perature was varied from 10 to 100°. Ethyl acetate was identified in the distillate, although in smaller yield; in addition there usually appeared a small fraction of $CH_3ClC(OC_2H_5)_3$, b.p. 147°, $n^{25}D$ 1.4132, d^{25} 1.031. *Anal.* Calcd. for $C_8H_{17}ClO_3$: Cl, 23.1. Found: Cl, 22.8.

Reaction of 2-Bromo-1,1,1-trifluoroethane.—This compound was unreactive and drastic conditions were necessary for the formation of ethers. When shaken at 100° for 48 hours with a 1:1:1.5 molar ratio of halide:base:solvent, two products were obtained. The lower boiling had the following properties: b.p. 114.6°, $n^{25}D$ 1.397, d^{25}_4 1.513, MR_D 30.6. *Anal.* Calcd. for $C_4H_7BrF_2O$: Br, 42.38. Found: Br, 42.32. These data compare well with 2-bromo-1-ethoxy-1,1-difluoroethane, $CH_2BrCF_2OC_2H_5$, prepared from 2-bromo-1-chloro-1,1-difluoroethane. The higher boiling material had properties identical with those of $CH_2BrC(OC_2H_5)_3$.[11]

Reaction of 1,1-Dichloro-2,2-difluoroethane.—This compound was considerably more reactive toward sodium ethoxide than those compounds previously considered and the complexity of the crude reaction product made the identification of individual compounds difficult. The reaction temperature varied from 25 to 100°; at the latter temperature the autoclave was used. In some experiments, potassium hydroxide dissolved in 95% alcohol was used rather than sodium ethoxide in absolute ethanol.

The principal product obtained was always 1,1-dichloro-2-fluoroethylene.[12] At higher temperatures dichlorovinyl ethyl ether[13]; $CCl_2{=}CHOC_2H_5$, b.p. 146°, $n^{25}D$ 1.4575, d^{25}_4 1.203, derived from the olefin $CCl_2{=}CHF$ was obtained while the series of compounds related to $CF_2{=}CHCl$ were also present in smaller amounts. The presence of $CH_2ClCF_2OC_2H_5$ was shown by its hydrolysis to ethyl chloroacetate. The dichlorovinyl ether, $CCl_2{=}CHOC_2H_5$, was made in 59% yield by the reaction of $CHCl_2CHF_2$ with alcoholic potassium at the reflux temperature; the addition of ethanol to $CCl_2{=}CHF$ gave a 75% yield of the same ether.

Reaction of 1-Chloro-1,2,2-trifluoroethane.—This compound, when treated with sodium ethoxide and ethanol for 3 hours at 120°, gave a 53% yield of 2-chloro-1-ethoxy-1,1-difluoroethane,[2] b.p. 89–93°, $n^{25}D$ 1.368, d^{25}_4 1.168. This ether gave a 72% yield of ethyl chloroacetate upon hydrolysis. In addition, a higher boiling fraction was obtained whose physical properties were reasonably close to the chloroörthoacetate, but it was present in insufficient amount for positive identification.

(11) F. Beyerstedt and S. M. McElvain, THIS JOURNAL, **59**, 1273 (1937).

(12) A. L. Henne and E. C. Ladd, *ibid.*, **58**, 402 (1936).

(13) F. Neher and W. Foster, *ibid.*, **31**, 412 (1909).

GAINESVILLE, FLORIDA

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY OF VANDERBILT UNIVERSITY]

Symmetrical 1,3-Bis-(alkane- and arylsulfonyl)-ureas

BY LAMAR FIELD AND FREDERICK A. GRUNWALD[1]

RECEIVED SEPTEMBER 22, 1952

A number of bis-sulfonylureas of the general formula $(RSO_2NH)_2CO$ have been prepared by a new method involving condensation of the metal salt of the corresponding sulfonamide with phenyl carbonate. Variables affecting the condensation and certain limitations of the rather general method are discussed. Chemical and pharmacological properties of the products are reported together with evidence for the structure of typical products.

Bis-sulfonylureas, in contrast to monosulfonylureas, have received but little consideration.[2] Both the paucity of information regarding the series of bis-sulfonylureas and the possibility of useful pharmacological activity in some members of this series motivated this investigation. The better known acylureas have several pharmacologically desirable characteristics which are said to make them preferable in several respects to the barbiturates.[3] Inasmuch as diacylureas are known to possess hypnotic activity,[4] it seemed of interest to determine the extent to which bis-sulfonylureas might also possess such activity.

