

I.

SYNTHESIS AND REACTIONS OF SOME THIAZOLES

II.

THIO-UREA PREPARATIONS

By

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A thesis submitted to the Faculty of the Graduate-School  
and the Department of Chemistry of the University  
of Kansas in partial fulfillment of the  
requirement for the Degree of  
Master of Science.

June 1st., 1920

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This space is reserved for the many thanks due Dr. F. B. Dains for his most valuable direction of this work and the encouragement given by him.

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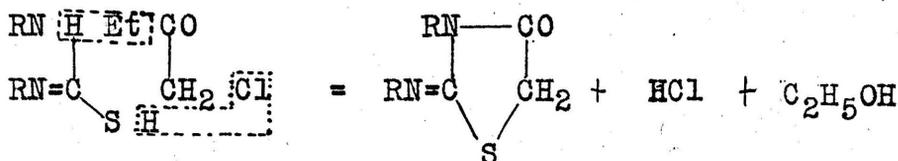
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PREFACE

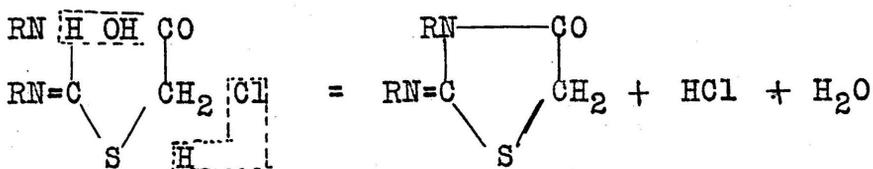
It has been found that molar quantities of R thio urea and the ethyl ester of chloroacetic<sup>1</sup> acid when heated together with the addition of the theoretical quantity of pyridine to react with the free HCl in most cases form give good yields of R R<sub>1</sub> isothiohydantoin or thiazoles. Thus we have the reaction proceeding as shown in the equation.



Since this reaction is carried out in alcohol the alcohol liberated does not interfere with the reaction while the HCl is disposed of with pyridine.

If we use the acid instead of the ester we find that we have the following reaction in which we have the hydrolysis of the isothiohydantoin with the formation of a glycollide.

(1) Jr. Am. Chem. Soc. 25, 369 (1903).  
 Jr. Am. Chem. Soc. 38, Sept., 1916.



The reaction of  $\text{CH}_2\text{ClCOOH}$  being much more desirable considerable work was done on the same trying to prevent the hydrolysis.

It was found that if the theoretical quantity of pyridine was added to form the hydrochloride that in most cases good yields could be obtained. These will be referred to more specifically later on.

It was thought that hydrolysis might be prevented if absolutely dry reagents were used. This was tried, using as solvents dry carbon tetrachloride, benzene, toluene, and ether with various temperatures; in all cases practically no action took place between the thio urea and the chloro-acetic acid. Thus it would seem to show that not only does the pyridine prevent hydrolysis but acts to some extent as a catalytic agent.

Calcium carbide was finely suspended in dry kerosene and the reaction thus tried, it being thought that the  $\text{HCl}$  would at once be removed with the formation of  $\text{Ca}(\text{Cl})_2$  and acetylene. A reflux condenser was connected to the flask containing the

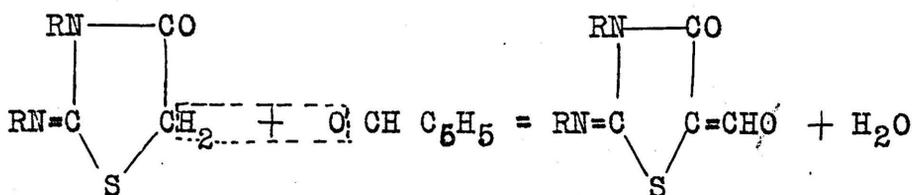
mixture and from the reflux a delivery tube so that acetylene if given off could be collected. In this reaction the ethyl ester of chloro acetic acid was used as the acid itself would very probably react with the calcium carbide. The temperature was gradually raised to about 150-160° and allowed to stay there till the acetylene had stopped coming over. Acetylene came over very fast for the first few minutes but soon ceased and did not come over even at the highest temperature. Hence the conclusion that there was very little reaction if any and the acetylene that was formed was very probably due to traces of moisture being present. Thus again it would seem that the pyridine served to some extent as a catalytic agent.

In a similar manner calcium carbonate, very finely suspended, was used with the acid and alcohol employed as a solvent. Negative results however resulted.

With the theoretical quantities of chloro-acetic acid and the thio urea was placed pyridine just sufficient to take up the HCl liberated. This was carried out in absolute alcohol and CaO also used. This seemed to increase the yield from 10 to 15 percent. This concludes the various methods that were used to prevent hydrolysis.

