The boiling points recorded in the literature for *o*-nitrotoluene are 218° (Beilstein); 218.4° (734 mm.) (Neubeck); 220.4° (Kahlbaum); 220.96° (Rechenberg).

For the *m*-nitrotoluene the following boiling points are given: 230–231° (Beilstein); 227.5° (736 mm.) (Neubeck); 228.63° (Rechenberg).

The following boiling points are reported for *p*-nitrotoluene: 238.0° (Beilstein); 239.0° (Neubeck); 237.7° (Kahlbaum); 239.0° (Rechenberg); 238.3° (Anderson and Eyring).

These data are plotted in terms of their deviation from our empirical equation in Fig. 2.

Summary

The vapor pressures of the three isomeric mononitrotoluenes have been determined from 50° to a few degrees above their respective boiling points. The boiling points at atmospheric pressure have been found to be as follows: *o*-nitrotoluene, 220.38°; *m*-nitrotoluene, 231.87°; *p*-nitrotoluene, 238.34°.

The latent-heat equations have been derived and the latent heats of vaporization calculated. The pressures calculated from these equations agree well with the observed values.

The entropies of vaporization at a concentration of 0.00507 mole per liter indicate that the molten mononitrotoluenes are normal liquids.

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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF WASHINGTON]

COMPLEX SALTS OF QUINOLINE, MERCURIC HALIDES AND ALKYL HALIDES, AND SOME ISOMERS

BY WILLIAM M. DEHN AND HARVEY COPE

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In two earlier papers[1] it was shown that complex salts of quinoline, metallic halides and hydrohalogen acids conform to types such as Q.MXn.HX, 2Q.MXn.HX, 2Q.MXn.2HX, 2Q.3MXn.2HX and also to certain hydrated forms of these types. Other types, as found in the literature, seem of doubtful existence.

In connection with these studies it was anticipated that if HX of these types were substituted by RX, salts of analogous composition could be formed, because some types, containing quaternary derivatives of quinoline[2] and other bases,[3] though comparatively rare, are found in the literature.

It is known that compounds of the composition Q.RX are more stable toward hydrolysis than compounds of the composition Q.HX, so it was

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[1] Dehn, THIS JOURNAL, **48**, 275, 278 (1926).

[2] See $2(Q.C_2H_5Cl).PtCl_4$ of Williams [*Jahresber.*, **9**, 534 (1856)]; $2(Q.C_5H_{11}Cl).PtCl_4$ of Tosse [*Ber.*, **16**, 1279 (1882)]; $Q.CH_3Cl.AuCl_3$ of Ostermayer [*Ber.*, **18**, 593 (1884)]; $Q.CH_3I.CuI$ of Kohn [*Monatsh.*, **33**, 419 (1912)].

[3] See $(CH_3)_4NI.HgI_2$ and $(C_2H_5)_4NI.HgI_2$ of Risse [*Ann.*, **107**, 223 (1858)].

hoped that these halides of quaternary bases would form more stable combinations with HgX_2 than do the corresponding Q.HX compounds; however, the converse usually was found to be true. Apparently, quinoline exercises so much of its affinity on RX that the residue of affinity for HgX_2 is substantially weakened, a condition especially noticeable with salts of the type $2Q.HgX_2.RX$. The most stable salts are of the types $Q.RX.HgX_2$ and $2Q.RX.HgX_2$.

The salts were prepared in anhydrous solvents such as acetone, methylethyl ketone, acetonitrile and acetic anhydride. Molecular equivalents of the components of the desired complex salts were used, but not always were such salts obtained, for reasons either of their non-existence or of partition in solution and precipitation of the more stable or less soluble forms. For example, when salts of the type $Q.HgX_2.QRX$ were sought, salts of the type $Q.RX.HgX_2$ were more easily formed and Q remained in solution; or when $Q.HX.HgX_2QRX$ was sought, apparently two molecules of it precipitated 2Q.RX.HgX while $2Q.HX.HgX_2$ remained in solution. The course of the reaction was followed closely by microscopic examination for one or more crystalline forms, by determination of the range and the variations of melting points and by ultimate chemical analysis. Most of the products were very soluble in hot acetonitrile and were less soluble in acetone. When the solute was too soluble, ether or benzene precipitated it from the acetonitrile or acetone solutions.