The direct synthesis of bis-sulfonylureas from sulfonyl chlorides and urea apparently is unsuccessful,[2] except possibly in a few special instances. The eight bis-sulfonylureas described in this paper, of which seven are new compounds, were prepared by conversion of the appropriate sulfonamide with an alkali–metal alkoxide to the corresponding sulfonamide salt. The dry salt was then condensed with phenyl carbonate in phenyl ether at 175°. Similar reactions with ethyl carbonate or with magnesium salts did not occur under these conditions.

This previously unreported reaction is probably similar to such base-catalyzed condensations as the Claisen acetoacetic ester condensation.[5] The overall result may be shown by the abbreviated equations, from which anion equilibria and reversibility of steps have been omitted for simplification.

$$2RSO_2NH_2 + 2OR'^- \longrightarrow 2[RSO_2NH]^- + 2R'OH$$

$$[RSO_2NH]^- + (C_6H_5O)_2CO \longrightarrow [(RSO_2N)_2CO]^- + 2C_6H_5OH$$

$$[(RSO_2N)_2CO]^- \xrightarrow{2H^+} (RSO_2NH)_2CO$$

The presumed similarity in mechanism to the Claisen condensation permits rationalization of the failure of ethyl carbonate to function in the condensation, since an intermediate ion formed by the attack of the sulfonamide anion on the ester would presumably release a resonance-stabilized phenoxide ion more readily than an ethoxide ion. The failure of the reaction with the magnesium salt of benzenesulfonamide might be ascribed to decreased anion activity of the less polar magnesium salt.

The general procedure as outlined above was used for the preparation of the 1,3-bis-(arylsulfonyl)-ureas (procedure A). Preparation of the 1,3-bis-(alkanesulfonyl)-ureas required a considerable reduction in the time of heating in order to obviate decomposition (procedure B); the greater solubility of the alkane-sulfonylureas in both water and organic solvents required usually that pro-

(1) Milbank Memorial Fellow, 1950–1951. Abstracted from the Ph.D. dissertation of Frederick A. Grunwald, September, 1952.

(2) For a review of sulfonylureas see F. Kurzer, *Chem. Revs.*, **50**, 1 (1952).

(3) F. G. Hobart, "Open-chain Ureide Sedatives," Leonard Hill, Ltd., London, 1951, p. 6 ff.

(4) R. W. Stoughton, *J. Org. Chem.*, **2**, 514 (1938); R. W. Stoughton, H. L. Dickison and O. G. Fitzhugh, THIS JOURNAL, **61**, 408 (1939).

(5) C. R. Hauser and B. E. Hudson, Jr., "Organic Reactions," Vol. 1, John Wiley and Sons, Inc., New York, N. Y., 1942, p. 266.

TABLE I

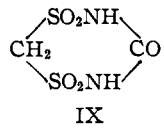
CONDENSATION PRODUCTS, $(RSO_2NH)_2CO$, FROM SULFONAMIDE SALTS AND PHENYL CARBONATE

No.	R	Procedure	Reaction product Yield, %	Reaction product M.p., °C.	M.p., °C. purified	Solvents for recrystallization[a]	Molecular formula	Analyses, %[b] Carbon Calcd.	Carbon Found	Hydrogen Calcd.	Hydrogen Found	Sulfur Calcd.	Sulfur Found
I	C_6H_5-	A	83	149–151	155–156	E + W	$C_{13}H_{12}O_6N_2S_2$[c]	45.87	46.10	3.55	3.42	18.84	18.93
II	*p*-$CH_3C_6H_4-$[d]				155–157.5[e]		$C_{14}H_{14}O_6N_2S_2$	48.90	49.05	4.38	4.49	17.41	17.38
	p-$CH_3C_6H_4-$	A[d]	81	98–104.5	100–104.5	E + W	$C_{14}H_{16}O_6N_2S_2 \cdot H_2O$					16.60	16.63
III	CH_3-	B	57	200–204 (dec.)	205.5–209	W, M	$C_3H_8O_6N_2S_2$	16.66	16.91	3.73	3.61	29.66	29.42
IV	C_2H_5-	B	75	126–130	130.5–132	M	$C_6H_{12}O_6N_2S_2$	24.58	24.91	4.95	5.03	26.25	26.54
V	*iso*-C_3H_7-	B	78	118–121	118.5–121	Ch + Ct[f]	$C_7H_{16}O_6N_2S_2$	30.88	31.23	5.92	6.24	23.55	24.11
VI	*n*-C_4H_9-	B	78	107–114.5	119–121	Ch + Ct, M	$C_8H_{20}O_6N_2S_2$	35.98	35.94	6.71	6.53	21.35	20.96
VII	$C_6H_5CH_2-$	B[g]	89	181–184	186–188	A	$C_{15}H_{16}O_6N_2S_2$	48.90	48.90	4.38	4.38	17.41	17.68
VIII	$C_6H_5CH{=}CH-$	A[h]	84	158–178 (dec.)	158–179 (dec.)	See (*h*)	$C_{17}H_{16}O_6N_2S_2$	52.02	51.74	4.11	4.24	16.34	16.20

