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Datasheet for the decision of 27 October 2010

Case Number: T 1698/07 - 3.4.02

Application Number: 04710166.2

Publication Number: 1673612

IPC: G01N 21/35

Language of the proceedings: EN

Title of invention:
Method and device for detecting water vapor within natural gas

Applicant:
SpectraSensors, Inc.

Opponent:
-

Headword:
-

Relevant legal provisions:
-

Relevant legal provisions (EPC 1973):
EPC Art. 56

Keyword:
"Inventive step - main, auxiliary request (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1698/07 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 27 October 2010

Appellant: SpectraSensors, Inc.
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Representative: Beyer, Andreas
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 8 May 2007 refusing European patent application No. 04710166.2 pursuant to Article 97(1) EPC 1973.**

Composition of the Board:

Chairman: A. G. Klein
Members: M. Rayner
B. Müller

Summary of Facts and Submissions

I. The present appeal is against the decision of the examining division refusing European patent application number 04 710 166.2 which concerns a system and method for detecting water vapour in natural gas.

II. In the examination and/or appeal proceedings, reference has been made to documents including the following.

D1 DE-A-34 13 914

D2 Kessler W J et al., Near IR diode laser-based sensor for ppb-level water vapor in industrial gases, Proc. SPIE, 3537, 139-149, 1999.

D5 Declaration made by Dr. Greg Sanger, Vice President of Engineering, SpectraSensors Inc.

D6 Applied Optics / Vol. 26, No.19 / 1 October 1987 - an article referring to the 1986 edition of the HITRAN database

D7 Table 2 showing 111 lines selected by searching the HITRAN database.

In the decision under appeal, the examining division substantiated its refusal with lack of inventive step of the subject matter of the independent claims of the requests before it. Independent claims 1 and 7 of auxiliary request 1 before the examining division include a feature referring to a wavelength range from 1.877 to 1.9 μm, or from 2.711 to 2.786 μm. Arguments of the examining division substantiating its decision include the following.

Document D1 discloses a system for detecting water vapor in natural gas, comprising an optical gas sensor for detecting a level of water vapor in the natural gas, the optical gas sensor comprising:
a color center laser light source for emitting a light having a narrow line width within the spectral range of 2.63 to 2.7 μm where water molecules absorb light at a substantially greater level than natural gas molecules (cf. page 11, third paragraph; page 12, third paragraph; figure 1, reference sign 1);
a detector for detecting the intensity of the light emitted from said light source after having passed through the natural gas sample (cf. paragraph bridging pages 13 and 14; figure 1, reference sign 10); and
electronics coupled to said detector for determining the level of water vapor in the natural gas based on the intensity of the light detected by said detector (cf. page 15, second paragraph; figure 1, reference sign 7). The system according to independent claim 1 of auxiliary request 1 differs from this disclosure in that the light source operates at a wavelength within the ranges claimed. The technical problem may therefore be seen in selecting an alternative NIR wavelength range where water molecules absorb more strongly than natural gas molecules.

The solution proposed in claim 1 is not considered to involve an inventive step because the person skilled in the art of NIR spectroscopy knows that in the NIR spectral range water molecules and natural gas molecules (i.e., methane molecules) have a plurality of absorption lines. As a starting point D1 suggests 2.63-2.7 μm on page 11, third paragraph, i.e. the skilled person would not investigate a large range of

wavelengths but would focus on wavelengths in the NIR spectral range and would identify the wavelength ranges proposed as being suitable. The spectral parameters of these lines are available in data bases such as the well-known HITRAN data base mentioned in document D2 (cf. page 141, last paragraph). The problem of detecting a species of interest in the presence of an interfering species is well known in the art of NIR spectroscopic gas measurements. Document D2 mentions, in the second paragraph on page 144, the problem of "interfering absorbance peaks from the ammonia sample gas" and anticipates utilising "a weaker absorption line if an ammonia interference was coincident with the 1.3525 μm water vapour absorption". Document D2 states in its abstract that the sensor is suitable for moisture measurements in natural gas. When confronted with the problem mentioned, the skilled person would straightforwardly identify sub-ranges where water vapor absorbs more strongly than methane. The selection of specific wavelength ranges where water vapour absorption substantially exceeds methane absorption is a matter of normal trial and error. Narrow line width laser light sources operating in various sub-ranges in the NIR wavelength range are well-known, e.g. color centre lasers as used in document Dl or tunable diode lasers as used in document D2 and the skilled person would select a suitable laser light source operating in said wavelength range. The application does not contain any indications that the selection of the specific wavelength ranges claimed in claim 1 provides any unexpected technical effect or that their use overcomes a technical prejudice. These wavelength ranges are thus an obvious selection from a limited range of

possibilities at which the skilled person arrives by normal design procedures.