Because all Q.RI compounds and their complex salts with mercuric iodide are colored yellow and because certain types such as $(Q.HgX_2).2RX$, $2(Q.HgX_2).2RX$, $3(Q.HgX_2).2RX$, $(Q_2.HgX_2).3RX$, $2(Q_2.HgX_2).3RX$, $3(Q_2.HgX_2).3RX$ are formed, it is impossible to assign definite constitutional formulas to the complex salts given in this paper. However, that definite constitutional relations are involved is evidenced by the formation of isomers. For example, when two different halogens are introduced into the $2Q.RX.HgX_2$ type, isomers are possible, provided that no exchange of halogen atoms takes place in solution. If, on the one hand, 2Q.RI and mercuric chloride are made to combine and, on the other hand, 2Q.RCl and mercuric iodide are made to combine, two different products, whose empirical compositions are identical, can be formed. Using all combinations of chloride, bromide and iodide in this manner, three pairs of isomers are possible and, indeed, have been prepared.

Salt	Isomeric salt
(a) $Q.RX.HgX_2$	(b) $Q.HgX_2.RX$
(c) $Q.RX.HgX_2.RX$	(d) $Q.HgX_2.2RX$
(e) $Q.RX.HgX_2.Q$	(f) $2Q.HgX_2.RX$
(g) $2Q.RX.HgX_2$	(h) $2Q.HgX_2.2RX$
(i) $Q_2.HgX_2.3RX$	
(j) $2(Q_2.HgX_2).3RX$	
(k) $3(Q.HgX_2).2RX$	

Theoretical considerations and studies of the compounds described in this paper suggest the preceding possible types, including isomers.

Representatives of all of these salts except c have been found and are here described.

With R remaining constant and involving in each salt two different halogens, and using thus all combinations of chloride, bromide and iodide, nine compounds for each group from a to h are possible and many more for Groups i, j and k. All nine compounds of Group g are given.

Analyses for halogen were made by dissolving the compound in acetone by warming and then rapidly adding silver nitrate solution. The silver halides were washed finally with acetone to remove $Q.RNO_3$. For mercury, the acetone solutions were treated directly with hydrogen sulfide and then water was added gradually. The mixtures were heated, filtered and washed with water and finally with acetone to remove Q.RI contaminating the mercuric sulfide.

The melting points show alternating irregularities as do fatty acids and other groups.

Experimental Part

In the following experiments, the order of arrangement is by types for alkyl derivatives other than ethyl which, on account of their number, the use of different halogens and the variety of products, are separately assembled. Types, not including ethyl, are all compounded with mercuric iodide and are all yellow in color. Types not including iodine are white.

Preparation of the Quinoline Alkyl Halides

The lower alkyl iodides react exothermically[4] with quinoline to yield QRI; the higher alkyl iodides must be heated. The chlorides require the longest heating; the bromides require less heating; the iodides, the least. The lower iodides are conveniently formed when the materials, placed in stoppered bottles, are exposed to direct sunlight. Some of the alkylations were made by boiling in direct sunlight; some were made by heating in sealed tubes. All of these experiments show that these compounds are formed with far more difficulty than are the corresponding Q.HX compounds; hence they are necessarily, at least toward hydrolysis, far more stable than the latter. The lower Q.RX compounds are less soluble in acetone and more soluble in benzene.

Quinoline-ethylchloride.[5]—When molecular proportions of quinoline and ethyl chloride were sealed in a tube and placed in direct sunlight, owing to the slowness of the reaction and the solubility of the additive compound in unchanged material, no reaction was apparent after a number of days. Finally crystals separated, but even after one year, both unchanged quinoline and ethyl chloride were detected in the mixture. The

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[4] See especially Lund and Wise, *J. Ind. Eng. Chem.*, **11**, 458 (1919).

