BL O/146/04

25 May 2004

PATENTS ACT 1977

BETWEEN

Thomas Swan & Company Limited Claimant

and

English Hop Products Limited Defendant

PROCEEDINGS

An application under Section 72(1) for revocation
of Patent Number GB2336363 B

HEARING OFFICER S N Dennehey

DECISION

1 Patent Application No. GB9817682.9 was filed on 13th August 1998 in the name of English Hop Products Limited (“the Defendants”), no earlier priority date was claimed. The application was granted on 15th March 2000 as patent number GB2336363 B (“the patent”) under the title “Hydrogenation of hop acids”.

2 An application under Section 72(1) of the Patents Act 1977 (“the Act”) for revocation of the patent was filed on 21st December 2001 by Thomas Swan & Company Limited (“The Claimants”). The grounds relied on by the Claimants are set out in their statement but can be summarised as follows:

C The invention so far as claimed in each and every claim of the Patent is not a patentable invention in that it was obvious and did not involve an inventive step having regard to matter forming the state of the art as at 13th August 1998.

Three prior art documents together with common general knowledge are cited by the Claimants in support of their case but as will emerge later, they only relied on one of these documents and common general knowledge at the hearing.

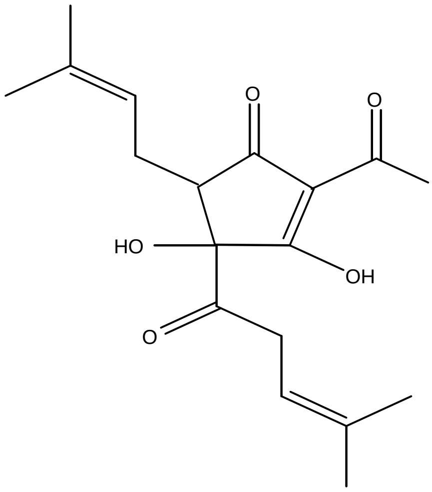
3 The Defendants filed a counter-statement on 19th March 2002 denying the allegations of lack of inventive step and/or obviousness. The Defendants subsequently filed an

amended counter-statement which repeated the arguments of the original and added an amended set of claims “for consideration in the revocation proceedings”, stipulating that these amended claims were offered “conditionally in the event of a finding adverse to the patentee in respect of the validity of the granted claims”. The Claimants filed an amended statement on 12th May 2003 which included an additional paragraph addressing the proposed amendments. The usual rounds of evidence then followed.

4 Rather late in the proceedings the Claimants sought to introduce evidence by way of experiments. The Defendants objected to this on the grounds that there was insufficient time for them to consider this new evidence before the hearing and the Office issued a preliminary opinion that the evidence should not be admitted. The Claimants subsequently withdrew their request to submit this evidence and the substantive matter duly came before me at a hearing at which Mr Piers Acland, instructed by patent agents Urquhart-Dykes & Lord appeared as Counsel for the Claimants and Mr Douglas Campbell, instructed by patent agents Brookes Batchellor appeared as Counsel for the Defendants. At the hearing, I had the benefit of skeleton arguments from Mr Acland and Mr Campbell.

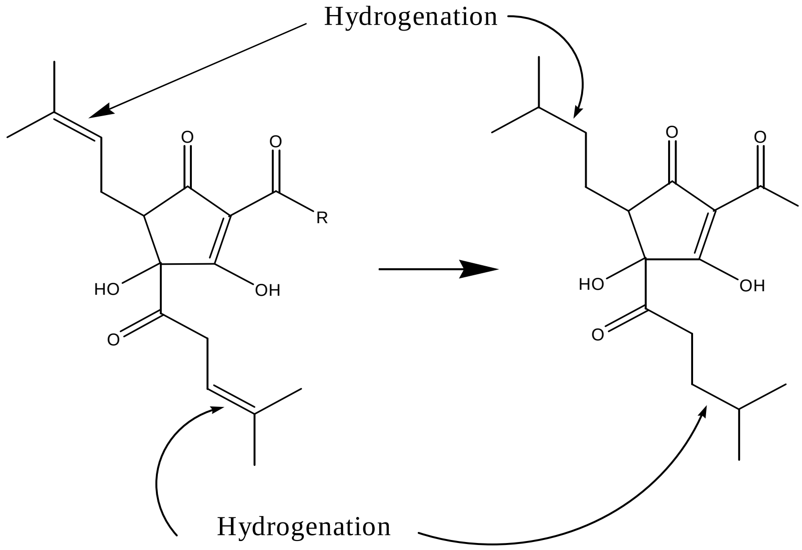
The technical field

5 Before turning to the subject matter of the patent, it may be helpful to outline the technical field of these proceedings. It relates to beer production and in particular to the use of hop extracts to impart flavour and bitterness to beer. In the 1980s, brewers started using purified bittering agents instead of hops and hop extracts. Dried hops contain hop acids known as a-acids and ß-acids. It is the a-acids which are used in beer making and during the wort boiling stage the a-acids are isomerised to iso-a-acids. It is these which are so important in bittering, preservation and the foaming properties of beer. The iso-a-acids have the following general structure:



6 A difficulty with iso-a-acids is that in beer they are prone to degrade in sunlight leading to the formation of 3-methyl-2-butene-1-diol, giving the beer an unpleasant taste. One method of preventing this degradation is hydrogenation of the unsaturated

side chains in iso-a-acids which prevents the formation of 3-methyl-2-butene-1-diol. As can be seen from the above structure, hop acids are carbocyclic rings containing a double bond and having unsaturated acyclic side chains and carbonyl and hydroxyl substituents. There are a number of sites where reaction may be expected to take place under hydrogenation conditions. The aim is to achieve hydrogenation of one or both of the double bonds in the side chains but leave the other potential reaction sites untouched, as illustrated below:



In this reaction the two double bonds arrowed in the structure on the left are hydrogenated to give the compound on the right in which none of the other reactive sites have been altered.

7 The standard method for hydrogenation of iso-a-acids in 1998 was catalytic hydrogenation of aqueous and alcohol solutions of iso-a-acids.

The patent

8 The patent relates to the hydrogenation of hop acids, and in particular to the hydrogenation of iso-a-acids to tetrahydro-iso-a-acids. In setting out the background art, the patent states that hop acids may be extracted from hops using liquid carbon dioxide or supercritical carbon dioxide and that it has been proposed to hydrogenate functional groups in organic compounds by carrying out the reaction in super-critical fluids. The patent aims to overcome problems associated with conventional methods for hydrogenation of hop acids such as low yield, production of a product with a tendency to precipitate during storage, the need to use flammable solvents or high dilution and the high catalyst cost due to fouling of the catalyst by resin components.

10 The invention of the patent is said to be based on the discovery that hop acids are soluble in super-critical carbon dioxide and that the unsubstituted side chains of hop acids can be hydrogenated effectively and without hydrogenolysis by carrying out hydrogenation in super-critical carbon dioxide; also that the tetrahydro product can be obtained at high yield, with only negligible amounts of dihydro and hexahydro

products.

11 The patent contains one independent claim and eight claims in total which read:

> *1 A process for hydrogenation of hop acids comprising forming a mixture of hop acids, hydrogen and carbon dioxide, bringing the mixture to a pressure greater than 73 bar and a temperature above 31°C so that the carbon dioxide is in a super critical state, and bringing the mixture into contact with a noble metal catalyst.*
>
> *2 A process according to claim 1 in which a continuous flow of the solution is passed though or over a bed of the catalyst.*
>
> *3 A process according to claims 1 or 2 in which the hydrogenation is carried out at 73 - 1000 bar.*
>
> *4 A process according to claim 3 in which the hydrogenation is carried out at 200 - 300 bar.*
>
> *5 A process according to any one of claims 1 to 4 in which the hydrogenation is carried out at a temperature of 35 - 100°C.*
>
> *6 A process according to any one of claims 1 to 5 in which iso-a-acids are converted to dihydroiso-a-acids or tetrahydroiso-a-acids or a mixture thereof.*
>
> *7 A process according to any one of claims 1 to 5 in which a-acids are converted to tetrahydroiso-a-acids or dihydroiso-a-acids or a mixture thereof.*
>
> *8 A process according to any one of claims 1 to 5 in which rho-iso-a-acids are converted to hexahydroiso-a-acids.*

12 The patent includes three examples. In the first, isohumulone (an iso-a-acid) is hydrogenated using a palladium on carbon catalyst to give 100% conversion to the tetrahydro product. In the second, isohumulone is converted to a mixture of 80% tetrahydro and 10% dihydro product. The third example also gives 100% conversion to the tetrahydro product.

The evidence and witnesses

13 The Claimants' evidence-in-chief and further evidence-in-chief comes as witness statements in the form of expert reports with exhibits from Dr James Croll Seaton. Their evidence-in-reply and further evidence-in-reply comes as witness statements in the form of expert reports with exhibits from Dr Seaton and from Professor Robbie Burch. Both were cross-examined at the hearing.