Independent method claim 7 is directed to the use of the system of claim 1 for determining the level of water in natural gas and therefore is, mutatis mutandis, also obvious in view of document D1.

III. The appellant requested that the decision under appeal be set aside and a patent granted on the basis of the main request comprising the following documents:

claims 1-9 filed on 27 October 2010,
description pages 1,2,2a,3,4,5 and 7 filed with the statement of grounds,
description pages 6,8 and 9 as published, and
drawing sheets 1/5-5/5 as published,
or, in the alternative on the basis of
claims 1-9 according to its auxiliary request filed on 27.10.2010.

Oral proceedings were requested on an auxiliary basis.

IV. In support of its request, the appellant argued as follows.

Firstly, the examining division provided no evidence that the HITRAN database mentioned in D2 actually discloses the comparative absorption spectra of water and methane at the specifically claimed wavelength ranges. Furthermore, there is no evidence that the HITRAN database provided such information at the priority date of the present application. Document D2 itself is particularly concerned with detecting water

vapour as an impurity in a stream of ammonia gas and specifically discloses the use of a laser operated at the wavelength of 1.392 μm. Secondly, the examining division provided no evidence whatsoever that the wavelength ranges recited in independent claims 1 and 7 were even known in the art at the priority date of the present application, let alone that they would have been considered obvious by an ordinary person skilled in the art. Thirdly, the examining division incorrectly concluded that the system and method for detecting water vapour in natural gas according to the present invention involved no more than a comparison of the absorption lines of water and methane (CH_4).

As is clearly demonstrated in document D5, the composition of natural gas may vary significantly. Although methane (CH_4) is the main component, natural gas may comprise a mixture of a wide variety of compounds other than methane, with the proportion of methane in the mixture also able to vary significantly. Natural gas may include a number of other alkanes (such as ethane, propane, butane, pentane, and/or hexane) as well as not insignificant amounts of carbon dioxide, hydrogen sulphide and nitrogen gas. In addition, small amounts of other compounds may also be present. Accordingly, the properties and characteristics of natural gas may not be accurately assumed merely to be equivalent to those for methane. The inventor identified that the wavelength ranges recited in claims 1 and 7 provided a surprisingly improved performance for complex natural gas compositions compared to other wavelengths that, on the basis of the absorption characteristics of methane (CH_4) and water alone, would also appear to be useful. In this respect, the

wavelength ranges claimed had been found to be less sensitive to the complex and variable composition of natural gas streams. In addition, these wavelength ranges exhibit a more linear response in the event of concentration changes in the gas composition, better resolution in the event of small concentration changes in the gas composition, and lower sensitivity to changes in the pressure of the gas stream. Furthermore, the claimed wavelength range exhibits a lower sensitivity to temperature changes. Even if a broad range of wavelength values were to be considered known to be available for obtaining spectral absorption lines for water in a methane background gas at the priority date of the present application, the specific wavelength ranges claimed constitute an inventive selection.

As is apparent from document D5, the appellant has achieved an enormous market penetration (i.e. in excess of 50% market share) and a high dollar value of annual sales within a very short time-frame, i.e. within a period of only four years from the priority date of the present application. The reason for such rapid success rests primarily upon the long-felt need in the market-place for a reliable and flexible alternative to the well-known and conventionally used chemical sensors. As noted in the original description page 2, lines 15-23, although such chemical sensors can provide accurate measurements of water vapour in a natural gas stream, those sensors are particularly susceptible to contamination by glycols, amines and oil components in the gas stream and typically require regular maintenance. Thus, the market had long awaited a product with which water vapour determination in

natural gas is not only theoretically possible without the inherent disadvantages of the known chemical sensors, but which actually provides a solution that is practical and suitable for use with natural gas streams in which the composition, concentration, pressure and temperature may fluctuate significantly during the service life of the sensor. The commercial success provides a clear indication of the presence of an inventive step.