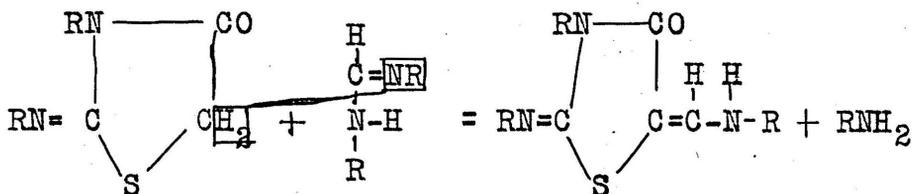
H. Beckurts and G. Frericks (Arch. Pharm. 253 page 233-265, 1915) have shown that the isothiohydantoin condense with benzaldehyde.

With benzaldehyde the condensation is as follows:



Stevenson<sup>1</sup> and Irwin in his thesis have shown their condensations with formamidines.

In the formamidine condensation we have:-



It was also found that the hydrolyzed isothiohydantoin, that is the 2.4. diketo isothiohydantoin or thiozole also condenses in like manner.<sup>2</sup> Thus it would seem that the reactions of the methylene hydrogen are almost independent of the

(1). J.A.C. Vol. 38, 1841.

(2). J.A.C. Vol. 38, 1841.

of the group at position 2.

The following pages will be given to the preparation of some of the isothiohydantoins and their reactions.

#### PREPARATION OF P TOLYL ISO-THIOHYDANTOINS

The di-para-tolyl iso-thiohydantoin was prepared by Irwin employing the thio urea and the ethyl ester of chloro acetic acid. Pyridine being used to prevent hydrolysis. By this method he obtained a 76% yield. He also used chloro-acetic acid and the thio urea but did not employ pyridine to prevent hydrolysis. His yield was very small. It was thought advisable to try this with the addition of pyridine to see if the yield of the unhydrolyzed product could not be increased.

The di-para-tolyl-thio urea was prepared by using Fry's method<sup>1</sup>. 102 grams of para toludine was placed in solution by using 300 cc. carbon disulphide and 80 cc. of pyridine. 253.8 grams of iodine was now placed in solution in carbon disulphide and pyridine. This is added to the para toludine. The apparatus is arranged with a reflux condenser. Upon slightly heating, the reaction takes place very vigorously. The H<sub>2</sub>S

(1) J. Amer. Chem. Soc. 35, 1539.

that is liberated being at once taken up or reacted on by the  $I_2$  forming HI and this reacts with the pyridine forming pyridine hydroiodide. The excess carbon disulphide is now distilled off by steam distillation along with any pyridine in excess. The thio urea is then washed with water several times removing pyridine hydroiodide and the thio urea crystallized from alcohol.

This method gives good yields with the para-brom-thio-urea and also the para-chlor-thio-ureas, as stated by Fry, but as tried out here with the para tolyl good yields were not obtained. The reaction resulting in a tarry decomposition product.

50 grams of di-para-tolyl-thio-urea, 100 cc. alcohol, 20 grams of chloroacetic acid and 16.5 grams of pyridine were heated on a water bath until the thio urea had disappeared. After standing over night white crystals separated out. The yield was about 60 percent. They gave a melting point of about  $127^\circ$ . There was also some of the hydrolyzed product formed which melts at  $162^\circ$ .

The analysis for the di-para-tolyl-iso-thio-hydantoin is as follows:-  $C_{17}H_{16}ON_2S$

Wt. Sample	Percent N found	Calculated
.2346	9.70	9.45
.4337	9.53	9.45

The normality of the KOH used was .1520 while that of the HCl was .1260. These reagents were employed in all of the following analyses.

An analysis was not made on the 2.4 diketo product as this was done by Irwin and as the melting point that we obtained was the same it an analysis was not thought necessary.

#### PREPARATION OF THE HYDROCHLORIDE

The N at 3 should show basic properties and should form hydrochlorides. Some benzene was very thoroughly dried and several grams of the di-para-toly~~s~~ di-phenyl isothiohydantoin was dissolved in the same by gently warming. After cooling, some dry HCl was allowed to pass through this solution. There was at once a somewhat gummy precipitate formed. This, however, upon standing soon assumed the form of definite crystals. These were dried in a dessicator and an analysis made on the same, simply by placing a weighed portion in a flask and running in 50 cc. of our standard KOH. After being thoroughly shaken, a back titration was made with standard HCl and thus the number of moles of HCl in the hydrochloride determined.

The analyses are as follows:  $C_{17}H_{16}ON_2S.HCl$

HCl found	wt. Sample	HCl theoretical
12.10	.3456	11.00
11.45	.2574	11.00
11.51	.4241	11.00

It is evident that the analyses run high. This is probably because of the difficulty of getting rid of all of the free HCl as these compounds had to be analyzed as soon as they were made. They were washed several times in dry benzene but it is still probably that traces of the free acid remained.

