

1

3,185,725

PREPARATION OF 2,6-DICHLOROBENZONITRILE
Harmannus Koopman, Weesp, Netherlands, assignor to
North American Philips Company, Inc., New York,
N.Y., a corporation of Delaware

No Drawing. Filed Apr. 27, 1960, Ser. No. 24,916
Claims priority, application Netherlands, Apr. 28, 1959,
238,687

2 Claims. (Cl. 260—465)

Applicant had already found, as described in his older patent application Serial No. 771,742, filed November 4, 1958, now Patent No. 3,027,248 that 2,6-dichlorobenzonitrile has herbicidal activity and particularly a strong growth inhibiting effect on germs and seedlings of mono- and dicotyle plants. Now it was found that this compound has an insecticidal activity, namely that it has a selective activity with respect to Colorado beetles.

Applicant has found a suitable process for the production of 2,6-dichlorobenzonitrile in which 2-amino-6-chlorobenzonitrile is used as starting material.

The invention relates to a process for the production of 2,6-dichlorobenzonitrile, characterized in that 2-amino-6-chlorobenzonitrile is converted into 2,6-dichlorobenzonitrile in manners known for this type of conversion or manners analogous thereto. Preferably, the 2-amino-6-chlorobenzonitrile is prepared from 2-chloro-6-nitrobenzonitrile in manners known for this type of reaction or manners analogous thereto. More in particular the invention relates to a process for the production of 2,6-dichlorobenzonitrile in which 2,3-dichloronitrobenzene is converted into 2-chloro-6-nitrobenzonitrile which is converted into 2-amino-6-chlorobenzonitrile and this compound into 2,6-dichlorobenzonitrile, performing these reactions in manners known for this type of reaction or manners analogous thereto.

2-chloro-6-nitrobenzonitrile and 2-amino-6-chlorobenzonitrile are not described in the literature. It has been found that the 2-chloro-6-nitrobenzonitrile has a satisfactory fungicidal activity and that 2-amino-6-chlorobenzonitrile may be used to influence the growth of plants.

For better understanding of the process according to the invention, the reactions in question will be described separately by way of example.

PREPARATION OF 2,6-DICHLOROBENZONITRILE FROM 2-AMINO-6-CHLOROBENZONITRILE

2-amino-6-chlorobenzonitrile can be prepared in manners known for this type of compounds or in manners analogous thereto. It is preferably prepared in the manner to be described below from 2-chloronitrobenzonitrile.

In this preparation, 2-amino-6-chlorobenzonitrile was diazotized and the diazonium compound formed was converted into the 2,6-dichlorobenzonitrile by means of the so-called Sandmeyer reaction or Gattermann reaction. These reactions may be carried out in manners commonly used for this type of reactions. (See for example Ullmann, Handbuch der Chemischen Technologie, Bd V, page 786—800 and 813—816 (1954).)

It was found that good results can be obtained in the diazotation also by the addition of a rather large excess of mineral acid and particularly hydrochloric acid. Preferably 5—20 times the theoretically required quantity is used. In addition it was found that the use of a small amount of a surface active substance favourably influences the formation of the diazonium compound from the amine. Preferably a non-ionogenic surface-active substance is used, for example polyoxy ethylene derivatives of fatty acid esters of a multivalent alcohol, such as glycerol, sorbitol, mannitol.

2

The conversion of the diazonium compound into 2,6-dichlorobenzonitrile may be carried out according to the known reaction of Sandmeyer in the presence of cuprochloride. It was found, that 1—10 mol. percent of cuprochloride with respect to the quantity of the diazonium compound may advantageously be used; this improves the yield of 2,6-dichlorobenzonitrile. Moreover it was found, that when using copper instead of cuprochloride (the so called Gattermann-reaction) satisfactory yields of 2,6-dichlorobenzonitrile can be obtained.

The reaction temperature in the conversion of the diazonium compound into 2,6-dichlorobenzonitrile was chosen between 20 and 90° C.; within this range, the temperature turned out to have little influence on the yield. This conversion is carried out in a mineral acid-containing aqueous medium. It was found that advantageously a non-water-miscible organic solvent may be added to the reaction mixture, the solvent preferably being satisfactory for the 2,6-dichlorobenzonitrile formed in the reaction, such as aromatic hydrocarbons, for example benzene and toluene. So in this manner a system is used which consists of two non-miscible liquids. By using such an organic solvent, the yield and the purity of 2,6-dichlorobenzonitrile are improved.