[5] Claus and Tosse prepared $C_9H_7N.C_2H_5Cl.H_2O$ (large rhombic plates; m. p., 92.5°) and also $C_9H_7N.C_2H_5Br.H_2O$ (rhombic plates; m. p., 80°) [*Ber.*, **16**, 1277 (1883)].

crystals were filtered off, dissolved in absolute alcohol and reprecipitated by anhydrous ether.

Quinoline-ethylbromide.—An excess of ethyl bromide was heated with quinoline under a reflux condenser for ten hours; direct sunlight was observed to promote the reaction. A heavy oil separated, and crystallized on standing. The crystals were dried on a clay plate, dissolved in absolute alcohol and reprecipitated with ether.

Quinoline-ethyliodide.—The materials reacted in a few hours in direct sunlight, coating the glass on light-exposed surfaces; they were recrystallized from acetonitrile. Data on these and related compounds are given in Table I.

TABLE I

DATA ON QUINOLINE ALKYL HALIDES

QRX	Solvent	Crystal form	M. p., °C.	Halogen, %	
				Calcd.	Found
Ethyl chloride	none	thin, hexagonal plates	122	18.33	18.39
Ethyl bromide	none	prisms	80	33.58	33.45
Ethyl iodide	none	prisms	158[a]	44.53	44.28
*iso*Propyl iodide	acetone	needles	136	42.44	42.37
n-Butyl iodide	acetone	prisms	174		
*iso*Butyl iodide	acetone	prisms	161		
Cetyl iodide	none[b]	needles	101	26.37	26.25
$Q.C_{16}H_{33}I.I_2$	benzene	needles	70	51.82	51.84
$Q.C_{16}H_{33}I.Br_2$	ethanol	flakes	80	44.72	45.06

[a] The earlier melting point (118°) found by Spaltenholz was that of $C_9H_7N.C_2H_5I.H_2O$ [*Ber.*, **16**, 1851 (1883)]. The anhydrous compound was prepared by Hoogewerff and Dorp who give as the melting point 158–160° [*Rec. trav. chim.*, **2**, 321 (1883)]. Miethe and Book give m. p. 156–157° [*Ber.*, **37**, 2009 (1904)]. Lund and Wise[4] give m. p. 155–157°.

[b] The mixture was permitted to stand in direct sunlight for several weeks and the resulting solid was recrystallized from benzene.

Type Q.RX.HgX$_2$ (a)

These compounds can be prepared by three methods. (1) They are best prepared by dissolving molecular equivalents of Q.RX and HgX$_2$ in hot acetonitrile, acetone or methylethyl ketone and letting them stand to crystallize or by adding ether to their concentrated solutions; (2) they can

TABLE II

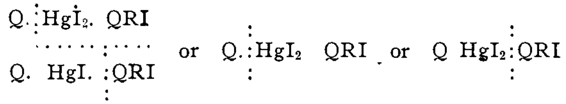
DATA ON TYPE Q.RX.HGX$_2$

R	Solvent	Crystal form	M. p., °C.	I, %		Hg, %	
				Calcd.	Found	Calcd.	Found
Methyl	acetonitrile	coarse clumps of monoclinic prisms					
	ethanol	long prismatic needles	165	52.28	52.25	27.65	27.75
n-Propyl	acetonitrile	prisms	155	50.66	50.72	...	...
*iso*Propyl	acetonitrile	prisms	128	50.66	50.42	26.62	26.75
n-Butyl	acetonitrile	prisms	122	49.80	49.40	...	...
*iso*Butyl	acetonitrile	prisms	151	49.80	49.60	...	...
iso-Amyl	acetonitrile	prisms	160	48.72	48.26	...	...
Cetyl	acetonitrile	rectangles	87	40.69	40.62	...	...

also be prepared from $2Q.RX.HgX_2$ and HgX_2 in the same solvents; (3) with some of the lower alkyl iodides, compounds of this type can be prepared from molecular equivalents of quinoline, alkyl iodide and mercuric-iodide or of quinoline—mercuric-iodide and alkyl iodide by boiling their solutions or on letting them stand for many days. However, since with Method 3 there is a tendency to yield the isomer $Q.HgI_2.RI$, impure products are obtained. These salts are much more soluble in the above-mentioned solvents than are the other types of complex salts.