In summary, the device and method claimed are clearly novel and based on an inventive step in view of the available prior art.

V. Consequent to the request of the appellant, oral proceedings were appointed by the board. In a communication attached to the summons, the board informed the appellant as follows.

There did not seem to be any dispute about the novelty analysis of the examining division. The board happened to have an article referring to the 1986 edition of the HITRAN database and enclosed pages 4058, 4062 and 4080 thereof. Around the middle of page 4062 and 4080, values meeting the second range in the independent claims seemed to be disclosed. Accordingly, the board had doubts about submissions as set out in "Firstly.." and "Secondly...". A problem with document D5 was that the improvements were not quantified and the second range was mentioned in only a very superficial way, - "Similar considerations went into selecting the 2711 nm to 2786 nm wavelength range". Especially for the second range, document D5 did not therefore seem persuasive on the question of a surprising result. A market share of

50% in a short time would indeed be an indication of an inventive step somewhere, but the board questioned whether this is due to the ranges, especially the upper one.

VI. During the oral proceedings, the appellant filed document D7 and argued as follows.

The HITRAN database offers many wavelengths, but a mere disclosure of a wavelength therein does not make it obvious. Many wavelengths seem suitable, but are in fact not. There are problems to be addressed with methane, ethane and carbon dioxide having strong lines. Furthermore changing pressure and temperature affects results. The appellant is the only company successfully supplying devices of a standard needed. In the United States, an accuracy of 0 to 400 ppmv (parts per million by volume) is required, in Europe it is 0 to 100 ppmv.

Following what might be considered obvious, a skilled person would have consulted the HITRAN database to search for strength of water line absorption and absence of interference from methane, ethane and carbon dioxide, usually expressed as a figure of merit. Document D7 illustrates a table useful in such an approach, where a large figure of merit would be sought. However, although line 14 (2781nm), within the range claimed, shows a not unusual line strength (0.57) and large values for figure of merit (over 4000, 4955.5 at line centre), it is not used in practice. On the other hand, practical use is made of line 44 (2711.17nm), within the range claimed, which has line strength (5.65) and a not unusual figure of merit (38.4 to 60.4 at line centre) is used. Line 82 (2629.52nm), outside the range

claimed, has a similar line strength (0.53) to line 14 and a lower figure of merit (0.4 to 0.9 at line centre).

In fact the best line is line 100 (1877.09nm) with line strength of 0.45 and Figure of merit from 1.6 to 6.7 at line centre. This line is used in higher priced devices. Cheaper devices use the range actually claimed.

VII. The independent claims of the main and auxiliary request are worded as follows.

Main Request

1. A system for detecting water vapor in natural gas, comprising an optical gas sensor (500) to detect a level of water vapor in the natural gas, the optical gas sensor comprising:
a light source (519) which emits light having a narrow line width into a sample of the natural gas at a wavelength where water molecules absorb light at a substantially greater level than natural gas molecules,
a detector (523) configured to detect the intensity of light emitted from said light source after the light passes through the natural gas sample, and
electronics coupled to said detector (523) for determining the level of water vapor in the natural gas based on the intensity of the light detected by said detector (523);
characterized in that the light source operates at a wavelength within a range from 2.711 to 2.786 μm.

7. A method for determining the level of water in natural gas, comprising the steps of:
generating light having a narrow line width at a

wavelength where water molecules absorb light at a substantially greater level than natural gas molecules;
passing the generated light through a sample of natural gas;
detecting the light passed through the natural gas; and
determining the level of water within the natural gas based on the intensity of the detected light;
characterized by the generated light having a wavelength in the range from 2.711 to 2.786 μm.

Auxiliary Request

The independent claims according to the auxiliary request differ from those of the main request in that in both claim 1 and claim 7, "2.711 to 2.786 μm" is changed to "2.711 or 2.786 μm"

Reasons for the Decision

1. The appeal is admissible.

2. Main request

2.1 Claims 1 and 7 up for decision before the board differ from the corresponding claims before the examining division as auxiliary request 1 solely by cancellation of one (1.877 to 1.901 μm) of two alternative wavelength ranges. The novelty analysis made by the examining division in relation to claims 1 and 7 compared with the disclosure of document D1 was not disputed by the appellant and the board itself sees no reason further to investigate this analysis. This

analysis thus applies to the claims before the board and leads to novelty over the disclosure of document D1 being understood to be given by virtue of the device operating at a wavelength within a range from 2.711 to 2.786 μm, rather than the range of 2.63 to 2.7 μm given in the third paragraph on page 11 of document D1. The problem addressed by the novel subject matter can be considered to be that of improving the known device for water vapour detection in natural gas.

