83. *Some Symmetrical Acylarylureas.*

By Edward N. Abrahart.

The preparation of *s*-benzoyl- and *s*-*p*-nitrobenzoyl-arylureas by general methods proceeds normally; on the other hand, that of *s*-3-hydroxy-2-naphthoylarylureas is complicated by side reactions in both of the methods employed. 3-Hydroxy-2-naphthoyl chloride readily condenses with itself to give a resinous product of depside properties and hence poor yields are obtained by the direct acylation of arylureas. The condensation of 3-*hydroxy*-2-*naphthoylurea* with aniline under certain conditions leads to ring-closure in the 2 : 3 position with the formation of a diketo-oxazine. Normal condensation occurs with an excess of aniline and a shorter period of heating.

The benzoyl and 3-hydroxy-2-naphthoyl derivatives of certain monoarylureas have been prepared by two general methods, *viz.*, by the interaction of the acyl chloride and an arylurea (cf. Walther and St. Włodkowski, *J. pr. Chem.*, 1899, **59**, 273 *et seq.*) and by the condensation of a monoacylurea with an arylamine at 160—170° (Palit, *J. Indian Chem. Soc.*, 1934, 479).

The *s*-*p*-nitrobenzoyl derivatives of phenyl-*o*-tolyl- and -*p*-tolyl-ureas have been obtained by acylation in pyridine at 100°, but all attempts to prepare the corresponding 3-hydroxy-2-naphthoyl compounds by similar means failed owing to the auto-condensation of the whole of the hydroxy-acid chloride, with the loss of hydrogen chloride. The decomposition product, a yellow amorphous powder containing no chlorine, was insoluble in cold alkali solution, hydrolysed by boiling to 3-hydroxy-2-naphthoic acid, and gave the anilide when boiled with aniline. In these and other properties the product closely resembles that obtained by the prolonged heating of 2-acetoxy-3-naphthoic acid (Meister Lucius and Bruning, *Chem. Zentr.*, 1916, II, 1094) (cf. " disalicylides " and other products obtained by heating *o*-acetoxybenzoic acid under reduced pressure; Anschütz, *Ber.*, 1919, **52**, 1883). Decomposition, giving a similar product, occurs when the acid chloride is heated at or above its melting point.

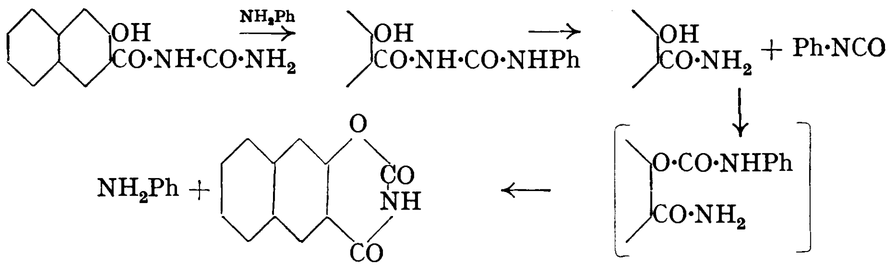
In its properties and modes of formation this product appears to be a depside or mixture of depsides, produced by the interaction of the OH and COCl groups of at least two molecules of the chloride (cf. di- and poly-salicylide from salicylic acid and phosphoryl chloride in pyridine; Einhorn and Mettler, *Ber.*, 1902, **35**, 3646; Anschütz, *ibid.*, p. 3506).

s-3-Hydroxy-2-naphthoylarylureas have, however, been prepared by heating the acid chloride and arylureas in dry benzene under reflux conditions. Approximately 60% of the acid chloride undergoes auto-condensation.

The observation of Kuhn (*Ber.*, 1884, **17**, 2881) that acylarylureas decompose at high temperatures (200°) into an amide and an *iso*cyanate has been verified by heating benzoyl- and *p*-nitrobenzoyl-arylureas with aniline at 200°, benzamide, or its derivative, and a diarylurea being formed :

$$R{\cdot}CO{\cdot}NH{\cdot}CO{\cdot}NHR' \longrightarrow R{\cdot}CO{\cdot}NH_2 + R'{\cdot}NCO\,;\; R'{\cdot}NCO + NH_2Ph \longrightarrow R'{\cdot}NH{\cdot}CO{\cdot}NHPh$$

a mechanism which is assumed by Palit (*loc. cit.*) in explaining the products obtained by the prolonged heating of acetylurea and aniline. When 3-hydroxy-2-naphthoylurea and aniline were heated together in equimolecular quantities for 3 hours at 170—180°, ammonia was evolved and 2 : 4-diketo-3 : 4-dihydro-ββ-1 : 3-naphthoxazine (Fries, *Ber.*, 1925, **58**, 2845) was obtained. Einhorn and Schmidlin (*Ber.*, 1902, **35**, 3653) obtained the corresponding benzene derivative by the action of phenyl *iso*cyanate on salicylamide, and it seems likely that the naphthalene analogue is produced by the following mechanism :



When heated for a short time with an excess of aniline, 3-hydroxy-2-naphthoylurea afforded *s*-3-*hydroxy*-2-*naphthoylphenylurea* in good yield.