14 Dr Seaton is Chairman of JRM products Limited, the principal business of which is the conversion of a-acids to iso-a-acids. Until 1994 he was professor of Brewing and Distilling at Heriot Watt University and he has been involved with the brewing industry since 1962. In his written evidence, he declares brief dealings with the

Claimants in 1996. Dr Seaton is clearly an expert in brewing and in the chemistry of hop acids and his evidence under cross-examination was clear and helpful. However as Mr Campbell observed in his closing submissions, it emerged under cross examination that Dr Seaton was and still is chairman of the Defendants' leading competitor and he accepted that in commercial terms what was bad for the patentee would be good for his company. Mr Campbell observed that as an expert witness, Dr Seaton should have disclosed this interest in his expert report. I agree, and although I do not consider that this omission seriously undermines the value of his evidence, it does give me rather less confidence in Dr Seaton as an expert witness in those instances where his opinion differs from that of the other experts.

15 Professor Burch currently holds the McClay Chair of Physical Chemistry in Queen's University Belfast and before that he was Professor in the Department of Chemistry at the University of Reading. His research interests for the last 30 years have been in heterogenous catalysis. His expert report covers his knowledge and experience in considerable detail and it is clear that Professor Burch is a leading expert in his field. However, under cross examination, Professor Burch made it clear that the hydrogenation of hop acids is something that he has no direct experience of. His oral evidence was clear, precise and helpful.

16 The Defendants' evidence comes as a witness statement in the form of an expert report from Professor Graham John Hutchings and a witness statement from Colin Anthony Hill. Both were cross-examined at the hearing.

17 Professor Hutchings is head of Department and Professor of Physical Chemistry at Cardiff University, a position he has held since 1 August 1997. Prior to that he held a number of posts predominantly in the area of catalysis, including hydrogenation of complex molecules, the control of selectivity in the transformation of complex molecules and heterogeneous catalysis in supercritical media. Professor Hutchings is clearly an expert in the field of catalysis and his oral evidence was clear and helpful.

18 Mr Hill is the Technical Director of Botanix Ltd, formerly English Hop Products Ltd (the Defendants), a position he has held since 1998. He has 23 years experience of the hop processing industry. He is a co-inventor of the invention which is the subject of the patent. Under cross examination, Mr Hill occasionally appeared reluctant to answer some questions put to him by counsel and at one point I felt I had to intervene to have the answer given. In his closing submission, Mr Acland put it to me that Mr Hill was not impartial, that his answers were at times evasive and that he displayed a reluctance to accept propositions that he knew to be correct. Whilst I accept that as an inventor of the patent Mr Hill cannot be entirely impartial, and that his sometimes taciturn demeanour under cross-examination inhibited a steady flow of questions and answers, I consider that his performance under cross examination was more attributable to nervousness and unfamiliarity with the proceedings than with any intention to mislead.

The law

19 The grounds on which a patent may be revoked are set out in Section 72 of the Act. The applicants are seeking revocation under sub-section (1)(a), which reads:

> *“**72**.-(1) Subject to the following provisions of this Act, the court or the comptroller may on the application of any person by order revoke a patent for an invention on (but only on) any of the following grounds, that is to say-*
>
> *(a) the invention is not a patentable invention:”*

20 The applicants are seeking revocation on the grounds that the invention is not a patentable invention in that it was obvious and did not involve an inventive step having regard to matter forming the state of the art as at 13th August 1998. What constitutes a patentable invention is defined in Section 1 of the Act and for present purposes, in sub-section (1)(b) which requires that a patent may be granted only for an invention which involves an inventive step. The criteria for an inventive step are set out in Section 3 of the Act:

> *“**3**. An invention shall be taken to involve an inventive step if it is not obvious to a person skilled in the art, having regard to any matter which forms part of the state of the art by virtue only of section 2(2) above (and disregarding section 2(3) above).”*

Section 2(2) defines the state of the art as:

> *“The state of the art in the case of an invention shall be taken to comprise all matter (whether a product, a process, information about either, or anything else) which has at any time before the priority date of that invention been made available to the public (whether in the United kingdom or elsewhere) by written or oral description, by use or in any other way.”*

21 What can be regarded as forming “part of the state of the art” is addressed in *Inhale Therapeutic Systems Inc. v. Quadrant Healthcare Plc* [2002] RPC 21 which I was referred to by both Mr Acland and Mr Campbell. Mr Campbell referred me to the headnote, page 421 where says:

> “The notional skilled person was assumed to have read and understood the contents of the prior art. It was no answer to say that in real life a piece of prior art would never have come to his attention. However, he came to the prior art without the knowledge or a suspicion that it was of significance to the problems he had to deal with and without any expectation that it offered him a solution to any problem he had in mind. Some pieces of prior art would be much more interesting than others. The very contents of a document directed at solving the particular problem at issue might suggest that it was a worthwhile starting point for further development. But the same might not be the case where a document came from a distant and unrelated field. It might be written in such a way that he skilled person would dismiss it as irrelevant to his work. The more distant a prior art document was from the field of technology covered by the patent, the greater the chance that an intelligent but uninventive person skilled in the art would fail to make the jump to the solution found by the patentee."

22 Mr Acland took me to paragraph 47 on page 437; which reads:

> "A document directed at solving the particular problem at issue will be seized upon by the skilled addressee. Its very contents may suggest that it is a worthwhile starting point for further development. But the same may not be the case where a document comes, say, from a distant and unrelated field."

and then to page 438 where the judge gives the example of an internal combustion engine and the baking industry; and makes the comments summarised in the headnote on page 421 which I have already noted.

23 With regard to the approach to be taken when considering inventive step, Mr Acland and Mr Campbell referred me to the test laid down by the Court of Appeal in *Windsurfing International Inc. v. Tabur Marine (Great Britain) Ltd* [1985] RPC 59. Although this test is well established, I consider it useful to set it our here. *Windsurfing* requires four steps to be taken when answering the question on obviousness, namely:

A. to identify the inventive concept in the patent in suit:

B. to impute to a normally skilled but unimaginative addressee what was common general knowledge in the art at the priority date;

C. to identify the differences if any between the matter cited and the alleged invention; and

D. to decide whether those differences, viewed without any knowledge of the alleged invention, constituted steps which would have been obvious to the skilled man or whether they required a degree of invention.

The cited documents

24 Originally the Claimants cited three documents but as indicated above, at the hearing Mr Acland made it clear that he would be relying on just one of those documents, namely:

> “Selective catalytic Hydrogenation of Organic Compounds in Supercritical Fluids as a Continuous Process” by Martin G Hitzler et al. published in *Organic Process Research & Development* May/June 1998 Volume 2, No.3 (referred to by all in these proceedings as “Hitzler”).

25 Initially the Defendants disputed the publication date of Hitzler but this has now been confirmed as 29 May 1998 by documentary evidence provide by the British Library which states “According to our records, this item was receipted by the British Library Document Supply Centre on 29 May 1998, and would have been available for public use from that date.” No issue over date therefore remains.

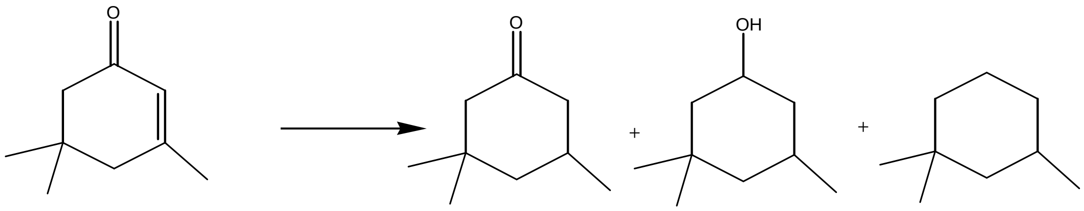
26 The abstract to Hitzler states “We report a new method for continuous hydrogenation in supercritical fluids (CO_2 or propane) using heterogeneous noble metal catalysts on Deloxan aminopolysiloxane supports. The method has considerable promise both for

laboratory-scale hydrogenation and for the industrial production of fine chemicals. It can be applied to a wide range of organic compounds including alkenes, alkynes, aliphatic and aromatic ketones and aldehydes, epoxides, phenols, oximes, nitrobenzenes, Schiff bases, and nitriles. Conversion of starting materials, product selectivity, and space-time yields of the catalyst are all high, and the reactors themselves are very small (5- and 10- mL volume). Supercritical hydrogenation enables the reaction parameters to be controlled very precisely. Results are presented for a series of different reactions showing product distributions, which are dependent on temperature, pressure, H_2 concentration, and the loading and nature of the catalyst. The hydrogenation of cyclohexene has been studied in some detail, and our results are related to the phase diagrams of the ternary system cyclohexane + CO_2 + H_2, which we present in a novel way, more suited to continuous reactors. Finally, we report that the supercritical hydrogenation of isophorone has advantages over conventional methods.”

