Acid-catalysed Racemisation of 1-*Methylheptyl Acetate.*

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[Reprint Order No. 4892.]

1-Methylheptyl acetate racemises when heated, in acetic acid solution, with strong acids.

Other esters of octan-2-ol, when heated with acetic acid in presence of strong acids, undergo some racemisation and yield extensively racemised 1-methylheptyl acetate. The reaction of 1-methylheptyl toluene-*p*-sulphonate with acetic acid occurs mainly with inversion of configuration.

EXPERIMENTS on the racemisation and reactions of 1-methylheptyl esters in acetic acid solution, which were referred to in a preliminary note (Balfe and Kenyon, *Nature*, 1941, **148**, 196), are summarised in Tables 1 & 2. These experiments arose from an investigation of the reaction of optically active 1-methylheptyl toluene-*p*-sulphonate with acetic acid which was complicated by the continuous racemisation of the resulting acetate by the toluene-*p*-sulphonic acid formed along with it. Under conditions which retard this racemisation, *e.g.* by extensively diluting the reactants with benzene (cf. the sixth and seventh experiments in Table 1), 1-methylheptyl toluene-*p*-sulphonate reacts with acetic acid to yield 1-methylheptyl acetate with 80% inversion of configuration.

TABLE 1. *Racemisation of* 1-*methylheptyl acetate* [all quantities are given in mols. per mol. of ester].

Acetic acid	Strong acid	Amount	Diluent	Amount	Hours on steam-bath	% Racemn. of recovered ester	$t_{\frac{1}{2}}$ racemn. hr.
50	—	0	—	0	48	0	—
18	$Me{\cdot}C_6H_4{\cdot}SO_3H$	1	—	0	12	18	—
18	,,	1	—	0	36	58	—
16	,,	1	H_2O	5	12	6	—
7	,,	1	—	0	24	96	—
7	,,	1	C_6H_6	45	24	8	—
2	,,	1	,,	11	12	8	—
2	,,	1	,,	11	36	41	—
2	,,	1	AcOEt	10	12	0	—
2	,,	1	,,	10	36	4	—
8	,,	1	—	0	12	2	—
18	H_2SO_4	0·5	—	0	24	100	3
16	,,	0·5	H_2O	5	24	64	16
7·5	,,	0·5	—	0	24	98	—
2	,,	0·5	Ac_2O	9	24	62	12
2	,,	0·5	COMeEt	10	24	50	24
2	,,	0·5	Dioxan	10	24	34	35 *
0	,,	0·5	,,	12	24	39	40 *
18	,,	0·5	—	0	3	53	3
14	,,	0·5	$MeNO_2$	4·5	3	43	4
11	,,	0·5	,,	9	3	50	3
8	,,	0·5	,,	13	3	69	2
4	,,	0·5	,,	18	3	83	1
18	,,	0·25	—	0	24	64	17
16	HCl	1	H_2O	5	12	69	—

* Extrapolated.

Hughes, Ingold, and Masterman (*J.*, 1939, 840) showed that 1-methylheptyl acetate, prepared by acid-catalysed esterification of (+)-octan-2-ol during 2—5 hours at 100°, is 30% racemic. We find that when the (+)-acetate is heated with acetic acid and sulphuric acid in proportions corresponding to the final concentrations of that experiment, the acetate is 7% racemised after 2·5 hours and 15% racemised after 5 hours. The conclusion of Hughes, Ingold, and Masterman (*loc. cit.*) that some racemisation occurs during the acid-catalysed esterification therefore remains valid though part of the racemisation which they observed may have occurred subsequently to the formation of the ester.

TABLE 2. *Formation of* 1-*methylheptyl acetate by the action of acetic acid* (*in the presence of a strong acid*) *on other* 1-*methylheptyl esters* [quantities are given in mols. per mol. of ester].

Acetic acid	Strong acid	Amount	Diluent or other reactant	Amount	Hr. on steam-bath	Original ester		Acetate formed	
						% recovd.	% racemn.	% isolated	% racemn.
1-*Methylheptyl benzoate.*									
18	$Me\cdot C_6H_4\cdot SO_3H$	1	$Ph\cdot CO_2H$	2	12	—	9	25	65 †
18	H_2SO_4	0·5	,,	2	12	30	15	24	99 *
18	,,	0·5	,,	2	24	12	39	32	99 *
18	,,	0·5	,,	2	36	12	62	37	99 *
18	,,	0·25	,,	2	12	—	2	—	62 *
18	,,	0·12	,,	2	12	—	0	—	62 *
0	,,	0·5	,, Dioxan	2 12	24	—	5	—	—
1-*Methylheptyl* o-*nitrobenzoate.*									
18	$Me\cdot C_6H_4\cdot SO_3H$	1	$NO_2\cdot C_6H_4\cdot CO_2H$	2	12	—	21	25	96 *
1-*Methylheptyl hydrogen phthalate.*									
18	,,	1	$C_6H_4(CO_2H)_2$	2	12	—	0	18	58 †

* Inverted configuration. † Retained configuration.