EXPERIMENTAL.

s-*Benzoyl*-o-*tolylurea*.—Benzoylurea (2 g.; 1 mol.) and *o*-toluidine (1·3 g.; 1 mol.) were heated together at 170—175° during 2 hours; the evolution of ammonia then ceased. The brown solid was freed from unchanged base by steam-distillation, and the hot aqueous solution rapidly filtered; the cooled filtrate deposited benzoylurea. The undissolved *s*-benzoyl-*o*-tolylurea crystallised from glacial acetic acid in colourless needles (1·9 g.), m. p. 211° (Walther and St. Wlodkowski, *loc. cit.*, give m. p. 210°; Gattermann and Cantzler, *Ber.*, 1892, **25**, 1089, m. p. 210°).

s-Benzoylphenylurea was obtained, when aniline was used, in 65% yield, m. p. 205°; Palit (*loc. cit.*) gives m. p. 204—205, and 51% yield. When heated with aniline at 220°, it gave benzamide and *s*-diphenylurea, m. p. and mixed m. p. 235°. When benzoylurea and ethylaniline were heated together in molecular quantities at 170—175°, no ammonia was evolved and the reactants were recovered unchanged.

s-*Benzoyl*-o-*chlorophenylurea*, fine colourless needles, m. p. 212°, from acetone (yield, 50%) (Found : N, 10·1. $C_{14}H_{11}O_2N_2Cl$ requires N, 10·2%), and *s*-benzoyl-*p*-chlorophenylurea, colourless needles, m. p. 232°, from glacial acetic acid (yield, 62%) (Stieglitz and Earle, *J. Amer. Chem. Soc.*, 1908, **30**, 416, give m. p. 235—237°), were obtained similarly.

s-p-*Nitrobenzoylphenylurea*.—(a) *p*-Nitrobenzoylurea (Jacobs and Heidelberger, *J. Amer. Chem. Soc.*, 1917, **39**, 1436) (2 g.; 1 mol.) was heated with aniline (1 g.; 1 mol.) at 165° during 2½ hours. The brown solid was subjected to steam-distillation, and the residue, which contained unchanged *p*-nitrobenzoylurea, was crystallised several times from glacial acetic acid; the pale yellow plates, m. p. 232°, obtained were identical with those described below. At 180°, the products were *p*-nitrobenzamide (yellow needles from water, m. p. 198°) and *s*-diphenylurea (needles from acetone, m. p. and mixed m. p. 235°).

(b) *p*-Nitrobenzoyl chloride (3 g.) was gradually added to a cold solution of phenylurea (2·2 g.) in pyridine (10 c.c.). The bulky precipitate dissolved completely on heating and after 1 hour the clear red solution was cooled, water added, and the colourless precipitate washed with cold acetone. The *product* crystallised from glacial acetic acid in pale yellow plates, m. p. 232°, undepressed by the specimen described above (Found : C, 59·5; H, 4·0. $C_{14}H_{11}O_4N_3$ requires C, 59·0; H, 3·9%). When heated with aniline at 200°, it gave *p*-nitrobenzamide and *s*-diphenylurea.

s-p-*Nitrobenzoyl*-o-*tolylurea*.—(a) *p*-Nitrobenzoylurea (2·0 g.) and *o*-toluidine (1·1 g.) were heated together at 160—165° during 3 hours. The *product* was isolated as before and obtained in fine fibrous needles (1·4 g.), m. p. 219°, from glacial acetic acid (Found : C, 60·7; H, 4·3. $C_{15}H_{13}O_4N_3$ requires C, 60·2; H, 4·35%).

(b) *p*-Nitrobenzoyl chloride (1·75 g.) and *o*-tolylurea (1·5 g.) were heated together in pyridine (10 c.c.) at 100° during 1 hour. The product crystallised from glacial acetic acid in pale yellow, fibrous needles, m. p. 219°, and in admixture with the previous preparation 218—219°.

s-p-*Nitrobenzoyl*-p-*tolylurea*.—(a) *p*-Nitrobenzoylurea (2 g.) and *p*-toluidine (1·1 g.) were heated together at 165° during 3 hours; the *product* crystallised from glacial acetic acid in yellow plates (1·6 g.), m. p. 244° (Found : C, 60·7; H, 4·3%).