The purification of the resulting 2,6-dichlorobenzonitrile may be carried out in various manners, for example by crystallization from solvents, for example alcohols, such as methanol, and aromatic hydrocarbons, such as benzene. Better methods are distillations with or without the use of steam.

The following examples illustrate the invention. Table I shows the results of a number of examples, the performance of which was analogous to that of Example 1.

Example 1

(a) *Diazotation of 2-amino-6-chlorobenzonitrile.*—To a mixture of 152 gr. (1.0 g. mol) of powdery 2-amino-6-chlorobenzonitrile, 1000 cm.³ of concentrated hydrochloric acid (S.G. 1.19) and 10 drops of a dispersion agent (polyoxyethylenesorbitol ester of a fatty acid) was added a cold solution (temperature 0—5° C.) of 70 g. (1.0 g. mol) of sodium nitrite in 250 cm.³ of water at 0—5° C. and while stirring. Then the mixture was stirred for another about 30 minutes at about 5° C. A little unchanged 2-amino-6-chlorobenzonitrile was removed by filtration. The diazonium compound 3-chloro-2-cyanobenzenediazonium chloride was not isolated for the following process.

(b) *Conversion of diazonium compound into 2,6-dichlorobenzonitrile.*—While stirring vigorously at room temperature, the solution of the diazonium compound obtained sub (a) was added, within about 30 minutes, to a mixture composed of 1000 cm.³ of benzene, 5 gr. of copper-powder, 0.02 g. mol. of cupro chloride in 10 cm.³ of concentrated hydrochloric acid (S.G. 1.19) and 250 cm.³ of strong hydrochloric acid (S.G. 1.19). After stirring for another about 15 minutes, the solution, in benzene, was separated from the aqueous layer, the benzene was distilled off and the residue was distilled off at normal pressure. (Boiling point: approx. 258° C.). Yield of 2,6-dichlorobenzonitrile: 141 gr. (82%). Melting point: 142—144° C.

In the examples given in Table I, 0.1 gr. mol. of 2-amino-6-chlorobenzonitrile was invariably used as starting material. The diazotation was carried out at a temperature between 0 and 5° C. The columns of this table show successively: the number of the example, the used quantity (in g. mol. of HCl) of strong hydrochloric acid (S.G. 1.19) in the diazotation reaction (reaction (a)), the quantity of cupro-chloride used in reaction (b), the temperature in ° C. applied in (b), the yield of 2,6-dichlorobenzonitrile, calculated on 2-amino-6-dichloroben-

zonitrile, and the melting point (in ° C.) of the resulting distilled 2,6-dichlorobenzonitrile.

TABLE I

Example No.	Cuprochloride (g. mol.)	Reaction temperature in (b) in ° C.	Yield 2,6-dichlorobenzonitrile in percent	Melting point 2,6-dichlorobenzonitrile in ° C.
2-----	0.05	70-75	67	143-145
3-----	0.01	25	83	141-142
4-----	0.005	25	79	141-142
5-----	0.002	25	83	142-143
6-----	0.001	25	79	142-143
7-----	0.002	30	78	144-145
8-----	0.002	75	78	142-143

PREPARATION OF 2-AMINO-6-CHLOROBENZONITRILE FROM 2-CHLORO-6-NITRO-BENZONITRILE

2-chloro-6-nitrobenzonitrile can be prepared according to the manners known for this type of compound and in manners analogous thereto, for example from 2-chloro-6-nitroniline (diazotation and reaction of Sandmeyer), from 2-chloro-6-nitrobenzaldehyde by successive conversion into corresponding oxime and nitrile. 2-chloro-6-nitrobenzonitrile is preferably prepared from 2,3-dichloronitrobenzene in the manner to be described below.

The reduction of 2-chloro-6-nitrobenzonitrile does not give a satisfactory yield of 2-amino-6-chlorobenzonitrile in alkaline medium. In addition to reduction, hydrolysis occurs of the cyano group. It was found that satisfactory results can be obtained if the reduction is carried out in acid medium. In this case, the commonly used reduction agents may be used. Catalytic reduction may be applied with for example palladium, for example on carbon, and hydrogen. Satisfactory yields can be obtained by carrying out the reduction with stannochloride and concentrated hydrochloric acid and in particular with iron and hydrochloric acid, in particular with iron and concentrated hydrochloric acid. It was found that in these examples the yield of 2-amino-6-chlorobenzonitrile can be raised by adding to the reaction mixture a lower alcohol, in particular methanol or ethanol.