These same samples (in order given in data) had 50 cc. of the standard KOH run into them after they had been brought to the neutral point by titration and then heated for about an hour, and again titrated. The results are as follows:

(Samples in same order as given on preceding page).

Acid found

7.8%

8.4%

7.

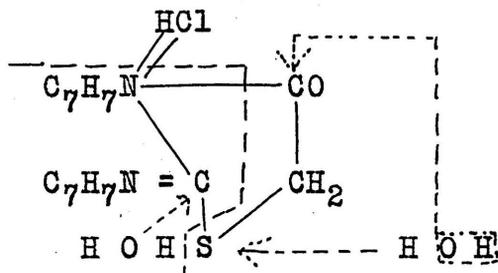
The sums of these two acid contents being the total acid or salt forming groups in the compound.

Or in other words, if we calculate two acid hydrogens to be present to the mole of the hydrochloride, we find that these titrations run from 1 to 2 percent low for the theoretical amount of acid hydrogen.

There remained after the heating with the KOH a powder which crystallized from alcohol in glistening fish like scales, having a melting point of  $264^{\circ}$ , and an analysis of the same proved their N content as follows:-

N found	Calculated
11.8	11.65
11.7	11.65

This taken together with the fact of that an excess of KOH beyond that necessary to neutralize the HCl of the salt would indicate that the mole hydrolyzed as follows:



this then reacting to form the sodium salt of the thio acid and di tolyl urea.

The melting point of the hydrochloride was 195-205°. In fact it seemed to decompose at this temperature. If allowed to stand exposed to the air, HCl is continually given off.

CONDENSATION REACTIONS OF CH<sub>2</sub> GROUP.

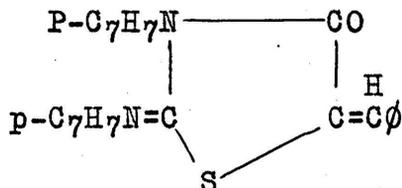
Condensation was now tried with benzaldehyde. di-p-tolyl isothiohydantoin and 6 cc. of benzaldehyde were heated under a reflux condenser for about four hours at 150° to 175°. At the end of this time any excess benzaldehyde was distilled off. Alcohol was added to the flask and almost at once the entire contents of the flask became solid. Fractional crystallization was used; short yellow needles came down from the alcohol after standing for some hours. They gave a melting point of 197°. The analysis is:

Nitrogen found	Nitrogen calculated for C <sub>24</sub> H <sub>20</sub> O <sub>2</sub> N <sub>2</sub> S
7.5	7.29
7.61	7.29

These crystals are very soluble in carbon tetrachloride, chloroform, and glacial acetic acid. They can best be recrystallized from chloroform by the addition of alcohol to a saturated solution of the latter. The yield in this case was 70 percent.

ACTION OF KOH

A few grams (6) of the benzaldehyde condensation product (formulae given below)



was put into an alcoholic KOH solution and heated under a reflux for several hours. From this there was long white needles separated out giving a melting point of 255, which corresponds to that of p-di-tolyl urea, given by Richler as 256. This is also in accord with the results obtained from the hydrolysis of the hydrochloride. There was also obtained a very small percent of a white short needles which gave a melting point of 208°. These when

3  
 mixed with p-tolyl 2.4 diketo 5 benzal tetra-hydro-thiozole as obtained on page 12 gave no decrease in the melting point. This would seem to show that the hydrolysis takes place in steps depending upon the temperature and the concentration of the reagents used.

PREPARATION OF THE DI-KETO-HYDANTOIN

Some of the P-di-tolyl-iso-thio-hydantoin was now hydrolyzed by heating in alcoholic solution with HCl, to the 3 tolyl 2.4. di-keto-iso-thio-hydantoin. This was then heated with a slight excess of benzaldehyde for several hours. Alcohol was added and the contents at once solidified. The product was very difficultly soluble in alcohol and came down as short white needles. They gave a melting point of  $210^{\circ}$ . The analysis is as follows:-

Nitrogen found

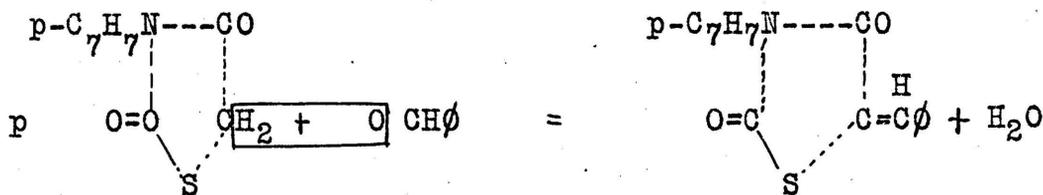
4.60

4.54

Nitrogen calculated  
for  $C_{17}H_{13}O_2NS$ .

