The opinion in support of the decision being entered today
is *not* binding precedent of the Board

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte GERHARD OLBERT, CHRISTIAN WALSDORFF,
KLAUS HARTH, ECKHARD STROFER, and MARTIN FIENE

Appeal 2007-0620
Application 10/323,626
Technology Center 1700

Decided: April 30, 2007

Before BRADLEY R. GARRIS, CHARLES F. WARREN, and
THOMAS A. WALTZ, *Administrative Patent Judges*.

WARREN, *Administrative Patent Judge*.

DECISION ON APPEAL

Applicants appeal to the Board from the decision of the Primary Examiner finally rejecting claims 1 through 39, all of the claims in the Application, in the Office Action mailed November 17, 2005. 35 U.S.C. §§ 6 and 134(a) (2002); 37 C.F.R. § 41.31(a) (2005).

The appeal was heard on April 4, 2007.

We affirm the decision of the Primary Examiner.

Claims 1, 17, and 33, as they stand of record,[1] illustrate Appellants' invention of a process for preparing chlorine by gas-phase oxidation of hydrogen chloride by means of a gas stream comprising molecular oxygen in the presence of a fixed-bed catalyst, and are representative of the claims on appeal:

1. A process for preparing chlorine by gas-phase oxidation of hydrogen chloride by means of a gas stream comprising molecular oxygen in the presence of a fixed-bed catalyst, which is carried out in a reactor having a bundle of parallel catalyst tubes which are aligned in the longitudinal direction of the reactor and are fixed at their ends into tube plates, with a cap at each end of the reactor and with one or more deflection plates which are arranged perpendicular to the longitudinal direction of the reactor in the intermediate space between the catalyst tubes and leave passages located alternately on opposite sides of the reactor free next to the interior wall of the reactor, with the catalyst tubes being charged with the fixed-bed catalyst, the hydrogen chloride and the gas stream comprising molecular oxygen being passed from one end to the reactor via a cap through the catalyst tubes and the gaseous reaction mixture being taken off from the opposite end of the reactor via the second cap and a liquid heat transfer medium being passed through the intermediate space around the catalyst tubes in a defined, virtually purely transverse flow of the liquid heat transfer medium against the catalyst tubes.

17. A process as claimed in claim 1 carried out in a reactor in which gaps of from 0.1 to 0.4 mm are present between the catalyst tubes and the deflection plates.

33. A process as claimed in claim 1, wherein the reactor includes at least two reaction zones which are separated in a largely liquid-tight manner by means of dividing plates.

The Examiner relies on the evidence in these references:

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[1] Claim 17 as copied in the Claim Appendix (Br. 12) erroneously contains the phrase "only in perpendicular direction to the catalyst tubes" which was

Smith	US 3,807,963	Apr. 30, 1974
Wanka	US 3,871,445	Mar. 18, 1975
Sawada	US 5,292,904	Mar. 8, 1994
Iwanaga	US 6,713,035 B1	Mar. 30, 2004

Appellants request review of the following grounds of rejection under 35 U.S.C. § 103(a) (Br. 4), the grounds all advanced on appeal:

claims 1 through 32 and 37 through 39 as unpatentable over Iwanaga in view of Smith (Answer 3-5); and

claims 33 through 36 as unpatentable over Iwanaga in view of Smith as applied to claims 1 through 32 and 37 through 39 further in view of Sawada and Wanka (*id.* 5-6).

Appellants argue the claims of the first ground of rejection as a group as well as claim 17 separately (Br. 5 and 9). Appellants argue the claims of the second ground of rejection as a group (*id.* 10). Thus, we decide this appeal based on appealed claims 1, 17, and 33 as representative of the grounds of rejection and Appellants' groupings of claims. 37 C.F.R. § 41.37(c)(1)(vii) (2005).

