

mercury in at least the lower range of 300 °C to 400 °C. Paragraph [0065] states that injection of the treated activated carbon prior to a fabric filter can provide a longer residence time of the sorbent, higher utilization levels, as well as the possibility of recovering and reinjecting the sorbent at lower costs.

Paragraph [0017] refers to the "...particular advantages of using bromine, rather than iodine or iodides, or chlorine or chlorides, with activated carbon..." but, as explained herein, "...bromine..." would be interpreted as elemental bromine (Br_2); moreover, paragraph [0017] fails to describe or suggest any "...particular advantages of using bromine..." Paragraph [0017]'s concluding statement referring to the "...tenacity of carbon-bromine-mercury complexes..." fails to compare the strength of such complexes to the strength of any other complexes, such as carbon-chlorine-mercury complexes, carbon-chloride-mercury complexes, carbon-iodine-mercury complexes, or carbon-iodide-mercury complexes; therefore, at best, the "...tenacity..." of the complexes described in the last sentence of paragraph [0017] can be regarded as a general statement, rather than as a comparative one.

Paragraph [0041] begins by stating that gaseous bromine (defined as Br_2) or hydrogen bromide (defined as HBr) increases the mercury absorption capacity of activated carbon. Then, paragraph [0041] goes on to explicitly state that gaseous bromine, defined as Br_2 in the prior sentence, produces a more effective mercury-absorbing carbon sorbent than iodine (I_2), iodide (I^-), chlorine (Cl_2), or chloride (Cl^-). With the precise definitions given for gaseous bromine (Br_2) and hydrogen bromide, and then reference only to gaseous bromine (Br_2) in the next sentence, Nelson makes clear that the comparison of efficacy is only with respect to elemental bromine (Br_2) and not hydrogen bromide. Paragraph [0041] fails to describe a general advantage of Nelson's invention; instead, paragraph [0041] specifically and particularly describes an advantage of elemental bromine (Br_2), which cannot be regarded as a general advantageous effect of "...the invention..." as it only applies to elemental bromine (Br_2). Accordingly, advantages explicitly attributed to Br_2 in paragraph [0041] of Nelson cannot be imputed to HBr by the last sentence of paragraph [0049].

Therefore, paragraph [0049] fails to describe or suggest that hydrogen bromide treatment of activated carbons is more effective for mercury removal than HCl or Cl^- treatment of activated carbons.

At paragraph [0050], Nelson states:

[0050] In the liquid form at ambient temperatures, elemental bromine is dense and compact, with advantages in transport and storage. To be utilized in this invention, however, it must first be heated to at least about 60° C. and turned into a gaseous state. In such a state it can more uniformly treat the carbonaceous materials at low levels and provide the desired effect of increasing their mercury sequestration capabilities. A preferred method of converting the liquid bromine to a bromine-containing gas is to use a heated lance. Liquid bromine can be metered into such a heated-lance system at one end and be distributed as a gas to the substrate materials at the other end.

Nelson therefore states that an advantage of elemental bromine (Br_2) is that it is dense and compact which provides advantages in transport and storage.

At paragraph [0051], Nelson states:

[0051] In some applications it may be beneficial to utilize a diluting carrier gas to better distribute the $\text{Br}_2(\text{g})$ or $\text{HBr}(\text{g})$ among the carbonaceous substrate particles. However, if the process of this invention is practiced in a batch mode, it can be preferable to use pure $\text{Br}_2(\text{g})$ or $\text{HBr}(\text{g})$. These can be

Nelson therefore states that elemental bromine (Br_2) or hydrogen bromide can be dispersed in a carrier gas during the treatment of the activated carbon.

At paragraph [0053], Nelson states:

reactive towards mercury. By exposing the carbon to the bromine at an elevated temperature, less of the bromine species will volatilize off from the sorbents during their transport and storage or upon their injection into the hot combustion stream.

Paragraph [0053] describes that elevated temperature during treatment can provide an advantage of reduced volatilization during transport, storage, or during injection into the hot flue gas, expanding on the advantage described at paragraph [0044].

At paragraph [0054], Nelson states:

[0054] Any level of bromination of carbonaceous substrates appears to increase their mercury-removal performance. While over 30 wt % of $\text{Br}_2(\text{g})$ can be adsorbed into some powdered activated carbons, for example, significant increases in mercury reactivity will be observed with only about 1 wt % $\text{Br}_2(\text{g})$ in the PAC. Greater degrees of bromination do correlate with greater maximum mercury capacities for a particular carbonaceous substrate. However, with the sorbent-injection application of this invention, only a fraction of a material's maximum possible mercury capacity is typically utilized, so the optimum level of bromine to combine with the carbon substrate may vary with the particular situation. If a PAC substrate is used, brominating to 1 wt % provides a highly-capable mercury sorbent, although a 5 wt % material performs better and may be preferable. Brominating to 15 wt % Br_2 generally produces an even more capable mercury sorbent, but as some of the bromine is held at less-energetic sites, there is a greater possibility that some degree of bromine may evolve off under some circumstances. Mercury sorbents with higher bromine concentrations will take longer to produce and cost more as well.

Paragraph [0054] refers to bromination of activated carbon, referring only to specific amounts of Br_2 used to treat the activated carbon and not giving any reference to, let alone specific amounts of, hydrogen bromide.

At paragraph [0062], Nelson states:

[0062] FIG. 4 describes the possible application of the sorbents to a plant which has a "hot-side" ESP, a particularly difficult situation for mercury control. In this equipment arrangement, the air preheater 22 follows the ESP 32, so the temperature of the mercury-containing flue gas in the ductwork 64 before the particulate collection is very high, in the range of 300-to-400° C. Plain powdered activated carbons do not capture any mercury at these temperatures and PACs impregnated with iodine or sulfur lose their impregnates. Surprisingly, the mercury sorbents prepared according to the process of this invention appear to capture mercury in at

least the lower end of this temperature range. Consequently, the sorbents from bin 71 can be useful even when injected at 72 into the very hot, low-oxygen, mercury-containing gases in ductwork 64. The sorbents would be collected with the other gas stream particulates in the hot-side ESP 32 and the cleaned gas would proceed through ductwork 65 to the smokestack.

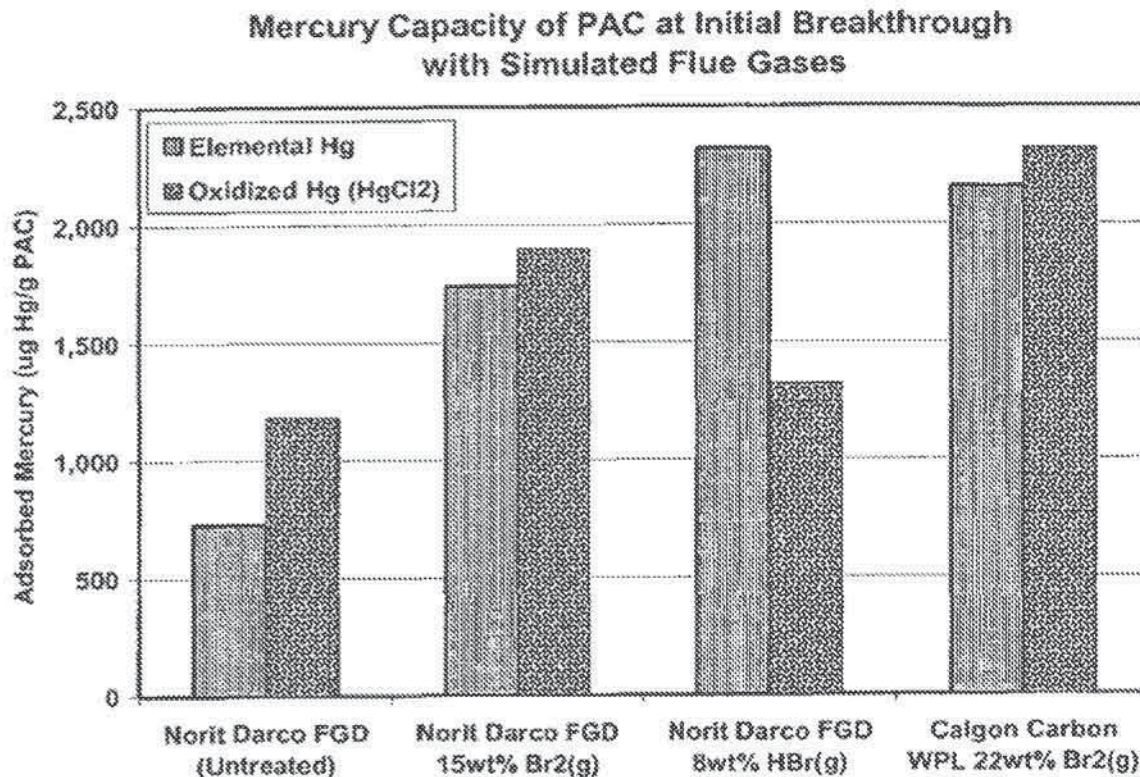
Paragraph [0062] states that mercury sorbents prepared according to Nelson's invention can capture mercury in at least the lower range of 300 °C to 400 °C, unlike activated carbons impregnated with iodine or sulfur.

At paragraph [0065], Nelson states:

[0065] Two such arrangements bear particular mention. FIG. 5 applies the sorbents in a "TOXECON®" arrangement. Here the mercury sorbents 71 are injected after an ESP 32 into the almost particulate-free ductwork 67 before a small, high-velocity fabric filter 33. In this manner the fly ash 80 does not become mixed with the carbonaceous sorbents, allowing the fly ash to be sold for concrete use. Moreover, the filter cake of fabric filter 33 would predominantly be mercury sorbent, allowing a longer residence time, higher utilization levels, and the possibility of recovering and reinjecting the sorbent to lower costs. The superior reactivity and capacities of the mercury sorbents of this invention make them prime candidates for use in such an arrangement.

Paragraph [0065] states that injection of the treated activated carbon prior to a fabric filter can provide a longer residence time of the sorbent, higher utilization levels, as well as the possibility of recovering and reinjecting the sorbent at lower costs.

Figure 12 of Nelson is reproduced below.



Paragraph [0080], discussing figure 12, states that:

...the brominated carbons adsorbed considerably more mercury species than the untreated version, with the improvements averaging about 100%. Importantly, the bromine-gas-treated sorbents removed about as much oxidized mercury-chloride from the test gases as elemental mercury, indicating performance improvements with both kinds of common flue-gas mercury species.

Both of the Br₂-treated activated carbons in figure 12 showed increased removal of both elemental mercury and oxidized mercury as compared to the untreated activated carbon. However, the HBr-treated activated carbon in figure 12 had hardly any improvement in removal of oxidized Hg compared to the untreated activated carbon, which paragraph [0080] describes as one of two common flue-gas mercury species, and that the removal of both of these species is “important.”

The majority of Nelson’s Examples (1-4 and 8) focus only on Br₂. Nelson’s Examples 5-7 demonstrate the use of HBr-treated sorbent; however, none of these Examples or any other parts of Nelson compare the mercury-absorption performance of HBr-treated activated carbon to HCl-treated activated carbon. Although figures 14 and 15 illustrate HBr-treated activated carbon and

Cl₂-treated activated carbon, Cl₂-treated activated carbon is not HCl-treated or Cl⁻-treated carbon and these figures fail to show any comparison to HCl- or Cl⁻-treated activated carbon.

At paragraph [0085], Nelson states:

sorbents of this invention. See FIG. 14. About three times as much chlorine-gas treated PAC was required to achieve the same degree of mercury removal as with bromine. The

Figure 14 of Nelson is reproduced below:

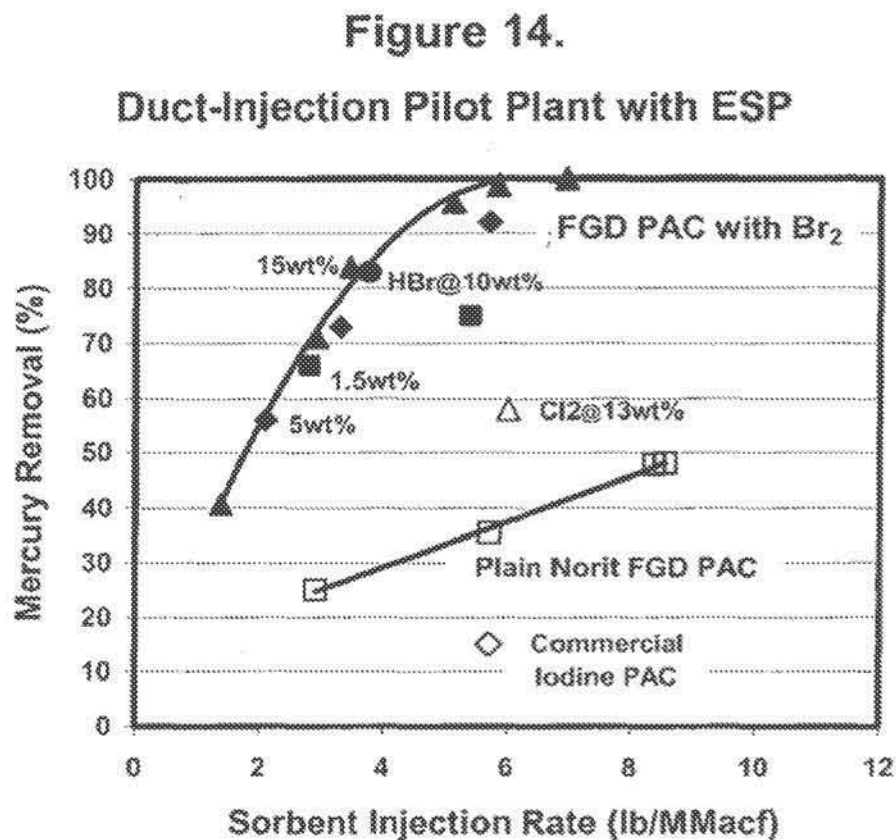


Figure 14 shows mercury removal percent from seven different types of activated carbons: commercial iodine activated carbon, plain Norit activated carbon, 13 wt% Cl₂-treated activated carbon, 10 wt% HBr-treated activated carbon, 1.5 wt% Br₂-treated activated carbon, 5 wt% Br₂-treated activated carbon, and 15 wt% Br₂-treated activated carbon. No HCl- or Cl⁻-treated activated carbon is shown in Figure 14 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon). Paragraph [0085] states that about three times as much chlorine-gas treated activated carbon was required to achieve the same degree of mercury removal as with bromine, which can only be a comparison between the 13 wt% Cl₂-treated

activated carbon and the 5 wt% Br₂-treated activated carbon which had a percent mercury removal that was about the same. Further, with regard to figure 14, Nelson states at paragraph [0084] that “[t]here was not much difference in performance between the various brominated samples, probably because in the duct-injection mode they only used a small fraction of their available mercury-adsorption capacity.” Therefore, Nelson states that figure 14 does not provide an accurate comparison between the brominated samples, because the full mercury-adsorption capacity was not utilized.

At paragraph [0087], and the following table, Nelson states:

[0087] Manufacture of the elemental bromine sorbents was much faster than for the others. The elemental bromine was adsorbed and reacted with the PACs much faster than was the elemental chlorine, for example—one-hundred-times faster. This allowed for quick and inexpensive manufacture of these sorbents. See the table below with rate data in terms of grams of gas adsorbed per kilogram of PAC per minute. The PAC adsorption of gaseous hydrogen bromide, HBr(g), was ten times faster than it was for chlorine.