Type $Q.RX.HgX_2.Q$ (e)

Compounds of this type were found to be difficult to prepare, owing largely to feeble intermolecular affinity of the components. It is conceivable that $Q + HgI_2 + Q.RI$ either do not cohere, or that the solvent and other conditions cause partition as indicated by



$$\begin{array}{l} Q.\vdots HgI_2.\ QRI \\ \cdots\cdots\vdots\cdots \\ Q.\ HgI.\ \vdots QRI \end{array} \quad \text{or} \quad Q.\vdots HgI_2\quad QRI \quad \text{or} \quad Q\ HgI_2\vdots QRI$$

Although many experiments were made to prepare other derivatives of $2Q.HgI_2.RI$, wherein R was the variable, only the methyl, *n*-propyl and *n*-butyl compounds were prepared in the pure form. Usually the compound sought was found to be contaminated with $Q.RI.HgI_2$, with quinoline—mercuric-iodide or with Q.RI and no clean separation could be made. Since the higher homologs are the more soluble in acetone, acetonitrile, etc., the separation was largely a question of solvent. When the components were very soluble, the first crop of crystals contained $Q.RI,HgI_2$; when very insoluble, as with benzene added to acetone solution, the crystalline mass contained large percentages of Q.RI.

The crystals were always examined microscopically—the presence of two or more forms, of course, proving the occurrence of mixtures. The melting points confirmed these observations, since they were usually lower than for the other types of salts involving the same alkyl group, and extended over many degrees of temperature. That the pure substance as, for example, $Q.HgI_2.QC_3H_7I$ (m. p., 130–150°), can melt over a range of temperature is explained on the basis of decomposition as indicated in $Q.HgI_2.Q.RI = Q + HgI_2.QRI$.

Diquinoline—mercuric-iodide—methyl-iodide.—When molecular proportions of quinoline—mercuric-iodide and quinoline—methyl-iodide were dissolved in hot acetone, and this solution was permitted to cool and stand, compact yellow prisms of rhomboid cross section, beveled ends and hexagonal sides were obtained; m. p., 170°.

Anal. Calcd. for $C_9H_7N.CH_3I.HgI_2$: I, 52.28. Found: 51.50.

The residual acetone solution gave off the odor of quinoline and by evaporation yielded other crops, melting at 120–130° and 105–112°, respectively. The final crystals were short prisms with obtusely beveled ends.

Anal. Calcd. for $2C_9H_7N.CH_3I.HgI_2$: I, 44.56. Found: 44.12, 44.60.

Diquinoline—mercuric-iodide—*n*-propyl-iodide.—When quinoline—mercuric-iodide and quinoline—*n*-propyl-iodide in molecular proportions were dissolved in hot acetone, or in acetonitrile, short yellow prisms of very obtusely beveled ends, rhomboid cross section and hexagonal sides were obtained; m. p., 108°.

Anal. Calcd. for $2C_9H_7N.HgI_2.C_3H_7I$: I, 43.09; Hg, 22.70. Found: I, 43.20; Hg, 22.55.

Diquinoline—mercuric-iodide—*n*-butyl-iodide.—When quinoline—*n*-butyl-iodide, mercuric iodide and quinoline were dissolved in hot methylethyl ketone, the crystals first precipitated on cooling consisted largely of quinoline—butyl-iodide—mercuric-iodide, as proved by crystal form, melting point and percentage of iodine. The third crop consisted of prisms, m. p. 86°, dissolved with difficulty in benzene or chloroform but easily in acetone.

