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THE CONSTITUTION OF SALTS OF CERTAIN CYCLIC IMIDES

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Following the suggestion of Teuchert[1] the numerous salts of succinimide, phthalimide and saccharin have usually been given nitrogen–metal linkages. The chief support for these structures is afforded by reactions of some of these salts with alkyl halides which give the same products as are formed by treatment of the anhydrides with the respective alkyl bases

$$(CH_2CO)_2N\boxed{M + I}R \quad \text{and} \quad (CH_2CO)_2\boxed{O + H_2}NR$$

However, with alkyl halides the silver and alkali metal salt differ in reaction, as do like salts of hydrocyanic acid, formanilide, diazo compounds, etc. With the same salt two reactions are sometimes simultaneously involved; the problem also is complicated by the apparent existence of two silver salts of phthalimide.

Therefore, placing the metal on nitrogen is hardly justified by the facts; the alternate form is the more probable, other evidence for which follows. When choice of union between an O or N atom exists, the metal usually, or more probably, assumes the former position. Direct substitution of M by R is not the only conceivable mechanism of reaction and is, indeed, the less probable one. When the imino hydrogen of cyclic imides is substituted by phenyl, etc., these derivatives themselves are still capable of forming salts. When the cyclic imides are treated with sodium in petroleum ether, toluene, etc., little or no hydrogen is evolved; apparently imino hydrogen does not condition the formation of these salts. The cyclic imides and the substituted cyclic imides form the same number of salts, which is always equal in number to the oxygen atoms present. For example, phthalimide and phthalanil both form mono- and di-metal salts, and saccharine forms mono-, di- and tri-metal salts. The initial compounds formed by the action of potassium or sodium hydroxide on unsubstituted cyclic imides are always additive compounds, which can be interpreted as hydrated salts. Therefore, the capacity for salt formation seems not dependent on the imino hydrogen but rather upon the carbonyl and sulfonyl groups.

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[1] Teuchert, *Ann.*, **134**, 150 (1865). See also Laurent and Gerhardt, *Ann. chim. phys.*, [3] **24**, 179 (1849); Dessaignes, *Ann.*, **82**, 231 (1852); Menschutkin, *ibid.*, **162**, 166 (1872); Landsberg, *ibid.*, **215**, 200 (1882); Ley and Werner, *Ber.*, **39**, 2179 (1906); Tschugaeff, *ibid.*, **40**, 1973 (1907); Lyons, THIS JOURNAL, **47**, 830 (1925); Cohn, *Ann.*, **205**, 301 (1880); Freudenburg and Uthemann, *Ber.*, **52**, 1509 (1919); Remsen, *Am. Chem. J.*, **6**, 260 (1884–1885); Noyes, *ibid.*, **8**, 180 (1896); Fahlberg and List, *Ber.*, **20**, 1597 (1887); Fahlberg and Remsen, *Am. Chem. J.*, **1**, 431 (1879); Defournel, *Bull. soc. chim.*, **25**, 322 (1876); Remsen and Palmer, *Am. Chem. J.*, **8**, 224 (1886).

Experimental Part

The salts were prepared by gently shaking bottles containing the solvent, the imide and the solid alkali, until the lump of alkali gave way to a powdery mass. The solvents used were alcohol, acetonitrile, methyl ethyl ketone and ether. Ether dried over sodium gave the best results. Equivalents of the imide and the alkali were used and in cases when all of the latter did not react, it could be removed from the precipitate, provided that minute chipping of it did not result from too energetic shaking. The crystalline or powdery products were filtered, washed, dried and the metal was determined by the sulfate method.

Table of Salts

(A = $C_4H_5O_2N$ = succinimide; B = $C_{10}H_9O_2N$ = succinanil; C = $C_8H_5O_2N$ = phthalimide; D = $C_{14}H_9O_2N$ = phthalanil; E = $C_7H_5O_3NS$ = saccharine; F = $C_{15}H_9O_3N$ = benzoylphthalimide; G = $C_{10}H_7O_3N$ = acetylphthalimide; H = $C_{15}H_{11}O_4NS$ = *o*-tolylsulfonylphthalimide.)

Composition	Solvent used	Crystals, etc.	Sodium, % Calcd.	Sodium, % Found	Potassium, % Calcd.	Potassium, % Found
A·2 NaOH	CH_3CN	Amorphous	25.67	25.79		
A·2 NaOH	Et_2O	Prisms	25.67	25.41		
B·NaOH	EtOH, Et_2O	Gel. ppt.	10.69	9.37		
B·KOH	MeCOEt	Needles			16.91	17.40
B·KOH	CH_3CN	Plates			16.91	17.48
B·2 NaOH	MeCOEt	Prisms	18.03	20.87		
B·2 NaOH	CH_3CN	Prisms	18.03	17.44		
B·2 KOH	CH_3CN				27.24	28.36
C·2 NaOH	CH_3CN		20.26	21.41		
C·2 KOH	MeCOEt	Needles			30.16	30.05
D·NaOH	CH_3CN		8.74	8.77		
D·KOH	EtOH, Et_2O	Gel. ppt.			14.00	14.49
D·KOH	CH_3CN	Silky needles			14.00	15.26
D·2 KOH	CH_3CN	Prisms			23.32	23.46
D·2 KOH	MeCOEt	Prisms			23.32	22.85
E·2 NaOH	CH_3CN	Small prisms	17.48	18.97		
E·2 KOH	MeCOEt	Prisms			26.48	25.53
E·3 NaOH	CH_3CN	Plates	22.76	23.19		
E·3KOH	MeCOEt	Thin hexagon plates			33.37	32.37
F·KOH	Et_2O	Needles			12.72	13.55
F·2 KOH	Et_2O	Needles			21.52	22.43
G·KOH	Et_2O	Prisms			15.95	16.06
H·2 KOH	Et_2O	Prisms			18.91	19.12

Summary

A number of poly-metal alkali salts of cyclic imides and anils were prepared; their capacity to form salts is numerically equal to the number of oxygen atoms present; the metal is probably held in –OM rather than in –N–M combinations.

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