4.75

4.75



This tends to show that the group joined to carbon atom at 2 does not exert a very great influence over the condensing power of the methylene hydrogens.

It was now wondered what influence an  $\text{NO}_2$  group in the benzaldehyde ring would have upon the condensation of the two reagents. This was tried

with the meta nitro benzaldehyde in a similar way as mentioned above. There was considerable evidence of condensation when the di <sup>mono</sup> p-tolyl <sup>at diket</sup> iso-thio-hydantoin was heated with m-nitro-benzaldehyde. The product was of a brownish-yellow color. It is very insoluble in alcohol, soluble in chloroform from which it was recrystallized. M.P. 230°.

Analysis for  $C_{24}H_{19}O_3N_3S$

Percent N found	Percent calculated.
8.5	8.39
8.45	8.39

#### REACTIONS WITH FORMAMIDINES

Condensation was now tried with di-phenyl formamidine, the details of which are as follows:

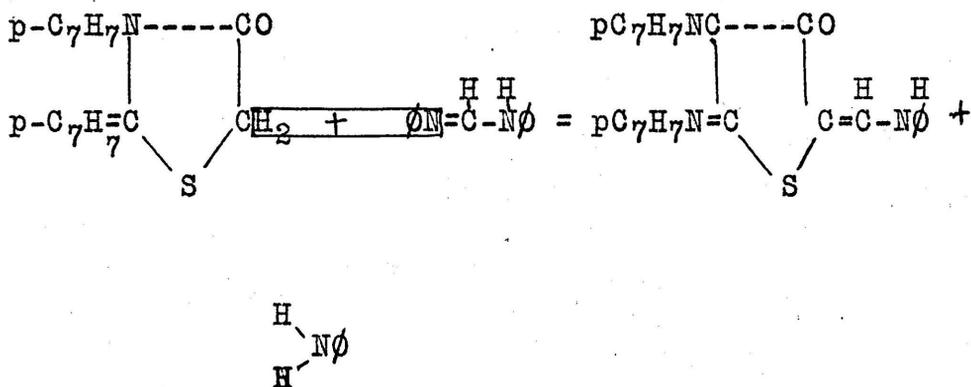
50 grams of freshly prepared diphenyl formamidine M.P. 135° was thoroly mixed with 10 grams of p-di-tolyl-iso-thio-hydantoin and the mixture gently heated over an oil bath. It was necessary to let the temperature reach about 140° before the condensation occurred to any great extent. It then rose to 160°. The flask was connected with a condenser and there was a cc. or so of aniline distilled over. After heating for about three hours, alcohol was added to the flask. The contents at once turned solid.

After repeated crystallization from alcohol, very long bright yellow needles separated out. They were very soluble in carbon tetrachloride, chloroform, acetic acid, and much more so in alcohol than the benzaldehyde product.

They gave a melting point of  $168^{\circ}$ . The analysis is as follows:-

Nitrogen found	Nitrogen calculated for $C_{24}H_{21}ON_3S$
10.74	10.53
10.90	10.53

The reaction:-



There was also obtained from this reaction a dark red substance which was very soluble in alcohol and upon evaporation of the alcohol became a very dark red substance of a tarry like nature and nothing could be done towards crystallizing it. This is very probably some decomposition product for it seemed that the longer the heating was continued the larger the amount, of this substance there was formed.

It was now thought best to see if other formamidines would likewise condense with the p-di-tolyl-iso-thio-hydantoin.

10 grams of di-alpha-naphthyl formamidine, M.P. 199°, were now thoroly mixed with 10 grams of p-di-tolyl-iso-thio-hydantoin and this mixture heated with a reflux condenser for about one hour at a temperature of from 200° to 230°. The reaction having cooled, alcohol was added to the flask. Its contents at once turned solid. Fractional crystallization was tried from alcohol which gave a pure product melting at 193° to 195°.

This compound was very soluble in alcohol, but far more so in carbon tetrachloride, chloroform, or acetic acid, these being used later on for recrystallizing purposes. As in the other there was a red substance formed of a tarry nature.