(b) *p*-Nitrobenzoyl chloride (1·75 g.), *p*-tolylurea (1·5 g.), and pyridine (10 c.c.) were heated at 100° during 1 hour. The product crystallised from glacial acetic acid in yellow plates, m. p. 245°, and in admixture with the previous preparation had m. p. 244°.

s-3-*Hydroxy*-2-*naphthoylphenylurea*.—A solution of 3-hydroxy-2-naphthoyl chloride (6·3 g.; 1 mol.), m. p. 94·5° (prepared by the method of Meyer, *Monatsh.*, **1901**, **22**, 791, who gives m. p. 191°, whereas Lesser, Kranepuhl, and Gad, *Ber.*, 1925, **58**, 2109, give m. p. 95—96°), in dry benzene (20 c.c.) was heated with finely powdered phenylurea (4·1 g.; 1 mol.) under reflux during 4 hours; hydrogen chloride was then no longer evolved. The bulky insoluble material was filtered off and digested with a little cold acetone to remove unchanged phenylurea. The colourless residue of s-3-*hydroxy*-2-*naphthoylphenylurea* crystallised from pyridine–alcohol in needles or long plates (2·7 g.), m. p. 303—305° (decomp.; after shrinking at 275—280°) (Found: N, 9·1. $C_{18}H_{14}O_3N_2$ requires N, 9·15%). It was soluble in warm aqueous potassium hydroxide, giving a bright yellow solution which on the addition of diazotised aniline afforded a red dye.

The benzene filtrate on evaporation yielded a brown transparent resin, which did not contain chlorine and did not exhibit phenolic properties. It dissolved, after long boiling, in aqueous potassium hydroxide, giving a bright yellow solution from which 3-hydroxy-2-naphthoic acid, m. p. and mixed m. p. 216°, was precipitated by mineral acid. The powdered resin, when boiled with aniline, afforded 3-hydroxy-2-naphthanilide, which formed plates from glacial acetic acid, m. p. 244° (cf. Meister Lucius and Brüning, *loc. cit.*).

The following 3-hydroxy-2-naphthoylarylureas were prepared by the same method as that used for the phenyl compound, to which they were similar in properties, and crystallised from pyridine–alcohol: s-3-*hydroxy*-2-*naphthoyl*-o-*tolylurea*, colourless felted needles, which blackened and shrank at 310° (Found: N, 8·5. $C_{19}H_{16}O_3N_2$ requires N, 8·7%). s-3-*Hydroxy*-2-*naphthoyl*-p-*tolylurea*, long silky needles, which blackened and shrank at 290° and melted at about 307° (decomp.); yield, 42% (Found: N, 8·6%). s-3-*Hydroxy*-2-*naphthoyl*-o-*methoxyphenylurea*, cream-coloured needles, which blackened and shrank at 270°; yield, 43% (Found: N, 8·5. $C_{19}H_{16}O_4N_2$ requires N, 8·3%). s-3-*Hydroxy*-2-*naphthoyl*-p-*methoxyphenylurea*, long, colourless needles, which melted to a yellow liquid when plunged into a bath at 240°; blackening occurred on gradual heating (Found: N, 8·6%). s-3-*Hydroxy*-2-*naphthoyl*-p-*chlorophenylurea*, pale yellow needles, m. p. 240° (decomp.) (Found: N, 8·0. $C_{19}H_{13}O_3N_2Cl$ requires N, 8·2%).

3-*Hydroxy*-2-*naphthoylurea*.—A solution of the acid chloride (10 g.; 1 mol.) in dry benzene (40 c.c.) was heated with dry powdered urea (3 g.; 1 mol.) under reflux during 5 hours. The bulky yellow product was separated from the benzene solution (which on evaporation yielded a resin), washed with cold acetone, and digested with cold water. The dried solid crystallised from glacial acetic acid in diamond-shaped plates of 3-*hydroxy*-2-*naphthoylurea*, which charred at 270—275° (Found: N, 12·3. $C_{12}H_{10}O_3N_2$ requires N, 12·1%). The urea dissolved readily in aqueous sodium carbonate, giving a bright yellow solution; when this was heated, ammonia was evolved and sodium 3-hydroxy-2-naphthoate formed.

Reaction with aniline. A mixture of 3-hydroxy-2-naphthoylurea (3 g.; 1 mol.) and aniline (1·2 g.; 1 mol.) was heated at 170—180°. Ammonia was evolved and, after 3 hours, the cooled melt was extracted with cold alcohol, which removed unchanged aniline. The residue crystallised from pyridine–alcohol in diamond-shaped plates, m. p. *ca.* 300° (decomp.). The substance was unaffected by cold dilute alkalis and acids, but dissolved in boiling aqueous potassium hydroxide, giving a bright yellow solution from which ammonia was evolved; 3-hydroxy-2-naphthoic acid was precipitated on the addition of acid. The substance appears to be identical with the 2 : 4 diketo-3 : 4-dihydro-ββ-1 : 3-naphthoxazine described by Fries (*loc. cit.*) (Found: C, 67·8; H, 3·6. Calc. for $C_{12}H_7O_3N$: C, 67·6; H, 3·3%).

3-Hydroxy-2-naphthoylurea (1·7 g.) was heated with aniline (7·2 g.), in which it dissolved, at 180° during 1 hour. Ammonia was evolved and needles or long plates soon began to separate. The cooled mass was extracted with boiling alcohol, which was then rapidly filtered. The residue crystallised from pyridine–alcohol in needles, which shrank and blackened at about 280°. It was identical in properties with the *s*-3-hydroxy-2-naphthoylphenylurea described above (Found: N, 9·5. Calc.: N, 9·15%).

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