Gaseous Halogen	Final Loading on FGD PAC (wt %)	Adsorption Rate (gm of gas) (kg PAC = min)	Concentration in Storage Vessel (ppm)
Br ₂ (g)	5%	10	0
Br ₂ (g)	15%	10	0.5
HBr (g)	9%	1	N.A.
Cl ₂ (g)	13%	0.1	>40

Paragraph [0087] states that the activated carbon adsorbed elemental bromine (Br₂) and hydrogen bromide (HBr) faster than chlorine (explicitly shown as Cl₂ in the Table). The table shows the amount of treatment material (Br₂, HBr, or Cl₂) absorbed on the activated carbon and the rate of adsorption of the treatment material on the activated carbon. Paragraph [0087] and the table that follows make no statements describing or suggesting mercury removal rates of the treated activated carbon.

Figure 15 of Nelson is reproduced below:

Figure 15.
Lausche Plant Duct-Injection ESP Trials

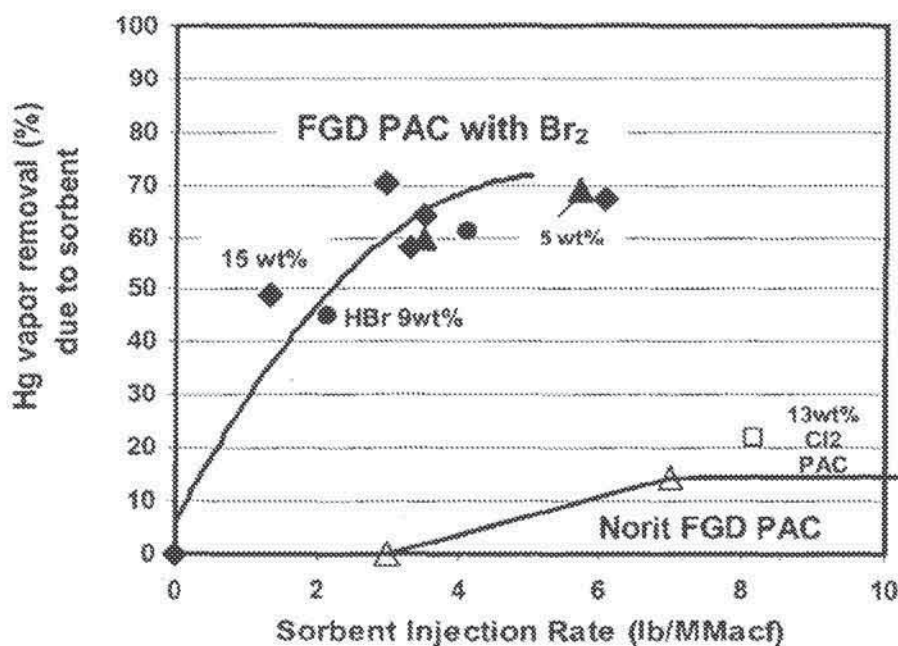


Figure 15 shows mercury removal percent from five different types of activated carbons: Norit activated carbon, 13 wt% Cl₂-treated activated carbon, 9 wt% HBr-treated activated carbon, 5 wt% Br₂-treated activated carbon, and 15 wt% Br₂-treated activated carbon. No HCl- or Cl⁻-treated activated carbon is shown in Figure 15 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon). For all data points showing HBr-treated activated carbon, a higher sorbent injection rate was needed to achieve equivalent mercury-removal performance as the Br₂-treated activated carbons (i.e., the HBr data points for a given mercury-removal percentage are always to the right of the Br₂ data points for that mercury-removal percentage), indicating HBr-treated activated carbon to have less mercury-removal ability than Br₂-treated activated carbons.

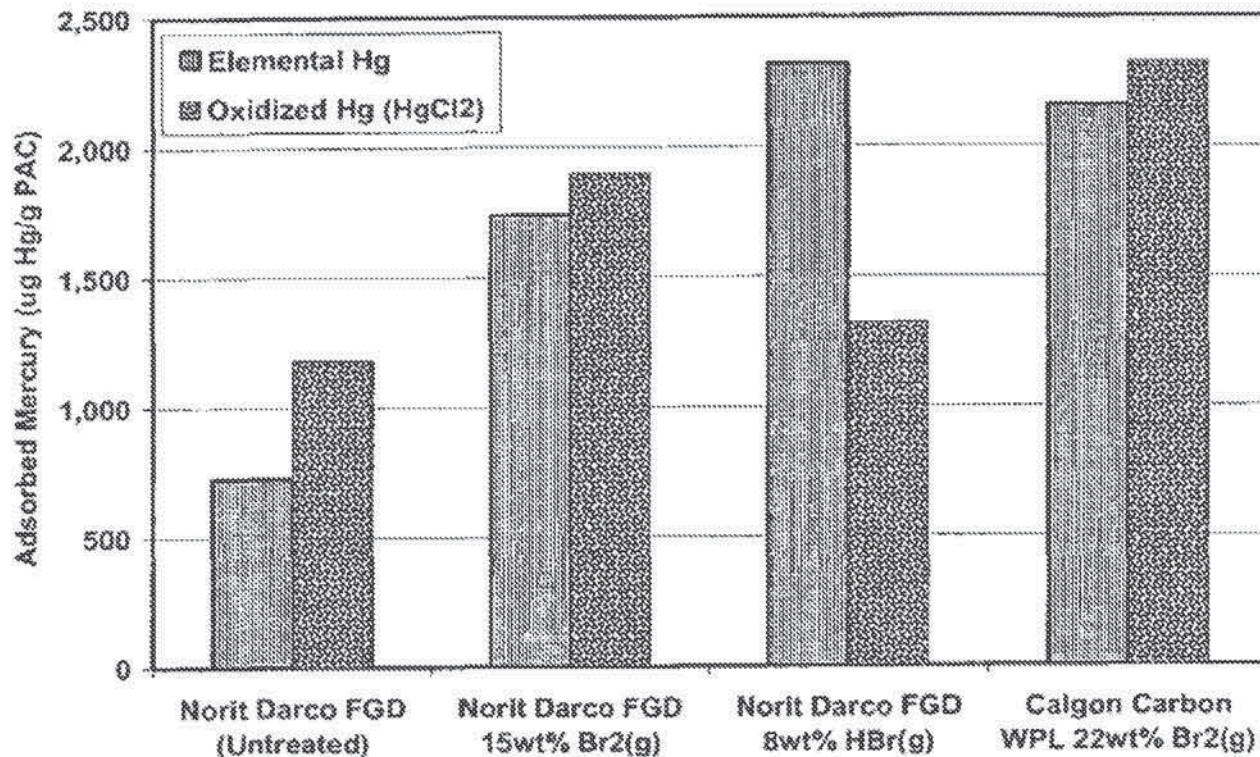
At paragraph [0092], Nelson states:

[0092] The brominated sorbents of this invention, on the other hand, performed very well with this difficult flue gas, achieving about 50% mercury removal with only 2 lb/MMacf of sorbent consumption and almost 70% removal at an injection rate of 4 lb/MMacf. PACs brominated with Br₂ to 5 wt % and 15 wt %, and with HBr to 9 wt % all performed similarly.

Paragraph [0092] refers to the data shown in Figure 15. However, Figure 15 shows mercury removal percent from five different types of activated carbons: Norit activated carbon, 13 wt% Cl₂-treated activated carbon, 9 wt% HBr-treated activated carbon, 5 wt% Br₂-treated activated carbon, and 15 wt% Br₂-treated activated carbon. No HCl- or Cl⁻-treated activated carbon is shown in Figure 15 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon).

Taken in the context of the entire document, figures 14-15 and paragraph [0092] fails to describe or suggest equivalent mercury-removal performance of HBr-treated activated carbon and Br₂-treated activated carbon. With regard to figure 14, Nelson states at paragraph [0084] that “[t]here was not much difference in performance between the various brominated samples, probably because in the duct-injection mode they only used a small fraction of their available mercury-adsorption capacity.” Therefore, Nelson states that figure 14 does not provide an accurate comparison between the brominated samples, because the full mercury-adsorption capacity was not utilized. In figure 15, for all data points showing HBr-treated activated carbon, a higher sorbent injection rate was needed to achieve equivalent mercury-removal performance as the Br₂-treated activated carbons (i.e., the HBr data points for a given mercury-removal percentage are always to the right of the Br₂ data points for that mercury-removal percentage), indicating HBr-treated activated carbon to have less mercury-removal ability than Br₂-treated activated carbons. In figure 12, reproduced below, Nelson compares the mercury capacity of untreated activated carbon, 15 wt% Br₂-treated activated carbon, 8 wt% HBr-treated activated carbon, and 22 wt% Br₂-treated activated carbon.

Mercury Capacity of PAC at Initial Breakthrough with Simulated Flue Gases



Paragraph [0080], discussing figure 12, states that:

...the brominated carbons adsorbed considerably more mercury species than the untreated version, with the improvements averaging about 100%. Importantly, the bromine-gas-treated sorbents removed about as much oxidized mercury-chloride from the test gases as elemental mercury, indicating performance improvements with both kinds of common flue-gas mercury species.

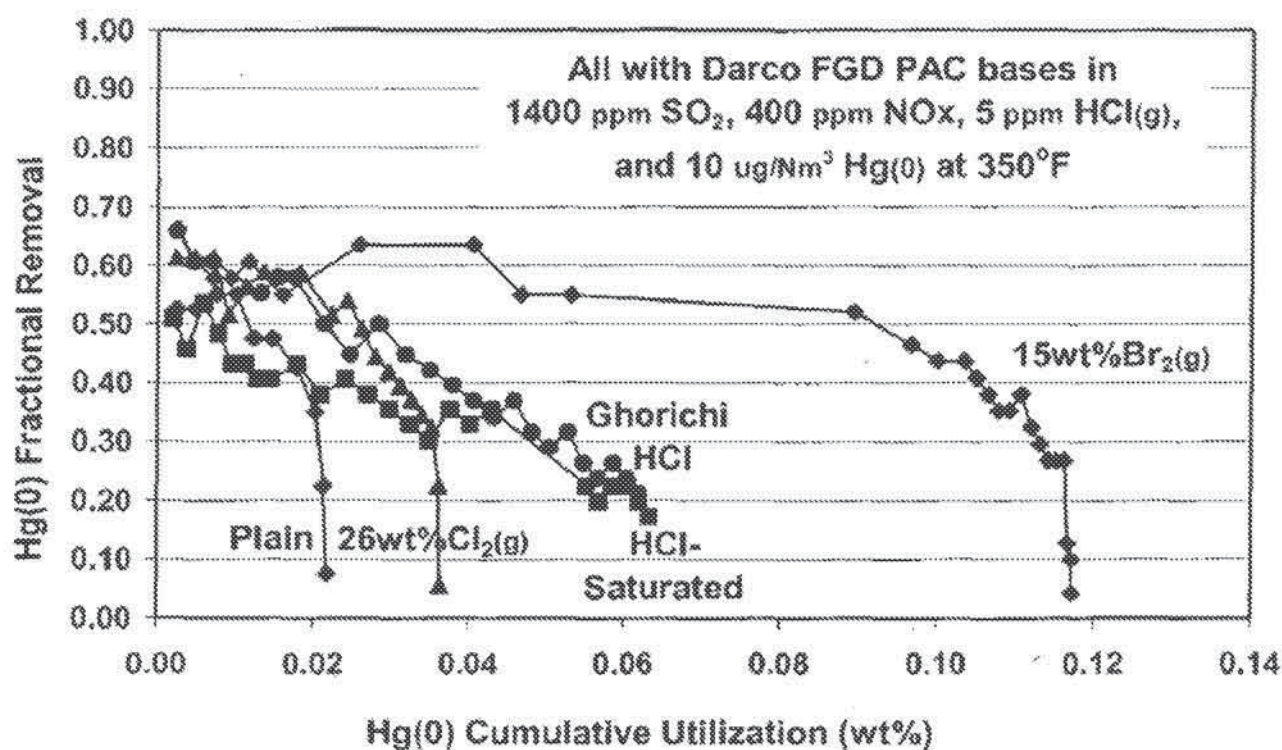
Both of the Br₂-treated activated carbons in figure 12 showed increased removal of both elemental mercury and oxidized mercury as compared to the untreated activated carbon. However, the HBr-treated activated carbon in figure 12 had hardly any improvement in removal of oxidized Hg compared to the untreated activated carbon, which paragraph [0080] describes as one of two common flue-gas mercury species, and that the removal of both of these species is “important.”

Nelson does not portray the mercury removal abilities of activated carbon treated with Cl₂ outside the flue gas as equivalent to that of activated carbon treated with HCl outside the flue gas.

At figure 11, reproduced below, Nelson shows mercury breakthrough curves for elemental mercury removal from a non-flue gas "mercury-challenge gas" for powdered activated carbon with various halogen treatments performed outside the flue gas.

Figure 11.

**Mercury Breakthrough Curves
for PAC with Various Halogen Treatments**



At paragraph [0077], reproduced below, Nelson discusses figure 11.

[0077] The sample that had been exposed to gaseous chlorine, $\text{Cl}_2(\text{g})$, exhibited some improvement in mercury removal performance relative to the plain, untreated PAC. Two samples of HCl-treated PACs showed even higher ultimate mercury capacities, but poorer kinetics. One of these samples had been pretreated by flowing gas-phase HCl through the PAC sample until it no longer added mass. The other, acquired from Ghorishi et al., was produced by a dilute liquid-phase HCl treatment described in their publications. The elemental mercury breakthrough curves of the two HCl-treated PACs were very similar, exhibiting a slow and steady drop-off in performance, indicative of poor mercury adsorption kinetics. In contrast, the brominated sample of this invention broke through very sharply and captured more than five times the elemental mercury of the untreated PAC.

At paragraph [0077], Nelson states that the HCl-treated powdered activated carbons had higher capacities for elemental mercury, but showed poorer kinetics. Although some information about how the Cl_2 - and HCl-treated activated carbons would behave in a flue gas can be learned from figure 11, a flue gas contains additional species that were not present in the “mercury challenge gas”, and, further, can include other forms of mercury other than the elemental mercury measured by the breakthrough test of figure 11, such as oxidized mercury. Nelson does not perform mercury-removal testing of HCl-treated activated carbons in a flue gas. However, Nelson in figure 11, paragraph [0077], and paragraph [0012] refers to HCl-treated activated carbon from Ghorishi et al., which had about the same performance in figure 11 as the HCl-saturated activated carbon prepared by Nelson. At paragraph [0012] Nelson describes a publication by this author, Ghorishi, S.B., Keeney, R.M., Jozewicz, W.S., Serre, S.D. and Gullett, B.K., 2001, In-flight capture of elemental mercury by a chlorine-impregnated activated carbon, Annual Air and Waste Management Association(AWMA) Conference, Orlando, FL, Vol. 24, No. 28 (“Ghorishi”).

Ghorishi's conclusion at page 11 states that over 80% mercury removal was accomplished from a flue gas using activated carbon treated outside the flue gas with HCl. Comparing these results to Nelson's results shown in figures 14 and 15, 80% mercury removal is better than the about 58% removal by Cl_2 -treated activated carbon in figure 14, is better than the about 22% removal by Cl_2 -treated activated carbon in figure 15, and is better than the maximum mercury removal of HBr-

or Br₂-treated activated carbons in figure 15. Therefore, one of ordinary skill in the art hypothetically reviewing Nelson would not only conclude that activated carbon treated outside the flue gas with HCl not only has higher capacity for elemental mercury than Cl₂-treated activated carbon as shown in Nelson's figure 11, but also from comparing Ghorishi to Nelson that activated carbon treated outside the flue gas with HCl has better mercury removal performance in flue gas than Cl₂-treated activated carbon. Accordingly, even if, merely for the sake of argument, one of ordinary skill in the art were to conclude from Nelson's statements at paragraph [0092] that activated carbon treated with HBr or Br₂ outside the flue gas have similar mercury removal abilities, this would not lead to the conclusion that activated carbon treated with HBr outside the flue gas has better mercury removal abilities than activated carbon treated with HCl outside the flue gas.