[a] E, ethanol; W, water; M, methanol; A, acetone; Ch, chloroform; Ct, carbon tetrachloride. [b] Sulfur analysis in this Laboratory. Other analyses are by the Clark Microanalytical Laboratory, Urbana, Ill. (also mol. wt.), and the Micro-Tech Laboratories, Skokie, Ill. [c] Calcd.: N, 8.23; found: N, 8.21. [d] II was isolated as the monohydrate; loss of weight on drying to constant weight at 56° (3 mm.) during 66 hours, 4.60% (calcd. for II·H_2O, 4.65%). In isolating II, 150 ml. of 0.5 *N* alkali was used. [e] P. Tischendorf obtained a compound of m.p. 180° from the reaction of *p*-toluenesulfonamide and phosgene which presumably differs from II, although benzenesulfonamide gave a compound of m.p. 155° probably identical with I; *J. prakt. Chem.*, [2] **51**, 350 (1895) [*J. Chem. Soc., Abstracts*, **68**, I, 287 (1895)]. [f] Traces of colored impurity were removed by extracting an alkali solution of V with ether and acidifying. [g] With 0.06 mole of sulfonamide, 135 ml. of 0.6 *N* sodium hydroxide was required. [h] Use of 0.04 mole of sulfonamide required 160 ml. of methanol. The usual darkening during reaction was not observed. Attempts to recrystallize VIII resulted in poor recovery and unidentified decomposition products; purification was effected by solution in insufficient 0.1 *N* sodium hydroxide to dissolve all of the VIII, removal of solid, and acidification with insufficient 0.1 *N* hydrochloric acid to precipitate all of the VIII remaining. VIII rapidly decolorized 2% aqueous potassium permanganate.

cedure B differ from procedure A also in the method of isolation of the product. All of the bis-sulfonylureas prepared are rather easily hydrolyzed, though apparently less easily than the diacylureas.[4] Hydrolysis sometimes led to difficulty in purification and in all instances mild conditions were necessary when heating with solvents which could cause cleavage.

Considerable generality for the reaction is disclosed by the nature of compounds I–VIII shown in Table I. With α-chloroethanesulfonamide, however, instability even under the milder conditions of procedure B resulted in extensive charring and gas evolution during the reaction and no bis-sulfonylurea could be isolated. A second limitation appeared in the failure of methionamide (methanedisulfonamide) to cyclize to an analog of barbituric acid (IX) which has been the object of previous un-



IX

successful synthetic attempts.[6] The reaction with phenyl carbonate of both the disodium and dilithium salts of methionamide at temperatures up to 230° eventuated either in extensive decomposition or in recovery of the amide (59–64%). Of incidental interest was an unsuccessful attempt to obtain cyclohexane-1,1-disulfonyl chloride, the amide of which might be better adapted to cyclization, by chlorine oxidation at 5° of cyclohexane-1,1-dithiol. The carbon–sulfur bond was cleaved and 98–99% of the sulfur was isolated as barium sulfate. The principal organic product, on the basis of elementary analysis, infrared absorption spectrum and functional-group tests appeared to be a trichlorocyclohexanone, probably the 2,2,6-isomer.

(6) (a) G. Schroeter, *Ann.*, **418**, 169 (1919); (b) J. C. Bauer and G. L. Jenkins, *J. Am. Pharm. Assoc.*, **26**, 485 (1937).