The reduction with iron and concentrated hydrochloric acid is preferably carried out at a temperature between 20 and 80° C.

The following examples illustrate the process. Table II gives the results of a number of examples, the performance of which is analogous to that of Example 9.

Example 9

17 gr. (0.30 g. at.) of iron powder added portion-wise, in 15 minutes, and while stirring, to a mixture of 18.2 gr. (0.1 g. mol.) of 2-chloro-6-nitrobenzonitrile, 50 cm.³ of methanol and 55 cm.³ (0.68 g. mol.) of concentrated hydrochloric acid (S.G. 1.19). The reaction is exothermal; during the addition of the iron powder, the reaction mixture was cooled in a manner such that the temperature remained at 65-70° C. After the addition of all the iron powder, stirring at this temperature was continued for another 15 minutes. Then the reaction mixture was poured into 1 l. of water. The 2-amino-6-chlorobenzonitrile separated and was filtered off and then air-dried. Yield: 13.5 g. (89%); melting point: 132-134° C.

In the examples given in Table II, 0.1 g. mol. of 2-chloro-6-nitrobenzonitrile was invariably used as starting material. The columns of this table designate successively: the number of the example, the used quantity of iron, concentrated hydrochloric acid (S.G. 1.19) and lower alcohol, the reaction temperature in ° C., the yield of 2-amino-6-chlorobenzonitrile in percent, calculated on the quantity of 2-chloro-6-nitrobenzonitrile from which was started and the melting point of 2-amino-6-chlorobenzonitrile obtained. In the Examples 10 and 11 no alcohol was used; in Example 12 ethanol was used and in the Examples 13-17 methanol was used.

TABLE II

Ex. No.	Fe (g. at.)	HCl (g. mol)	Alcohol in cm. ³	Reaction temperature in ° C.	Yield in percent	Melting point in ° C.
10-----	0.27	2.5	-----	30	70	134-136
11-----	0.36	1.24	-----	23	52	133-136
12-----	0.36	1.24	200	ca. 70	88	133-134
13-----	0.36	0.93	200	65-70	85	133-134
14-----	0.36	1.24	200	60-65	88	134-135
15-----	0.36	1.24	100	65-70	83	134-135
16-----	0.30	0.62	50	65-70	92	131-134
17-----	0.30	0.93	50	65-70	85	133-134

PREPARATION OF 2-CHLORO - 6 - NITROBENZONITRILE FROM 2,3-DICHLORONITROBENZENE

In this preparation, the chlorine atom which is bound to the benzene nucleus in the ortho position with respect to the nitro group, must be replaced by a CN-group, while the other chlorine atom is not substituted. It was found that this can be achieved by heating the 2,3-dichloronitrobenzene with cuprous cyanide or a mixture of cuprous cyanide and an alkali metal cyanide.

The reaction of 2,3-dichloronitrobenzene with said cyanides may be carried out in various manners. Applicant has found that a suitable method is that in which the 2,3-dichloronitrobenzene is heated with cuprous cyanide or a mixture of cuprocyanide and an alkali metal cyanide and in particular that in which a tertiary nitrogenous base is present.

The reaction temperature is preferably chosen between 140 and 240° C. and in particular between 160 and 200° C.

Suitable tertiary nitrogenous bases are: pyridine or pyridines substituted by alkyl groups, for example collidine, picolines or lutidines, and further quinoline. Pyridine is to be preferred. The quantity of tertiary base is chosen so that less than approx. 0.5 mol and preferably 0.05-0.3 mol is used per mol of 2,3-dichloronitrobenzene.

If only cuprous-cyanide is used as cyanide, preferably equimolar quantities with respect to 2,3-dichloronitrobenzene are used. The use of larger quantities does not give any improvements of the yields of 2-chloro-6-nitrobenzonitrile, calculated on 2,3-dichlorobenzonitrile. Cuprous-cyanide may advantageously be replaced partially (to approx. 70 mol percent) by an alkali cyanide, preferably by sodium cyanide or potassium cyanide.

The process is illustrated with reference to the Example 18 to be described below and the examples summarized in Table III which were carried out in a manner analogous to that of Example 18.