With respect to claims 1 and 17, the Examiner contends Iwanaga would have disclosed the gas-phase oxidation of hydrogen chloride by means of a gas stream comprising molecular oxygen in the presence of a fixed-bed catalyst is an exothermic reaction which results in the formation of hot spots in the catalyst tubes that must be controlled (Answer 3-4). The Examiner contends that Iwanaga discloses "that in the industrial process, a shell-and-tube heat exchanger type fixed bed multi-tube reactor may be used" (*id.* 4). The Examiner contends the difference between the claimed process and Iwanaga's process is the latter "does not specifically disclose the

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deleted from this claim in the Amendment filed August 25, 2005

presence of one or more annular deflection plates in the shell-and-tube heat exchanger type fixed bed multi-tube reactor" (*id.* 4). The Examiner contends Smith discloses a shell-and-tube reactor with baffles for conducting, inter alia, exothermic reactions, wherein a series of alternating, horizontal baffles or deflection plates 10 extend partway across the reactor shell forming space 11 in which no catalyst tubes are present, providing "a 'defined, virtually purely transverse flow'" of the liquid heat transfer medium against the catalyst tubes as claimed (*id.* 4-5). The Examiner concludes it would have been obvious to add Smith's baffles to the shell-and-tube heat exchanger type reactor of Iwanaga "to improve the heat exchange rate" (*id.* 5).

With respect to claim 33, the Examiner contends Iwanaga and Smith do not disclose multiple regions in the reactor (Answer 5). The Examiner contends Wanka discloses the reaction tank for, inter alia, exothermic chemical processes, can be divided by partitions into three unconnected sections for independent temperature control, pointing to Wanka's Fig. 6 as "illustrating the contact tubes as rolled to attain a fluid tight fit in a partition" (*id.* 5-6). The Examiner concludes it would have been obvious to divide the reactor into multiple sections as suggested by Wanka to separately control the temperature in each section.[2]

With respect to claim 1, Appellants contend there is insufficient evidence to combined Iwanaga and Smith and then modify Iwanaga's heat exchanger system by incorporating Smith's horizontal baffles (Br. 5-6).

(Amendment 2).

Appellants contend Iwanaga does not suggest the need for horizontal baffles in the chlorine producing process for any reason, disclosing that a tube with surrounding jacket controls the temperature in the reaction zone (*id.* 6). Appellants contend Smith teaches exothermic reactions using inert diluents, thermally stable reactants or product components, particularly in the dehydrogenation of alkylated aromatic hydrocarbons, and would not have suggested to one of ordinary skill in the art to use such baffles in a chlorine producing process as disclosed by Iwanaga (*id.* 5-6). Appellants contend the combination of Iwanaga and Smith requires a change in the basic principle of operation of Iwanaga's process because Smith teaches bypass 13 transports a portion of the heat exchange medium from conduit 12 back to the heat exchange chamber, thus inserting Iwanaga's heat exchange medium, including molten salt, into the hydrogen chloride and oxygen gas reaction mixture (*id.* 6-7). Appellants contend one of ordinary skill in the art would not have used Smith's horizontal baffles in the jacket of the tubular reactor of Iwanaga as it would prevent the preferred feature of the heat exchange flowing from the bottom to the top of the jacket, and thus Iwanaga teaches away from the combination (*id.* 7-8).

With respect to claim 17, Appellants contend the required gap in the claimed range between the catalyst tube and the deflection plate or baffle is not suggested by the combination of references because Iwanaga does not disclose a horizontal baffle and the catalyst tube and baffle are connected in Smith (Br. 9). With respect to claim 33, Appellants contend Wanka

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[2] A discussion of Sawada is not necessary to our decision. *See In re Kronig*, 539 F.2d 1300, 1302-04, 190 USPQ 425, 426-28 (CCPA 1976).

discloses a reaction tank for, inter alia, any exothermic chemical reaction in which there is radial heat exchanger medium flow and the reaction tank is divided into three superposed sections 42', 42", and 42'" that are not connected to each other and have separate pumps and regulators, and thus, is not combinable with Iwanaga and Smith (*id.* 10-11).