Some assurance that the structures of compounds I–VIII are correctly assigned is provided by the nature of the condensation itself and its success with aromatic as well as with aliphatic sulfonamides. Confirmatory evidence is provided by the identity of I with material synthesized from benzenesulfonyl isocyanate and benzenesulfonamide.[7] Furthermore, the neutral equivalents of both the aromatic compound I and the aliphatic compound III, as well as the molecular weights of I and IV, agree well with expected values. Both I and III upon hydrolysis give the expected amount of carbon dioxide and quantitative yields of the corresponding sulfonamide. III, IV and VI showed no indication of ketone groups in chemical tests. The infrared spectra of compounds I–IV have been determined, but are not here reported as interpretation must await the availability of further data; the similar spectra of I and II differ in some respects from the similar spectra of III and IV.

Pharmacological tests were conducted on the monosodium salts of I–VIII, since the bis-sulfonylureas as such are insufficiently soluble in water. All of these sodium salts were found to be ineffective as hypnotics when administered orally in rats at levels of 250–900 mg./kg. The salts of I–IV and VI–VII likewise are ineffective as anticonvulsants when tested orally in rats at 400 mg./kg. by the metrazole and electroshock methods. The salt of VII is ineffective in chemotherapeutic screening tests, and that of II is only very slightly active *in vitro* in antituberculosis tests.

Acknowledgment.—We are indebted to the Research Corporation of New York for generous grants supporting this work. We wish to thank Dr. Dwight E. Morrison of the Lilly Research Laboratories of Indianapolis, Indiana, for arranging for the pharmacological tests which were kindly carried out by Dr. K. K. Chen, E. E. Swanson, W. B. Sutton and H. M. Powell.

(7) O. C. Billeter, *Ber.*, **37**, 695 (1904).

Experimental[8]

Sulfonamides.—Two procedures were used. One was the method of Dutt[9] with certain modifications better suited to large scale use. For example, dry ammonia gas was passed into 159 g. (1.39 moles) of methanesulfonyl chloride in 400 ml. of dry benzene, initially with ice-cooling, until no sulfonyl chloride odor remained (8 hours). The resulting precipitate was separated by filtration, dried at 20 mm. and triturated with 350 ml. of hot butanone. Methanesulfonamide obtained from the filtered extract was recrystallized from 1:2 ethanol–benzene and then amounted to 82.8 g. (63%), m.p. 89–91°.

Ethanesulfonamide was similarly obtained (46%, m.p. 58–60°). 1-Butanesulfonamide was prepared in ether and obtained simply by filtration and evaporation of the filtrate; recrystallization was from 1:3 chloroform–carbon tetrachloride (50%, m.p. 47.5–49°).

The liquid ammonia procedure of Asinger, *et al.*,[10] was used with 36 g. of 2-propanesulfonyl chloride.[11] The crude sulfonamide was recrystallized from 3:2 chloroform–carbon tetrachloride (yield 89%, m.p. 61–65°). The modified Dutt procedure gave only 21% of crude sulfonamide, crystallizable only after molecular distillation.

The Asinger procedure was also used with α-chloroethanesulfonyl chloride[12] (75% yield, m.p. 62–64°, recrystallized from benzene) and β-styrenesulfonyl chloride[13] (75%, m.p. 142–144°. Reaction was effected at the b.p. of ammonia; recrystallization was from water without preliminary separation of ammonium chloride).

Methionamide was prepared in 16% over-all yield, m.p. 235.5–236.5°, from the dipotassium salt of methionic acid by the procedure of Bauer and Jenkins[6b]; we are indebted to the General Chemical Division of the Allied Chemical and Dye Corp., New York, N. Y., for a generous supply of the dipotassium salt. The cyclohexane-1,1-dithiol used in the attempted preparation of cyclohexane-1,1-disulfonyl chloride was kindly provided by Dr. B. C. McKusick of the du Pont Experimental Station, Wilmington, Delaware.

Sulfonamides and sulfonyl chlorides not referred to above were commercial materials. Refined benzenesulfonamide was generously given by the Wyandotte Chemicals Corp., Wyandotte, Michigan.