Nelson never directly compares the mercury-removal ability of HBr-treated activated carbon with HCl-treated activated carbon. With Nelson clearly indicating that HBr-treated activated carbon has inferior mercury-removal ability as compared to Br₂-treated activated carbon, and that HCl-treated activated carbon has superior mercury-removal ability as compared to Cl₂-treated activated carbon, there is no way that one of ordinary skill in the art hypothetically considering Nelson could conclude that HBr-treated activated carbon has equivalent or superior mercury-removal ability compared to HCl-treated activated carbon.

No part of Nelson describes or suggests that HBr or Br⁻ even have the same effectiveness for mercury sequestration when used to treat activated carbons as HCl or Cl⁻, let alone that HBr or Br⁻ are more effective for mercury sequestration when used to treat activated carbons than HCl or Cl⁻. A person of ordinary skill in the art would have no reason to modify Felsvang's HCl or Cl⁻ process with a different promoter to form an effective carbon sorbent for mercury removal if the resulting mercury-removal efficiency could not be reasonably predicted to be the same or greater as that of Felsvang's original process. Therefore, a person of ordinary skill in the art would not be motivated to replace Felsvang's HCl or Cl⁻ treatment of activated carbon with Nelson's HBr treatment. Independent claims 27, 54, and 55 are patentable for at least this reason.

I(A)(3). Reply to Examiner's response to arguments.

The Office Action states:

II A. The applicant traverses the combination of Felsvang and Nelson combination stating that there is no motivation for a person of ordinary skill in the art to use Nelson's bromide additives in Felsvang's process. The applicant contends that one having ordinary skill in the art would not be motivated to replace Felsvang's chloride-treatment with treatment by another material as the prior art does not disclose the bromide additives performing the same or better mercury-removal efficiency.

The examiner disagrees. See Fig. 14 of Nelson which shows that about 3 times the amount of chlorine treated PAC was required to achieve the same degree of mercury removal as with bromine. (paragraph [0085]). Also see the absorption rate in the table on page 8. Further as the rejection above states. Both chlorine and bromine are known within the art to treat activated carbon and therefore it would be well within the capability of one having ordinary skill in the art to *either replace the Cl with or include in addition to the halogen or halide promoter comprising HBr, Br⁻, or a combination thereof to promote activated carbon (Nelson paragraphs [0017] and [0041]) so as to provide an effective carbon sorbent for mercury.*

The Office Action states that Fig. 14 of Nelson shows that about 3 times the amount of chlorine treated PAC was required to achieve the same degree of mercury removal as with bromine, citing to paragraph [0085]. The Office Action also cites to the absorption rate in the table on page 8.

Although figures 14 and 15 illustrate HBr-treated activated carbon and Cl₂-treated activated carbon, Cl₂-treated activated carbon is not HCl- or Cl⁻-treated carbon and these figures fail to show any comparison to HCl- or Cl⁻-treated activated carbon.

At paragraph [0085], Nelson states:

sorbents of this invention. See **FIG. 14**. About three times as much chlorine-gas treated PAC was required to achieve the same degree of mercury removal as with bromine. The

Figure 14 of Nelson is reproduced below:

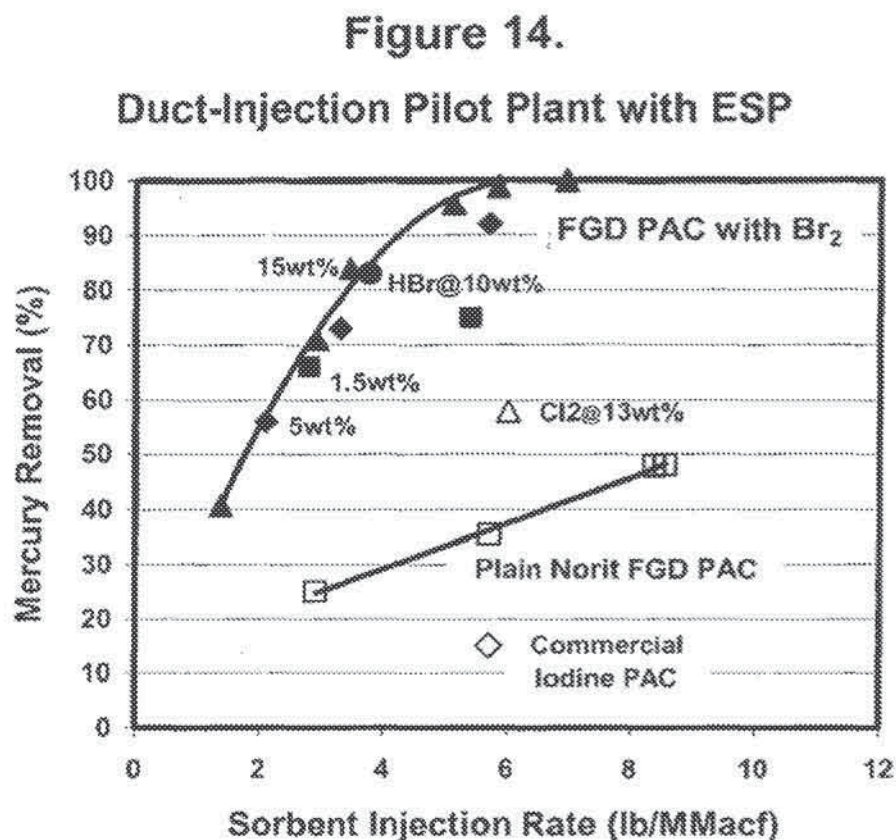


Figure 14 shows mercury removal percent from seven different types of activated carbons: commercial iodine activated carbon, plain Norit activated carbon, 13 wt% Cl₂-treated activated carbon, 10 wt% HBr-treated activated carbon, 1.5 wt% Br₂-treated activated carbon, 5 wt% Br₂-treated activated carbon, and 15 wt% Br₂-treated activated carbon. No HCl- or Cl⁻-treated activated carbon is shown in Figure 14 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon). Paragraph [0085] states that about three times as much chlorine-gas treated activated carbon was required to achieve the same degree of mercury removal as with bromine, which can only be a comparison between the 13 wt% Cl₂-treated activated carbon and the 5 wt% Br₂-treated activated carbon which had a percent mercury removal that was about the same.

At paragraph [0017], Nelson states:

[0017] The particular advantages of using bromine, rather than iodine or iodides, or chlorine or chlorides, with activated carbons for mercury control have not been previously appreciated. Gaseous bromine and hydrogen bromide have been combined with carbon substrates before, but not to sequester mercury from hot combustion-gas streams. For example, Greinke U.S. Pat. No. 5,372,619 found that bromine-treated carbon can make a superior natural-gas storage medium. In another example, SKC Inc. sells a small tube with hydrobromic acid-treated charcoal to sample air for ethylene oxide. However, with both of these uses it is important that the adsorption targets, natural gas and ethylene oxide, be easily desorbable from the carbon, the exact opposite of what is required in a mercury vapor sequestration application. In a similar vein, in U.S. Pat. No. 6,475,461 Ohsaki describes a process for treating carbon substrates with gaseous bromine or chlorine, but then explicitly desorbs them to achieve his desired product. Seki U.S. Pat. No. 3,961,020; Yoshida and Seki et al. U.S. Pat. No. 4,174,373; and Knoblauch et al. U.S. Pat. No. 5,179,058 impregnate activated carbon with bromine to produce a catalyst for reacting nitrogen oxide with ammonia to form nitrogen and water. In this application too, the bromine of the carbon does not act as a sequestration agent, permanently tying up its target. Rather, it serves as a catalyst, taking part in a repeated series of desired chemical reactions, but not becoming permanently consumed by any of them. Perhaps it is understandable that the tenacity of carbon-bromine-mercury complexes could be overlooked.

The first sentence of paragraph [0017] refers to the "...particular advantages of using bromine..." for treatment of activated carbons for mercury control, which must mean either elemental bromine (Br_2) or the element bromine generally, and is not a specific reference to bromides (Br^-). The "...particular advantages of using bromine..." is compared to iodine (I_2), iodides (I^-), chlorine (Cl_2), and chlorides (Cl^-), but no specific comparison is made between bromides (Br^-) and chlorides (Cl^-). However, it does not make sense for Nelson to refer to the element bromine generally while specifically distinguishing between chlorine (Cl_2) and chlorides (Cl^-), and iodine (I_2) and iodides (I^-) in the same sentence. If Nelson wanted to compare both

elemental bromine (Br_2) and hydrogen bromide (HBr) to the other halides specifically disclosed in the first sentence, Nelson would have specifically distinguished between bromine (Br_2) and bromides (Br^-); therefore, "...bromine..." in the first sentence of paragraph [0017] would be interpreted as elemental bromine (Br_2), and not as the element bromine generally.

No "...particular advantages of using bromine..." are explicitly described in paragraph [0017], with the remainder of the paragraph focusing on the failure of the prior art to use bromine with activated carbon for mercury control, describing various disadvantages of other processes, such as the desorbability of Br_2 , HBr , or Cl_2 from the activated carbon, or the failure of the Br_2 or HBr to act as a mercury sequestration agent. The paragraph concludes with a statement that it is understandable that "...the tenacity of carbon-bromine-mercury complexes..." could be overlooked, which must refer to complexes including either elemental bromine (Br_2) or the element bromine generally, with no specific reference to bromide (Br^-) or complexes formed therefrom. The concluding statement of paragraph [0017] is directed toward the discussion in the bulk of paragraph [0017]—the prior art fails to use bromine with activated carbon for mercury control and therefore fails to generate carbon-bromine-mercury complexes—rather than as a statement of any relative advantage of bromine over other halogens or halides. The "...tenacity of carbon-bromine-mercury complexes..." is not specifically compared to the strength of any other complexes, such as carbon-chlorine-mercury complexes, carbon-chloride-mercury complexes, carbon-iodine-mercury complexes, or carbon-iodide-mercury complexes; therefore, at best, the "...tenacity..." of the complexes described in the last sentence of paragraph [0017] can be regarded as a general statement, rather than as a comparative one. Paragraph [0017] fails to attribute any advantage of Nelson's invention specifically to HBr or Br^- , and, moreover, fails to describe or suggest that HBr or Br^- treatment of activated carbon could provide equal, let alone better, mercury removal than HCl or Cl^- treatment of the activated carbon.

At paragraph [0044], Nelson states:

[0044] Production of the new mercury sorbent materials is simple and inexpensive. The carbon material and the bromine gas need simply be contacted with each other for the advantageous mercury-reactive surface compounds to quickly form. Elemental bromine is a liquid at ambient temperature, but turns to a gas at only a modestly elevated temperature. Hydrogen bromide is a gas at even ambient temperature. Using a gas-phase carbon reactant considerably simplifies the production of the sorbent and leads to the low costs which are a requirement for a sorbent to be used as a once-through duct injectant. Any common mixing method and equipment can be used to contact the gaseous bromine species with the carbon-based substrates, although it is preferably lined with corrosion-resistant material, because the bromine species can be quite corrosive. It is also preferable that the mixing of bromine gas and carbon be done at an elevated temperature. This keeps the bromine gas in the gaseous form, but also minimizes the amount of any bromine physically-adsorbed into the pores of the carbon. Such physically adsorbed bromine is not chemically bound to the carbon lattice and can be emitted in handling, in storage, and especially, when the sorbent is injected into a hot flue gas.

Paragraph [0044] expands on the general advantage described in paragraph [0021] of simple and inexpensive generation and use of the treated activated carbon sorbent. Paragraph [0044] also describes that elevated temperature during treatment can provide an advantage of reduced physical-adsorption of the elemental bromine or the hydrogen bromide, which helps to avoid emission during handling, storage, and during injection into a hot flue gas. The advantages are not described or suggested to include equal or greater mercury-removal ability of HBr- or Br⁻-treated activated carbon as compared to HCl- or Cl⁻-treated activated carbon.

The Office Action states:

The applicant contends that the Nelson reference does not disclose HBr and Br⁻ being more effect with activated carbons than chlorides.

The examiner disagrees. The Nelson reference discloses that HBr is used to provide bromide to the system. Example 5, paragraph [0083] states that the brominated PACs were treated with HBr or Br₂. Figures 14 and 15 disclose that HBr-treated PAC performs better than chlorine treated PAC. Further one having ordinary skill in the art would expect PAC treated with HBr or Br₂ would result in a very similar modified PAC as they both include bromide (see paragraph [0092] which discloses that each of the brominated PACs performed similarly). The examiner also points to paragraph [0087] of Nelson which discloses that PAC adsorption of gaseous hydrogen bromide being ten times faster than it was for chlorine.

The Office Action states that the Nelson reference discloses that HBr is used to provide bromide to the system, and that Example 5, paragraph [0083] states that brominated PACs were treated with HBr or Br₂. Applicant cannot find the language of providing HBr “to the system” in Nelson; paragraph [0083] in Example 5 describes treating powdered activated carbons with different amounts of gaseous Br₂(g) or HBr prior to injecting the activated carbons into the flue gas. However, Nelson fails to describe or suggest that treatment of activated carbon with HBr provides the same, let alone better, mercury removal efficiency as activated carbon treated with HCl or Cl⁻.

With regard to figures 14 and 15, as explained above, although figures 14 and 15 illustrate HBr-treated activated carbon and Cl₂-treated activated carbon, Cl₂-treated activated carbon is not HCl- or Cl⁻-treated carbon and these figures fail to show any comparison to HCl- or Cl⁻-treated activated carbon. Figure 14 shows mercury removal percent from seven different types of activated carbons: commercial iodine activated carbon, plain Norit activated carbon, 13 wt% Cl₂-treated activated carbon, 10 wt% HBr-treated activated carbon, 1.5 wt% Br₂-treated activated carbon, 5 wt% Br₂-treated activated carbon, and 15 wt% Br₂-treated activated carbon. No HCl- or Cl⁻-treated activated carbon is shown in Figure 14 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon). Paragraph [0085] states that about three times as much chlorine-gas treated activated carbon was required to achieve the same degree of mercury removal as with bromine, which can only be a comparison between the 13 wt% Cl₂-treated activated carbon and the 5 wt% Br₂-treated activated carbon which had a percent mercury removal that was about the same. Figure 15 shows mercury removal percent from five different types of activated carbons: Norit activated carbon, 13 wt% Cl₂-treated activated carbon, 9 wt% HBr-treated

activated carbon, 5 wt% Br₂-treated activated carbon, and 15 wt% Br₂-treated activated carbon. No HCl- or Cl⁻-treated activated carbon is shown in Figure 15 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon).

The Office Action states that paragraph [0087] of Nelson discloses that PAC adsorption of gaseous hydrogen bromide was ten times faster than it was for chlorine. At paragraph [0087], and the following table, Nelson states:

[0087] Manufacture of the elemental bromine sorbents was much faster than for the others. The elemental bromine was adsorbed and reacted with the PACs much faster than was the elemental chlorine, for example—one-hundred-times faster. This allowed for quick and inexpensive manufacture of these sorbents. See the table below with rate data in terms of grams of gas adsorbed per kilogram of PAC per minute. The PAC adsorption of gaseous hydrogen bromide, HBr(g), was ten times faster than it was for chlorine.

