

## Candidate's answer

### CLAIMS

1. *A process for producing acetonitrile and vinyl cyanide comprising contacting a mixture containing propylene, ammonia and an oxygen-containing gas with a copper (II) catalyst at a temperature of from 200 to 350°C, wherein a carboxylic acid is added to the mixture before the mixture contacts the catalyst, and further wherein the carboxylic acid is acetic acid or formic acid and the concentration of the carboxylic acid is 1-30 molar percentage of the carbon-containing compounds present.*
2. *A process according to claim 1 wherein the carboxylic acid is acetic acid and the acetic acid is obtained as a by-product of a process according to claim 1.*
3. *A process according to claim 1 or 2 wherein the carboxylic acid is added to the mixture as an aqueous solution.*
4. *A process according to any of claims 1 to 3 wherein the concentration of the carboxylic acid added to the mixture is not more than 15 molar percentage of the carbon-containing compounds present.*
5. *A process as claimed in any of claims 1 to 4 wherein the oxygen-containing gas is air.*
6. *A process as claimed in any preceding claim wherein the copper (II) catalyst comprising copper (II) chloride or copper (II) nitrate.*
7. *Apparatus for producing acetonitrile and vinyl cyanide, the apparatus comprising:*
  - i. *a reactor (3) for holding a reaction bed,*
  - ii. *means for heating the reaction bed in the reactor (3),*
  - iii. *at least one conduit (1, 2, 9, 10) for inputting reactants to the reactor (3),*
  - iv. *a conduit (5) allowing materials to exit the reactor (3) and enter*
  - v. *a spray tower (4) for spraying water onto the materials exiting the reactor (3),*
  - vi. *a cooling tower (6) for condensing the vinyl cyanide and acetonitrile exiting from the spray tower (4),*
  - vii. *a distillation tower (8) for separating vinyl cyanide and acetonitrile from the condensate obtained in the cooling tower (6), and*
  - viii. *a conduit (9) for recycling an aqueous solution of acetic acid obtained in the spray tower (4) to the reaction bed.*

Dear Sirs,

This letter is in response to the communication under Art.94 (3) EPC.

1. Amendment

- 1.1 I file herewith new claims 1 to 7 to replace those currently on file. I reserve the right to file a divisional application pursuant to any subject-matter removed from the claim set due to the new claims filed herewith.
- 1.2 Claim 1 has been amended to specify that 1-30 carbon mol % concentration of carboxylic acid is added to the mixture before the mixture contacts the catalyst. Basis for this amendment can be found in paragraph [005] of the application (“it has further.....the catalyst” and “The concentration ..... the reactants”). It is clear that this general disclosure is taught as combinable with the general disclosure of previous claim 1 in paragraph [006]
- 1.3 Claim 1 has also been amended to specify that the carboxylic acid is acetic acid or formic acid. Basis for this amendment is explicit in paragraph [008] of the application where it states that “The carboxylic acid must be acetic acid or formic acid”. This is unequivocal and therefore must be combinable with the other disclosures of amended claim 1.
- 1.4 New Claim 2 finds basis in paragraph [016] of the application which states that “The use of the acetic acid which is a by-product of the reaction is also shown to be possible”. It is also clear from paragraph [013] “The acetic acid ..... is removed for further use as described herein” and “The aqueous solution of acetic acid .... can be recycled” that the teaching of recycling of acetic acid is a general one, and so combinable with the features of claim 1.
- 1.5 Claim 3 finds basis in paragraph [005] where it is generally stated that “the carboxylic acid is usually added as an aqueous solution”, of course, the use of the word “usually” teaches that this is an optional feature suitable to be the subject of a dependant claim.
- 1.6 Claim 4 finds basis in paragraph [005] where it is taught that “the addition of more than 15 carbon mol % of carboxylic acid, however, makes the reaction too slow to be economically viable”. Since the skilled person will be aware that the economics of a situation will not remain static, and are anyway not always the deciding factor in how a process is carried out, they will understand that the limitations to “not more than 15” is a general optional one, and so appropriate for a claim dependent on claims 1 to 3 filed herewith.
- 1.7 New claims 5 and 6 are based on claims 2 and 3 as filed, respectively. These claims have been made dependent on the preceding claims filed herewith. Basis for these dependencies can be found in paragraph

[008] where it is clear that the use of air (“such as air,” and “It is not essential to use air”) and the use of  $\text{CuCl}_2$  or  $\text{Cu}(\text{NO}_3)_2$  as catalyst (“Preferably ..... but other salts can be used”) are generally applicable optional features.

- 1.8 New claim 7 is based on claim 4 as originally filed with the amendment to specify a conduit for recycling acetic acid. Basis for this amendment can be found in paragraph [013] (“The aqueous solution ..... conduit 9”) in combination with Fig.1.
- 1.9 It is therefore submitted that the new claims are in conformity with Art 123 (2) EPC.