1,3-Bis-(arylsulfonyl)-ureas. Procedure A.—The general method may be illustrated by the preparation of I. Benzenesulfonamide (9.45 g., 0.06 mole) was added to the sodium methoxide prepared from 1.38 g. (0.06 mole) of sodium and 75 ml. of commercial absolute methanol in a 300-ml. three-necked flask provided with a condenser protected from moisture by Drierite. The mixture was heated at the reflux temperature until a homogeneous solution resulted. Methanol was then removed under reduced pressure; use of a wooden boiling stick and careful control of temperature and pressure prevented bumping. Dry benzene (10 ml.) was added to the nearly dry residue and was likewise removed under reduced pressure. The solid was then dried at 2-mm. pressure; yield of white salt 10.73 g. (100%).

The salt was pulverized in the flask and suspended in 35 ml. of phenyl ether, b.p. 118–120° (5 mm.). The flask was provided with a mechanical stirrer, and with an air condenser and dropping funnel protected with Drierite. A solution of 7.07 g. (0.033 mole) of phenyl carbonate (m.p. 79–81°) in 35 ml. of phenyl ether was then added during two hours to the well-stirred mixture while it was heated in an oil-bath maintained at 175–180°. During continuation of stirring and heating for three hours, the mixture darkened to an amber color which probably results from oxidation products of phenol and is usually characteristic of a successful condensation.

The mixture was then cooled and shaken thoroughly with 50 ml. of cold 1.5 *N* sodium hydroxide solution. Phenyl ether was removed by extraction with ether. The aqueous layer was acidified with 3 *N* hydrochloric acid until precipitation ceased (about *p*H 2, after addition of 50 ml. of acid). The solid obtained after brief chilling of the precipitated amber oil was separated by filtration and was washed twice with 10 ml. of cold water. The filter cake was pressed to remove some of the phenol and then triturated to remove the remainder with three 10-ml. portions of ether while chilling in ice–salt. There was obtained 8.44 g. (83%) of white crystalline I, m.p. 149–151°, which after recrystallization from warm ethanol adjusted to incipient turbidity with about 0.7 volume of water gave 7.61 g. (75%), m.p. 152.5–154°. Further recrystallization gave I having a constant m.p. of 155–156°.

Authentic 1,3-bis-(benzenesulfonyl)-urea prepared[7] from benzenesulfonyl isocyanate and benzenesulfonamide had after recrystallization a constant m.p. of 154–155.5°; the mixture m.p. of this material with I prepared from phenyl carbonate was 155–156°. The neut. equiv. of I, determined in 1:1 ethanol–water by electrometric titration, was 346 (calcd. 340). The first inflection in the titration curve, from which this value was taken, was quite sharp; a second inflection at approximately the correct point for the second acidic hydrogen was noticeable but was much less conspicuous. The mol. wt. of I (Rast method in camphor) was 331 (calcd. 340). Hydrolysis of 2.3408 g. of I, by boiling in 3 *N* sodium hydroxide for 10 minutes and then acidifying, resulted in evolution of 0.3128 g. of carbon dioxide[14] (103% of the calcd. 0.3027 g.); benzenesulfonamide isolated amounted to 2.17 g. (100%), m.p. and mixture m.p. 150–153°. I is hydrolyzed completely in boiling water during 15 minutes, benzenesulfonamide being the only solid then isolable.

The effect of several variations in procedure A was examined. *p*-Toluenesulfonamide was recovered in 72% yield after being heated with urea at 225°, and in 70% yield after its sodium salt had been heated with excess ethyl carbonate under reflux. The use of ethyl carbonate in an otherwise exact duplication of procedure A resulted only in 83% recovery of benzenesulfonamide. Simple fusion of *p*-toluenesulfonamide and phenyl carbonate eventuated in recovery of 72% of the ester and 82% of the sulfonamide; fusion at 240° was also unpromising. Omission of phenyl ether from procedure A or the use of more vigorous conditions than those of procedure A proved distinctly disadvantageous.

Use of the magnesium salt of benzenesulfonamide under conditions otherwise similar to those of procedure A permitted only recovery of 65% of the sulfonamide. In contrast, use of the lithium salt gave I in 86% yield; this variation is not considered superior to procedure A, however, because solubility effects involving the lithium ion complicate isolation.