With respect to claim 1, the Examiner responds Smith teaches baffles in tube-and-shell reactors used for exothermic reactions to control the temperature and the absence of tubes in passage regions allows unrestricted heat exchange medium flow from one baffle zone to another (Answer 7). The Examiner maintains that one of ordinary skill in the art would have used Smith's reactor as Iwanaga's tube-and-shell reactor for the exothermic process taught therein wherein temperature control is important (*id.* 7-10). The Examiner contends that Smith discloses bypass 13 as a preferred embodiment which is not required (*id.* 10). With respect to claim 17, the Examiner responds that while Smith's Figs. 1 and 2 do not show all details including whether a gap is present, it is disclosed that the catalyst tubes are secured to the supporting plates and thus do not require the baffles for support (*id.* 10). The Examiner further contends it would have been within the ordinary skill in the art to design the reactor to facilitate tube replacement and provide clearance between the tubes and baffles to compensate for any tube expansion caused by high reaction temperature (*id.* 11-12). With respect to claim 33, the Examiner responds that as claimed, the reaction zones are separated in a largely liquid-tight manner and thus, the zones are not connected in the same manner as the unconnected, separate zones in Wanka (*id.* 13).

With respect to claim 1, Appellants reply Iwanaga teaches the hot spot problem can be solved by suppressing hot spot activity in the catalyst-packed layer and does not teach the uncompensated use of a shell-and-tube heat exchanger type fixed bed reactor, such compensation taught at column 6, line 17, to column 8, line 27, arguing there is no advantaged suggested by the reference to select the uncompensated reactor (Reply Br. 1-4). Appellants contend with respect to column 6, lines 22-25, 28-30, and 32-33, and Example 1, that Iwanaga does not teach a tube-and-shell type reactor without a compensating jacket and heating medium control, and further teaches that a tubular reactor with a jacket is sufficient (*id.* 4-5). Appellants contend Smith does not teach the use of the baffle containing tube-and-shell reactor with any possible exothermic reaction, nor that an improved heat exchange rate results from the use of baffles (*id.* 5-7). With respect to claim 17, Appellants reply Smith does not disclose the claimed gaps, contradicts easy removal by securing the catalyst tubes in supporting plates, and use of the same material for baffles, end plates, and tube eliminates the expansion problem (*id.* 8).

The issues in this appeal are whether the Examiner has carried the burden of establishing a prima facie case of obviousness in combining the references as applied, and based thereon, whether one of ordinary skill in this art would have modified the shell-and-tube reactor of Smith with respect to the flow of the heat exchange medium, and would have used the shell-and-tube reactor of Smith as the shell-and-tube reactor in the process of Iwanaga.

The plain language of independent claim 1 encompasses processes preparing chlorine by the exothermic gas-phase oxidation reaction of hydrogen chloride and molecular oxygen, carried out in any reactor which, as illustrated, inter alia, by Specification Figs. 1-3, has a bundle of parallel catalyst tubes 2 aligned in the longitudinal direction and fixed by tube plates 3, and one or more deflection plates 6 arranged perpendicular to the catalyst tubes in the intermediate spaces between the tubes with passages 7 located alternatively next to the interior wall on opposite sides of the reactor (Specification 12). Thus, the reactor has a "wall," shell, or jacket surrounding the bundle of parallel catalyst tubes. Claim 1 further specifies passing any liquid heat transfer medium 25 through the intermediate space around the catalyst tubes "in a defined, virtually purely transverse flow of the liquid heat transfer medium against the catalyst tubes." There is no limitation specifying any specific process parameter, such as catalyst packing, temperature, and pressure.

The Specification discloses it is "a shell-and-tube reactor which has no tubes in the region of the passages" that achieves the specified "defined, virtually purely transverse flow of the liquid heat transfer medium" as claimed in claim 1 (Specification 3:27-35). One of ordinary skill in this art readily knows that a "shell-and-tube" reactor has several parallel catalyst tubes in a bundle surrounded by a shell, that is, a wall or jacket, for heat transfer purposes, the basic design of which can be gleaned from the shell-and-tube reactors illustrated in the Specification Figs. and, for example, in Smith's Fig. 1. In contrast, the claims do not encompass a tubular reactor in which a single tube is surrounded by a shell, wall or jacket for heat transfer

purposes.[3]

The plain language of dependent claim 17, as illustrated, inter alia, by Specification Figs. 1C and 2C, specifies gaps 20 of from 0.1 to 0.4 mm are present between catalyst tubes 2 and deflection 6 (Specification 12). The plain language of dependent claim 33, as illustrated, inter alia, by Specification Fig. 3, specifies the reactor contains at least two reaction zones separated in a largely liquid-tight manner by dividing plates 11 (*id.*).

