to 19.

Tables 7.Iabc and 7.IIabc show compositions, volumes, viscosities and densities of the solutions together with feeding rates Q_f and final selectivities of the reaction. Figure 7.2 presents the final selectivities plotted versus the feeding time.

Table 7.Ia. First series of tests - initial reactor content; w_p=40%.

Exp.no.	HCl [mol/dm^3]	Ester [mol/dm^3]	V [cm^3]	ρ [g/cm^3]	μ [Pa·s]	KCl [g/kg]
1	0.01012	0.01024	680.10	1.0680	0.306	11.50
2	0.01029	0.01030	680.04	1.0684	0.307	11.56
3	0.01012	0.01024	680.10	1.0680	0.306	11.50
4	0.01025	0.01056	680.04	1.0681	0.303	11.50
5	0.01025	0.01056	680.04	1.0681	0.303	11.50
6	0.01013	0.01066	680.17	1.0679	0.305	11.50

Table 7.Ib. First series of tests - feeding solution; w_P=40%.

Exp.no.	NaOH [mol/dm^3]	V [cm^3]	ρ [g/cm^3]	μ [Pa·s]
1	0.1974	35.79	1.0686	0.329
2	0.2008	35.79	1.0682	0.330
3	0.1974	35.79	1.0686	0.329
4	0.1998	35.79	1.0685	0.331
5	0.1998	35.79	1.0685	0.331
6	0.1987	35.79	1.0685	0.330

Table 7.Ic. First series of tests - final solutions after experiment; n=100rev/min, a=19.

Exp.no.	Q_f [cm^3/min]	Ester [mol/dm^3]	X [%]	V [cm^3]	ρ [g/cm^3]	μ [Pa·s]
1	2	0.005685	41.00	715.77	1.0682	0.306
2	1	0.005763	37.25	716.03	1.0681	0.305
3	0.5	0.006493	32.81	715.77	1.0682	0.307
4	0.385	0.006948	30.90	715.91	1.0680	0.305
5	0.25	0.007200	28.38	715.91	1.0680	0.306
6	0.18	0.007786	23.55	715.84	1.0681	0.307

Table 7.IIa. Second series of tests - initial reactor content; w_P=40%.

Exp.no.	HCl [mol/dm^3]	Ester [mol/dm^3]	V [cm^3]	ρ [g/cm^3]	μ [Pa·s]	KCl [g/kg]
1	0.01073	0.01025	679.98	1.0679	0.304	11.25
2	0.01014	0.01093	680.04	1.0681	0.305	11.50
3	0.009758	0.01050	680.10	1.0680	0.304	11.53
4	0.009758	0.01050	680.10	1.0680	0.304	11.53

Table 7.IIb. Second series of tests - feeding solutions; w_P=40%.

Exp.no.	NaOH [mol/dm^3]	V [cm^3]	ρ [g/cm^3]	μ [Pa·s]
1	0.1999	35.79	1.0686	0.330
2	0.2003	35.79	1.0682	0.328
3	0.1977	35.79	1.0687	0.329
4	0.1977	35.79	1.0687	0.329

Table 7.IIc. Second series of tests - final solutions after experiment; n=400rev/min, a=19.

Exp.no.	Q_f [cm^3/min]	Ester [mol/dm^3]	X [%]	V [cm^3]	ρ [g/cm^3]	μ [Pa·s]
1	1	0.008201	15.39	715.79	1.0679	0.304
2	0.59	0.008374	12.13	715.84	1.0681	0.305
3	0.385	0.008595	14.00	715.92	1.0680	0.307
4	0.3	0.008499	14.98	715.92	1.0680	0.306

The experimental results show that increasing the feeding time, t_f, has no effect on the final selectivity in the case when agitation speed equals 400 rev/min (Re=24). On the other hand, in the case when agitation speed equals 100 rev/min (Re=6) this effect is detectable even for long feeding times.

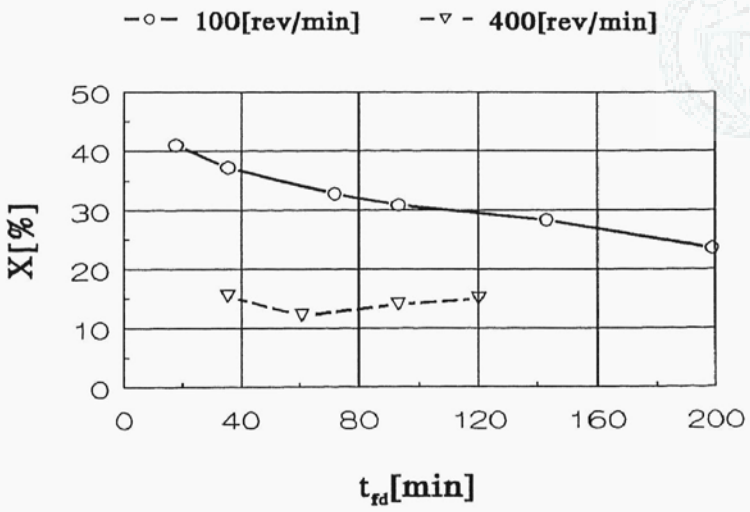

Figure 7.2. Effect of the feeding time on the final selectivity in the semi-batch reactor - experimental data.

7.2.2. Effect of the Rotational Speed on the Product Distribution.

The rate of mixing is strongly related to the local deformation rate of liquid elements - see chapter 3.1. The local deformation rates are directly dependent on the rotational speed of the pitched-blade turbine in the experimental system. The third series of experiments was performed to determine the magnitude of this effect.