The analyses for this are:-

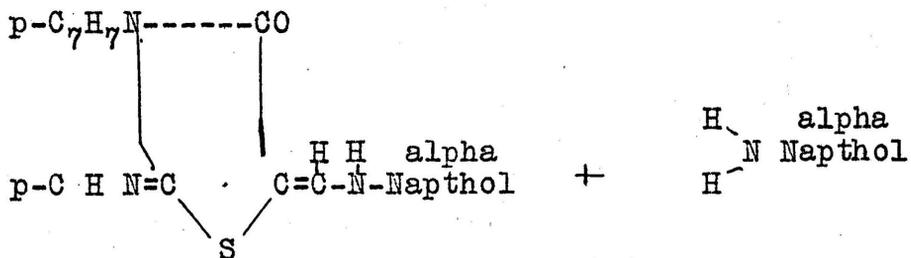
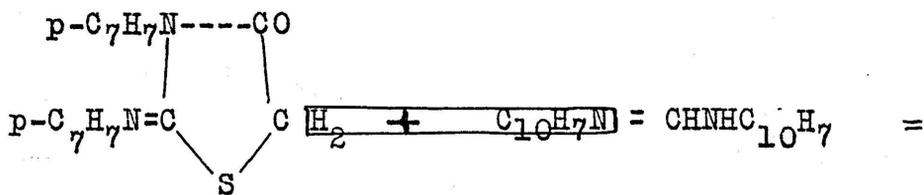
Nitrogen found	Nitrogen calculated for $C_{28}H_{25}N_3OS$
10.1	9.35
10.1	9.35

The reaction equation is given on the following page.

Some of the di-alpha-naphthyl formamidine di-p-tolyl-iso-thio-hydantoin condensation product was mixed with di-alpha-naphthyl formamidine

and this gave a melting point of 167°.

The reaction from the preceding page is:-



Condensation was now tried using in place of the di-alpha-naphthyl formamidine, di-beta-naphthyl formamidine. The same quantities were used and were heated in the same way as in the case of the alpha that was just given. This gives a very bright yellow product which has about the same solubility as the alpha. Its melting point is 215°. There was in this case as in all of the others a reddish tar obtained.

The analyses for this compound are:

Nitrogen found	Nitrogen calculated for $C_{28}H_{23}ON_3S$ .
9.45	9.35
9.52	9.35

The yield obtained in all of these condensations was good (50-60%).

It might be said that all of these reactions gave tests for primary amines.

It might also further be stated that if heating at high temperatures or a continuation of heating for a long period tends to decompose all the condensation products. The resulting mass being a tar from which it is impossible to obtain crystalline products, hence in their preparation this is to be avoided.

#### BEHAVIOR TOWARDS BROMINE.

It will be noticed that in all of these condensation reactions that we have the grouping  
 $\begin{matrix} H \\ | \\ C=C-R. \end{matrix}$  The question now occurs as to the behavior of this towards  $Br_2$ . Some of the p-di-tolyl-iso-thio-hydantoin benzaldehyde product was taken and to this sufficient carbon tetra-chloride added to put it in solution; to this was added a solution of bromine in carbon tetra-chloride. The bromine was gradually absorbed on standing and there resulted a very bright red compound of definite crystalline

structure which when heated to 125 - 130° decomposes but there was no evidence of any bromine being given off, hence this may or may not be a molecular rearrangement; because of lack of time nothing more definite has been found out regarding this bromine product.

## P-DI-BROM-DI-PHENYL-ISO-THIO-HYDANTOIN

Para brom aniline was prepared by suspending by means of a stirring machine, acetanilid in water; to this was then added very slowly bromine till the theoretical quantity of bromine had been added. It was then hydrolyzed etc., to get the para brom-aniline. This method in one trial gave a yield as high as 40% while in another trial, the yield ran as low as 10%. Remmers<sup>1</sup> points out that this method can be expected to give only very low yields due to the formation of the di-brom- and tri-brom products. The product that was obtained was hard to purify.

Fry's method<sup>2</sup> for the preparation of the thio urea was used. 100 grams of para-brom-aniline, 400 cc. of CS<sub>2</sub> 65.8 grams of iodine and about 30 cc. of pyridine were used. This was gently heated and the reaction was very vigorous. Yield was about 75 percent.

10 grams of p-di-brom-diphenyl thio urea, 2.4 grams of chloro acetic acid and 1 cc. of pyridine were heated together on a water bath until the urea had disappeared. After standing a while there were crystals separating out that were almost colorless having a faint lemon yellow color.

(1). J. of Chem. Soc. Abs.

(2). J.A.C. vol. 35, p. 1539.