We find Iwanaga would have disclosed to one of ordinary skill in this art processes preparing chlorine by the exothermic gas-phase oxidation reaction of hydrogen chloride and molecular oxygen in which excessive hot spots in the catalyst layers in the reaction zone are suppressed by dividing the catalyst-packed layer into two reaction zones of different activity and by controlling the temperature of the reaction zones with a heat exchanger system (Iwanaga, e.g., col. 1, ll. 44-55, col. 5, ll. 15-37, and col. 6, ll. 17-37). "[T]he heat exchanger system means a system providing a jacket outside the tubular reactor, which is filled with the catalyst" (*id.* col. 6, ll. 21-25). "In the industrial process, a *shell-and-tube* heat exchanger type fixed bed multi-tube reactor may be used, in which *tubular reactors* . . . are arranged *in parallel,* and a *jacket is provided around the tubular reactors*" (*id.* col. 6, ll. 28-33; emphasis added). The heat exchange system medium can be molten salts (*id.* col. 6, ll. 37-50). Iwanaga teaches that the catalyst layer is divided into at least two reaction zones the temperatures of which are controlled by the heat exchanger system wherein, inter alia, "a jacket is

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[3] *See, e.g.*, **Tubular Reactor**, *Chemical Engineers' Handbook* **4**-21 and **Fig. 4-4** (Robert H. Perry and Cecil H. Chilton eds., 5th ed., New York,

divided into at least two sections with partitions and the heating media are independently circulated in the partitioned sections" (*id.* col. 6, l. 58, to col. 7, l. 2). "The partitions may be directly fixed to the tubular reactors by welding, although a gap may be left between each partition and the tubular reaction to an extent that the heating media can be substantially independently circulated" (*id.* col. 7, ll. 2-6). "The heating medium in the jacket is preferably flowed from the bottom to the top of the jacket so that the medium has no cavitation therein" (*id.* col. 7, ll. 6-8). Iwanaga exemplifies the use of "a fixed bed reactor . . . consisted of a nickel tubular reactor . . . equipped with a jacket" (*id.* col. 7, ll. 52-56).

We find Smith would have disclosed to one of ordinary skill in this art a reaction apparatus for, inter alia, exothermic chemical reactions, in which an inert diluent, thermally stable recycle reactant, or product is utilized to heat or cool the reaction stream (Smith, e.g., col. 1, l. 23, to col. 2, l. 3, and col. 2, ll. 9-26). The reactor illustrated in Smith's Fig. 1 has reactor shell 1 with reactant stream inlet and product stream outlet 2,3 and a reaction chamber containing parallel reaction tubes 4 extending longitudinally between supporting plates 5,6 which are secured to the wall of shell 1, wherein reactor tubes 4 can be filled with a catalyst (*id.* col. 2, ll. 34-44, and col. 4, ll. 57-62). The space between plates 5,6 and the reactor wall forms heat exchange chamber 7 with inlet and outlet 8,9 for heat exchange medium circulation (*id.* col. 2, ll. 34-44). In chamber 7, a series of alternating, horizontal baffles 10, perpendicular to reaction tubes 4, form a series of zones providing flow of the heat exchange medium transversely

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McGraw-Hill Book Company, 1973).

across reactor tubes 4 (*id.* col. 2, ll. 53-58). The baffles 10 extend partially across shell 1 forming space 11 which permits the flow of heat exchange medium from one baffle zone to another as illustrated in Smith's Fig. 2 (*id.* col. 2, ll. 53-61, and col. 2, l. 66, to col. 3). The number of baffles 10 employed depends on desired conditions, inter alia, temperature control (*id.* col. 2, ll. 54-65).