Gaseous Halogen	Final Loading on FGD PAC (wt %)	Adsorption Rate (gm of gas) (kg PAC = min)	Concentration in Storage Vessel (ppm)
Br ₂ (g)	5%	10	0
Br ₂ (g)	15%	10	0.5
HBr (g)	9%	1	N.A.
Cl ₂ (g)	13%	0.1	>40

Paragraph [0087] states that the activated carbon adsorbed elemental bromine (Br₂) and hydrogen bromide (HBr) faster than chlorine (explicitly shown as Cl₂ in the Table). The table shows the amount of treatment material (Br₂, HBr, or Cl₂) absorbed on the activated carbon and the rate of adsorption of the treatment material on the activated carbon. Paragraph [0087] and the table that follows make no statements describing or suggesting mercury removal rates of the treated activated carbon.

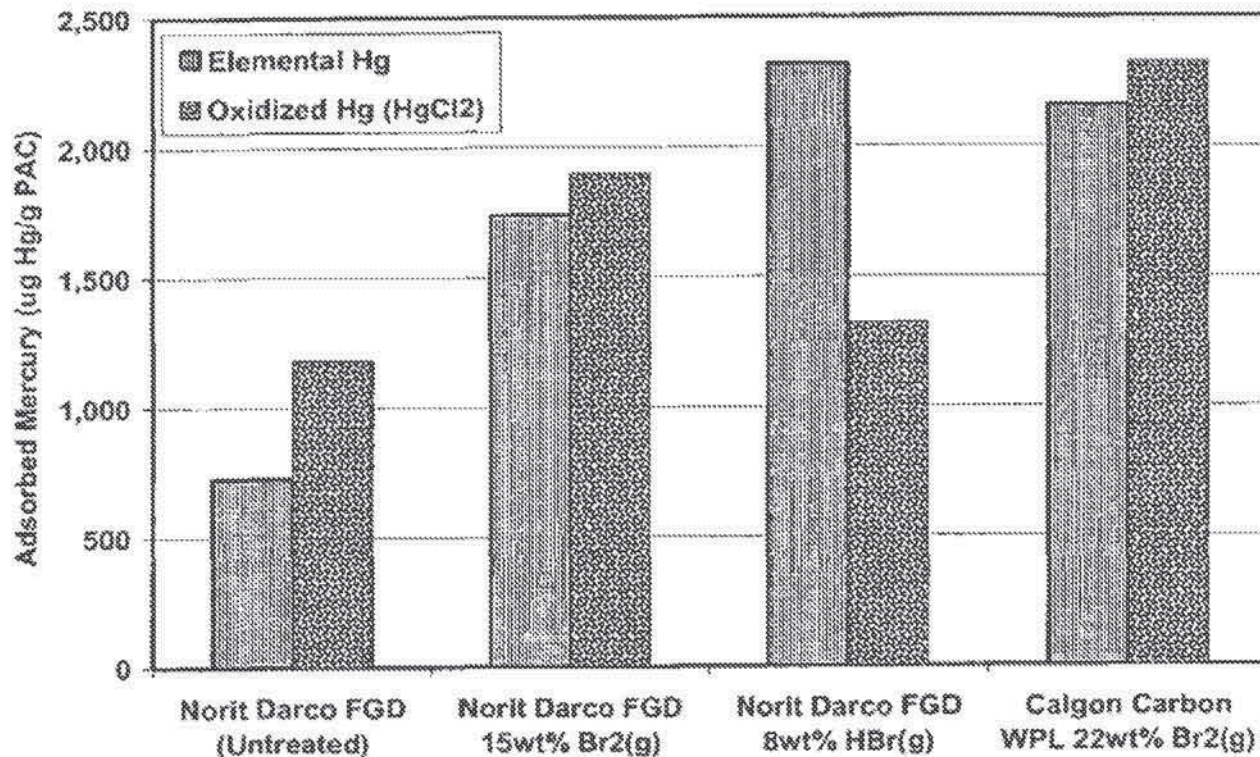
The Office Action states that one having ordinary skill in the art would expect activated carbon treated with HBr or Br₂ would result in a very similar modified PAC as they both include bromide, citing to paragraph [0092] as allegedly disclosing that each of the brominated PACs performed similarly. Applicant notes Declaration C at item 18 which explains that Br₂ is not and does not include Br⁻. At paragraph [0092], Nelson states:

[0092] The brominated sorbents of this invention, on the other hand, performed very well with this difficult flue gas, achieving about 50% mercury removal with only 2 lb/MMacf of sorbent consumption and almost 70% removal at an injection rate of 4 lb/MMacf. PACs brominated with Br_2 to 5 wt % and 15 wt %, and with HBr to 9 wt % all performed similarly.

Paragraph [0092] refers to the data shown in Figure 15. However, Figure 15 shows mercury removal percent from five different types of activated carbons: Norit activated carbon, 13 wt% Cl_2 -treated activated carbon, 9 wt% HBr-treated activated carbon, 5 wt% Br_2 -treated activated carbon, and 15 wt% Br_2 -treated activated carbon. No HCl- or Cl^- -treated activated carbon is shown in Figure 15 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon).

Taken in the context of the entire document, figures 14-15 and paragraph [0092] fails to describe or suggest equivalent mercury-removal performance of HBr-treated activated carbon and Br_2 -treated activated carbon. With regard to figure 14, Nelson states at paragraph [0084] that “[t]here was no much difference in performance between the various brominated samples, probably because in the duct-injection mode they only used a small fraction of their available mercury-adsorption capacity.” Therefore, Nelson states that figure 14 does not provide an accurate comparison between the brominated samples, because the full mercury-adsorption capacity was not utilized. In figure 15, for all data points showing HBr-treated activated carbon, a higher sorbent injection rate was needed to achieve equivalent mercury-removal performance as the Br_2 -treated activated carbons (i.e., the HBr data points for a given mercury-removal percentage are always to the right of the Br_2 data points for that mercury-removal percentage), indicating HBr-treated activated carbon to have less mercury-removal ability than Br_2 -treated activated carbons. In figure 12, reproduced below, Nelson compares the mercury capacity of untreated activated carbon, 15 wt% Br_2 -treated activated carbon, 8 wt% HBr-treated activated carbon, and 22 wt% Br_2 -treated activated carbon.

Mercury Capacity of PAC at Initial Breakthrough with Simulated Flue Gases



Paragraph [0080], discussing figure 12, states that:

...the brominated carbons adsorbed considerably more mercury species than the untreated version, with the improvements averaging about 100%. Importantly, the bromine-gas-treated sorbents removed about as much oxidized mercury-chloride from the test gases as elemental mercury, indicating performance improvements with both kinds of common flue-gas mercury species.

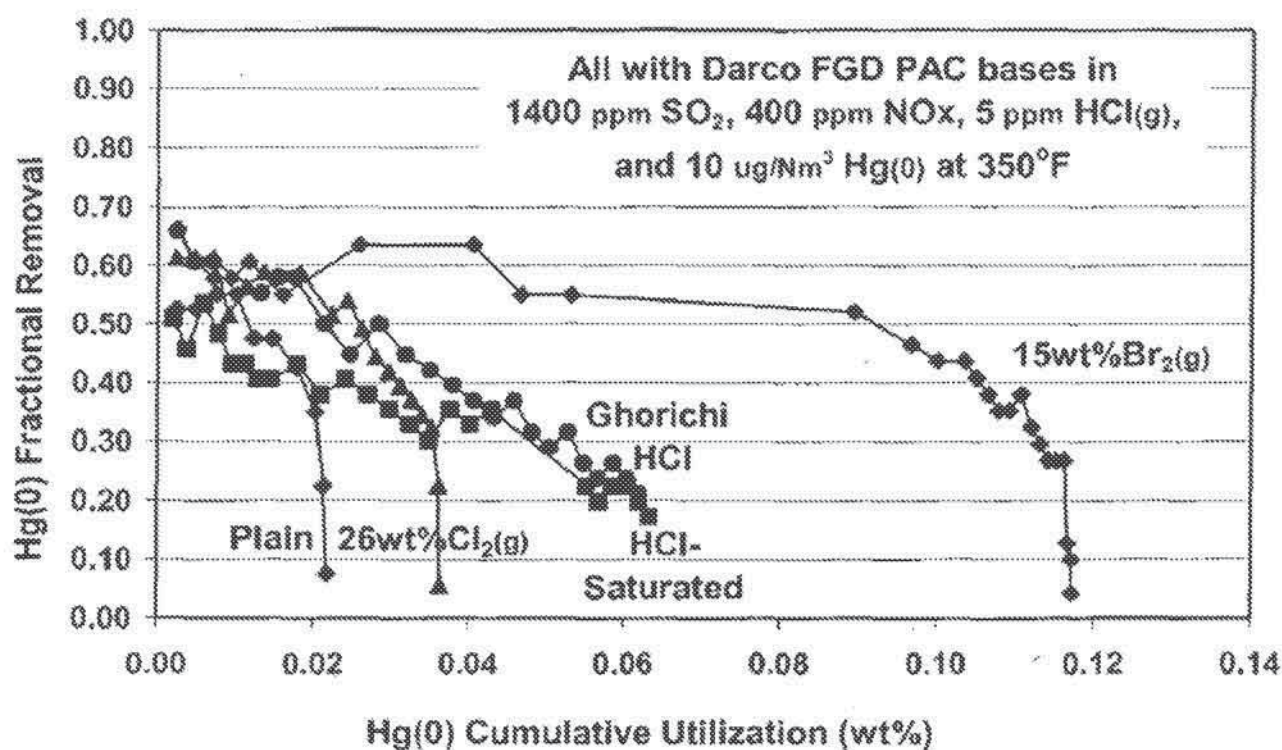
Both of the Br₂-treated activated carbons in figure 12 showed increased removal of both elemental mercury and oxidized mercury as compared to the untreated activated carbon. However, the HBr-treated activated carbon in figure 12 had hardly any improvement in removal of oxidized Hg compared to the untreated activated carbon, which paragraph [0080] describes as one of two common flue-gas mercury species, and that the removal of both of these species is “important.”

Nelson does not portray the mercury removal abilities of activated carbon treated with Cl₂ outside the flue gas as equivalent to that of activated carbon treated with HCl outside the flue gas.

At figure 11, reproduced below, Nelson shows mercury breakthrough curves for elemental mercury removal from a non-flue gas “mercury-challenge gas” for powdered activated carbon with various halogen treatments performed outside the flue gas.

Figure 11.

**Mercury Breakthrough Curves
for PAC with Various Halogen Treatments**



At paragraph [0077], reproduced below, Nelson discusses figure 11.

[0077] The sample that had been exposed to gaseous chlorine, $\text{Cl}_2(\text{g})$, exhibited some improvement in mercury removal performance relative to the plain, untreated PAC. Two samples of HCl-treated PACs showed even higher ultimate mercury capacities, but poorer kinetics. One of these samples had been pretreated by flowing gas-phase HCl through the PAC sample until it no longer added mass. The other, acquired from Ghorishi et al., was produced by a dilute liquid-phase HCl treatment described in their publications. The elemental mercury breakthrough curves of the two HCl-treated PACs were very similar, exhibiting a slow and steady drop-off in performance, indicative of poor mercury adsorption kinetics. In contrast, the brominated sample of this invention broke through very sharply and captured more than five times the elemental mercury of the untreated PAC.

At paragraph [0077], Nelson states that the HCl-treated powdered activated carbons had higher capacities for elemental mercury, but showed poorer kinetics. Although some information about how the Cl_2 - and HCl-treated activated carbons would behave in a flue gas can be learned from figure 11, a flue gas contains additional species that were not present in the “mercury challenge gas”, and, further, can include other forms of mercury other than the elemental mercury measured by the breakthrough test of figure 11, such as oxidized mercury. Nelson does not perform mercury-removal testing of HCl-treated activated carbons in a flue gas. However, Nelson in figure 11, paragraph [0077], and paragraph [0012] refers to HCl-treated activated carbon from Ghorishi et al., which had about the same performance in figure 11 as the HCl-saturated activated carbon prepared by Nelson. At paragraph [0012] Nelson describes a publication by this author, Ghorishi, S.B., Keeney, R.M., Jozewicz, W.S., Serre, S.D. and Gullett, B.K., 2001, In-flight capture of elemental mercury by a chlorine-impregnated activated carbon, Annual Air and Waste Management Association(AWMA) Conference, Orlando, FL, Vol. 24, No. 28 (“Ghorishi”).

Ghorishi's conclusion at page 11 states that over 80% mercury removal was accomplished from a flue gas using activated carbon treated outside the flue gas with HCl. Comparing these results to Nelson's results shown in figures 14 and 15, 80% mercury removal is better than the about 58% removal by Cl_2 -treated activated carbon in figure 14, is better than the about 22% removal by Cl_2 -treated activated carbon in figure 15, and is better than the maximum mercury removal of HBr-

or Br₂-treated activated carbons in figure 15. Therefore, one of ordinary skill in the art hypothetically reviewing Nelson would not only conclude that activated carbon treated outside the flue gas with HCl not only has higher capacity for elemental mercury than Cl₂-treated activated carbon as shown in Nelson's figure 11, but also from comparing Ghorishi to Nelson that activated carbon treated outside the flue gas with HCl has better mercury removal performance in flue gas than Cl₂-treated activated carbon. Accordingly, even if, merely for the sake of argument, one of ordinary skill in the art were to conclude from Nelson's statements at paragraph [0092] that activated carbon treated with HBr or Br₂ outside the flue gas have similar mercury removal abilities, this would not lead to the conclusion that activated carbon treated with HBr outside the flue gas has better mercury removal abilities than activated carbon treated with HCl outside the flue gas.