27 Hitzler goes on to describe the hydrogenation of isophorone and I will set this out in detail here since it assumed considerable importance at the hearing.

As shown above, hydrogenation of isophorone (37) gives rise to one or more of the products (38), (39) and (40). In Hitzler, under the heading “Advantages of Supercritical Reaction. The Hydrogenation of Isophorone” it is stated that:

> “We now apply these ideas to the hydrogenation of isophorone, a functionalized cyclohexene derivative of commercial interest in the fine chemicals industry. An important process is the selective hydrogenation of the ring double bond which yields 3,3,5-trimethylcyclohexanone (dihydroisophorone) (38), which is used as solvent for vinyl resins, lacquers, varnishes, paints and other coatings.



37 38 39 40

> Most of the hydrogenation processes described in the patent literature either show low overall conversion but high selectivity for 38 or give high conversion with poor selectivity. A process which combines high conversion *and* high selectivity is very desirable because the boiling points of 37, 38 and the by products 39 and 40 are very close to each other and so purification of 38 by distillation is difficult and costly.”

28 Hitzler then describes a process in which isophorone is hydrogenated in supercritical carbon dioxide over a palladium catalyst and states “For reactor temperatures $<200^{o}$C, the conversion to 38 was quantitative with no 39 or 40 detectable by H NMR or GC. At higher reactor temperatures, the selectivity dropped.”

The skilled person

29 It is important in construing the patent and assessing obviousness to assess correctly the characteristics of the person skilled in the art. On this point Mr Acland took me to *Richardson Vicks Inc's Patent* [1997] RPC 888 where at page 895, Aldous L J states:

> "Each case will depend upon the description in the patent, but there is no basis in law or logic for including within the concept of 'a person skilled in the art' somebody who is not a person directly involved in producing the product described in the patent or in carrying out the process of production."

A crucial question then is: who is the skilled person in the context of the present invention? Mr Acland and Mr Campbell had somewhat differing views on this matter. In his skeleton argument, Mr Acland describes the skilled addressee in the following terms:

> "The patent is addressed to a person or a group with an interest in the manufacture of bittering agents. Those involved directly in carrying out the process described in the patent would have an understanding of the chemistry of hop acids and their derivatives and would know the principles of beer making, all the way from raw materials to finished product (i.e. a Hop Chemist such as Dr Seaton). The addressee would also have experience in the field of catalytic hydrogenation and would be familiar with the chemistry and typical process conditions used in small scale and large scale hydrogenations (i.e. a Catalyst Chemist)."

30 In his opening submission, Mr Acland again referred to the skilled addressee as a hop chemist and referred me to Dr Seaton's third expert report where he said:

> "In some cases, the skilled addressee would have sufficient experience of catalytic hydrogenation reactions to try the Hitzler process by himself. In other cases (myself included) he would consult someone with greater knowledge and experience in the field of catalytic hydrogenation to undertake the practical aspects of assembling and testing the process with hop acids. I have read a copy of Professor Robbie Burch's report and the 'skilled man' he describes in paragraph 25 of his report is just the sort of person whom I (and others like me) would have consulted."

31 Thus, as he said in his closing submissions, for Mr Acland the skilled person "includes the hop chemist and the catalyst chemist. The addressee is therefore a team of those two people." As to whether the catalyst chemist is really necessary, Mr Acland said "In answer to the question: why one would need to consult a catalyst chemist? It would rather depend on what one were doing. As Dr. Seaton explains, if one were seeking to make a continuous process, then there maybe some hop chemists who are capable of doing that themselves. He personally would not have felt comfortable with doing that and he would have approached a catalyst chemist. It really is as simple as that. There may be some chemists who can do it themselves, there may be not. The addressee must include people who are directly involved and, in my submission, a catalyst chemist would be one of them." I note here that Dr Seaton refers to a continuous process when considering the need for a catalyst chemist. As I will discuss later, a problem with this is that a continuous process does not feature as part of the central inventive concept although it is a preferred embodiment of the patent.

32 Mr Campbell expressed the view that the skilled man is the manufacturer of bittering agents in the brewing industry, an individual who seems to me to be similar to Mr Acland's hop chemist. Mr Campbell argued that the patent does not require detailed knowledge of catalysis or suggest that such knowledge is required. Thus he argued that Mr Acland's catalyst chemist is not relevant. I pressed Mr Campbell on this point and asked if, given that we have in the inventive concept of claim 1 the hydrogenation of hop acids in the presence of a noble metal catalyst, he was saying that the patent is not related to catalysis. His response was to argue that this was a well known catalyst already used in industry, "you can use the same old catalyst, the same noble metal catalyst you always have used." On this basis, he argued that it would not be necessary to consult a catalyst chemist and thus the skilled man or notional "team" did not include a catalyst chemist. To reinforce this position, Mr Campbell referred me to his cross examination of Dr Seaton who was the Claimants brewing expert. He referred Dr Seaton to his third expert report where he said "In some cases, the skilled addressee would have sufficient experience of catalytic hydrogenation reactions to try the Hitzler process by himself." In response, Dr Seaton said "I was putting myself in the other category of someone who did not have that skill. I was reserving the situation that perhaps there would be someone who had those skills." Thus it seems that Dr Seaton was prepared to concede that the catalyst chemist may not be necessary.

33 On balance I am inclined to accept Mr Campbell's argument that the relevant skilled man is the manufacturer of bittering agents or hop chemist in the brewing industry but I would expect that notional man to have some basic knowledge of catalysis.

Inventive step

34 Mr Acland's case on inventive step relied on common general knowledge and the disclosure of Hitzler.

The inventive concept

35 To apply the four *Windsurfing* steps I must first identify the inventive concept. Section 125(1) of the Act indicates what is understood to be the "invention" protected by the patent. It explains in effect that an invention for which a patent has been granted shall be taken to be that specified in the claims of the patent specification, as interpreted by the description and any drawings. There is no significant difference between the parties on this. In his skeleton argument Mr Acland describes the inventive concept as "the hydrogenation of hop acids in supercritical carbon dioxide in the presence of a noble metal catalyst," and when I asked Mr Campbell if he agreed that was fair he said "Basically, yes. I just stress two aspects, in particular. I stress, first, the use as a reaction medium rather than just a solvent for extraction of supercritical CO_2, and the hydrogenation of hop acids. I think it is just a slight change in emphasis." Accordingly I shall work on the basis that in its broadest aspect the inventive concept lies in the hydrogenation of hop acids in supercritical carbon dioxide in the presence of a noble metal catalyst.

The common general knowledge

36 The second *Windsurfing* step is to identify what was common general knowledge of

the notional skilled man at the priority date of the inventive concept. There is considerable common ground regarding what would have been included in the common general knowledge of the hop chemist in 1998. In his closing submissions, Mr Acland set out his view of common general knowledge for the hop chemist as follows:

i The predominant method of making hop acid extracts was to use supercritical carbon dioxide.

ii The isomerisation of a-acids to iso-a-acids was readily achieved by heating an alkali solution of a-acids or their salts.

iii Tetrahydroiso-a-acids were one of the principal bittering agents.

iv The standard method for making tetrahydroiso-a-acids was to hydrogenate iso-a-acids using a Pd/C catalyst in aqueous or organic solvents.

v There were problems associated with the catalytic hydrogenation of iso-a-acids. The occurrence of competing reactions could lead to a loss of yield and the presence of impurities. Under-hydrogenation and over-hydrogenation (resulting in the formation of neohydroiso-a-acids) were known possibilities. In addition the liability of tetrahydroiso-a-acids to drop out of solution (although the reasons were not entirely understood) and poisoning of the catalyst were both known.

vi A carbon-carbon double is one of the most easily hydrogenated functional groups. The two C=C bonds in the iso-a-acid side chains are the easiest to hydrogenate.

37 In his closing submissions, Mr Campbell agreed with i, ii and iii above.

38 With regard to iv, the standard method for making tetrahydroiso-a-acids, he agreed but made the point that the Pfizer and Haas processes which were identified by Dr Seaton as two known methods for making tetrahydroiso-a-acids, “were just two well known and widely used commercial processes in the prior art; neither process was perfect”. He said that Dr Seaton “confirmed that the Pfizer product had ‘made the market’.” I have carefully scanned the transcript and I cannot find and do not recall that phrase being used by Dr Seaton. However, I note that in his first expert report Dr Seaton says “By 1998 the Pfizer method and the Haas process would have been known to everyone working in the field.” In this respect, Mr Campbell also argued that there was no suggestion of any technical or commercial dissatisfaction with these reactions, ie nothing forcing the skilled addressee to look for something new.