Anal. Calcd. for $2C_9H_7N.C_4H_9I.HgI_2$: I, 42.42; Hg, 22.35. Found: I, 42.16; Hg, 22.30.

Type $2(Q.RX).HgX_2$ (g)

These compounds are characterized by great insolubility in acetone or in methylethyl ketone, and great solubility in acetonitrile. From the latter they can be precipitated by adding ether. They are best prepared by dissolving in hot concentrated solvents and letting stand to crystallize. They can also be prepared from $Q.RX.HgX_2$ and $Q.RX$ in the same solvents.

Diquinoline—methyl-iodide—mercuric-iodide.—Molecular proportions of diquinoline—methyl-iodide and mercuric iodide in hot acetonitrile solution gave elongated hexagonal plates, m. p. 210°, dissolving with difficulty in hot acetonitrile, acetone, etc.

When quinoline—hydrogen-iodide—mercuric-iodide and quinoline—methyl-iodide were dissolved in hot acetone, $2Q.2CH_3I.HgI_2$ precipitated in accordance with the reaction: $2Q.HI.HgI_2.QCH_3I = 2Q.2CH_3I.HgI_2 + 2Q.HI.HgI_2$. Data on compounds of this type are given in Table III.

TABLE III

DATA ON COMPOUNDS OF TYPE 2(Q.RI)HGI

R	Solvent	Crystal form	M. p., °C.	I, %		Hg, %	
				Calcd.	Found	Calcd.	Found
Methyl	acetonitrile	hexagons (elongated)	210	50.95	50.75	20.13	20.05
n-Propyl	none	rhombohedrons	157	48.25	47.98	...	...
*iso*Propyl	acetonitrile	hexagons	160	48.25	48.35	...	...
n-Butyl	acetonitrile	prisms	158	47.20	47.10	...	...
*iso*Butyl	acetonitrile	prisms	168	47.20	47.02	...	...
iso-Amyl	acetone	rectangles	156	45.79	45.74	...	...
Cetyl	acetone	rectangles	84	...	...	14.15	14.24

Type $Q.HgX_2.RX$ (b)

Though many salts of this type were sought only ethyl, *iso*propyl and *sec.*-butyl iodides gave data indicating the compounds.

***iso*Propyl Iodide Salt.**—When quinoline—mercuric-iodide was placed in contact with an excess of *iso*propyl iodide and gently warmed, light yellow prisms were obtained, softening at 100° and melting at 152°. Its isomer melts at 128°.

Anal. Calcd. for $C_9H_7N.HgI_2.C_3H_7I$: I, 50.66; Hg, 26.62. Found: I, 50.31; Hg, 26.58.

sec.-**Butyl Iodide Salt.**—When the materials were heated together, an oil was formed. On dissolving this in acetone and precipitating with alcohol, thin, elongated leaflets were obtained, softening at 90° and melting at 130°.

Anal. Calcd. for $C_9H_7N.HgI_2.C_4H_9I$: I, 49.80; Hg, 26.24. Found: I, 49.96; Hg, 26.27.

Type $2Q.HgX_2.RX$ (f)

Ethyl Iodide Salt.—When diquinoline—mercuric-chloride was treated with an excess of ethyl iodide in direct sunlight for days, caking was observed. After the solid had been filtered off and washed with ether, white rhombic crystals were obtained, softening at 115° and melting at 140°.

Anal. Calcd. for $2C_9H_7N.HgCl_2.C_2H_5I$: Cl_2I, 28.86. Found: 28.66.

n-**Propyl Iodide Salt.**—In direct sunlight the white crystals of diquinoline—mercuric-iodide gradually gave way to thin, yellow, rhomboid plates, softening at 105° and melting at 125°. The isomer melts at 108°.

Anal. Calcd. for $2C_9H_7N.HgI_2.C_3H_7I$: I, 43.09. Found: 43.14.