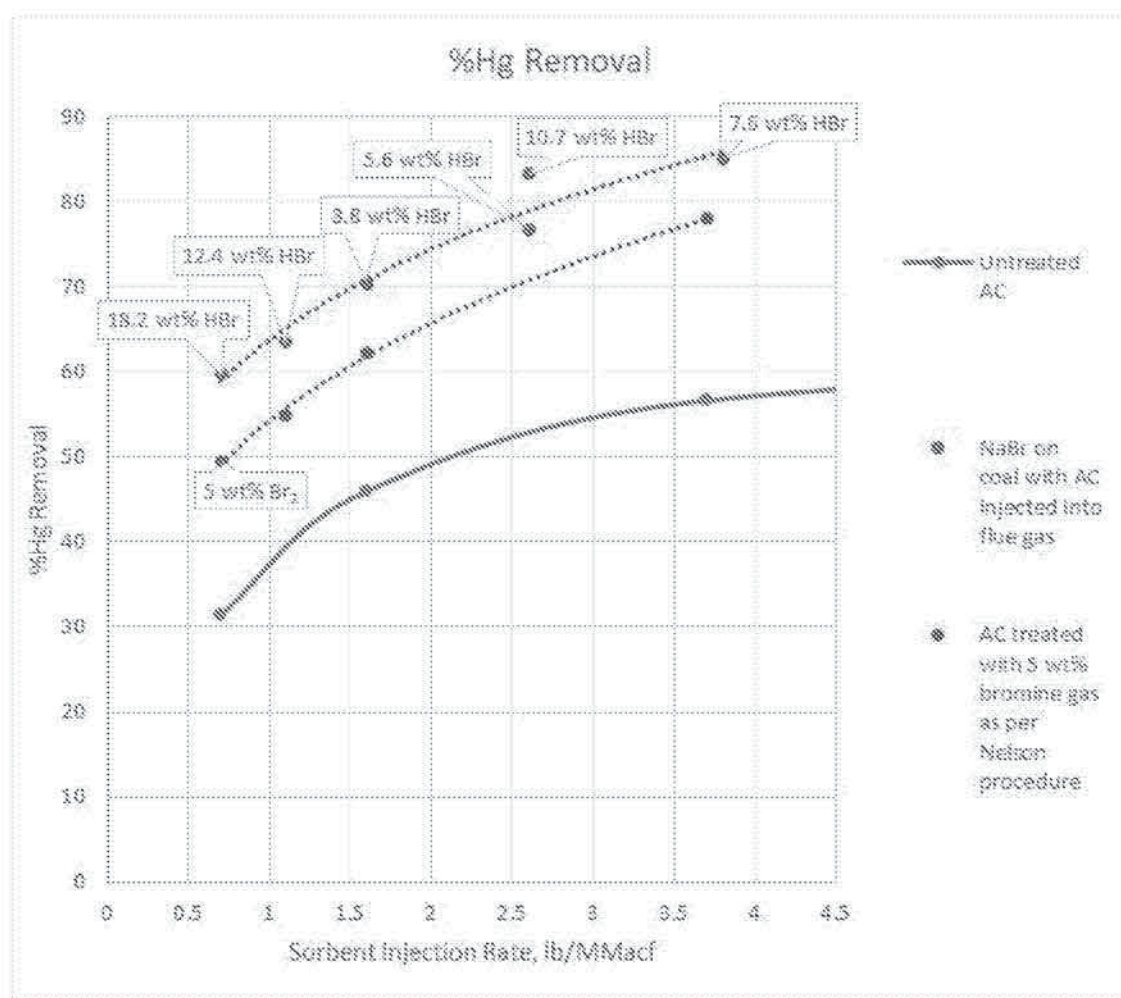
Nelson never directly compares the mercury-removal ability of HBr-treated activated carbon with HCl-treated activated carbon. With Nelson clearly indicating that HBr-treated activated carbon has inferior mercury-removal ability as compared to Br₂-treated activated carbon, and that HCl-treated activated carbon has superior mercury-removal ability as compared to Cl₂-treated activated carbon, there is no way that one of ordinary skill in the art hypothetically considering Nelson could conclude that HBr-treated activated carbon has equivalent or superior mercury-removal ability compared to HCl-treated activated carbon.

I(B). In-flight promotion versus treatment outside the flue gas.

I(B)(1). In-flight promotion with HBr or Br⁻ promoters is more effective for mercury removal than treating the sorbent with HBr, Br⁻, or Br₂ outside the mercury-containing gas.

The inventors of the present application have discovered that by combusting coal in the presence of a HBr or Br⁻ promoter, and by placing an activated carbon sorbent in the mercury-containing gas, as presently claimed, the activated carbon can be promoted by the promoter in-flight in the mercury-containing gas, and further, that in-flight HBr or Br⁻ promotion of the activated carbon is more effective for mercury removal than use of an activated carbon that is treated with HBr, Br⁻, or Br₂ outside the flue gas.

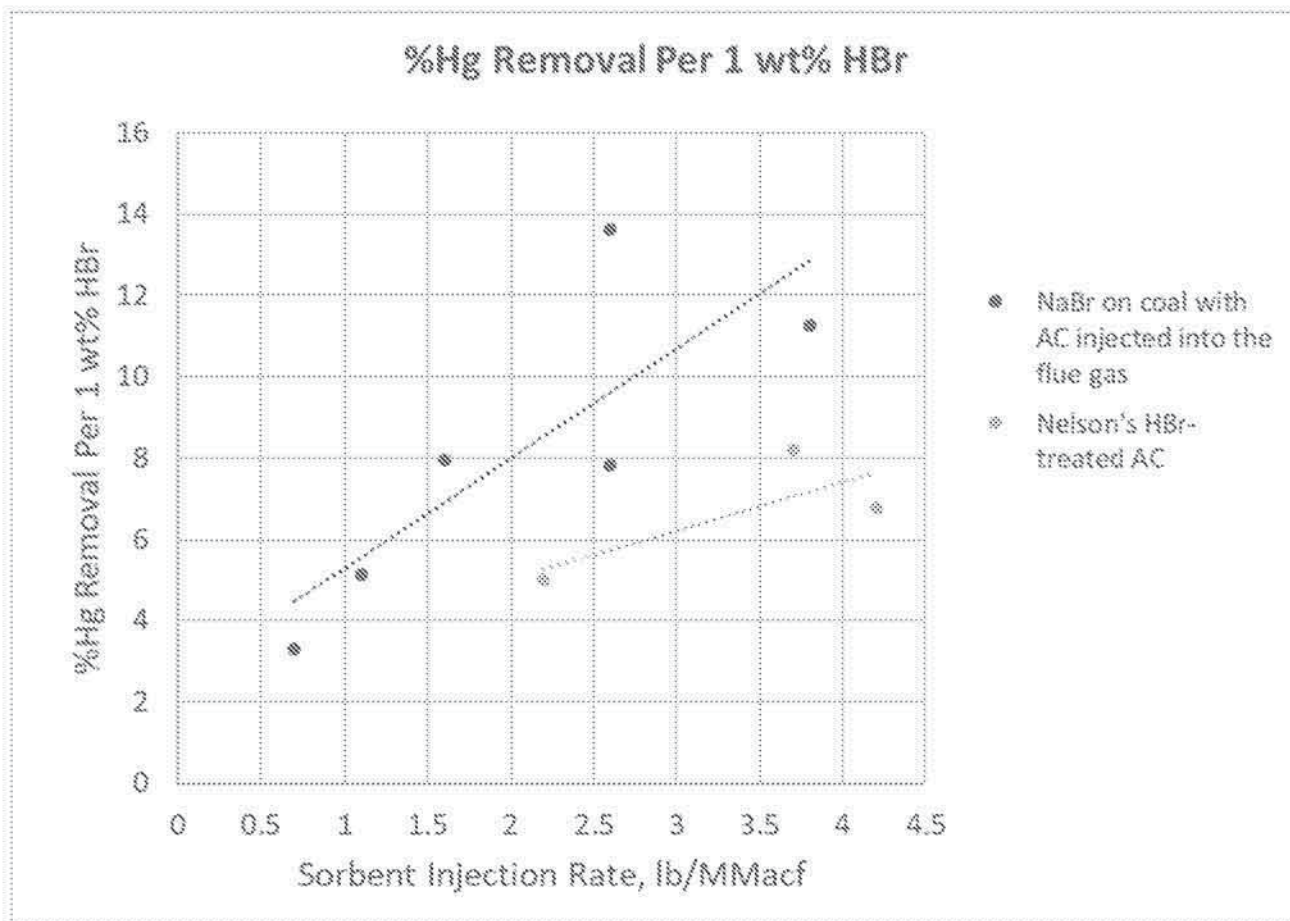
As explained in Declaration B, pilot-scale testing was performed with activated carbon alone (untreated) injected into the flue gas, the activated carbon treated with Br_2 outside the flue gas as per the Nelson procedure (see, Declaration B at item 7), and with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, Declaration B at items 8-11. The plot given in Declaration B at item 11 is reproduced below.



The data in the plot above from item 11 of Declaration B show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas (in-flight promotion with Br^*) provided a higher percent of mercury removal at all tested sorbent injection rates as compared to the activated carbon alone (untreated) and compared to the activated carbon treated with Br_2 outside the flue gas described herein at item 6 as per the Nelson procedure.

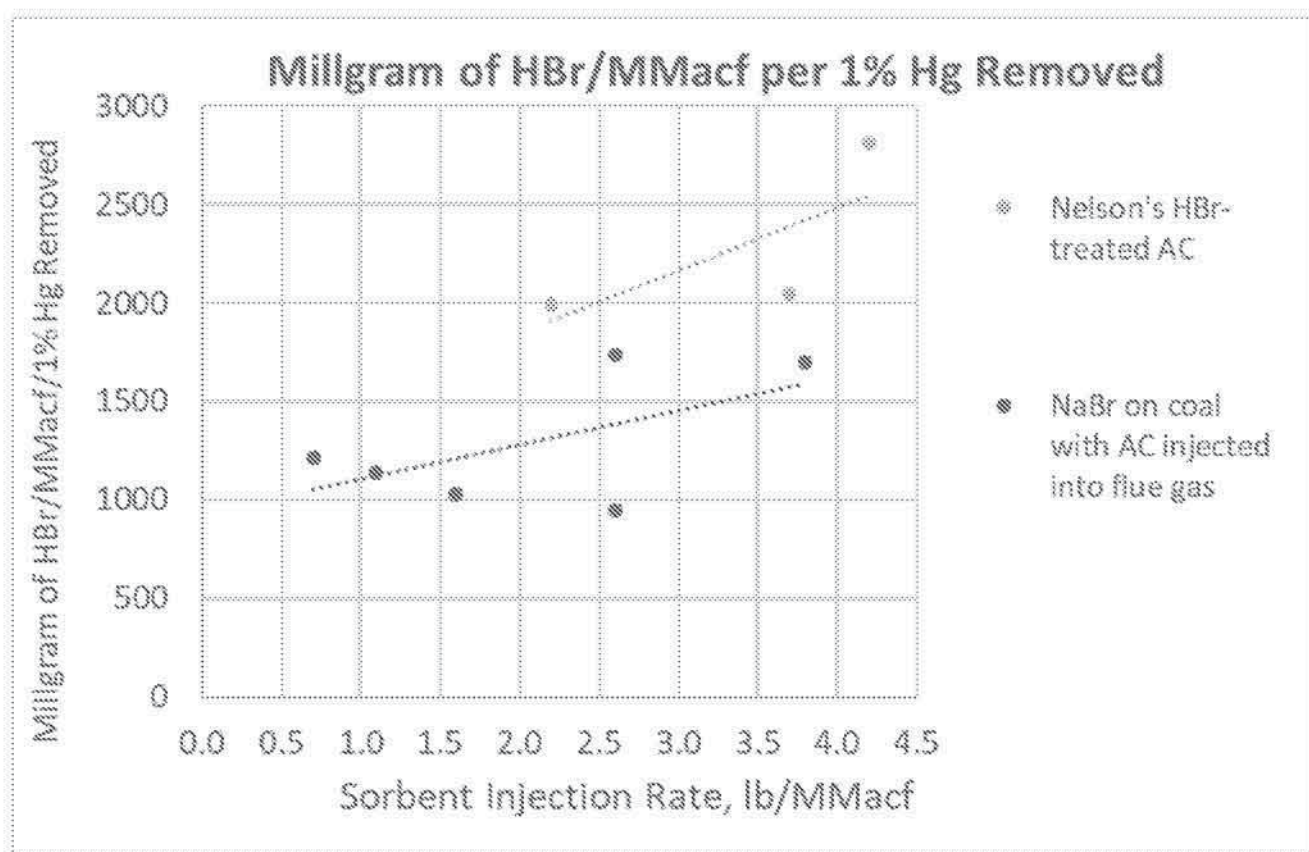
With NaBr added to the coal and activated carbon injected into the flue gas, there was a significant reduction in the amount of sorbent required to achieve similar mercury removal compared to the activated carbon treated with Br₂ outside the flue gas. For example, to achieve 70% mercury removal, 2.5 lb/MMacf of Br₂-treated carbon was required, as compared to 1.6 lb/MMacf with NaBr added to the coal and activated carbon injected into the flue gas; an additional $(2.5 - 1.6 / 1.6) * 100\%$ or 56% treated sorbent was required to achieve the same level of mercury removal. See, Declaration B at items 2-5 and 12.

The percent mercury removal per 1 wt% HBr versus the sorbent injection rate was compared with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas using the pilot-scale plant, and with Nelson's activated carbon treated with HBr outside the flue gas. The data for Nelson's activated carbon treated with HBr outside the flue gas was taken directly from Nelson. The first plot given in Declaration B at item 13 is reproduced below, but only showing the HBr data.



The data in the plot above, derived from the first plot at item 13 of Declaration B, show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly higher (about 2x) percent mercury removal per 1 wt% HBr at all tested sorbent injection rates as compared to Nelson's activated carbon treated with HBr outside the flue gas. See, Declaration B at item 14.

The data from the pilot-scale plant was also plotted to show the milligrams of HBr/MMacf per 1% mercury removal versus the sorbent injection rate with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for Nelson's activated carbon treated with HBr outside the flue gas. The second plot given in Declaration B at item 13 is reproduced below.



The data in the plot above, derived from the second plot at item 13 of Declaration B, show that NaBr added to coal prior to introduction to the furnace with injection of untreated activated

carbon into the flue gas provided a significantly lower milligrams of HBr/MMacf per 1% mercury removal at all tested sorbent injection rates as compared to Nelson's activated carbon treated with HBr outside the flue gas, indicating more efficient (approximately 2x) use of HBr for mercury removal during in-flight promotion of activated carbon than treatment of activated carbon outside the flue gas. See, Declaration B at item 14.

As explained at item 9 of Declaration D, Nelson's experimental setup in Examples 5 and 7 and the experimental setup described at item 8 of Declaration B inject activated carbon sorbent into a flue gas upstream of an ESP and use no scrubber, making the procedures comparable. However, the higher HCl concentration in Nelson's Example 7 flue gas allows for easier mercury removal, due to HCl acting as a promotor of the activated carbon, as compared to the pilot-scale setup described at item 8 of Declaration B. Further, the higher mercury concentration in Nelson's Example 5 makes it easier for Nelson's sorbents to remove the same overall percentage of mercury from the flue gas, as compared to the pilot-scale setup described at item 8 of Declaration B. Therefore, if Nelson's Example 5 and 7 HCl and mercury concentrations were changed to match those of the pilot-scale setup described at item 8 of Declaration B, Nelson's sorbents would remove a lower percentage of mercury than found in Nelson's Examples 5 and 7, meaning that Nelson's sorbents would exhibit an even lower (and less efficient) percent mercury removal per 1 wt% HBr at any sorbent injection rate than shown in the second plot above (derived from the first plot at item 13 of Declaration B), and would exhibit an even higher (and less efficient) milligrams of HBr/MMacf per 1% mercury removal at any sorbent injection rate than shown in the third plot above (derived from the second plot at item 13 of Declaration B).

I(B)(2). There is no way a person of ordinary skill in the art could predict that in-flight promotion of a sorbent with HBr or Br⁻ promoters is more effective for mercury removal than use of a sorbent that is treated with the same promoters outside the flue gas.

The M.P.E.P. at the beginning of § 2143.02 states (emphasis added) “[a] rationale to support a conclusion that a claim would have been obvious is that all the claimed elements were known in the prior art and one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, *and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art.*”

As admitted by the Office Action, Felsvang fails to describe or suggest HBr or Br⁻ promoters. Felsvang also fails to describe or suggest that treatment of an activated carbon with a HCl or Cl⁻ additive outside of flue gas has any advantages over in-flight promotion of an activated carbon with an HCl or Cl⁻ promoter. Further, as shown herein at **I(D)**, treatment of activated carbon outside the flue gas with HCl provides better mercury removal than in-flight promotion of activated carbon with HCl or Cl⁻. Therefore, a person of ordinary skill in the art hypothetically having Felsvang in-hand would have no clue that in-flight promotion of activated carbon with a halide could give the same or better percent mercury removal over halide treatment outside of the flue gas, and would be led away from Felsvang's process if they investigated the relative mercury removal of treatment of the activated carbon with HCl or Cl⁻ outside the flue gas versus in-flight treatment with HCl or Cl⁻ in the flue gas.