39 Mr Campbell agreed with v above and added that catalytic hydrogenation was known to be influenced by many factors, eg. the catalyst, the solvent, temperature, pressure etc. He added that it is important to recall that the particular issue with iso-a-acids was to get the C=C double bonds to react producing the tetrahydroiso-a-acids but for the reaction to stop at that point such that the carbonyl group did not react. Mr Campbell did not address me on point vi above.

40 I am satisfied that the common general knowledge for the hop chemist would have

been as set out in Mr Acland’s six points i to vi above, with Mr Campbell’s provisos.

41 Mr Acland went on to set out what he considered would have been the common general knowledge of the catalyst chemist by reference to the oral evidence given by Professor Hutchins:

a It would have been known to the catalyst chemist in 1998 that supercritical carbon dioxide was used for certain industrial extraction processes, it is environmentally friendly as compared with organic solvents, it is non-toxic and non-flammable and it can be used as a medium for hydrogenation reactions.

b The reaction environment is easily tailored to suit the reaction conditions by altering temperature and pressure, as is the case with all reaction media. The specific advantage being that some materials which are not soluble in other solvents are particularly soluble in supercritical carbon dioxide.

c Use of supercritical carbon dioxide results in reduction in interphase transport limitations (mass flow).

d In some reactions, catalyst lifetime and activity are prolonged leading to higher yields. In other cases the reverse is true. Professor Hutchings described supercritical fluids as “interesting media and people are getting interesting results”.

e When using supercritical carbon dioxide, pressure and temperature can be used to manipulate reaction kinetics and selectivity.

42 Having checked the transcript I am satisfied that this is an accurate summary of Professor Hutchings’ assessment of what the catalyst chemist would have known in 1998.

43 As I have indicated above, Mr Campbell argued that the catalyst chemist is not relevant and he did not address me in any detail on what would have been the common general knowledge of the catalyst chemist.

Differences between the cited matter and the alleged invention

44 The third step in the *Windsurfing* test is to identify the differences between the cited matter and the alleged invention. The only cited matter relied on by the Claimants at the hearing was the Hitzler paper which I have already summarised. However, before I consider the third *Windsurfing* step, I need to address Mr Campbell’s arguments regarding what he claims to be the obscurity of Hitzler from the point of vew of the hop chemist. Mr Campbell referred me to *Inhale Therapeutic Systems Inc. V. Quadrant Healthcare PLC* [2002] RPC 21, and in particular to the head note at page 421:

> "The notional skilled person was assumed to have read and understood the contents of the prior art. It was no answer to say that in real life a piece of prior art would never have come to his attention. However, he came to the prior art

> without the knowledge or a suspicion that it was of significance to the problems he had to deal with and without any expectation that it offered him a solution to any problem he had in mind. Some pieces of prior art would be much more interesting than others. The very contents of a document directed at solving the particular problem at issue might suggest that it was a worthwhile starting point for further development. But the same might not be the case where a document came from a distant and unrelated field. It might be written in such a way that he skilled person would dismiss it as irrelevant to his work. The more distant a prior art document was from the field of technology covered by the patent, the greater the chance that an intelligent but uninventive person skilled in the art would fail to make the jump to the solution found by the patentee."

Mr Campbell argued that Hitzler was published in *Organic Process Research & Development*, a journal which he said was obscure to hop chemists, and not even mainstream for catalyst chemists. In this respect he referred to the oral evidence of Dr Seaton who, under cross examination, agreed that *Organic Process Research & Development* was not everyday reading in the brewing industry nor among those who manufacture bittering agents. Dr Seaton confirmed that he had not seen Hitzler until it was presented to him in preparation for this case. He also referred to the oral evidence of Professor Hutchings who expressed the view that *Organic Process Research & Development* "is not one of the primary journals that one would select for top results."

45 Clearly, Mr Campbell was seeking to persuade me that *Organic Process Research & Development* was a journal which, in the words of *Inhale* above, came from a distant and unrelated field, and that it might be written in such a way that the notional skilled person would dismiss it as irrelevant to his work. "The more distant a prior art document was from the field of technology covered by the patent, the greater the chance that an intelligent but uninventive person skilled in the art would fail to make the jump to the solution found by the patentee." I think the issue here is just how "distant and unrelated" must a document be for its significance to be diminished in the way Mr Campbell appeared to be suggesting.

46 In responding to this, Mr Acland also took me to *Inhale* where Laddie J gave an example of the situation outlined above;

> "For example, in theory a notional skilled person engaged in trying to improve the operation of an internal combustion engine is assumed to know, or have read and assimilated the contents of all published material including those, say, in the baking field. It may be that a document in the latter field discloses something which, if applied to the internal combustion art, would produce a marked improvement in performance. However, the person skilled in the art is not deemed to read the baking document in the knowledge, or even with a suspicion, that it is of significance to the problems he has to deal with. It may be that it is written in such a way that, although he understands it, the skilled person will dismiss it as irrelevant to his work. The more distant a prior art document is from the field of technology covered by the patent, the greater the chance that an intelligent but uninventive person skilled in the art will fail to make the jump to the solution found by the patentee."

This provides a very helpful perspective. The distance between the internal combustion art and the baking art is clearly much greater than that between the hydrogenation of hop acids and reactions described in Hitzler in *Organic Process Research & Development*. The patent relates to catalytic hydrogenation of hop acids, *Organic Process Research & Development* is a journal in the field of organic reactions and Hitzler describes the catalytic hydrogenation of organic compounds. Accordingly I am satisfied that Hitzler is something the notional skilled person must be assumed to have read and understood, and not immediately dismissed.

47 I can now turn to the third *Windsurfing* test and consider the differences between the cited matter and the alleged invention. The only cited matter relied on by the Claimants at the hearing was the Hitzler paper which I have already summarised but to recap, Hitzler describes a method for continuous hydrogenation in supercritical fluids (CO_2 or propane) using heterogeneous noble metal catalysts which can be applied to a wide range of organic compounds. There are clear similarities to the invention of the patent. Mr Acland put it to me that the only relevant difference is that Hitzler does not expressly mention hop acids as being suitable substrates for hydrogenation. Given that the inventive concept, as I have already said, lies in the hydrogenation of hop acids in supercritical carbon dioxide in the presence of a noble metal catalyst and that Hitzler discloses hydrogenation of organic compounds in supercritical carbon dioxide in the presence of a noble metal catalyst, I am satisfied that this interpretation is correct. I do not think that Mr Campbell disputed this.

Obvious to try

48 This brings me to the fourth and final *Windsurfing* step, to decide whether the difference between the alleged invention and the disclosure of Hitzler identified above, viewed without any knowledge of the alleged invention, constituted a step which would have been obvious to the skilled man or whether it required a degree of invention.

49 The Claimants' position is straightforward. In his closing submission Mr Acland put it that Hitzler is describing a new hydrogenation process with numerous advantages over conventional processes. He is using the same solvent as is used to make hop acid extracts. From the title alone, it is clear that Hitzler is concerned with selectivity i.e. addressing one of the known problems associated with conventional hydrogenation of iso-a-acids. In the majority of the reactions shown, Hitzler is using palladium - the catalyst of choice for hop acid hydrogenation. Hitzler shows that aliphatic carbonyls are difficult to hydrogenate and that the process can be used to achieve 100% selectivity of a C=C bond in the presence of a carbonyl i.e. the same general chemistry as in the conversion of iso-a-acids to tetrahydroiso-a-acids. The hop chemist would immediately see the relevance of Hitzler to hop hydrogenations and would see it as a worthwhile starting point for further development.

50 In response, the Defendants outlined a number of reasons why the skilled man would not be encouraged to try the Hitzler process for the hydrogenation of hop acids:

- Hop acids are significantly more complex molecules than those hydrogenated in Hitzler with more potential reaction sites. This applies particularly to isophorone which the Claimants relied on heavily.

C Although it was known to use supercritical carbon dioxide to prepare hop extracts, doubts were expressed regarding the solubility of iso-a-acids in this medium because they are more polar than the natural hop acids.

C The reaction conditions in Hitzler were a lot more extreme than they were in the manufacture of bittering agents.