Smith discloses that the exchange medium flow through the reactor from inlet 8 to outlet 9 is successively transversely across all reactor tubes 4 with "the general flow of the heat exchange medium is concurrent with the flow of the reaction mixture through the reactor tubes" because "the temperature differential across the walls of the reactor tubes is greatest where the concentration of reactant is highest and therefore requiring the greatest heat transfer, whether the reaction is endothermic or exothermic" (*id.* col. 3, ll. 15-25). Smith provides this flow via conduit 12 between heat exchange medium outlet 9 and incoming reactant conduit 17, and the incoming heat exchange medium conduit and heat exchange medium inlet 8 (*id.* col. 3, ll. 26-29 and 50-56). Smith discloses that bypass 13 is an optional, preferred conduit (*id.* col. 3, ll. 30-49). Smith exemplifies the reactor with the dehydrogenation of alkylated aromatic hydrocarbons, an endothermic reaction (*id.* col. 4, l. 1 et seq.).

We find Wanka would have disclosed to one of ordinary skill in this art an apparatus for, inter alia, exothermic chemical reactions, in which the temperature of the heat exchange medium longitudinally of the catalyst tubes can be controlled (Wanka, e.g., col. 2, l. 20, to col. 3, l. 24). As illustrated in Wanka's Fig. 1, cylindrical reaction tank 1 has horizontal distributor plates

or baffles 7 defining radial flow of heat exchange medium perpendicular to a bundle of longitudinal contact tubes 2 which are filled with catalyst and secured to headers 3,4 that define the heat exchange chamber and open into hoods or chambers 5,6 (Wanka, e.g., col. 2, ll. 20-46, and col. 3, l. 44, to col. 5, l. 4). Wanka further discloses, as illustrated in Fig. 5, dividing reaction tank 42 with separating partitions or diaphragms 43,44 into three superposed, unconnected sections 42', 42", and 42"' each with a separate inlet and outlet conduits for temperature control in different sections of the reactor (*id.* col. 2, ll. 47-60, and col. 5, l. 55, to col. 6, l. 55). Wanka discloses, as illustrated in Fig. 6, separation between the sections can be attained by rolling contact tubes 2 into separating partitions 43,44 (*id.* col. 6, ll. 56-59). We find one of ordinary skill in this art would characterize Wanka's illustrated reactors as shell-and-tube reactors.

We determine one of ordinary skill in this art would have found in Iwanaga the specific teaching to use a shell-and-tube reactor, that is, a bundle of parallel catalyst tubes longitudinally arranged in and surrounded by a shell or jacket which provides a heat exchanger system, to control, at least in part, the hot spot(s) in the catalyst tube occurring during the exothermic gas-phase oxidation reaction of hydrogen chloride and molecular oxygen. Indeed, Iwanaga's disclosure does not support Appellants' contention the shell-and-tube reactor is taught in the reference to be further surrounded by an additional shell or jacket for heat exchange purposes.

We determine the Examiner properly identified the reactor illustrated in Smith's Fig. 1 as a shell-and-tube reactor falling within the teaching of Iwanaga. We agree with the Examiner that bypass 13 illustrated in Smith's

Fig. 1 is an optional embodiment taught by Smith. In this respect, one of ordinary skill in this art would have recognized from the teachings of Smith that without bypass 13, the heat exchange medium would flow through incoming heat exchange medium conduit to heat exchange medium inlet 8 without the addition of material from conduit 12 bypassing incoming reactant conduit 17.