Nelson mentions treating activated carbon outside of flue gas, and then adding the activated carbon to flue gas. Nelson fails to describe or suggest in-flight promotion of an activated carbon with a halide in the flue gas. Therefore, a person of ordinary skill in the art hypothetically having Nelson in-hand would also have no idea that in-flight promotion of activated carbon with a halide could have any advantages over halide treatment outside of the flue gas.

There is no way to predict from the presently cited references the superior mercury capture discovered by the present inventors that occurs when activated carbon is promoted with HBr or Br⁻ promoters in-flight in the mercury-containing gas, as occurs when following the present claims. The Office Action states at the end of the second full paragraph on page 4 that Nelson's additives would be combined with Felsvang's process "...so as to provide an effective carbon sorbent for mercury." However, a person of ordinary skill in the art would have no idea that in-flight promotion with HBr or Br⁻ promoters could work better than Nelson's HBr-treatment outside the flue gas. Felsvang fails to describe or suggest that in-flight promotion provides a sorbent with even the same (let alone superior) properties as a sorbent treated outside the flue gas, and, as explained herein at **I(D)**, treatment of activated carbon outside the flue gas with HCl actually provides better mercury removal than in-flight promotion of activated carbon with HCl or Cl⁻; similarly, Nelson fails to describe in-flight promotion, let alone that in-flight promotion provides the same or superior mercury removal ability as compared to treatment outside the flue gas.

The only way that a person of ordinary skill in the art could discover that in-flight promotion of activated carbon with HBr or Br⁻ promoters is more effective for mercury removal than HBr treatment outside the flue gas would not be from the cited references alone; instead, the person of ordinary skill would need to actually modify Felsvang with Nelson as alleged, and then compare the mercury removal of Felsvang's modified process to Nelson's sorbent treated outside the flue gas.⁸ However, the person of ordinary skill carrying out such a combination would be surprised to find that in-flight promotion with HBr or Br⁻ is more effective for mercury removal than HBr treatment of the sorbent outside the flue gas. The process giving rise to these surprising results was discovered by the inventors of the present application. Surprising results are a hallmark of patentability; only by having the present application in-hand could such results be predicted, and a need to resort to hindsight analysis to predict the advantages of the combination asserted by the Office Action is indicative that the presently claimed invention is not obvious over the cited references. Accordingly, independent claims 27, 54, and 55 are patentable over Felsvang in view of Nelson for at least this additional reason.

II(B)(3). Reply to Examiner's response to arguments.

The Office Action states:

II(B)(1). The applicant contends that the bromide promoters are more effective for mercury removal than treating the sorbent with bromide or bromine additives outside the mercury-containing gas. The applicant further provides a graph to demonstrate these unexpected results.

⁸ In the event the Examiner intends to argue that such advantages are inherent in the cited art, Applicant notes that the claimed invention is not specifically disclosed in the prior art. The Examiner cannot reason inherency in a §103 context based on a mere proposed or hypothetical combination of features from cited references. Such reasoning would merely reflect the Examiner's reliance on impermissible hindsight. See, M.P.E.P. § 2112(IV).

These unexpected results are not commensurate with the scope of the claims. The applicant is claiming HBr and Br⁻ while the graph only demonstrates HBr. Further the comparisons between the prior art and that of the current invention do not demonstrate unexpected results. The applicant's data is unclear as it is either HBr (as specified in the actual graph) or NaBr (as specified in the legend). Further the 18.2 data point has no labeling on what the promoter is. None of the data point include what amount is being specified, wt%, vol% etc. The results would be expected by one having ordinary skill in the art as the wt% (if we are to assume the amount specified is wt%) of the amount supported on the upper most line is greater than that of the wt% on the middle trending line. Further claim 1 does not include NaBr on coal. Lastly it is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods.

As explained in Declaration C at item 28, when NaBr is added to coal, gaseous NaBr is formed in the flue gas, and HBr is formed in the flue gas. As explained in Declaration C at item 33, NaBr is a salt that includes Na⁺ and Br⁻. Therefore, placing NaBr on the coal (as specified in the legend of the plot given at item 11 of Declaration B) results in formation of HBr and Br⁻ in the flue gas (as specified in the graph), and the results shown are commensurate with the scope of the claims. In the graphs in Declaration B all halides in the flue gas formed from halide salts placed on the coal are assumed to be in the form of the respective hydrogen halide for comparative purposes, although these could be in the form of the gaseous halide salt or the hydrogen halide—this assumption is made for consistency across all the graphs in Declaration B. As the graphs show trends between %Hg removal and halide content of the flue gas, so long as the amounts of the different halides present in the flue gas are compared in a consistent way it does not matter whether they are in the form of the hydrogen halide or the halide ion in the flue gas for purposes of comparing relative %Hg removal.

The data table at item 10 of Declaration B shows that the 18.2 data point of the plot shown at item 11 corresponds to 18.2 wt% HBr, and that all of the labels on the data set “NaBr on coal with AC injected into flue gas” indicate wt% HBr. Additionally, for increased clarity, Declaration B is revised to indicate wt% and properly labels the 18.2 data point in the plot shown at item 11.

The Office Action states that the results would be expected by one having ordinary skill in the art because the amount of HBr on the upper line, representing NaBr on coal with AC injected into the flue gas, are greater than the wt% of the middle trending line, representing AC treated with

5 wt% bromine outside the flue gas as per the Nelson procedure. Applicant does not agree that the results are not unexpected. The unexpected results described in the Response are that in-flight promotion of a sorbent with HBr or Br⁻ promoters is more effective for mercury removal than use of a sorbent that is treated with the same promoters outside the flue gas (as explained herein at I(B), using the first and second plots from item 13 of Declaration B), and that in-flight promotion with HBr or Br⁻ promoters is more effective for mercury removal than in-flight promotion with HCl or Cl⁻ promoters (as explained herein at I(C)). Applicant included the plot at item 11 primarily to show that adding NaBr to coal and injecting untreated AC into the flue gas is an effective way to remove mercury.

The Office Action states that it is not clear whether the results are because of different components being reacted or because of the different method being used. However, all of the data shown in the plot at item 11 of Declaration B is shown in the tables at items 9 and 10 of Declaration B, which is all derived from the same pilot-scale test unit described at item 8 of Declaration B, using the same components, the same type of AC, and the same method, with the only variations between the data sets being the type of treatment of the AC (i.e., no treatment, treatment with Br₂ outside the flue gas prior to injection, and adding NaBr to coal while injecting untreated AC into the flue gas); item 11 of Declaration B has been revised to clarify this point.

The Office Action states:

The second graph on page 14 comparing NaBr on coal to HBr treated AC and it is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods. To do that the graph would have to be comparing HBr in the present method to HBr in the prior art method. Further the applicant has not shown the amount of promoter supported by each (wt%) data point. Lastly claim 1 does not include NaBr on coal.

The second graph on page 12 of the last Response was the first graph from item 13 of Declaration B. The Office Action states that the components used must be the same for both methods, such that the graph compares HBr in the present method to HBr in the prior art method. However, as explained in Declaration C at item 28, when NaBr is added to coal, gaseous NaBr is formed in the flue gas, and HBr is formed in the flue gas. As explained in Declaration C at item 33, NaBr is a salt that includes Na⁺ and Br⁻. Therefore, placing NaBr on the coal results in formation of

HBr and Br⁻ in the flue gas. All of the NaBr is assumed to be converted to HBr in the graph, such that the components being compared are the same for both methods.

Although the data set “NaBr on coal with AC injected into flue gas” is shown in the table in item 10 and is derived from the pilot-scale test unit described at item 8 of Declaration B, while the data set “Nelson’s HBr-treated AC” is from Nelson, as explained at item 9 of Declaration D and at I(B)(1) herein, data from Nelson’s experimental setup and from the pilot-scale unit of item 8 of Declaration B are validly comparable—further, Nelson’s conditions used in Examples 5 and 7 allow for easier mercury removal than in the pilot-scale unit of item 8 of Declaration B, such that if Nelson’s Example 5 and 7 HCl and mercury concentrations were changed to match those of the pilot-scale setup described at item 8 of Declaration B, Nelson’s sorbents would remove a lower percentage of mercury than found in Nelson’s Examples 5 and 7.

The Office Action states that “the application has not shown the amount of promoter supported by each (wt%) data point.” However, the y-axis indicates the percent mercury removal per 1 wt% HBr; therefore, the wt% promoter data is part of what is shown on the graph. Further, the table at item 10 indicates the specific amount of HBr for each data point.

The Office Action states:

The third graph on page 15 compares HBr treated AC and NaBr on coal with AC injected into flue gas. The graph states Milligram of HBr/MMacf/1%Hg Removed. As HBr is not a part of the current application data points it is unclear how to interpret this graph. Claim 1 does not include NaBr on coal. Further is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results, the components used must be the same for both methods.

The third graph on page 13 of the last Response was the second graph from item 13 of Declaration B. The Office Action states that HBr is not a part of the current application data points, and that the claims do not include NaBr on coal. However, as explained in Declaration C at item 28, when NaBr is added to coal, gaseous NaBr is formed in the flue gas, and HBr is formed in the flue gas. As explained in Declaration C at item 33, NaBr is a salt that includes Na⁺ and Br⁻. Therefore, placing NaBr on the coal results in formation of HBr and Br⁻ in the flue gas. All of the NaBr is assumed to be converted to HBr in the graph, such that the components being compared are the same for both methods.

Although the data set “NaBr on coal with AC injected into flue gas” is shown in the table in item 10 and is derived from the pilot-scale test unit described at item 8 of Declaration B, while the data set “Nelson’s HBr-treated AC” is from Nelson, as explained at item 9 of Declaration D and at I(B)(1) herein, data from Nelson’s experimental setup and from the pilot-scale unit of item 8 of Declaration B are validly comparable—further, Nelson’s conditions used in Examples 5 and 7 allow for easier mercury removal than in the pilot-scale unit of item 8 of Declaration B, such that if Nelson’s Example 5 and 7 HCl and mercury concentrations were changed to match those of the pilot-scale setup described at item 8 of Declaration B, Nelson’s sorbents would remove a lower percentage of mercury than found in Nelson’s Examples 5 and 7.

The Office Action states:

I(B)(2). The applicant contends that there is no way a person of ordinary skill in the art could predict from the cited references that in-flight promotion of a sorbent with bromide promoters is more effective for mercury removal.

The examiner contends that the applicant has not established that it is more effective.

Applicant respectfully disagrees. As explained above, the data does provide evidence that in-flight promotion of a sorbent with HBr or Br⁻ promoters is more effective for mercury removal than use of a sorbent that is treated with the same promoters outside the flue gas.

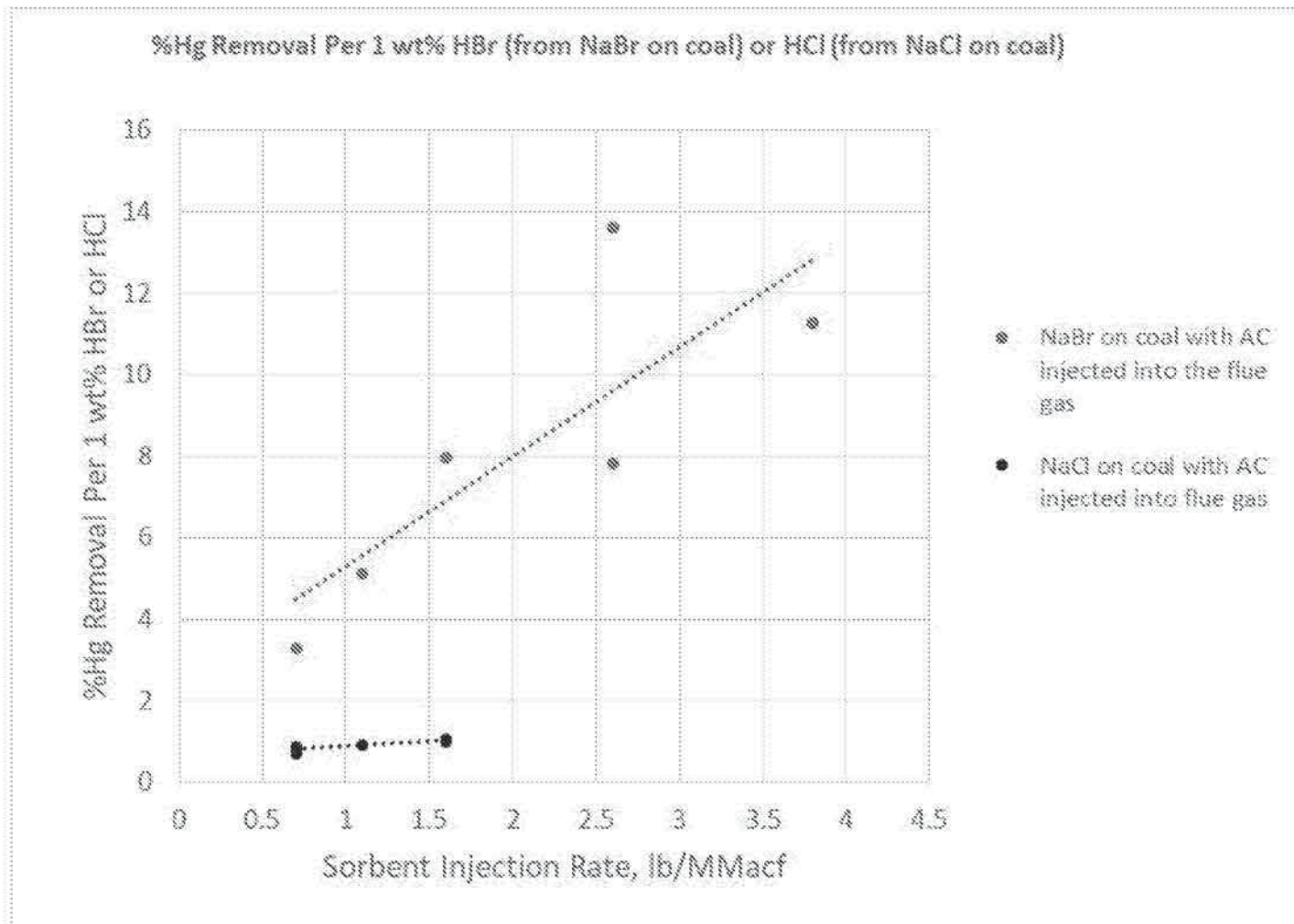
I(C). In-flight promotion with HBr or Br⁻ versus HCl or Cl⁻.

I(C)(1). In-flight promotion with HBr or Br⁻ promoters is more effective for mercury removal than in-flight promotion with HCl or Cl⁻ promoters.

The inventors of the present application have discovered that that in-flight HBr or Br⁻ promotion of an activated carbon in a mercury-containing flue gas is significantly more effective for mercury removal than in-flight HCl or Cl⁻ promotion of an activated carbon.

As explained in Declaration B, pilot-scale testing was performed with NaBr or NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, Declaration B at items 8-10. The

first plot given in Declaration B at item 13 is reproduced below, but not showing the data from Nelson's HBr-treated AC.



The data in the plot above, derived from the first plot at item 13 of Declaration B, show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly higher (about 6-8x) percent mercury removal per 1 wt% HBr or HCl at all tested sorbent injection rates compared to the NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. See, Declaration B at item 14.