51 I will consider the evidence on this fourth *Windsurfing* step starting with the evidence given by Dr Seaton and Mr Hill who were the brewing experts. Firstly, there was Dr Seaton who was the Claimants’ brewing expert. Early in his cross examination Dr Seaton was asked about his dealings with Thomas Swan (the Claimants) in 1996. Dr Seaton explained that at the time he was looking for a company that hydrogenated hop acids and he was put in touch with the Claimants. He said “we went to see Swan and they told us that they had a patent in this field for carrying out this process in supercritical CO_2 which, I must say seemed to be a very good idea.” Dr Seaton did not specifically identify the patent that Swan “had in this field” but I note that one of the documents cited in the original application for revocation is PCT patent publication number WO 97/38955 in the name of Thomas Swan & Co. Ltd, entitled “Supercritical Hydrogenation” which claims a process very similar to that described in Hitzler, indeed, Hitzler is a co-inventor. This in itself suggests to me that Dr Seaton did not at the time consider such a process to be of obvious application to the hydrogenation of hop acids. This view is reinforced by the following extract from the transcript:

Mr Campbell *“Surely, it must have come as quite a surprise to you to learn that they were using such a new and unproven technique, did it not?”*

Dr Seaton *“Yes”*

52 Dr Seaton went on to explain how Swan appeared to have failed in its attempt to carry out the hydrogenation of hop acids using their process. On that basis, Dr Seaton was asked about how he would respond if after 1996 someone had come to him and asked for his professional opinion of using supercritical CO_2 for the purpose of hydrogenation of iso-a-acids, “*you would presumably have told them that it had been tried, but it had failed?*” In reply, Dr Seaton said “*I could only tell them the story I have just told you.”*

53 When Dr Seaton was taken to Hitzler, it was put to him that “*if in 1998 you put this article in front of someone who actually manufactured bittering agents for a living, they would not see this article as being of particular interest, would they?”* Dr Seaton disagreed. When asked to explain, he said:

> “*There is a process laid out there that would hopefully lend itself to the hydrogenation of iso-alpha-acids. It is a very interesting process. It is not something that I was not familiar with until I did read through this, but it does have all the elements of being possible to make it into a commercial process as is mentioned in the article.*

> *My own view of hydrogenation would be at that time, and still is, that this is just simply another solvent for a hydrogenation process and the key thing to selectivity in hydrogenations is the catalyst that you use. At that time using charcoal is very definitely the catalyst of choice for this. There would be a strong possibility of carrying out hydrogenations in supercritical [*carbon dioxide*] and getting very similar results to an organic solvent like Haas, for instance.*"

54 There are some contradiction and discrepancies here. On the one hand Dr Seaton when referring to Hitzler says of supercritical CO_2, "this is just simply another solvent for a hydrogenation process," yet when asked about the almost identical Swan process he said that he was surprised that they were using such a new and unproven technique. Further when it was put to him that after his dealings with Swan, if someone had come to him and asked for his professional opinion of using supercritical CO_2 for the purpose of hydrogenation iso-a-acids, he would have told them that it had been tried, but it had failed, he did not deny this. On the other hand, on Hitzler he said "It is a very interesting process. It is not something that I was not familiar with until I did read through this, but it does have all the elements of being possible to make it into a commercial process" and further that "There would be a strong possibility of carrying out hydrogenations in supercritical [carbon dioxide] and getting very similar results to an organic solvent like Haas, for instance."

55 It must be remembered that Dr Seaton is a highly qualified and experienced man in the brewing art and he is an expert on hop chemistry. He has given evidence that when in 1996 he heard that Swan was proposing to hydrogenate hop acids in supercritical CO_2, he was surprised that they were using such a new and unproven technique. He has also given evidence that the process appeared not to have worked and when it was put to him that if someone had come to him and asked for his professional opinion of using supercritical CO_2 for the purpose of hydrogenation iso-a-acids, he would have told them that it had been tried, but it had failed, he did not deny this. This suggests two things to me; firstly that even a man of Dr Seaton's considerable skill and experience in the field would not have considered the process proposed by Swan to be obvious. Secondly there is evidence from Dr Seaton that when Swan tried the process, it did not work. Nevertheless, Dr Seaton appears to be arguing that the **averagely** skilled man would look at the very similar Hitzler document and think it an obvious process to try for the hydrogenation of hop acids. I do not find this convincing. I have already dealt with Dr Seaton's interest in these proceedings through being chairman of the Defendants' leading competitor. I think this, taken together with the inconsistencies referred to above means that I should treat his evidence with caution.

56 With that proviso, I will look at the reason Dr Seaton gave as to why the skilled man would think the Hitzler process would be suitable for hydrogenation of hop acids. Dr Seaton agreed that there is nothing in Hitzler about the manufacture of bittering agents and when asked what specific statements in Hitzler would catch the eye of someone in 1998 who was manufacturing bittering agents he referred particularly to the hydrogenation of isophorone which gave 100% yield and 100% selectivity for a C=C double bond and did not hydrogenate an associated carbonyl group. He also referred to the hydrogenation of 1-octene and cyclohexene which are quantitatively reduced. He said "there are pages of double bond hydrogenations there which certainly would be of

interest because that is all one wants to do with the hydrogenation of iso-a-acids." Dr Seaton also referred to the Hitzler description of the hydrogenation of ketones and pointed out that cyclohexanone could not be hydrogenated at mild temperature with a palladium catalyst and "as far as the hop chemist is concerned the key information is it would not hydrogenate under mild conditions using palladium charcoal." His point was that this would lead the hop chemist to think that the Hitzler process would not hydrogenate the carbonyl groups in hop acids.

57 Turning now to the evidence of Mr Hill who is a co-inventor of the patent, early in his cross examination it emerged that Mr Hill did not consider himself to be skilled in chemistry. When asked about the structure of hop acids and related products he said, "I am not a chemist. I am a process individual. I am not a skilled chemist, but I do understand processes and I do understand analysis. The actual chemistry is not what I am interested in. I am interested in the manufacture of products." He also said "I am not an expert on molecules .... I cannot assist you on structural chemistry". At times this appeared to be a line Mr Hill adopted when he felt his answers may be damaging to the Defendants and this was put to me by Mr Acland in his closing submissions. However, I think that in most cases this was simply an indication that Mr Hill was getting out of his depth with some of the more technical questions. Mr Hill made it quite clear that he did not think that he could put himself in the position of the notionally skilled man. I note this, but I also note Mr Campbell's closing submission in which he put it to me that Mr Hill is much closer to the normal manufacturer of bittering agents than are the other witnesses.

58 Mr Hill was asked whether in the light of the benefits set out in Hitzler, the skilled man would have a natural desire to see whether the Hitzler process worked when he used it with iso-a-acids. He at first appeared rather reluctant to give a direct answer and I felt the need to intervene. He then went on to list a number or reasons why he thought the skilled man would not be encouraged to try Hitzler for hop acid hydrogenation. This may be summarised as follows:

- The most relevant compound in Hitzler is isophorone but he did not think a person in his position would look at isophorone and instantly see hop acids.

- The temperatures and pressures in Hitzler are extremely high compared with previous knowledge about isomerisation and hydrogenation of hop acids.

- With regard to the use of supercritical carbon dioxide he would see "some connectivity" because it had been used to extract hop acids but he would be worried about the solubility of iso-a-acids in this solvent.

- He would be worried that isophorone is a much smaller molecule than iso-a-acids and it has its C=C double bond in a ring rather than an acyclic side chain.

59 Mr Hill was pressed on whether these worries would be sufficient to prevent him from investigating whether the Hitzler process would reduce iso-a-acids. He said that it would "because the example is so extreme compared with what I am used to." However, when asked if he thought the notional skilled man might try the Hitzler

process, he said “I am not in a position to be described as a notional skilled man.”

60 Regarding his concerns about the solubility of iso-a-acids in supercritical CO_2, Mr Hill had said in his written evidence that in his experience isomerised and derivatised hop acids were more polar than naturally occurring hop acids, pointing to potentially lower solubility in a non polar solvent (which is what supercritical CO_2 is) than that of naturally occurring hop acids. Mr Acland put it to Mr Hill that if the skilled man was concerned about the solubility of iso-acids, he would know that by increasing the temperature and pressure, he would expect to be able to increase the polarity of supercritical CO_2 and to thereby increase the solubility of the iso-acids. Mr Hill agreed with this but said “That statement is quite broad. Increase temperature pressure, polarity increases. I think if you actually look further you would discover that the polarity does not increase hugely. It does not become a solvent with the power of ethanol, for example, which you have already stated can be used for isomerised hop acids.” Mr Hill was pressed repeatedly on this point, the line of questioning ended as follows:

> *Q.* *That is why I just want to ask you about the solubility because solubility is one of the points you make a number of times in your evidence. Is it your evidence that based solely upon solubility, lack of knowledge about the actual solubility of the derivatised products and supercritical carbon dioxide, he would go no further?*
>
> *A.* *He would be sufficiently discouraged.*
>
> *Q.* *That is not quite what I asked you? I am asking you, would he stop there?*
>
> *A.* *I think he probably would stop there because he would look to see what the prior methods of manufacture were: ethanol and water, two very polar solvents, and he would be discouraged.*

61 Mr Acland then put it to Mr Hill that if the skilled man were concerned about solubility in supercritical carbon dioxide he would know that if there turned out to be a problem an obvious way forward would be to simply reduce the concentration of substrate. Mr Hill’s answer was that “If there was a low solubility he would be forced to reduce the concentration of the iso-alpha-acids. That would get him to the point where it was non-commercially viable.”