Type $2Q.HgX_2.2RX$ (h)

Diquinoline—mercuric-iodide—dimethyl-iodide.—When diquinoline—mercuric-iodide was treated with an excess of methyl iodide in direct sunlight, the white crystals of the former gave way to yellow aggregates of rhomboid prisms with hexagonal sides, softening at 155° and melting at 190°. During the melting, an oil distilled to the cold parts of the capillary tube.

Anal. Calcd. for $2C_9H_7N.HgI_2.2CH_3I$: I, 50.75. Found: 50.50.

Type $2Q.HgX_2.3RX$ (i)

n-**Propyl Salt.**—In direct sunlight, white crystals of diquinoline—mercuric-chloride by contact with *n*-propyl iodide formed yellow prisms softening at 115° and melting at 125°.

Anal. Calcd. for $2C_9H_7N.HgCl_2.3C_3H_7I$: Cl_4I_2, 43.36. Found: 43.00.

Type $4Q.2HgX_2.3RX$ (j)

iso-**Amyl Salt.**—In an excess of *iso*-amyl iodide, crystals of diquinoline—mercuric-iodide yielded light yellow prisms, softening at 100° and melting at 124°.

Anal. Calcd. for $4C_9H_7N.2HgI_2.3C_5H_{11}I$: I, 44.00. Found: 44.00.

Type $3Q.3HgX_2.2RX$ (k)

Methyl Iodide Salt.—By contact with an excess of methyl iodide, quinoline—mercuric-iodide changed rapidly to deep yellow crystals; m. p., 160–168°.

Data on all derivatives of this type are given in Table IV.

TABLE IV

DATA ON THE TYPE $3Q.3HgI_2 2RI$

R	Solvent	Crystal form	M. p., °C.	I, % Calcd.	I, % Found	Hg, % Calcd.	Hg, % Found
Methyl	none	?	160–168	49.91	50.42	29.58	30.16
n-Propyl	ethanol	needles	118–125	48.57	48.23	...	...
n-Butyl	none	?	158	48.08	49.60	28.49	27.96
iso-Amyl	none	rhomboids	140–160	47.30	47.78	28.03	27.74

Ethyl Derivatives

Type Q.RX.HgX_2

Quinoline—ethyl-iodide—mercuric-iodide.—This was prepared from quinoline—ethyl-iodide and mercuric-iodide in hot absolute alcohol, from which long, thin, prismatic needles were obtained. It is formed as a by-product of its isomer. With quinoline—hydrogen-iodide it yields gridiron aggregates of yellow crystals; its isomer does not.

Data on all the derivatives of this type prepared in ethanol are given in Table V.

TABLE V

DATA ON TYPE Q.RX.HgX_2

			X, %		Hg, %	
X.HgX_2	Crystal form	M. p., °C.	Calcd.	Found	Calcd.	Found
I.HgI_2	thin prisms	131	51.49	51.23	26.99	27.11
I.$HgCl_2$	needles	133	35.55	35.85	...	...
I.$HgBr_2$	rhomboids	143–146	44.42	44.20	...	...
Br.$HgBr_2$	rhomboids	169	40.06	39.96	33.52	33.70
Br.$HgCl_2$	rhomboids	193	29.60	29.40	...	...
Br.HgI_2	rhomboids	121	48.19	48.07	...	...

Type Q.HgX_2.RX

Quinoline—mercuric-iodide—ethyl-iodide.—This isomeric form was prepared by treating quinoline—mercuric-iodide with an excess of ethyl iodide. Although heating hastens the reaction, the formation of its isomer or melted mixtures with the isomer and unchanged quinoline—mercuric-iodide hinders its subsequent purification. Therefore, a mixture of pulverized quinoline—mercuric-iodide and an excess of ethyl iodide is shaken frequently while standing in direct sunlight. Heating to 50° will melt and cake the product. After decanting the unchanged ethyl iodide, the crystals were extracted with warm alcohol to remove needles of the isomer. Though melting at the same temperature as its isomer, it differs from it in being practically insoluble in cold alcohol, in not reacting with quinoline—hydrogen-iodide in cold alcohol and in its crystalline form—yellow aggregates of octahedrons or short rhombic prisms with pyramidal ends. Melting yields the stable isomer.