EXPERIMENTAL

Racemisation of 1-*Methylheptyl Acetate.*—The maximum reported rotatory power for the (+)-ester, from (+)-octan-2-ol, is $[\alpha]_D^{16}$ +6·90° (Houssa and Phillips, *J.*, 1929, 2510). Since, however, ester of varying optical purity was used the results of the experiments are recorded as % racemisation, *i.e.*, loss in rotatory power as % of original rotatory power. Approximately 3-g. portions of the acetate were heated on the steam-bath with the reactants and solvents and for the periods stated in Table 1. The maximum duration of continuous heating was limited by circumstances to 12 hr. and in more prolonged experiments two or more separate periods of heating were required, with intermediate cooling to room temp. during some 12 hr. It was established that 1-methylheptyl acetate does not undergo racemisation at room temperature under any of the experimental conditions used. The reaction mixture was finally diluted with water and extracted with ether, and the extract washed with water and sodium hydrogen carbonate solution until free from acid, dried with potassium carbonate, and concentrated. The residual 1-methylheptyl acetate was redistilled (b. p. *ca.* 90°/20 mm.) to constant refractive index (n_D^{20} 1·415—1·416), and the rotatory power of the homogeneous product observed. Where times of half-racemisation were recorded, larger amounts of ester were used and the equivalents of 3 g. of ester were withdrawn at 3-hr. intervals of heating for recovery of the ester as described above : $t_{\frac{1}{2}}$ was read from the plot of % racemisation against time. The solution darkened too rapidly to allow of continuous polarimetric observation.

Other esters were prepared by the reaction of optically pure octan-2-ol with the appropriate acid chloride or anhydride in presence of pyridine, and % racemisation was calculated on the assumption that the esters were optically pure (Table 2).

In all experiments, % racemisation was calculated on the assumption that optically pure 1-methylheptyl acetate has α_D^{17-22} +6·5° (*l*, 1) (Pickard and Kenyon, *J.*, 1911, **99**, 60; Hughes, Ingold, and Masterman, *loc. cit.*).

Racemisation of 1-*methylheptyl acetate* (cf. Hughes, Ingold, and Masterman, *loc. cit.*). A solution of the ester (10·3 g.; α_D^{16} +6·16°) in acetic acid (32·7 g.), containing water (1·3 g.) and sulphuric acid (0·59 g.), was heated in boiling water. Portions were withdrawn at intervals, and the ester recovered as previously described. The rotatory powers, α_D^{16}, of the recovered ester were : after 1·3 hr. 5·85°, 2·6 hr. 5·70°, 5·4 hr. 5·24°.

Reactions of 1-*Methylheptyl Toluene*-p-*sulphonate.*—The maximum observed rotatory power of this ester is α_D^{22} −7·41° (*l*, 1) : this value was employed to calculate the optical purity of the various specimens used : α_D^{16} +6·5° (*l*, 1) was used to calculate the optical purity of 1-methylheptyl acetate formed. From these two figures the % racemisation during reaction was calculated.

(i) *With sodium acetate in acetic acid.* The toluene-*p*-sulphonate (11·4 g.) (α_D^{22} +7·15°; *l*, 1) with sodium acetate (6·6 g., 2 mols.) in acetic acid (19·2 g., 8 mols.) was heated for 36 hr. on the steam-bath. The resulting acetate (1·9 g.), isolated as described above, had α_D^{20} −4·00°, *i.e.*, inversion of configuration and 35% racemisation had occurred.

(ii) *With acetic acid; no diluent.* A solution of the toluene-*p*-sulphonate (11·4 g.) (α_D^{22} +6·3°; *l*, 1) in acetic acid (19·2 g., 8 mols.) was heated on the steam-bath for 12 hr. The acetate obtained (1·8 g.) had α_D^{21} −1·25°, *i.e.* inversion of configuration and 80% racemisation had occurred.

(iii) *With acetic acid diluted with benzene.* The toluene-*p*-sulphonate (11·4 g.; α_D^{18} −5·2°) in acetic acid (19·2 g., 8 mols.) and benzene (114 c.c.) was heated on the steam-bath for 48 hr. The resulting acetate (1·7 g.) had α_D^{18} +2·9°, *i.e.*, inversion of configuration and 40% racemisation had occurred.

Thanks are expressed to Imperial Chemical Industries Limited for a grant.

BATTERSEA POLYTECHNIC, LONDON, S.W.11. [*Received, December* 15*th*, 1953.]