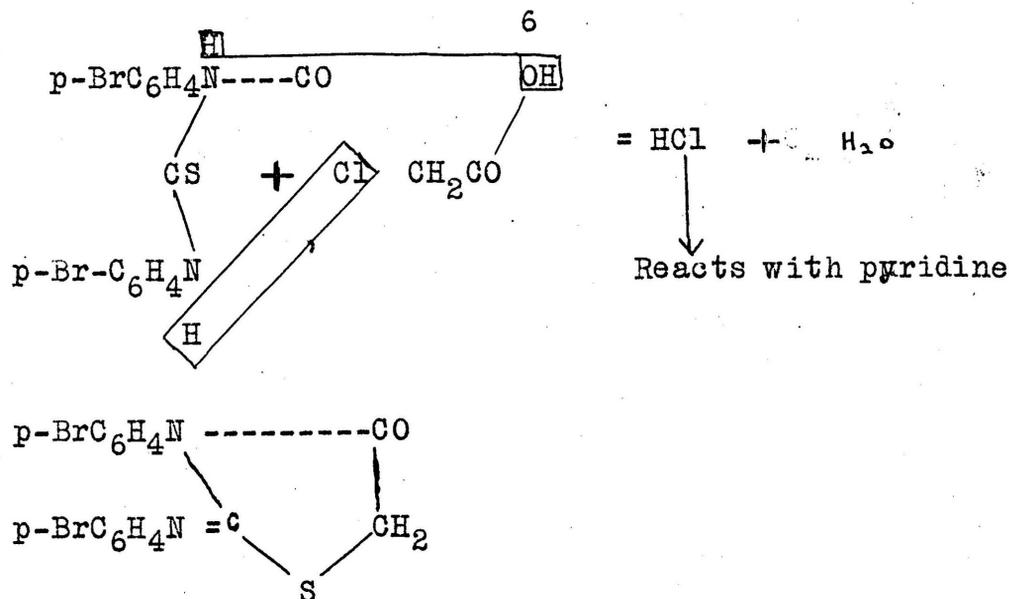
These gave a melting point of  $183^{\circ}$ ; when they were mixed with some of the thio urea the mixture melted at  $150^{\circ}$ . The yield in this case was very good.

The analysis is as follows:

Nitrogen found	Nitrogen calculated for $C_{15}H_{10}ON_2SBr_2$
6.1	6.58
6.2	6.58

It would look as though that this compound might not be pure.

The equation for this reaction is as follows:



This same reaction was tried using the ethyl ester of chloro acetic acid in the theoretical proportions also using pyridine. The yield was somewhat better than in the case of the chloro



About 5 grams of the p di-brom-di-phenyl iso-thio-hydantoin was heated with benzaldehyde a reflux condenser being used. Heating was continued for about 3 hours and the excess benzaldehyde distilled off. Alcohol was now added and there was a yellow precipitate formed which crystallized in the form of light yellow needles.

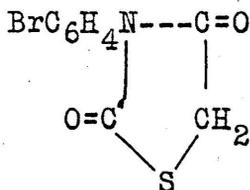
The melting point of these crystals was  $220^{\circ}$ . They are very difficultly soluble in alcohol, soluble in chloroform, and glacial acetic acid.

Analysis for  $C_{22}H_{14}ON_2Br_2S$

Percent N found	Percent N calculated
5.50	5.45
5.57	5.45

It might also be mentioned here that the 2.4-diketo compound was obtained from the p-di-brom-diphenyl-iso-thio-hydantoin very readily and gave a melting point of  $130^{\circ}$  which is a little higher than that given by Irwin, for some reason or other.

The formula is:



P-DI-CHLORO-DI-PHENYL-ISO-THIO-HYDANTOIN.

Ten grams of p-di-chloro-thio-urea and 2.1 grams of chloro-acetic acid were mixed in an alcoholic solution with 2.6 grams of pyridine to check hydrolysis. This was then heated on a water bath till the thio-urea had disappeared; after standing for some time crystals of a substance came down that were almost colorless. These were then recrystallize from alcohol and they had a very slight pale yellow cast to them much of the same color as the brom compound, that has just been described. The yield was about 65%. It might be said that in this case and in the case of the p-di-brom product much difficulty was experienced in getting these products.

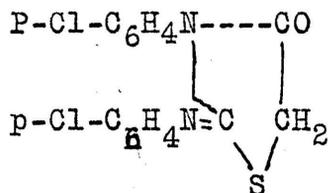
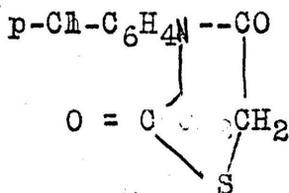
These crystals gave a melting point of 165° and when mixed with the corresponding urea they melted at 143°.

A good yield was also obtained by using the ethyl ester of chloroacetic acid together with pyridine in the theoretical proportions.

The analysis for  $C_{15}H_{10}ON_2SCl_2$

Nitrogen found	Nitrogen calculated for $C_{15}H_{10}ON_2SCl_2$
8.52	8.32
8.48	8.32

A few grams of this was now heated with alcohol acidified with HCl. Thus the 2,4 diketo or hydrolyzed product was obtained. Its melting point was 135-137° which corresponds very closely to that given by Irwin.