I(C)(2). There would be no way for a person of ordinary skill in the art to predict this advantage from the from the cited references.

As explained herein at **I(A)(2)(d)**, Nelson fails to describe or suggest that treatment of activated carbon with HBr or Br⁻ could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to Felsvang.

The only way that a person of ordinary skill in the art could discover that in-flight promotion with HBr or Br⁻ promoters is more effective for mercury removal than in-flight promotion with HCl or Cl⁻ promoters would not be from the cited references alone; instead, the person of ordinary skill would need to actually modify Felsvang with Nelson as alleged, and then to compare the mercury removal of Felsvang's modified process to Felsvang's original process.⁹ However, the person of ordinary skill carrying out such a combination would be surprised to find that promotion of activated carbon with HBr or Br⁻ could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to Felsvang. The process giving rise to these surprising results was discovered by the inventors of the present application. Surprising results are a hallmark of patentability; only by having the present application in-hand could such results be predicted, and a need to resort to hindsight analysis to predict the advantages of the combination asserted by the Office Action is indicative that the presently claimed invention is not obvious over the cited references. Accordingly, independent claims 27, 54, and 55 are patentable over Felsvang in view of Nelson for at least this additional reason.

I(C)(3). Reply to Examiner's response to arguments.

The Office Action states:

⁹ In the event the Examiner intends to argue that such advantages are inherent in the cited art, Applicant notes that the claimed invention is not specifically disclosed in the prior art. The Examiner cannot reason inherency in a §103 context based on a mere proposed or hypothetical combination of features from cited references. Such reasoning would merely reflect the Examiner's reliance on impermissible hindsight. See, M.P.E.P. § 2112(IV).

I(C)(1). The applicant contends that one having ordinary skill in the art would not have predicted in-flight chloride promotion of activated carbon to be more effective for mercury removal than in-flight chloride promotion.

The examiner disagrees. Nelson discloses that bromide is a better promoter of AC for the purpose of mercury removal as shown above. Therefore one having ordinary skill in the art would expect an in-flight bromide promoted sorbent to be superior to an in-flight chloride promoted sorbent.

I(C)(2). The applicant argues that one having ordinary skill in the art would not predict this advantage from the cited references.

The examiner disagrees for the reasons stated above.

However, as explained herein at I(A)(2)(d) and I(A)(3), Nelson fails to describe or suggest that HBr-treatment of activated carbon provides better mercury removal ability than HCl-treated activated carbon; therefore, there is no way one of ordinary skill in the art could reasonably predict from Felsvang and Nelson that treatment of activated carbon with HBr or Br⁻ could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to Felsvang.

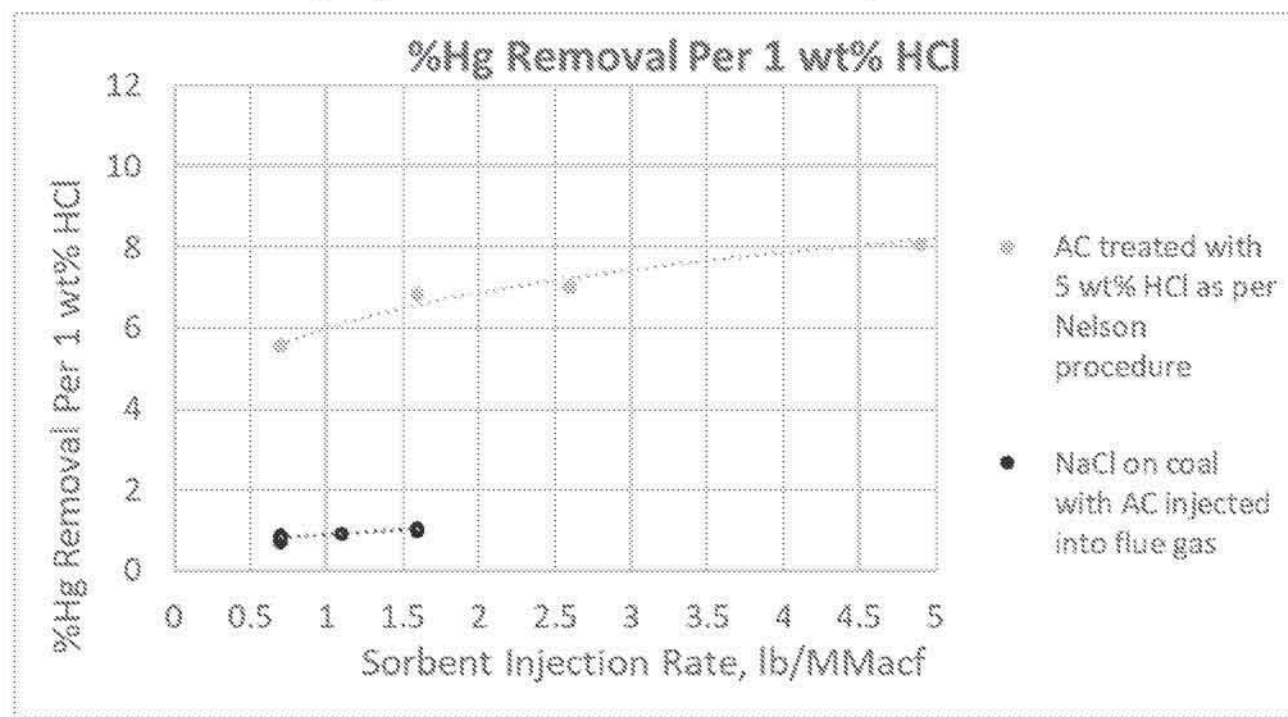
I(D). A person of ordinary skill in the art would find that treatment of activated carbon outside the flue gas with HCl as per Nelson's process actually provides more effective mercury removal per wt% HCl than treatment of activated carbon with HCl or Cl⁻ in the flue gas.

I(D)(1). Even if a person of ordinary skill in the art compared the mercury removal of Felsvang to activated carbons treated with HCl outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties per wt% HCl.

As explained herein at I(A)(2)(c), Felsvang fails to describe or suggest that in-flight promotion of activated carbon with HCl or Cl⁻ in the flue gas provides better mercury removal than treatment of activated carbon outside the flue gas with HCl. A person of ordinary skill would notice the extremely poor improvement (if any improvement actually occurred) caused by addition of activated carbon in Felsvang's sole Example showing the use of activated carbon (Example 4) (see I(A)(2)(c) herein) and would question whether Felsvang's process is an efficient way to use

activated carbon for mercury removal as compared to Nelson's process. Merely for the sake of argument, if one of ordinary skill in the art were to investigate Felsvang's embodiments including activated carbon and compare the relative mercury-removal ability to that of activated carbon treated with HCl outside the flue gas, as explained below, they would find that treatment of activated carbon outside the flue gas with HCl as per Nelson's process actually provides more effective mercury removal per wt% HCl than treatment of activated carbon with HCl or Cl^- in the flue gas, which would lead one of ordinary skill in the art away from using Felsvang's process.

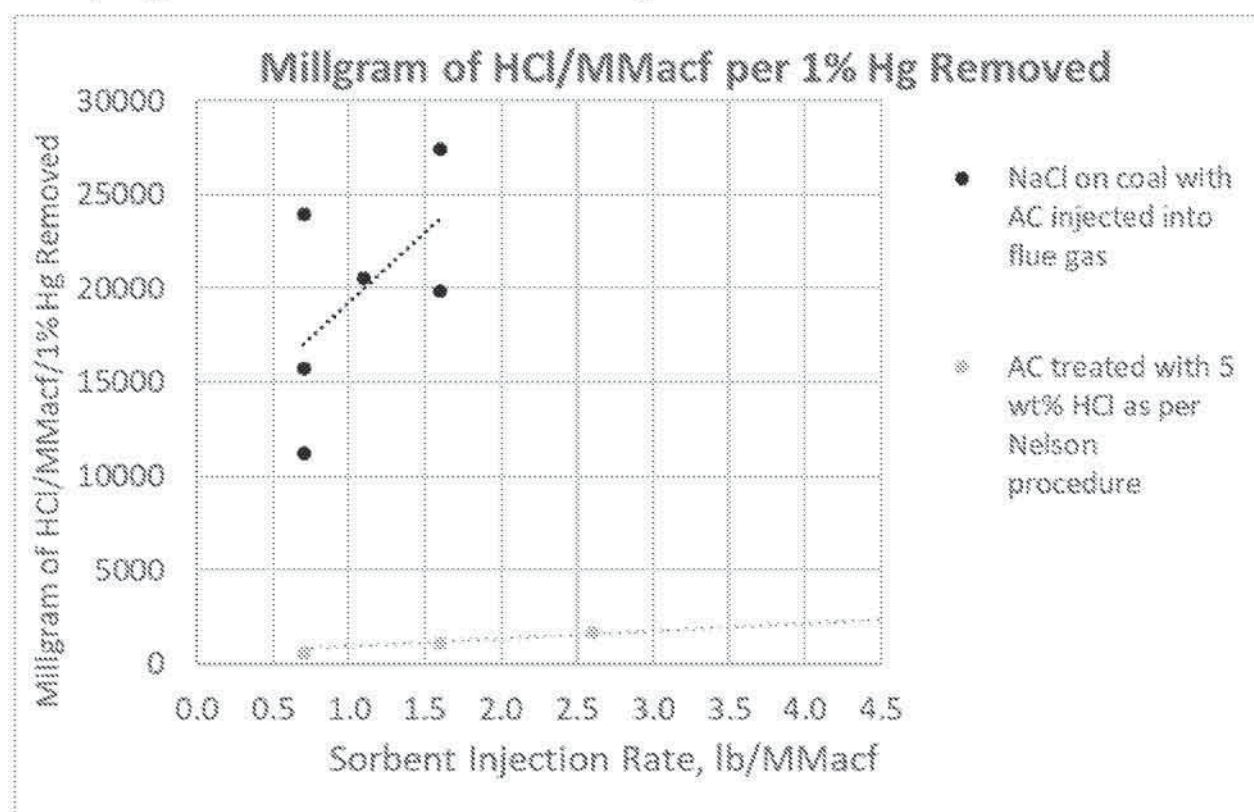
As explained in Declaration B, pilot-scale testing was performed with activated carbon treated with HCl outside the flue gas as per the Nelson procedure (see, Declaration B at item 7), and with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, Declaration B at items 8-10. The first plot given in Declaration B at item 15 is reproduced below.



The data in the plot above from the item 15 of the Declaration B show that activated carbon treated with HCl outside the flue gas as per the Nelson procedure provided a much higher percent of mercury removal per 1 wt% HCl at all tested sorbent injection rates as compared to NaCl added to

coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. See, Declaration B at item 16.

The pilot-scale data was also plotted to show the milligrams of HCl/MMacf per 1% mercury removal versus the sorbent injection rate with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure. The second plot given in Declaration B at item 15 is reproduced below.



The data in the second plot above from item 15 of Declaration B show that the milligrams of HCl/MMacf per 1% mercury removal versus the sorbent injection rate with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas was significantly higher as compared to the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure, indicating more efficient use of HCl for mercury removal by treatment of activated carbon outside the flue gas than by promotion in-flight.

I(D)(2). Reply to response to arguments.

The Office Action states:

I(D)(2). The applicant contends that "Even if a person of ordinary skill in the art compared the mercury removal of Felsvang's activated carbons promoted with Chloride in the flue gas to activated carbon treated with HCl outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties".

This appears to be merely conjecture by the applicant as no factual evidence has been presented.

The graphs on pages 20 and 22, has NaCl compared to HCl. It is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods. Further the examiner points to the y-axis which has HCl which is not included in one set (NaCl) of the data points so it is unclear how the data points are being obtained.

The Office Action states that Applicant's contention that a person of ordinary skill in the art comparing Felsvang's process to treatment of activated carbon with HCl outside the flue gas would find that in-flight promotion provides less mercury removal is conjecture and is unsupported by factual evidence. However, Applicant's contention is not conjecture and is supported by data provided in Declaration B, as described herein at **I(D)(1)**; therefore, Applicant does not understand this statement of the Office Action.

The Office Action states that the graphs have NaCl compared to HCl, and that the y-axis has HCl which is not included in one set (NaCl) of the data points so it is unclear how the data points are being obtained. However, as explained in Declaration C at item 28, when NaCl is added to coal, gaseous NaCl is formed in the flue gas, and HCl is formed in the flue gas. NaCl is a salt that includes Na^+ and Cl^- . Therefore, placing NaCl on the coal results in formation of HCl and Cl^- in the flue gas. In the graphs in Declaration B all halides in the flue gas formed from halide salts placed on the coal are assumed to be in the form of the respective hydrogen halide for comparative purposes, although these could be in the form of the gaseous halide salt or the hydrogen halide—this assumption is made for consistency across all the graphs in Declaration B. As the graphs show trends between %Hg removal and halide content of the flue gas, so long as the amounts of the different halides present in the flue gas are compared in a consistent way it does not matter whether

they are in the form of the hydrogen halide or the halide ion in the flue gas for purposes of comparing relative %Hg removal.

The Office Action states that in order to establish that the method being used has unexpected results the components used must be the same for both methods. However, the data sets in the first and second plots at item 15 of Declaration B were taken from the table at item 10, which was produced using the same pilot-scale setup described at item 8, using the same components, the same type of AC, and the same method, with the only variations between the data sets being the type of treatment of the AC (i.e., AC treated with 5 wt% HCl outside the flue gas prior to injection into the flue gas, or placing NaCl on the coal and injection of untreated AC into the flue gas); item 15 of Declaration B has been revised to clarify this point.

I(E). Objective evidence of non-obviousness of the claimed invention.

Applicant herein discusses objective evidence of nonobviousness presented in Declaration

A. The M.P.E.P. at §716.01(a) states that:

Affidavits or declarations, when timely presented, containing evidence of criticality or unexpected results, commercial success, long-felt but unsolved needs, failure of others, skepticism of experts, etc., must be considered by the examiner in determining the issue of obviousness of claims for patentability under 35 U.S.C. 103.

The M.P.E.P. at §716.01(d) states that:

When an applicant timely submits evidence traversing a rejection, the examiner must reconsider the patentability of the claimed invention. The ultimate determination of patentability must be based on consideration of the entire record, by a preponderance of evidence, with due consideration to the persuasiveness of any arguments and any secondary evidence.

As explained in Declaration A at items 1-6, before the priority date of the presently claimed invention, the EPA called for new mercury removal technology in the 1990s, evidencing recognition of a problem and long-felt but unsolved needs that the presently claimed invention provides a solution for.

As explained in Declaration A at items 7-8, before the priority date of the presently claimed invention, the EPA espoused the conventional wisdom in favor of pre-treated sorbents, not in-flight

sorbent enhancement in the flue gas, evidencing a teaching away from the presently claimed invention by others.

As explained in Declaration A at items 9-11, before the priority date of the presently claimed invention, Sidney Nelson touted brominated sorbent, not in-flight sorbent enhancement in the flue gas, evidencing a teaching away from the presently claimed invention by others.

As explained in Declaration A at items 12-13, after the priority date of the presently claimed invention, the EPA continued to teach away from in-flight sorbent enhancement in the flue gas, evidencing a teaching away from the presently claimed invention by others and skepticism by experts that the presently claimed invention could provide effective and efficient mercury control.

As explained in Declaration A at items 14-15, before the priority date of the presently claimed invention, the Department of Energy funded research into in-flight sorbent enhancement in the flue gas, evidencing recognition of a problem and long-felt but unsolved needs that the presently claimed invention provides a solution for.