1,3-Bis-(alkanesulfonyl)-ureas. Procedure B.—The reaction was carried out as described in procedure A, except that the phenyl carbonate solution was added during one-half hour and stirring and heating were then continued for 1.5 hours; except with VII the greater solubility of the sulfonamide salts permitted use of smaller amounts of methanol in their preparation. Concentrated hydrochloric acid was used for acidification after extraction of phenyl ether. In the preparation of 1,3-bis-(methanesulfonyl)-urea (III), after acidification to *p*H 2, phenol generally appeared alone and was extracted with ether. A small amount of III which began to appear as the phenol was extracted was separated by filtration from the ether extract and was combined with III obtained by chilling the aqueous layer. The crude III was washed with small amounts of cold water and recrystallized. Small additional amounts of III were obtainable by concentration of the aqueous residue and washing under reduced pressure at a temperature below 35°.

IV and V were more soluble in ether than III. The ether extract was therefore dried and evaporated and the residue, after trituration with carbon tetrachloride to remove phenol, was combined with material from the aqueous phase for recrystallization. VI and VII, on the other hand, precipitated as solids after acidification and chilling so that ether extraction at this point was unnecessary. The crude VI and VII precipitates were freed of phenol by washing with ice-water and triturating with carbon tetrachloride; very little product remained in the aqueous phase.

Electrometric titration of purified III gave neut. equiv.

(8) Melting points are corrected and boiling points are uncorrected.

(9) P. K. Dutt, *J. Chem. Soc.*, **125**, 1464 (1924).

(10) F. Asinger, W. Schmidt and F. Ebeneder, *Ber.*, **75B**, 40 (1942).

(11) Prepared from the thiol in 79% yield, b.p. 65–66° (10 mm.), by a method based on those of Asinger, *et al.*,[10] and C. Ziegler and J. M. Sprague, *J. Org. Chem.*, **16**, 621 (1951).

(12) R. L. Shriner and A. H. Land, *ibid.*, **6**, 888 (1941).

(13) See L. Field and F. A. Grunwald, *ibid.*, **16**, 946 (1951).

(14) Determined by the method of H. H. Willard and N. H. Furman, "Elementary Quantitative Analysis," 3rd. ed., D. Van Nostrand Co., Inc., New York, N. Y., 1940, p. 402.

219 (calcd. 216). The carbon dioxide evolved after hydrolysis of 1.5253 g. of III amounted[14] to 0.3216 g. (104%). No evidence for the presence of a carbonyl group was obtained upon testing III, IV or VI with 2,4-dinitrophenylhydrazine. III was completely hydrolyzed in boiling water during 15 minutes; freeze-drying of the resulting solution gave 100% of the expected amount of methanesulfonamide, m.p. and mixture m.p. 89.5–91.5°. The mol. wt. of IV was 210 (Signer isothermal distillation technique with acetone as solvent; calcd. 244.)

Sodium Salts of Bis-sulfonylureas.—The general procedure employed for preparation of the monosodium salts used for pharmacological testing may be illustrated by that used in preparing the salt of I.

1,3-Bis-(benzenesulfonyl)-urea (3.1 g., 0.0091 mole) was mixed with slightly less than an equivalent amount of 1.00 *N* sodium hydroxide, following which the mixture was diluted with water until most of the salt dissolved. Additional sodium hydroxide was then added slowly until the *p*H was 6.9. The mixture was filtered to remove a trace of undissolved solid and the clear filtrate was freeze-dried. The bulky white solid obtained was easily soluble and amounted to 3.11 g. (94%).

NASHVILLE 5, TENN.

[CONTRIBUTION FROM THE IPATIEFF HIGH PRESSURE AND CATALYTIC LABORATORY, DEPARTMENT OF CHEMISTRY, NORTHWESTERN UNIVERSITY]

Synthesis of 2,2,4-Trimethyl-4-phenylpentane and 2,2,4-Trimethyl-4-cyclohexylpentane. Reactions of 2,2,4-Trimethyl-4-phenylpentane

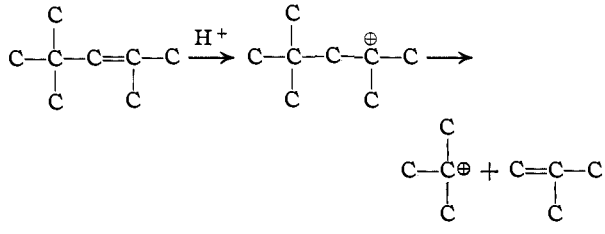
BY HERMAN PINES, RALPH MYERHOLTZ, JR.,[1a] AND V. N. IPATIEFF[1b]

RECEIVED AUGUST 25, 1952

2,2,4-Trimethyl-4-cyclohexylpentane and 2,2,4-trimethyl-4-phenylpentane have been prepared from 2,2,4-trimethyl-4-(*p*-hydroxyphenyl)-pentane. The stability of 2,2,4-trimethyl-4-phenylpentane in the presence of several alkylation catalysts has been determined. In none of the cases studied was there any evidence of appreciable instability under alkylation conditions when sulfuric acid, hydrogen fluoride or ferric chloride were used.