2,4 Diketo compound. p-di-chloro-diphenyl-iso-thio-hydantoin.

Condensation products were now tried with the formamidines.

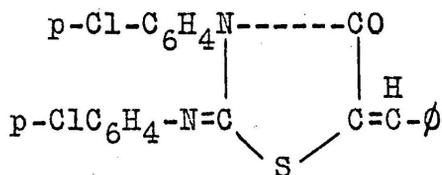
6 grams of the di-p-chloro-diphenyl-iso-thio-hydantoin and 5.3 grams of beta di-naphthyl formamidine was heated together in an oil bath. The temperature ranging from 200 to 230°. Heating was continued for about an hour. Alcohol was then added to the flask and the contents at once turned solid. This when recrystallized from alcohol gave short needles of a



The analysis for  $C_{22}H_{14}ON_2SCl$ :

Nitrogen found	Nitrogen calc.
6.60	6.59
6.49	6.59

Formula:



PREPARATION OF DI-PARA-BROM-DI-PHENYL-THIO-UREA  
FROM THE THIO AMMONIUM SALT.

In the preparation of the thio ureas used for the synthesis of the thiozoles Fry's method was used.<sup>1</sup> This method will give very good results with the para-chlor and para-brom-di-phenyl-thio-ureas. The objection to this method however is the expensive reagents that are required. Hence another method that would give good results was the aim sought for in the following experiments.

30 grams of para-brom analine were taken and placed in solution using just enough alcohol to dissolve it. 40 cc. of CS<sub>2</sub> were now added to this and then 50 cc. of very strong ammonia water was added. This was now placed under an air condenser and let stand over night. After the solution had first been made there was a great absorption of heat due to the para-brom analine going into solution but upon adding the ammonia water, the solution gradually warmed up and in the course of an hour the reaction was proceeding very vigorously. The reaction continued for several hours. There was considerable ammonium sulphide collected on the sides of the condenser. After letting

(1) J.A.C. Vol. 35, 1539.

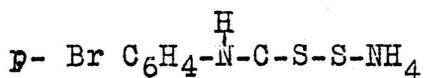
the reaction go for about three hours a mass of crystals separated out. The solution was then filtered off and an analysis run on these crystals to determine the percent of ammonia nitrogen they contained.

The analysis:-

Nitrogen found	Nitrogen calculated
7.00	5.31
6.50	5.31

This analysis was made by taking some of these yellowish white crystals, drying on a plate and then distilling with an excess of sodium hydroxide and thus we can obtain the ammonia nitrogen. As is shown, these analyses run about one or two percent high. This is to be expected to be the case as they come from a solution of strong ammonia and ammonium sulphide.

This analysis however is close enough to show that these crystals contain one mole of ammonia and their formulae is very probably:

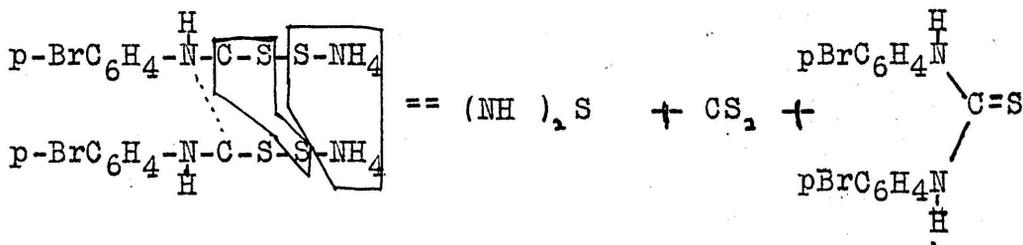


An analysis was run on these same crystals after they had been standing for some time and the results are as shown:

Nitrogen found	Nitrogen calc.
4.00	5.31
4.50	5.31

Thus it would seem that these thio ammonium salts tend to lose their ammonia. It might be well to state that these crystals were exposed to the atmospheric conditions during this time, from which if they were protected, this loss of ammonia might not occur.

It was now found that if we took these crystals and boiled them in water there was a very rapid evolution of ammonia and also hydrogen sulphide. Hence it would seem that thio ammonium salt is very unstable and breaks down upon being boiled with water as is shown:



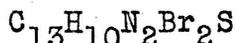
This tendency to decompose is also shown in taking a melting point when it was found that between the temperatures of  $125^\circ$  and  $135^\circ$  this ammonium salt decomposed very rapidly.

The above equation shows the decomposition of this ammonium salt to the thio urea. Boiling

is now continued till there is no ammonia given off and the water has become clear from the ammonium sulphide it contains. There is thrown down during this boiling an insoluble grayish powder. This was now dissolved in alcohol in which it is very difficultly soluble. It crystallizes from this upon standing in long white needles.