We agree with Appellants that Smith would have taught the intra-reactor flow of the heat exchange medium and the conduit arrangement illustrated in Smith's Fig. 1 with a diluent or a stable reactant or product not affected by heat encountered in conducting an exothermic or endothermic reaction as heat exchange medium. However, we are of the opinion that one of ordinary skill in this art would have recognized that the reactor of Smith can be used to conduct endothermic and exothermic reactions with other heat exchange mediums not affected by heat by merely disconnecting conduit 12 from conduit 17, resulting in control of the heat exchange medium flow separate from the reactant flow. Indeed, this person would have recognized that the flow of any heat exchange medium horizontally across the longitudinal catalyst tubes would provide the cooling or heating benefits apparent from the disclosure of Smith, and thus that the loss of the function of combining the reactant and the heat exchange medium and the use of a different heat exchanged medium would not change the basic principle of operation of the reactor. *See, e.g.*, *In re Kuhle*, 526 F.2d 553, 555, 188 USPQ 7, 9 (CCPA 1975); *In re Wilson*, 377 F.2d 1014, 1017, 153 USPQ 740, 742 (CCPA 1967) (elimination of component whose function is not desired); *In re Keegan*, 331 F.2d 315, 319, 141 USPQ 512,

515 (CCPA 1964) (no unexpected result in omission of element and its function). In this respect, we find no disclosure in Smith which limits the teachings with respect to the reactor to the endothermic reaction exemplified therein.

Thus, we are of the opinion that, as the Examiner concludes, one of ordinary skill in the art would have reasonably selected the shell-and-tube reactor of Smith modified to separately control the heat exchange medium as the shell-and-tube reactor for Iwanaga's process. We are not convinced otherwise by Appellants' contentions. We recognize, as Appellants point out, Smith teaches the heat exchange medium flows through the reactor concurrent to the reactant flow, and that Iwanaga prefers countercurrent flow in this respect. The non-preferred embodiment thus apparent to one of ordinary skill in this art from Iwanaga's disclosure is concurrent flow of the reactant and heat exchange medium which is the same flow taught in Smith. Thus, for this reason and the modifications that one of ordinary skill in this art would have reasonably made to Smith's illustrated reactor discussed above, the use of Smith's reactor does not result in a change in the principle of operation of Iwanaga as argued.

Accordingly, on this record, we are of the opinion that the Examiner properly combined Iwanaga and Smith and concluded that one of ordinary skill in this art following the combined teachings of the references would have reasonably arrived at the claimed process encompassed by claim 1, including all of the limitations thereof arranged as specified therein. Indeed, the arrangement of the horizontal baffle or deflector plates arranged horizontal to the longitudinal catalyst tubes illustrated in Smith's Figs. 1 and

2 correspond to an embodiment encompassed by claim 1 illustrated in Specification Figs. 2 and 2A.

With respect to claim 17, we agree with Appellants that Smith does not disclose whether the baffle plates are secured to the catalyst tubes. However, Iwanaga teaches that the partition plates, which control heat exchange medium flow similar to baffle plates and both types of plates are affixed to the reactor wall, can optionally be attached to the catalyst tubes by welding. In this respect, Iwanaga further teaches that where not attached, the gap between the plate and the tube must not substantially prevent independent circulation between the partitioned sections of the reactor. Thus, we agree with the Examiner that it is within the ordinary skill in this art to leave a gap between the baffle and the tube to the extent that the desired flow of the heat exchange medium across the tube is not substantially prevented.

With respect to claim 33, Iwanaga clearly teaches at least two substantially liquid-tight zones separated by partition(s) for independent heat exchange flow in any reactor and Wanka further illustrates such separate zones in a shell-and-tube reactor with horizontal heat exchange medium flow across catalyst tubes. Thus, contrary to Appellants' contentions, one of ordinary skill in this art would have combined Iwanaga, Smith, and Wanka and modified the shell-and-tube reactor of Smith to include at least two substantially liquid tight, unconnected separate heat exchange zones.

Accordingly, based on our consideration of the totality of the record before us, we have weighed the evidence of obviousness found in the combined teachings of Iwanaga and Smith and as further combined with

Sawada and Wanka with Appellants' countervailing evidence of and argument for nonobviousness and conclude that the claimed invention encompassed by appealed claims 1 through 39 would have been obvious as a matter of law under 35 U.S.C. § 103(a).

The Primary Examiner's decision is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a)(1)(iv) (2005).

AFFIRMED

sld/ls

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