As explained in Declaration A at item 16, after the priority date of the presently claimed invention, in-flight sorbent enhancement in the flue gas was finally recognized as a critical advancement, evidencing praise by others for the presently claimed invention.

As explained in Declaration A at items 17-19, after the priority date of the presently claimed invention, in-flight sorbent enhancement in the flue gas experienced commercial success and was copied by Sidney Nelson and other competitors, evidencing copying of the presently claimed invention by others.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 1-3, 5-8, 14, and 21-26 under 35 U.S.C. § 103(a) over Felsvang in view of Nelson.

II. The Office Action rejected claim 4 under 35 U.S.C. § 103(a) over U.S. patent no. 5,435,980 ("Felsvang") in view of U.S. patent publication no. 2004/0003716 ("Nelson") and U.S. patent no. 6,848,374 ("Srinivasachar").

This rejection is respectfully traversed.

Claim 4 is presently canceled.

Further, as explained herein at **I**, independent claims 27, 54, and 55 are patentable over Felsvang and Nelson. Srinivasachar mentions treating activated carbon with halide salts or halogen acids prior to placing the activated carbon into flue gas. See, col. 6. lines 2-20. However, like Nelson, Srinivasachar fails to describe or suggest promotion of activated carbon in flue gas, and also fails to describe or suggest that HBr or Br⁻ have the same or greater effectiveness for mercury removal when used to treat activated carbons than chlorides. Accordingly, there would be no motivation for a person of ordinary skill in the art to use Srinivasachar's bromide additives in Felsvang's process. Further, there is no way to determine from Srinivasachar that in-flight promotion with bromide promoters is more effective for mercury removal than treating the sorbent with bromide or bromine additives outside the mercury-containing gas (as explained herein at **I(B)(1)**), or that in-flight promotion with bromide promoters is more effective for mercury removal than in-flight promotion with chloride-promoters (as explained herein at **I(C)(1)**). Additionally, even if a person of ordinary skill in the art compared the mercury removal of Felsvang's activated carbons promoted with chloride in the flue gas to activated carbons treated with HCl outside of the flue gas as used in Nelson and Srinivasachar, they would not determine that in-flight promotion provides the same or better mercury removal properties, as explained herein at **I(D)**. As such, Srinivasachar fails to remedy the deficiencies of Felsvang and Nelson. Therefore, claims 27, 54, and 55 are patentable over Felsvang in view of Nelson and Srinivasachar.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claim 4 under 35 U.S.C. § 103(a) over Felsvang in view of Nelson and Srinivasachar.

III. The Office Action rejected claim 9 under 35 U.S.C. § 103(a) over U.S. patent no. 5,435,980 ("Felsvang") in view of U.S. patent publication no. 2004/0003716 ("Nelson") and U.S. patent no. 6,848,374 ("Srinivasachar").

This rejection is respectfully traversed.

Claim 9 is presently canceled.

Further, as explained herein at **I**, claims 27, 54, and 55 are patentable over Felsvang and Nelson. As explained herein at **II**, Srinivasachar fails to remedy the deficiencies of Felsvang and Nelson. Therefore, claims 27, 54, and 55 are patentable over Felsvang in view of Nelson and Srinivasachar.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claim 9 under 35 U.S.C. § 103(a) over Felsvang in view of Nelson and Srinivasachar.

IV. The Office Action rejected claim 10 under 35 U.S.C. § 103(a) over U.S. patent no. 5,435,980 ("Felsvang") in view of U.S. patent publication no. 2004/0003716 ("Nelson") and U.S. patent no. 6,136,749 ("Gadkaree").

This rejection is respectfully traversed.

Claim 10 is presently canceled.

Further, as explained herein at **I**, claims 27, 54, and 55 are patentable over Felsvang and Nelson. Gadkaree mentions forming activated carbons in the presence of an alkali metal halide co-catalyst, see, claims 1 and 10. Gadkaree's Examples use KI or SnCl₂, and Gadkaree fails to describe or suggest relative mercury removal activities of activated carbons treated with bromide versus other halide additives. Gadkaree fails to describe or suggest promotion of activated carbon in flue gas, and does not even specifically mention bromide or bromine additives. Therefore, like Nelson, Gadkaree also fails to describe or suggest that HBr or Br⁻ have the same or greater effectiveness for mercury removal when used to treat activated carbons than chlorides. Accordingly, Gadkaree fails to remedy the deficiency of Nelson and Felsvang explained herein at **I(A)** that there would be no motivation for a person of ordinary skill in the art to use Nelson's bromide additives in Felsvang's process. Further, there is no way to determine from Gadkaree that in-flight promotion with bromide promoters is more effective for mercury removal than treating the sorbent with bromide or bromine additives outside the mercury-containing gas (as explained herein at **I(B)(1)**), or that in-flight promotion with bromide promoters is more effective for mercury removal than in-flight promotion with chloride-promoters (as explained herein at **I(C)(1)**). Additionally, Gadkaree fails to remedy the deficiency of Nelson and Felsvang explained herein at **I(A)** that even if a person of ordinary skill in the art compared the mercury removal of Felsvang's activated carbons promoted with chloride in the flue gas to activated carbons treated with HCl outside of the flue gas as used in Nelson, they would not determine that in-flight promotion provides the same or better mercury removal properties. As such, Gadkaree fails to remedy the deficiencies of Felsvang and Nelson. Therefore, claims 27, 54, and 55 are patentable over Felsvang in view of Nelson and Gadkaree.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claim 10 under 35 U.S.C. § 103(a) over Felsvang in view of Nelson and Gadkaree.

Double Patenting Rejection

V. Double patenting rejections.

V(A). The Office Action rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 7,435,286 in view of U.S. patent no. 5,435,980 ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-30 of U.S. patent no. 7,435,286 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(B). The Office Action rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-25 of U.S. patent no. 8,168,147 in view of U.S. patent no. 5,435,980 ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-25 of U.S. patent no. 8,168,147 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(C). The Office Action rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-60 of U.S. patent no. 8,512,655 in view of U.S. patent no. 5,435,980 ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-60 of U.S. patent no. 8,512,655 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(D). The Office Action rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-60 of U.S. patent no. 8,821,819 in view of U.S. patent no. 5,435,980 ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-60 of U.S. patent no. 8,821,819 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(E). The Office Action rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-33 of U.S. patent no. 9,757,689 in view of U.S. patent no. 5,435,980 ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-33 of U.S. patent no. 9,757,689 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(F). The Office Action rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-20 of U.S. patent no. 9,468,886 in view of U.S. patent no. 5,435,980 ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-20 of U.S. patent no. 9,468,886 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(G). The Office Action rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 8,652,235 in view of U.S. patent no. 5,435,980 ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-30 of U.S. patent no. 8,652,235 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(H). The Office Action provisionally rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/295,594 in view of ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-16 of copending application no. 15/295,594 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(I). The Office Action provisionally rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 8-20 of copending application no. 15/589,359.

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 8-20 of copending application no. 15/589,359.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(J). The Office Action provisionally rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/853,029 in view of ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-20 of copending application no. 15/853,029 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(K). The Office Action provisionally rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 14/712,558.

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-20 of copending application no. 14/712,558.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(L). The Office Action provisionally rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/951,970.

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-20 of copending application no. 15/951,970.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(M). The Office Action provisionally rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/382,114 in view of ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-20 of copending application no. 15/382,114 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(N). The Office Action provisionally rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/853,029 in view of ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-20 of copending application no. 15/853,029 in view of Felsvang and Nelson. This rejection appears to be a duplicate of the rejection listed herein at V(J).

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(O). The Office Action provisionally rejected claims 1-10, 14, and 21-26 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/978,760 in view of ("Felsvang") and U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed. Applicant does not admit that claims 1-10, 14, and 21-26 are obvious over claims 1-20 of copending application no. 15/978,760 in view of Felsvang and Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

CONCLUSION

It is respectfully submitted that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone the undersigned at (612) 349-9580 to facilitate prosecution of this application.

If necessary, please charge any additional fees or deficiencies, or credit any overpayments to Deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402-0938
(612) 373-6900

Date July 10, 2019

By 

Nicholas P. Lanzatella
Reg. No. 63,803

IN THE CLAIMS

Please amend the claims as follows:

1-26. (Canceled)

27. (New) A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, to provide the mercury-containing gas, wherein the coal comprises added Br₂, HBr, a bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber, or

the combustion chamber comprises added Br₂, HBr, a bromide compound, or a combination thereof, or

a combination thereof;

injecting a sorbent comprising activated carbon into the mercury-containing gas downstream of the combustion chamber;

contacting mercury in the mercury-containing gas with the sorbent; and

separating the sorbent contacted with the mercury from the mercury-containing gas.

28. (New) The method of claim 27, wherein the coal comprises the added Br₂, HBr, the bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber.

29. (New) The method of claim 27, wherein the combustion chamber comprises the added Br₂, HBr, the bromide compound, or a combination thereof.

30. (New) The method of claim 27, wherein the coal is combusted in the combustion chamber at a coal-combustion facility, wherein the Br₂, HBr, bromide compound, or combination thereof, is added to the coal before the coal enters the combustion chamber, wherein the addition of the Br₂, HBr, bromide compound, or combination thereof, to the coal is performed at the coal-combustion facility.

31. (New) The method of claim 27, wherein the coal is combusted in the combustion chamber at a coal-combustion facility, wherein the Br₂, HBr, bromide compound, or combination thereof, is added to the coal before the coal enters the combustion chamber, wherein the addition of the Br₂, HBr, bromide compound, or combination thereof, to the coal is performed at a site other than the coal-combustion facility.
32. (New) The method of claim 27, wherein the combustion chamber is an electric utility coal combustion chamber.
33. (New) The method of claim 27, wherein the combustion chamber is a coal combustion furnace.
34. (New) The method of claim 27, wherein the coal comprises a subbituminous coal.
35. (New) The method of claim 27, wherein the coal comprises a lignite coal.
36. (New) The method of claim 27, further comprising
measuring the mercury content of the mercury-containing gas; and
modifying, in response to the measured mercury content of the mercury-containing gas,
an injection rate of injecting the sorbent into the mercury-containing gas,
an amount of the Br₂, HBr, the bromide compound, or a combination thereof, added
to the coal or the combustion chamber, or
a combination thereof.
37. (New) The method of claim 36, wherein the measuring of the mercury content comprises continuous measurement.
38. (New) The method of claim 27, further comprising:
modifying, in response to a measured mercury content,
an injection rate of injecting the sorbent into the mercury-containing gas,

an amount of the Br₂, HBr, the bromide compound, or a combination thereof, added to the coal or the combustion chamber, or

a combination thereof.

39. (New) The method of claim 27, wherein the mercury-containing gas comprises about 1 g to about 30 g of the element bromine per 100 g of the sorbent.

40. (New) The method of claim 27, wherein the sorbent contacted with the mercury comprises the element bromine and mercury.

41. (New) The method of claim 27, comprising removing greater than 70 wt% of the mercury in the mercury-containing gas.

42. (New) The method of claim 27, comprising removing greater than 70 wt% of the mercury in the mercury-containing gas with the sorbent.

43. (New) The method of claim 27, wherein the sorbent in the mercury-containing gas comprises about 1 g to about 30 g of the added Br₂, HBr, the bromide compound, or a combination thereof, per 100 g of the sorbent.

44. (New) The method of claim 27, wherein the Br₂, HBr, or the bromide compound is contacted with the sorbent in vapor form, gaseous form, liquid form, or in an organic solvent.

45. (New) The method of claim 27, wherein the activated carbon comprises powdered activated carbon, granular activated carbon, or a combination thereof.

46. (New) The method of claim 27, wherein the sorbent injected into the mercury-containing gas is a sorbent obtained by contacting a sorbent with a halogen or halide promoter prior to the injection of the sorbent into the mercury-containing gas.

47. (New) The method of claim 27, wherein the sorbent injected into the mercury-containing gas is free of contact with a halogen or halide promoter prior to injection of the sorbent into the mercury-containing gas.

48. (New) The method of claim 27, wherein the combustion chamber comprises a boiler.

49. (New) The method of claim 27, wherein the mercury-containing gas is a flue gas.

50. (New) The method of claim 27, wherein the injection of the sorbent into the mercury-containing gas occurs upstream of a particulate separator, a scrubber, or a combination thereof.

51. (New) The method of claim 50, wherein the particulate separator comprises a baghouse, an electrostatic precipitator, a fabric filter, or a combination thereof.

52. (New) The method of claim 27, wherein a halide sorbent enhancement additive comprises the added Br₂, HBr, bromide compound, or combination thereof.

53. (New) The method of claim 52, wherein the sorbent enhancement additive comprises the bromide compound.

54. (New) A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, to provide the mercury-containing gas, wherein the mercury-containing gas comprises a halogen or halide promoter comprising HBr, Br⁻, or a combination thereof, wherein

the coal comprises added Br₂, HBr, a bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber, or

the combustion chamber comprises added Br₂, HBr, a bromide compound, or a combination thereof, or

a combination thereof;

injecting a sorbent comprising activated carbon into the mercury-containing gas downstream of the combustion chamber;

contacting mercury in the mercury-containing gas with the sorbent; and

separating the sorbent contacted with the mercury from the mercury-containing gas.

55. (New) A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, to provide the mercury-containing gas, wherein the mercury-containing gas comprises a halogen or halide promoter comprising HBr, Br⁻, or a combination thereof, wherein

the coal comprises added Br₂, HBr, a bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber, or

the combustion chamber comprises added Br₂, HBr, a bromide compound, or a combination thereof, or

a combination thereof;

injecting a sorbent comprising activated carbon into the mercury-containing gas downstream of the combustion chamber such that the activated carbon reacts with the halogen or halide promoter in the mercury-containing gas to form a promoted sorbent;

contacting mercury in the mercury-containing gas with the promoted sorbent;

separating the promoted sorbent contacted with the mercury from the mercury-containing gas;

measuring the mercury content of the mercury-containing gas; and

modifying, in response to the measured mercury content,

an injection rate of injecting the sorbent into the mercury-containing gas,

an amount of the Br₂, HBr, the bromide compound, or a combination thereof, added to the coal or the combustion chamber, or

a combination thereof.

A/N 15/974,343

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.

Examiner: AMBER ROSE ORLANDO

Application No.: 15/974,343

Group Art Unit: 1776

Filed: May 8, 2018

Docket No.: 4820.001US9

Confirmation No.: 1072

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.116

Mail Stop AF

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

Applicant has received the Final Office Action dated January 14, 2019. Please enter the following.

This response is accompanied by a Petition, as well as the appropriate fee, to obtain a three-month extension of the period for responding to the Office Action, thereby moving the deadline for response from April 14, 2019 to July 14, 2019.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/974,343	05/08/2018	Edwin S. Olson	4820.001US9	1072
21186	7590	07/16/2019		
SCHWEGMAN LUNDBERG & WOESSNER, P.A.			EXAMINER	
P.O. BOX 2938			ORLANDO, AMBER ROSE	
MINNEAPOLIS, MN 55402				
			ART UNIT	PAPER NUMBER
			1776	
			NOTIFICATION DATE	DELIVERY MODE
			07/16/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/974,343	05/08/2018	Edwin S. Olson	4820.001US9	1072
21186	7590	08/21/2019		
SCHWEGMAN LUNDBERG & WOESSNER, P.A. P.O. BOX 2938 MINNEAPOLIS, MN 55402			EXAMINER ORLANDO, AMBER ROSE	
			ART UNIT	PAPER NUMBER
			1776	
			NOTIFICATION DATE	DELIVERY MODE
			08/21/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com