62 These questions on solubility and the effect of increasing temperature and pressure and of reducing concentrations were repeated in numerous ways but in my view Mr Hill remained consistent in his answers. To summarise Mr Hill’s position as I understood it:

C Mr Hill did not consider himself to be described as a notional skilled man so his position is what he personally would have thought.

C he would have had concerns about the solubility of iso-a-acids in supercritical CO_2 because of their higher polarity when compared to natural hop acids.

- he agreed that the solubility could be increased by increasing temperature and pressure but that the increase would be relatively small and would give nowhere near the solubility of ethanol or water, the conventional solvents at the time.

- he agreed that another way of addressing solubility issues would have been to operate at lower concentrations but that would make the process less commercially attractive.

- In terms of solubility, the conventional solvents were entirely satisfactory such that he would not have seen the need to experiment with ways of increasing the solubility in supercritical CO_2.

Thus Mr Hill’s position is that the solubility concerns, the fact that increasing temperature and pressure would only result in a small improvement and that reduced concentrations would be commercially undesirable, taken together with the fact that conventional solvents appeared to work well, would give him no incentive to try the Hitzler process. That is Mr Hill’s position, whether it would have been the position of the notionally skilled man I will return to after I have considered the other evidence.

63 Mr Acland then moved onto the Hitzler disclosure on the hydrogenation of isophorone; he put it to Mr Hill that the Hitzler process was able to achieve 100% selective hydrogenation of isophorone to dihydro-isophorone and that “The skilled man would see that if Hitzler's process could be used to make dihydro-isophorone without any technical under or over-hydrogenation, it is likely that the same process could be used to achieve the selective hydrogenation of iso-acids to tetra.” As indicated above, Mr Hill disagreed pointing out that isophorone is a much smaller molecule than iso-a-acids and it has its C=C double bond in a ring rather than an acyclic side chain.

64 On the reaction conditions used in Hitzler, Mr Hill said “I would also look at the temperature and I would see that the temperatures are extremely high compared with all the previous knowledge about isomerisation, hydrogenation of hop acids. Generally speaking, hop acids are hydrogenated at low temperatures relatively. I would look at those temperatures and say, "Those are extreme". I would also look and say, Okay, this is using a solvent gas which has been commonly used to extract hops and it has some connectivity. Hops are attracted to CO_2. This is describing methods of chemistry in CO_2. I would be worried by the solubility. I would be worried about the solubility in a combination of CO_2 and hydrogen. I would be worried about the temperature.”

65 Under prolonged and detailed cross examination Mr Hill remained firm on his main points, that he would have major reservations about the solubility of iso-a-acids in supercritical CO_2 because of their higher polarity when compared to natural hop acids and that he would not have any incentive to experiment in this respect and he expressed the same concerns about the solubility of the hydrogenated hop acid reaction products. He would be concerned by the reaction conditions used in Hitzler and he would not be prompted by the hydrogenation of isophorone to attempt the same process for hop acids. I must recognise that Mr Hill himself said that he could not put himself in the position of the notionally skilled man, however I think he was led to that

statement at least in part by the nature of the questions he was asked under cross-examination which revealed gaps in his knowledge of chemistry. I do not think however that this means that Mr Hill was not representative of the notionally skilled man in the manufacture of bittering agents and for that reason I think that his evidence carries considerable weight.

66 I Turn now to the evidence of Professor Burch who was the Claimants' catalyst chemist. In cross examination Professor Burch was asked his views on Professor Hutchings' evidence that Hitzler related to relatively simple molecules with either one or two functional groups in contrast to the more complex hop acids. He responded by saying that in terms of selective hydrogenation some, like isophorone, are not simple compounds.

67 Professor Burch was asked to comment on Mr Hill's concerns regarding the solubility of iso-a-acids in supercritical CO_2; in reply he said "If I put myself, again, in the position of my skilled man, my third year student, I think they could simply go ahead and do it. The difference between an iso-acid and non-iso-acid is a very tiny change. The change of polarity is going to be completely negligible. I do understand from Mr. Hill's report that he says in his experience the iso-acids will be polar. That is a non-quantitative statement so I cannot make a judgment on what it means. If I look at the structures of the two compounds, the hydrogen in the OH group on the right-hand side of the compound is the acidic hydrogen. That is very strongly acidic and very strongly stabilised by the oxygen and carbon-carbon double bonds on the same side of the molecule. That is the hydrogen that is going to be removed from the potassium to make potassium or calcium magnesium salt. That is completely isolated from the parts of the molecule that change under isomerisation. That acid is wrong. It is not going to be affected to a significant extent and that is the molecule that generated polarity. If I go back to my organic chemistry, my reading of it is when I change from the normal acid to the iso-alpha-acid, I would hardly change the polarity and therefore in terms of solubility and nonporous solvent, I would be very confident that the change in solubility would be relatively small. In any case, I know from carbon dioxide that if I want to improve the solubility by an order of magnitude, I only have to boost the pressure up by merely a factor of two because the solvating part of carbon dioxide is very sensitive to its density." Clearly there is a major difference between Mr Hill and Professor Burch on this issue of solubility. What I take from this is that Professor Burch is of the opinion that the difference in solubility is small or negligible, however that is an opinion and, however expert, not based on actual experience of working with hop acids whereas Mr Hill is saying that in his experience of working with hop acids, iso-acids are polar to the extent that it would cause him concern regarding their solubility in supercritical carbon dioxide.

68 Mr Campbell took Professor Burch to the issue of the reaction conditions in Hitzler. Professor Burch's response was that such conditions would be severe in conventional process by which he meant batch process but that they were what he would expect for a continuous processes of the kind described in Hitzler. He added that "With a continuous process I would be perfectly happy to accept that these results were correct. I am trying to be very precise because I think it is very important here that the majority of people, prior to this type of work, would have used the batch process. In industry to a large extent the batch process is a skill up from organic chemistry at university.

When you have a continuous process you can change the selectivity enormously because you can control the contact time. I think that is the critical difference. You can operate at higher temperatures, be it a gas phase process or a liquid phase process and get a much higher throughput of product in a fixed time because you can operate at a higher temperature with very small contact time and still retain the selectivity." Through much of his evidence, Professor Burch attached considerable importance to the fact that Hitzler relates to a continuous process. For example he also used this to explain why he was not surprised to see the 100% selectivity in the Hitzler hydrogenation of isophorone; "I think if I had run this experiment at 200 degrees in a conventional system I would have been surprised to get such selectivity because it is quite a high temperature for a palladium catalyst. .... No, the highest temperature I would have been surprised in a conventional system. By conventional system, just to clarify, I mean a batch process where one has much less control over reaction."

69 On the use of continuous processes at the time Professor Burch said "For 1998 this was the state of the art continuous hydrogenation." and went on to say " I do not honestly know whether he [*Hitzler*] was the first to propose it or not. I simply repeat what I said that in a large part of the industry people do not use continuous processes. My understanding from people like Johnson Matthey is they have a known barrier to overcome in getting such people even to consider a continuous process. Again, I cannot answer whether Hitzler was first to suggest it or not, but my experience is that it is not seen as being the first choice by most people in this area simply because they come from a background in chemistry where there is a comfortable feeling of dealing with large flasks rather than continuous processes." To me this implies that in 1998 the notionally skilled man may well not have been attracted to a continuous process of the kind described in Hitzler precisely because of this "known barrier" referred to by Professor Burch.

70 Professor Burch also referred to the continuous process described in Hitzler when he was asked about Professor Hutchings' written evidence in which he said that based on the teachings of Swan and Hitzler, it would not be obvious that changing from an organic solvent or aqueous solvent to a supercritical fluid as the reaction mechanism would solve this selectivity problem. In reply Professor Burch said " I think that this again is selective in referring to the Hitzler paper. For me when I read the Hitzler paper there were essentially two key things about it. One is the solvent the other is the continuous process. Again, I come back to what I might call the conventional process. If I was changing from an organic solvent, again, I would want to define what that was to a supercritical fluid in a batch process, then I might expect to see relatively small changes. I do emphasise the point that the Hitzler paper, as I read it, is about two things. It is about changing the solvent and the process." When asked by Mr Campbell whether is would be obvious changing to a supercritical solvent would solve the selectivity problem, Professor Burch said "If that was the only thing that you did I would not expect them to have a significant effect."

71 Thus in looking at why the skilled man would be encouraged to try Hitzler for the hydrogenation of hop acids, Professor Burch seems to put considerable emphasis on the continuous nature of the Hitzler process. I am not sure that this helps the Claimants' case. The patent does not have as its inventive concept a continuous process although it does include a claim to the process when carried out continuously.

