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Paper No. 43
Entered: March 3, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

E. I. DU PONT DE NEMOURS AND COMPANY AND
ARCHER-DANIELS-MIDLAND COMPANY,
Petitioners,

v.

FURANIX TECHNOLOGIES B.V.,
Patent Owner.

Case IPR2015-01838
Patent 8,865,921 B2

Before TONI R. SCHEINER, SHERIDAN K. SNEDDEN and CHRISTOPHER G. PAULRAJ, *Administrative Patent Judges.*

PAULRAJ, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

E. I. du Pont de Nemours and Company and Archer-Daniels-Midland Company (collectively, "Petitioners") filed a Petition (Paper 1, "Pet."), requesting institution of an *inter partes* review of claims 1–10 of U.S. Patent No. 8,865,921 B2 (Ex. 1001, "the '921 Patent"). Furanix Technologies B.V. ("Patent Owner") did not file a Preliminary Response. We have jurisdiction under 35 U.S.C. § 314, which provides that an *inter partes* review may not be instituted "unless . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." We determined that the information presented in the Petition demonstrated that there was a reasonable likelihood that Petitioners would prevail in challenging claims 1–5 and 7–9 as unpatentable under 35 U.S.C. § 103(a). Pursuant to 35 U.S.C. § 314, the Board instituted trial on March 9, 2016, as to those claims of the '977 Patent. Paper 10 ("Institution Decision"; "Inst. Dec."). We denied Petitioners' request for rehearing of our decision to deny institution as to the patentability challenge for claims 6 and 10. Paper 20.

Following our institution, Patent Owner filed a Response to the Petition. Paper 23 ("PO Resp."). Petitioners filed a Reply to Patent Owner's Response. Paper 29 ("Reply"). An oral hearing was held on November 16, 2016. The transcript of the hearing has been entered into the record. Paper 42 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. Based on the record before us, we conclude that Petitioners have not demonstrated by a preponderance of the evidence that claims 1–5 and 7–9 of

the ’921 Patent are unpatentable based on the obviousness challenges presented in the Petition.

A. Related Proceedings.

The parties have not identified any separate related matters under 42 C.F.R. § 42.8(b)(2). Pet. 1; Paper 5, 1.

B. The ’921 Patent (Ex. 1001)

The ’921 patent issued on October 21, 2014, and claims priority to a provisional application filed on October 7, 2009. *See* Ex. 1001, Title Page. It names Cesar Muñoz De Diego, Matheus Adrianus Dam, and Gerardus Johannes Maria Gruter as the inventors. *Id.*

The ’921 patent relates generally to methods for preparing 2, 5-furan dicarboxylic acid (FDCA), or a dialkyl ester of FDCA, by contacting 5-hydroxymethylfurfural (HMF), and/or derivatives thereof, with an oxygen-containing gas in the presence of oxidation catalysts comprising cobalt (Co), manganese (Mn), and bromine (Br) (*i.e.*, a Co/Mn/Br catalyst), and an acetic acid solvent at elevated temperatures. *Id.*, Abstract, 1:18–26, 2:39–45. The ’921 patent states that “FDCA can be produced in particular from esters of HMF, such as for example 5-acetoxymethylfurfural (AMF) or a mixture of one or more of these compounds with HMF, such as for example from a mixture of AMF and HMF.” *Id.* at 1:21–24. The ’921 patent further discusses the use of FDCA obtained according to the process described therein to prepare a dialkyl ester of 2,5-dicarboxylic acid by the reaction of FDCA with a C_1–C_5 alkyl alcohol. *Id.* at 5:20–41. The ’921 patent acknowledges that the esterification of FDCA was known in the prior art. *Id.* at 5:42–58.

According to the '921 patent, FDCA has been identified as a priority chemical for establishing a "green" chemistry industry, but no commercial process exists for its production. *Id.* at 1:34–38. The specification states that FDCA, a furan derivative, is often synthesized in the laboratory from HMF obtained from carbohydrate containing sources such as glucose, fructose, sucrose, and starch. *Id.* at 1:30–43. The derivatives of HMF are known to be potential and versatile fuel components and precursors for the production of plastics. *Id.* at 1:44–46. The specification identifies prior art processes for the oxidation of HMF to FDCA with a Co/Mn/Br catalyst at temperatures ranging from 50 to 125°C, which resulted in low reactivity or yield loss. *Id.* at 1:48–67, 2:1–35. The '921 patent seeks to improve prior art yields by controlling the temperature and/or pressure under which the oxidation reaction occurs. *Id.* at 4:34–61.

In particular, the '921 patent specification explains that "[t]he pressure in a commercial oxidation process may vary within wide ranges," and "is determined by the solvent (e.g., acetic acid) pressure at a certain temperature." *Id.* at 4:34–39. Moreover, the pressure is preferably selected to maintain the solvent in the liquid phase, which "means that pressures between 5 and 100 bar can be used with a preference for pressures between 10 and 80 bar." *Id.* at 4:39–43. The oxidant can be an oxygen-containing gas, such as air, which "can be continuously fed to and removed from the reactor," in which case "the oxygen partial pressure will suitably be between 1 and 30 bar or more preferably between 1 and 10 bar." *Id.* at 4:43–46, 51–55. Conversely, all of the oxygen-containing gas can be supplied at the start of the reaction, but this will require a significantly higher pressure. *Id.* at 4:45–51. The specification further explains that "[t]he temperature of the

reaction mixture is at least 140° C., preferably from 140 and 200° C., most preferably between 160 and 190° C." *Id.* at 4:56–58. The specification notes that "[g]ood results" were achieved at about 180°C, but cautions that "[t]emperatures higher than 180° C may lead to decarboxylation and to other degradation products." *Id.* at 4:58–61.

The '921 patent includes working examples describing experiments in which the oxidation reaction was carried out with a Co/Mn/Br catalyst at an air pressure ranging from 20–60 bars and temperatures ranging from 100 to 220°C. *Id.* at 6:8–11. More particularly, Example 1 describes the oxidation of HMF and/or AMF at 180°C for 1 hour with 20 bar air pressure, which resulted in FDCA yields of up to 78.08%. *Id.* at 6:34–46, Table 1. Example 2 provides a comparative example in which AMF oxidation was conducted at 100°C and 30 bar for 2 hours, showing that FDCA yields under those conditions were lower than the results obtained at higher temperature. *Id.* at 6:50–62, Table 2.

C. Illustrative Claims

Claims 1–5 and 7–6 are challenged in this *inter partes* review. Independent claim 1 is illustrative, and reproduced below:

> 1. A method for the preparation of 2,5-furan dicarboxylic acid comprising the step of contacting a feed comprising a compound selected from the group consisting of 5-hydroxymethylfurfural ("HMF"), an ester of 5-hydroxymethylfurfural, 5-methylfurfural, 5-(chloromethyl)furfural, 5-methylfuroic acid, 5-(chloromethyl)furoic acid, 2,5-dimethylfuran and a mixture of two or more of these compounds with an oxygen-containing gas, in the presence of an oxidation catalyst comprising both Co and Mn, and further a source of bromine, at a temperature between 140° C and 200° C at an oxygen partial pressure of 1 to 10 bar, wherein a solvent or solvent mixture comprising acetic acid or acetic acid and water mixtures is present.

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