It has previously been reported[2] that depolyalkylation occurred when an attempt was made to alkylate benzene with diisobutylene in the presence of sulfuric acid. The reaction yielded *t*-butylbenzene and *p*-*di*-*t*-butylbenzene rather than the expected 2,2,4-trimethyl-4-phenylpentane (V).

These results may be interpreted in either of two ways: (1) Upon reaction with the catalyst the diisobutylene gives rise to a carbonium ion which may undergo cleavage to give a *t*-butyl carbonium ion and isobutylene.[3] The *t*-butylcarbonium ion as such or as formed from the isobutylene could then condense with benzene to give the products obtained.



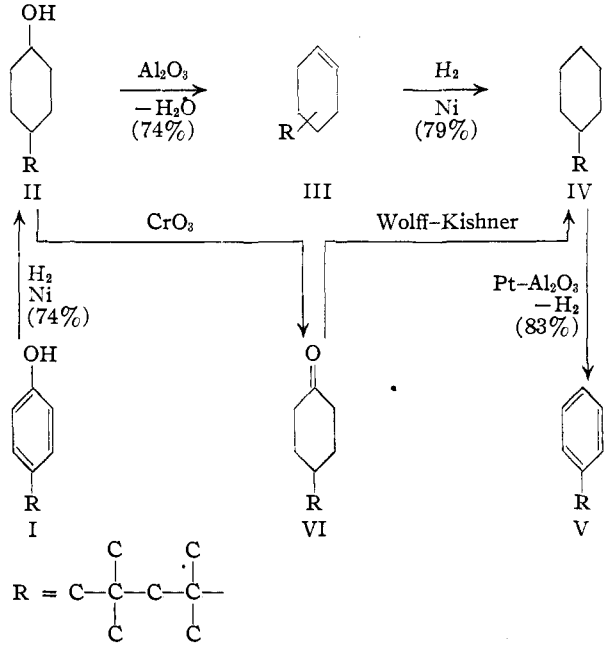
(2) Compound V, if formed, might be reactive under alkylation conditions and undergo a cleavage reaction to give the observed products.

Since migration of alkyl groups is known to occur when *di*-*t*-butylbenzenes or *di*-*t*-amylbenzenes are treated with sulfuric acid or anhydrous ferric chloride,[4] it seemed of interest to prepare V and investigate its stability in the presence of several alkylation catalysts.

Huston and co-workers have reported the synthesis of V using 2,4,4-trimethyl-2-pentanol and benzene in the presence of aluminum chloride.[5] However, the yield was low; some *t*-butylbenzene was obtained as a by-product and the purity of the product was not determined spectroscopically. In order to obtain a pure sample of V it was decided to prepare it by a previously described method[6] starting with 2,2,4-trimethyl-4-(*p*-hydroxyphenyl)-pentane which is commercially available.

Discussion of Results

Synthesis of 2,2,4-Trimethyl-4-phenylpentane (V).—Compound V was prepared by the sequence of reactions



(1a) Universal Oil Products Predoctoral Fellow, 1950–1952.

(1b) Deceased November 29, 1952.

(2) V. N. Ipatieff and H. Pines, THIS JOURNAL, **58**, 1056 (1936).

(3) F. G. Ciapetta, S. J. Macuga and L. N. Leum, *Ind. Eng. Chem.*, **40**, 2091 (1948).

(4) V. N. Ipatieff and B. B. Corson, THIS JOURNAL, **59**, 1417 (1937).

(5) R. C. Huston, R. L. Guile, J. J. Sculati and W. N. Wasson, *J. Org. Chem.*, **6**, 252 (1941).

(6) H. Pines, G. J. Czajkowski and V. N. Ipatieff, THIS JOURNAL, **71**, 3798 (1949).