The three examples described in the patent are all carried out in an autoclave as batch processes. The patent does say that in commercial production “a continuous flow system is preferred” and a schematic drawing of such a system is shown, but there does not appear to be any suggestion that at the time a continuous process had actually been tried. The fact that the batch process in the patent appears to work perfectly well does suggest to me that there is an element of hindsight in Professor Burch’s emphasis on the attraction of the continuous Hitzler process. To some extent, Professor Burch’s evidence suggests that he would in fact have been surprised by the results achieved in the patent using a batch process.

72 In this respect I note that it is not disputed that common general knowledge at the time included that the standard method for making tetrahydroiso-a-acids was to hydrogenate iso-a-acids using a Pd/C catalyst in aqueous or organic solvents. The significant difference between this and the patent is that the patent uses supercritical carbon dioxide, yet under cross-examination Professor Burch said “No. Again, in the whole process of hydrogenation I have tried to emphasise all the way through my report that it is a multi- faceted problem. If you change the solvent and do absolutely nothing else is what I said, then do not expect much of an effect. If you change the solvent and do not take account of the catalyst then you are actually changing something that on the surface could be absolutely critical. The way in which the solvent molecules will interact with the catalyst surface can have an effect on the way in which the reactor molecules approach that surface. You have to be very careful. If the only thing you change was the solvent and nothing else and you did not take account of the change that might happen simply by not changing the catalyst, then all sorts of other effects could set in. Why I focussed on Hitzler was the continuity of the process which is a major change in how you contact the reactants with the catalyst surface. If I change my solvent to another form of solvent and I use two forms of carbon, one of which is hydrophilic and one of which is hydrophobic, I completely change the nature of the chemistry and the surface and that could indeed have an effect on selectivity.” This suggests to me that Professor Burch is saying that the change from an aqueous or organic solvent of the prior art process to the supercritical solvent of the patent would not necessarily have been expected to produce the results achieved, because as he said “If you change the solvent and do absolutely nothing else is what I said, then do not expect much of an effect.”

73 Mr Campbell went on to ask Professor Burch for his views on the perceived difficulties with the Hitzler process as seen by Mr Hill; “All I am asking you to accept is: is it possible you are coming at it at too high a level? When Mr. Hill says there is concern it is possible that indeed Mr. Hill is right and to the averagely skilled bittering agent manufacturer these would be seen as real problems?” Professor Burch’s response was to say “The skilled man I was trying to mimic was someone who had expertise in hydrogenation, not someone who was an expert in hop chemistry.” This I think epitomises a problem I have with some aspects of Professor Burch’s evidence. Professor Burch is a very skilled and experienced expert in catalysis and hydrogenation reactions and he described in detail the lengths he had to go to to put himself in the position of averagely skilled person in the field of hydrogenation and he was not able to put himself in the position of a hop chemist. On the issue of common general knowledge, Professor Burch said “I think the average person would want to keep up with the latest developments in the technology unless they are working with it.

Supercritical carbon dioxide as a solvent for hydrogenation really was a step out technology. It offered an opportunity to do things in a completely different, very clean environmentally friendly way. I think, going back to 1990, that would have been a strong argument for anyone to look at this and simply to keep themselves abreast of the literature", but when asked the extent to which he thought this would have been known to the averagely skilled manufacturer of bittering agents he said "I certainly have no information about that at all."

74 Having considered Professor Burch's evidence very carefully I think that there is a risk that he has assumed too great a level of expertise for the notionally skilled man in the relevant field. As I have said earlier, I see the skilled man in this case as being a manufacturer of bittering agents or hop chemist in the brewing industry who would have some knowledge of catalysis. I think Professor Burch is placing rather too much reliance on the skilled man's knowledge of catalysis in an area which he himself said was " step out technology" at the time.

75 Finally, I need to consider the evidence of Professor Hutchings who was the Defendants' catalysis chemist. A substantial part of Professor Hutchings' evidence under cross examination was on the issue of whether it would be obvious to try Hitzler for the hydrogenation of hop acids. On this point he was first asked whether the skilled man would think that the Hitzler process was potentially useful for the hydrogenation of hop acids. His response was that he did not think they would make the connection. Mr Acland repeated the question in slightly different terms:

> " *I understand they would not make the connection because your skilled chemist is not somebody who knows anything about* [hop] *acids. Let me put this to you, assume that the skilled man is approached by a friendly hop hydrogenator in 1998? The hop hydrogenator says this. He does not say, 'Professor'. He says, 'skilled man'. He says, 'The way in which we make tetrahydroiso products at the moment is by hydrogenation of iso-acids using palladium as a catalyst in an aqueous solution or in ethanol. He says, "Under-hydrogenation and over-hydrogenation are both problems, but by monitoring the reaction by HPLC and by monitoring the uptake of hydrogen, we can make a commercial product.' He then says, 'I have a copy of this paper by Hitzler and I want your advice as a skilled man on whether Hitzler's process can be used to hydrogenation iso-acids.' Your advice would be, what?*"

Professor Hutchings' response was:

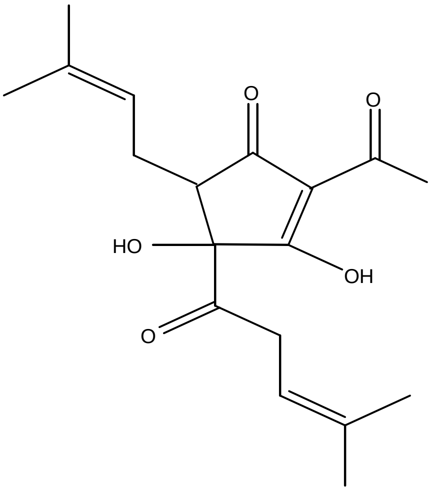
> "*My advice as the skilled catalysis person is that there is very little to connect the two because what you have with the hop acids is effectively a "diene" which is very big with a huge thing in the middle which could easily be hydrogenated. If you look at the Hitzler conditions, they are on the whole about 100 degrees above critical temperature, being used at temperatures which are quite high compared to what the person bringing me the question would have been used to. We are talking about a much higher pressure and so therefore....If you could just let me finish. You did ask me a question and I am trying to give an opinion as a skilled person. There are two single examples, one is the one octene going to octane which is really one functional group, which could be hydrogenated. The other*

> *example has a conjugated system and under that system, if you look at the literature, with palladium it is always the carbon-carbon double bond that is hydrogenated and not the carbon oxygen double bond. You would look at this and you will see there is not a connection between this and that. There just is not the connection.*”
>
> “*I am answering on the basis that the molecules that you want to hydrogenate contain a vast array of functional groups and, yes, you will hydrogenate them, but what I am saying it would be difficult to say, based on Hitzler, that you can then go and say that it is only going to hydrogenate the carbon-carbon double bonds and not take off that OH group or touch the carbonyl group.*”

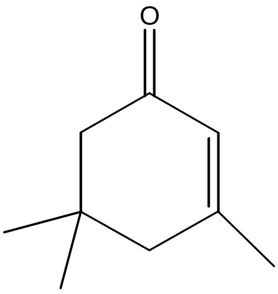
76 Mr Acland repeated this same basic question a number of times with similar answer and I intervened to ask Professor Hutchings “Would the skilled man think this obvious to try in the light of Hitzler”, his response was “No, because the step out from the isophorone/conjugated system to much more complicated molecules when a diene has not been exemplified by Hitzler, which I see as a key omission, is not obvious.” Mr Acland took Professor Hutchings through the Hitzler discussion of isophorone in details and returned to the basic question and asked whether Professor Hutchings would say to the hop hydrogenator “Give it a go” (“it” being applying the Hitzler process to hop acids), his response was that if he said that, he would add “With the expectation that it will not be successful”.

77 Professor Hutching remained firm throughout his cross examination in the opinion that Hitzler would not strike the skilled man as being an obvious process to try for the hydrogenation of hop acids. This opinion as I understood it was based largely on the relative complexity of hop acids compared to the compounds disclosed in Hitzler and on the number of potential reaction sites which may be susceptible to hydrogenation in the molecule.

78 There is clearly conflict between the evidence of Professors Burch and Hutchings on this specific point. Professor Burch said in his oral evidence, “I would have thought the isophorone example in Hitzler would be ‘manna from Heaven’. It would have been just what he was looking for and he would have thought ‘Wow, that molecule has got bits in that I have got to worry about. I know there are other bits sticking out here and sticking out there, but I will give it a go”, while Professor Hutchings emphasised the differences between hop acids and isophorone. It is perhaps helpful at this stage to look again at the two structures.