## 2. Novelty

- 2.1 Claim 1 is novel over D1 and D2 by virtue of the disclosure in claim 1 of the addition of carboxylic acid to the reaction mixture before the mixture contacts the catalyst. The only disclosure of a carboxylic acid in D1 is as a reaction product (see [011] of D1 “The reaction products ..... acetic acid”; [012] “The water spray cools the reaction products. The acetic acid dissolves ...” and Table 1 “Acetic Acid in Product %”). In D2 it is clear that there is no carboxylic acid in the reaction mixture until after the mixture has had a chance to contact, and react in the presence of, the catalyst. See [003] and [004] of D2 and note there is no Acetic Acid at point “0” and it only appears in the solution from the outlet that is situated 1m along the catalyst.
- 2.2 Claims 2 to 6 are novel by virtue of being dependent on Claim 1 (see Guidelines C/IV/11.13).
- 2.3 Claim 7 is novel over D1 due to the disclosure in claim 7 of a conduit for recycling acetic acid. In comparison, there is no disclosure in D1 of any conduit connecting the contents of the spray tower of D1 to the reaction chamber of D1 (see Fig. 1 D1 and items (3) and (4)). Claim 7 is novel over D2 as the apparatus of claim 7 has many additional features not disclosed in D2, such as a spray tower.

## 3. Inventive Step

- 3.1 D2 may be taken to be the closest prior art (CPA) as it discloses the reaction of propylene, ammonia and air using a copper (II) catalyst to produce vinyl cyanide and acetonitrile.
- 3.2 The difference between the process of D2 and the invention of claim 1 is the addition of acetic acid or formic acid at a defined concentration to the reaction mixture before exposure to the catalyst.
- 3.3 This difference leads to an ability to vary and optimize the amount of acetonitrile that is produced in the reaction, and to increase the amount of propylene feed converted to vinyl cyanide and acetonitrile. This is

demonstrated by comparing run numbers 4 to 7 of Table 1 of the Application with [003] and [004] of D2. The objective problem solved by the present invention is therefore the provision of an improved process for making acetonitrile and vinyl cyanide.

- 3.4 There is no suggestion in D2 of using carboxylic acid to alter the reaction conditions on the catalyst. In fact the focus of D2 is on the importance of the physical properties (e.g. particle size) of the catalyst. Even where acetic acid is present in the reaction in D2, due to the build-up of acetic acid by-product (see [003] and [004]), there is no obviously apparent correlation between acetic acid concentration and acetonitrile production. Therefore the skilled person would be actually discouraged from adding carboxylic acid.
- 3.5 The skilled person would not look to D1 to find the solution to the problem because there is no explicit mention in D1 of acetonitrile, let alone any mention of using carboxylic acid to affect acetonitrile production.
- 3.6 Document D1 could be considered the closest prior art for the invention of claim 7 because D1 also discloses a system for producing vinyl cyanide using a copper (II) catalyst and comprising many of the same structural features.
- 3.7 The difference between D1 and claim 7 is the conduit for recycling acetic acid in the system.
- 3.8 This difference leads to the ability to use an otherwise not useful by-product of the reaction to improve the amount of the desirable products of the reaction itself. The objective problem solved by the invention of claim 7 is therefore to provide an improved, more efficient apparatus which increases the amount of acetonitrile produced.
- 3.9 The invention of Claim 7 solves this by allowing the recycling of acetic acid.
- 3.10 There is no suggestion to recycle acetic acid in this way in D1. Indeed there is no mention of using carboxylic acids to increase acetonitrile production at all; acetonitrile is not even explicitly mentioned. So the skilled person would not arrive at claim 7 from D1.
- 3.11 The skilled person would not combine teachings of D1 and D2 to arrive at claim 7 either, as the system of D1 and D2 would not be readily combinable nor provide an apparatus of claim 7.
- 3.12 Therefore claims 1 and 7, and all claims dependent thereon (see Guidelines C/IV/11.13) are inventive over the disclosures of D1 and D2.

4. Unity

- 4.1 Claims 1 and 7 are unified by the special technical feature of carboxylic acid use to improve reaction production of acetonitrile.

I believe this response and the claims filed herewith therefore meet all the Examiners objections, and the claims are in order for Grant subject to the amendment of the description.

**EXAMINATION COMMITTEE I**

Candidate No.

## Paper B (Chemistry) 2012 - Marking Sheet

Category		Maximum possible	Marks awarded	
			Marker	Marker
<b>Claims</b>	Process	20	20	20
	Apparatus	14	12	14
	Other Claims	6	4	4
<b>Arguments</b>	Amendments	8	8	8
	Novelty	16	16	14
	Inventive Step	36	28	25
<b>Total</b>		100	88	85

Examination Committee I agrees on 87 marks and recommends the following grade to the Examination Board:

**PASS**  
(50-100)

**COMPENSABLE FAIL**  
(45-49)

**FAIL**  
(0-44)

28 June 2012

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Chairman of Examination Committee I