2.2 The board agrees with the examining division that the person skilled in the art of NIR spectroscopy knows that in the NIR spectral range water molecules and natural gas molecules (i.e. methane molecules) have a plurality of absorption lines and that the spectral parameters of these lines are available in data bases such as the HITRAN data base mentioned in document D2. The appellant questioned in written proceedings whether the HITRAN database disclosed absorption spectra of water and methane. The board itself does not doubt that the database was well known at the priority date of the application and that water and methane were among the compounds treated therein, as was evidenced by document D6 for example. The board also has no doubt that the skilled person would have considered alternative wavelengths and interference in striving to improve the device, an exemplary reference to such latter procedure being, as identified by the examining division, present in document D2, page 144 at the end of the first complete paragraph.

2.3 The appellant's position is that such considering of alternative wavelengths was simply not enough to provide an improved sensor because the key feature of

the range selected from all the wavelengths available was not obvious. The board can accept that the environment in the gas pipeline such as the components therein and temperature and pressure conditions mean that not all wavelengths which a priori seem suitable by virtue of their water/methane absorption will actually be suitable. Nevertheless, the appellant's approach does not convince the board because selecting the wavelengths is, at the end of the day, just a matter of trial and error. Some will be better than others, the skilled person will take the better ones which meet the design target concerned. Thus, the board considers trial and error testing around known wavelengths would obviously have led to suitable wavelengths.

2.4 Document D5 did not give the board any reason to doubt its view because, for the "2.711 to 2.786 μm" range, as set out in the summons to oral proceedings, no quantified improvement for the range was actually given. Moreover, detailed sales figures substantiated by evidence relating to market penetration were not presented. Furthermore, it is not apparent how any improved sales are related to the range claimed. The board has, for example, been given no reason to exclude any improved sales being down to the wavelength range which has been cancelled in the claims before the board, rather than the claimed range of 2.711 to 2.786 μm or indeed to any other not specified features of the device. Furthermore, since the disclosure of document D1 is the starting point from which inventive step has been assessed, the submissions of the appellant relating to chemical sensors as prior art are not relevant.

2.5 The status or not of document D7 as starting point for assessing the subject matter claimed is open. However, taking the submission of the appellant at face value, document D7 also offered no reason for the board to change its view, but rather reinforced that view. The board observes that the claimed range does not even include the optimum performance wavelength, i.e. wavelengths are simply selected in a trial and error way to meet a design target for a cheaper range of sensors, it is not necessary to find any special or surprising way of establishing the best wavelengths to achieve this. Nor is the range itself any guarantee of success, because some wavelengths such as line 14 are allegedly not used. In fact, high line strength line 44 is used, which, a priori, is what the skilled person would expect. In other words, the board was not able to identify any inventive selection, not did it see any surprising effect or technical prejudice overcome.

2.6 In view of the foregoing, the board has been offered no convincing reason to question the approach of the examining division and has thus to conclude that the subject matter of independent claim 1 cannot be considered to involve an inventive step within the meaning of Article 56 EPC 1973. A corresponding conclusion applies to the subject matter of method claim 7 for corresponding reasons.

3. Auxiliary Request

3.1 Compared with the main request, the independent claims are limited to the end values of the range, i.e. 2.711 or 2.786 μm. At first glance, selecting just two

wavelengths might seem a difficult task. However, as can be seen from the discussion of the main request above, these particular wavelengths are just two of a number of possibilities at the end of a range selected or rejected by trial and error. No surprising effect or advantage at these particular wavelengths has been identified by the board. On this basis, they would therefore, in fact, have been reached by the skilled person, just as any other satisfactory wavelength is the range, without any inventive step. The subject matter of independent claims 1 and 7 of the auxiliary request cannot therefore be considered to involve an inventive step within the meaning of Article 56 EPC.

4. The appeal therefore fails.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar The Chairman

M. Kiehl A. G. Klein