Anal. Calcd. for $C_9H_7N.HgI_2.C_2H_5I$: I, 51.49; Hg, 26.99. Found: I, 51.25; Hg, 27.41.

Quinoline—mercuric-bromide—ethyl-iodide.—When quinoline—mercuric-bromide and ethyl iodide were permitted to stand for months in direct sunlight, coarse yellow prisms of rhombic cross section, asymmetrical beveled ends and irregular hexagonal sides were obtained; m. p., 125°

Anal. Calcd. for $C_9H_7N.HgBr_2.C_2H_5I$: Hg, 31.08. Found: 30.80.

Type 2Q.2C_2H_5X.HgX_2

The nine possible compounds of this series were prepared by adding cold solutions of diquinoline diethyl halide to cold solutions of mercuric halide, the solvents employed being either acetonitrile or acetone. Data on the salts of this type are given in Table VI. Nos. 2 and 4, 3 and 7, 6 and 8 are isomers.

Table VI

Data on Type $2Q.2C_2H_5XHgX_2$

$X.HgX_2$	Color	Crystal form	M. p., °C.	X, % Calcd.	X, % Found	Hg, % Calcd.	Hg, % Found
$Cl.HgCl_2$	white	hexagonal	232–235	21.53	21.76		
$Cl.HgBr_2$	yellow	rhombic	221–223	30.87	30.65		
$Cl.HgI_2$	yellow	rhombic	173–175	38.59	39.06		
$Br.HgCl_2$	white	rhombic	177–180	30.87	30.46		
$Br.HgBr_2$	white	prisms	189–190	38.21	37.76	23.98	24.20
$Br.HgI_2$	yellow	prisms	173	44.46	44.02	21.56	21.85
$I.HgCl_2$	yellow	prisms	155	38.59	39.22	23.66	23.88
$I.HgBr_2$	yellow	plates	174	44.46	44.88		
$I.HgI_2$	yellow	hexagonal[a]	188	49.55	49.10	19.58	19.97

[a] When molecular equivalents such as to form $3Q.3C_2H_5I.2HgI_2$ were dissolved in acetone, only $2Q.2C_2H_5I.HgI_2$ precipitated while $Q.C_2H_5I.HgI_2$ remained in solution. With iodide the reaction $2Q.2RI.HgI_2 + I_2 = QRI.HgI_2 + QC_2H_5I.I_2$ took place.

Summary

1. Possible types of complex salts containing quinoline, alkyl halides and mercuric halides were studied and were found to be quite numerous.
2. Analogous salts hitherto described, of Types II, VI and VII, only, were found. The homologous salts of these respective types alternately show irregularities of melting point.
3. Other types of complex salts involving alkyl halides are described.
4. Some isomeric salts are described and discussed.

SEATTLE, WASHINGTON

[CONTRIBUTION FROM THE LABORATORY OF ORGANIC CHEMISTRY OF INDIANA UNIVERSITY]

A SHORT METHOD FOR THE ESTIMATION OF SELENIUM IN ORGANIC COMPOUNDS

BY W. E. BRADT WITH R. E. LYONS

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Introduction

In an effort to choose a method for the determination of selenium in organic compounds, 21 methods, which had been proposed in the literature, were studied. Each of these failed to fulfil at least one of the conditions obtaining in our work. Any determination of selenium in organic compounds presupposes the decomposition of that compound, usually by means of the Carius method. The presence of nitric acid, or of nitrates, however, makes the use of 16 of these methods impossible. Two of the remaining methods, the Frerichs[1] and the Lyons and Shinn[2] methods, avoid this difficulty only by means of long and tedious manipulation. Of the three

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[1] Frerichs, *Arch. Pharm.*, **240,** 656 (1902).

[2] Lyons and Shinn, THIS JOURNAL, **24,** 1087 (1902).