These needles gave a positive test for nitrogen sulphur and halogen. They were insoluble in HCl.

The analysis shows:



7.57

7.26

7.70

7.26

They gave a melting point of  $188^{\circ}$ . This is higher than that given in B. or that that is obtained from the p-Br-thio-urea as obtained from Fry's method, which is  $179$  to  $180^{\circ}$ . A mixture was now made from these crystals (M.P.  $188^{\circ}$ ) and some of those obtained from Fry's method (M.P.  $180$ ) and the melting point of the resulting mixture was  $180^{\circ}$ .

Thus from the data at hand the only conclusion possible is that the melting point of the p-dibrom-diphenyl thio urea must be  $188^{\circ}$  and that this method gives a purer compound than has been previously prepared by other methods.

Mr. R.G. Story now ran this preparation, using the

same quantities. The yield resulting was 57.5 percent; this yield is somewhat low and there is no doubt that it can be brought up considerably by varying the proportions of reagents used. Another interesting fact presents itself and that is that with the carbon disulphide and ammonia present in the alcoholic solution, there is a great probability that some of the corresponding urethane would be formed, and if this is the case, it would cut down the yield of the thiourea. Therefore it would be interesting to carry out these experiments in another medium other than alcohol thus preventing the formation of the urethane.

PREPARATION OF THE P-DI-CHLORO-DIPHENYL-THIO-UREA  
FROM THE THIO AMMONIUM SALT.

20 grams of para chloro aniline were taken and put into an alcoholic solution using just enough alcohol to dissolve the para chloro aniline. To this was then added 30 cc. of  $CS_2$  and about 50 cc. of strong ammonia water. The flask was now placed under an air condenser and allowed to stand for some time. In about an hours time there was considerable heat being evolved and the reaction was going on very vigorously. This reaction continued for several hours. Upon standing over night, there was a mass of the thio ammonium salt crystals separated out. These were

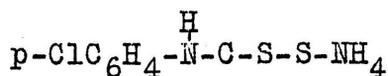
taken out and dried on a porous plate and an analysis made of them as soon as possible.

The analysis shows the following:

Nitrogen found	Nitrogen calculated.
7.84	6.35
7.70	6.35

It must be remembered that this analysis is for ammonia nitrogen only and that the same is very apt to run high because of the conditions under which it is made.

However, the analysis is close enough to show that the ammonia contains only one mole of ammonia. Then we would expect it to have the following formula:



This, like the brom (p) ammonia salt decomposes upon heating. This salt was now placed in water and then boiled. Upon boiling there was, as in the case of the brom (p) salt, a very rapid evolution of ammonia and hydrogen sulphide. The boiling continued for about two hours till all of the ammonia and the hydrogen sulphide had been evolved. There was a grayish like powder that separated out from the water, and this when dissolved in alcohol, crystallized from the alcohol in long white needles.

These needles give a positive test for halogen, sulphur and nitrogen. The analysis for the nitrogen



RESULTS WITH META-NITRO-ANILINE

20 grams of meta-nitro-aniline was dissolved in alcohol and to this was added 40 cc. CS<sub>2</sub> and about 50 cc. of strong ammonia water. In about an hour there was considerable heat being given off, and the reaction was proceeding even more violently than in the case of either of the two halogens described. It was now allowed to stand over night and there were long greenish yellow crystals separating out. These were then dried on a porous plate. They give a positive test for nitrogen (ammonia nitrogen) and when heated with boiling water some ammonia is given off. After repeated trials, there was a light greenish yellow powder obtained which gives a melting point of 160° which corresponds to that of the meta nitro-thio-urea. However there was only a very small amount of this obtained. There was obtained in this reaction a lot of free sulphur which was not the case in the halogen reactions described. It is very evident that this reaction has gone in some other method than that of the halogens described. It might be that the NO<sub>2</sub> group is reduced, which would explain the presence of the free sulphur, or the urethane might possibly be formed.

RESULTS WITH PARA-NITRO-ANALINE

20 grams of para nitro analine was mixed with the same proportions of the reagents named in the case of the meta nitro analine. There was no heat evolved in this case, and no evidence of any chemical reaction taking place whatever. At the end of 24 hours the para-nitro-analine was recovered from the solution unchanged.

RESULTS WITH ORTHO-NITRO-ANALINE

20 grams of ortho-nitro-analine were treated in the same way as described under the meta-nitro-analine. There was some evidence of reaction taking place, as there was considerable heat given off. Upon standing, crystals separated out, but nothing which resembled a thio-urea could be obtained from these.

It would seem that there is a good possibility of obtaining this ortho-thio-urea by employing a different solvent, and varying the proportions of the reagents used.