Example 18.—Preparation of 2-chloro-6-nitrobenzonitrile

960 g. (5 g. mol.) of 2,3-dichloronitrobenzene were heated at 165° C. A mixture of 447 g. of cuprous cyanide and 50 cm.³ of pyridine was added portion-wise, while stirring, and within 3.5 hours. During the addition and 30 minutes after the addition, the temperature of the reaction mixture was maintained between 165 and 170° C. The reaction is exothermal. The reaction mixture was poured into 2.5 l. of hot chloroform. The insoluble copper salts form a coarse-granular precipitate after some minutes. This was filtered off, powdered and extracted with benzene. The resulting extract was mixed with the chloroform solution, then the whole was washed twice with 250 cm.³ of concentrated hydrochloric acid (S.G. 1.19) and three times with 500 cm.³ of water, and then evaporated. The residue (865 g.) was extracted five times with 500 cm.³ of petroleum ether (boiling range 40-60° C.). The non-petroleum ether soluble 2-chloro-6-nitrobenzonitrile had a weight of 681 g. (75%). Melting point: 117-119° C.

184 g. of unchanged 2,3-dichloronitrobenzene could be recovered from the petroleum ether. So totally a yield of 93% of 2-chloro-6-nitrobenzonitrile was obtained.

In the examples given in Table III 0.1 g. mol of 2,3-di-

chlorobenzene was invariably used as starting material. The columns of this table successively state: the number of the example, the used quantities of cupro-cyanide, potassium cyanide and sodium cyanide respectively and of pyridine (in g. mol), the reaction temperature in ° C., the yield of 2-chloro-6-nitrobenzonitrile in percent calculated on the quantity consumed of 2,3-dichloronitrobenzene, and the melting point of the resulting product in ° C. The reaction time was invariably 1 hour. Instead of pyridine as tertiary nitrogenous base, in Example 31 used collidine and in Example 32 quinoline.

TABLE III

Ex. No.	CuCN (g. mol)	KCN NaCN (g. mol)	Pyridine (g. mol)	Reaction temperature in ° C.	Yield in percent	Melting point in ° C.
19	0.05	-----	0.025	160	79	115-117
20	0.10	-----	0.025	160	81	117-119
21	0.14	-----	0.025	160	86	114-117
22	0.06	¹ 0.04	0.025	170	82	115-118
23	0.05	² 0.05	0.025	160-165	80	115-117
24	0.03	¹ 0.07	0.025	170	74	114-117
25	0.10	-----	0.006	160-165	85	113-116
26	0.10	-----	0.012	160-165	87	116-118
27	0.10	-----	0.025	160-165	82	116-118
28	0.10	-----	0.025	180	85	115-117
29	0.10	-----	0.025	190	91	114-116
30	0.10	-----	0.025	200	92	112-116
31	0.10	-----	0.025	180	64	113-116
32	0.10	-----	0.025	155-160	48	110-119

¹ KCN.² NaCN.

Example 33.—Preparation of 2-chloro-6-nitrobenzonitrile from 2-chloro-6-nitraniline

17.2 g. (0.10 g. mol) of 2-chloro-6-nitraniline were diazotized in 60 cm.³ of concentrated sulphuric acid in which 7 g. of sodium nitrite had been dissolved. The resulting solution of the diazonium compound was added to a solution of 60 g. of potassium cyanide and 9 g. of cupro-cyanide in 100 cm.³ of water of 60° C. Then the resulting mixture was distilled by means of steam. The distillate was extracted with ether, the ether was distilled off, and the residue crystallized from methanol. The re-

sulting 2-chloro-6-nitrobenzonitrile melted at 117-119° C.

It was found that the preparation of 2-chloro-6-nitrobenzonitrile by reaction of 2,3-dichloronitrobenzene with cupro-cyanide may also be carried out without the presence of a tertiary base, such as pyridine, if a solvent is used for cupro-cyanide and the 2,3-dichloronitrobenzene. Such a solvent for example is dimethyl formamide and dimethyl sulphoxide. A practically quantitative yield of 2-chloro-6-nitro-benzonitrile calculated on used dichloronitrobenzene was obtained with dimethylformamide as a solvent and using equimolar quantities of 2,3-dichloronitrobenzene and cupro-cyanide at a reaction temperature of approx. 155° C. and a reaction time of 5 hours.

What is claimed is:

1. 2-chloro-6-nitrobenzonitrile.
2. 2-amino-6-chlorobenzonitrile.

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CHARLES B. PARKER, *Primary Examiner.*