Iso-a-acids



Isophorone

Clearly there are some similarities, both contain a carbocyclic ring system which includes a C=C double bond and both contain at least one carbonyl group attached to the ring. In both cases hydrogenation results in the reduction of at least one C=C double bond without affecting the carbonyl group. It is an important part of the Claimants’ case that these similarities would lead the skilled man to try the Hitzler process whereas the Defendants’ argue that the differences outweigh this. Looked at from Professor Burch’s “manna from Heaven” standpoint, isophorone has “got bits on it that I have got to worry about”; if by “worry” he means the bits that he would not want to hydrogenate, then isophorone only has the single carbonyl group as opposed to the more complex arrangements of carbonyl and hydroxyl groups in iso-a-acids. As for the C=C double bond, isophorone has one in the carbocyclic ring as do iso-a-acids and this C=C bond is reduced in the Hitzler hydrogenation of isophorone. However in the hydrogenation of iso-a-acids according to the patent, the carbocyclic double bond does not have to be reduced, rather it is the two C=C bonds in the side chains which are reduced.

79 Having carefully considered the evidence of both professors and the structures of isophorone and iso-a-acids, I have reached the conclusion that the similarities are deceptive and when looked at in detail suggest to me that a considerable element of hindsight is required to see the connection. In addition, there are clear elements of difference between the two.

80 I think now is the time to revisit the *Windsurfing* test and summarise the issues. On the first steo, there was very little between the parties on inventive concept which I have summarised as the hydrogenation of hop acids in supercritical carbon dioxide in the presence of a noble metal catalyst. Neither was there much disagreement on what was common general knowledge at the time of the priority date. I have set that out already and do not think I need to repeat it. There was however considerable discussion on who the normally skilled but unimaginative addressee is in this case. The Claimants said that the skilled addressee would be a team including a hop chemist and a catalyst chemist whereas the Defendants referred to the manufacturer of bittering agents in the brewing industry and did not see the need to include a catalyst chemist. Having considered this issue in detail I came to the conclusion that the relevant skilled man is the manufacturer of bittering agents or hop chemist in the brewing industry but I would expect that man to have some basic knowledge of catalysis. There was agreement on

the third *Windsurfing* step that the only difference between the cited matter and the alleged invention is that Hitzler does not expressly mention hop acids as being suitable substrates for hydrogenation. The real issue in this case is the fourth *Windsurfing* step, namely whether that one difference viewed without any knowledge of the alleged invention, constituted a step which would have been obvious to the skilled man or whether it required a degree of invention.

81 In simple terms it could be argued that because Hitzler discloses a process for the hydrogenation of organic compounds then it is obvious to try that process for any organic compound. I think that over simplifies the issue, there needs to be something in Hitzler which would encourage the skilled man to try it in his circumstances, in this case the hydrogenation of hop acids.

82 The Claimants have identified a number of reasons why they believe that the skilled man would be attracted to Hitzler. It discloses the hydrogenation of a range of organic compounds using supercritical carbon dioxide as the reaction medium, the same medium used for hydrogenation in the patent. It discloses the use of a palladium catalyst, as does the patent, and in some circumstances it results in a high degree of selectivity which the patent says has been difficult to achieve for hop acid hydrogenation. It discloses a continuous process which the patent says is desirable and the Claimants say that some of the compounds hydrogenated in Hitzler are similar to hop acids. More specifically the Claimants point to the Hitzler disclosure regarding the hydrogenation of isophorone and I think this is a crucial part of their case. In particular isophorone includes functional groups which are also present in hop acids namely a C=O double bond and a C=C double bond. In one example the Hitzler process achieves 100% conversion of the C=C bond without any conversion of the C=O bond which is the kind of selectivity that the patent aims to achieve.

83 On the use of supercritical carbon dioxide, the Claimants referred to its use in the extraction of hop acids, which was accepted by the Defendants, and argued that this would have made it an obvious solvent for use in the hydrogenation of iso-a-acids. The Defendants argued that solubility of naturally occurring hop acids in supercritical carbon dioxide did not necessarily mean that iso-a-acids would be sufficiently soluble. The main evidence on this issue came from Professor Burch and Mr Hill and as I have already said, having carefully considered the evidence from them both, it seems to me that Mr Hill’s evidence is to be preferred as it is based on actual experience of working with hop acids. Mr Hill was questioned at length on this point and remained firm in his view that these solubility concerns, the fact that increasing temperature and pressure would only result in a small improvement in solubility and that reduced concentrations would be commercially undesirable, taken together with the fact that conventional solvents appeared to work well, would give him no incentive to try the Hitzler process.

84 I do not take much from the fact that both Hitzler and the patent use a palladium catalyst. There appears to be no dispute that this was a well known hydrogenation catalyst which would be the natural choice when there was a desire to hydrogenate C=C double bonds selectively in the presence of C=O bonds. I also do not take much from the continuous process issue. As I have said with regard to Professor Burch’s evidence on this issue, the fact that the batch process in the patent appears to work perfectly well does suggest to me that there is an element of hindsight in Professor

Burch's emphasis on the attraction of the continuous Hitzler process. To some extent, Professor Burch's evidence suggests that he would in fact have been surprised by the results achieved in the patent using a batch process.

85 The Claimants' argument concerning the selectivity achieved in the Hitzler hydrogenation of isophorone is linked closely to their argument that isophorone has structural similarities to hop acids. As I have already said, having carefully considered the evidence of Professors Burch and Hutchings and looked further at the structures of isophorone and iso-a-acids in the light of that evidence, I have reached the conclusion that in the light of the apparent differences, the supposed similarities are deceptive and a considerable element of hindsight is required to see the connection. I think the case hinges on this point so I will consider it in a little more detail. Clearly isophorone contains a C=C and a C=O double bond and the Hitzler process can produce 100% hydrogenation of the C=C bond without any hydrogenation of the C=O bond. It is also clear that an objective of the patent is to hydrogenate one or more C=C bonds in iso-a-acids without hydrogenating other reaction sites including, amongst other things, C=O bonds. Thus there are superficial similarities but on closer inspection there are differences and I think it is useful to set these out in detail:

- The only C=C double bond in isophorone is in a six-membered carbocyclic ring and this bond is hydrogenated in the Hitzler process.

- There are three C=C bonds in iso-a-acids, one in a five-membered carbocyclic ring and two in acyclic side chains attached to that ring. In the process of the patent one or both of the C=C bonds in the side chains are hydrogenated but the one in the ring is not.

86 To reinforce this I go to Dr Seaton's written evidence in which he sets out a reaction scheme showing the hydrogenation of iso-a-acids to a variety of products including the dihydro, tetrahydro, hexahydro and rho derivatives. In none of these is the C=C bond in the carbocyclic ring hydrogenated. Thus it seems to me that an objective of the patent is not to hydrogenate a C=C bond analogous to the one in isophorone.

87 Regarding the other potential reaction sites in isophorone and hop acids:

- The only such site in isophorone is the single C=O bond attached to a six membered carbocyclic ring.

- I have heard evidence that in hydrogenation reactions using a palladium catalyst it would not be surprising to find that group was not hydrogenated.

- In iso-a-acids there are numerous sites which may be susceptible to hydrogenation. There is a C=O attached to a five-membered ring, two attached to the acyclic side chains, and two OH groups.

Thus only one of these "other" groups in iso-a-acids has much resemblance to the C=O bond in isophorone.

88 My view of this is that it is easy to see similarities between isophorone and iso-a-acids

when that is what you want to find. Once you have seen the patent, it is easy to trawl through the many compounds listed in Hitzler looking for those that have features in common with iso-a-acids. However, for the reasons I have given above, even if with hindsight one alights on isophorone, the similarities are not that strong.

89 This leads me to the conclusion that the Claimants' case does not pass the fourth *Windsurfing* test in that the only difference between Hitzler and the inventive concept of the patent, namely the application of Hitzler to the hydrogenation of hop acids, viewed without any knowledge of the alleged invention, did not constitute a step which would have been obvious to the skilled man.

Summary

90 Thus after carefully considering all the evidence and arguments before me, I have found that claim 1 of the patent as granted is not invalidated by the prior art that has been cited in this action in respect of inventive step. The remaining claims are dependent on claim 1 and are likewise therefore not invalidated by this prior art.

Amendments

91 In view of my finding on the validity of the claims of the patent as granted, I do not need to move on to consider the conditional amendments.

Costs

92 Both Mr Acland and Mr Campbell were content for me to make an assessment for costs on the basis of the standard Patent Office scale. The Defendants, English Hop Products Limited, have been successful and accordingly, applying the scale, I order Thomas Swan & Company Limited to pay them £3000 as a contribution to their costs. This sum should be paid within five weeks of the date of this decision, payment being suspended if an appeal is lodged.

Appeal

93 Under the Practice Direction to Part 52 of the Civil Procedure Rules, any appeal must be lodged within 28 days.

S N Dennehey
Director acting for the Comptroller