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(54) Titre : ADSORBANT POUVANT DECOMPOSER UN COMPOSE HALOGENE ORGANIQUE, ET SON PROCEDE DE PRODUCTION  
 (54) Title: ADSORBENT HAVING CAPABILITY OF DECOMPOSING ORGANIC HALOGEN COMPOUND AND METHOD FOR PRODUCING THE SAME

(57) **Abrégé/Abstract:**

A method for producing an adsorbent having the capability of decomposing an organic halogen compound, characterized in that it comprises reacting a salt of Pt and/or Pd, an organic titanium compound and an organic binder in a solvent, to thereby synthesize a dispersion of an organic metal compound precursor containing Pt and/or Pd and Ti in a molecule thereof, adding a TiO<sub>2</sub> sol to the dispersion to prepare a catalyst coating solution, impregnating an active carbon with the catalyst coating solution and heating the resultant mixture, thereby allowing the active carbon to carry thereon an organic halogen compound decomposition catalyst comprising TiO<sub>2</sub> and, dispersed therein, fine particles of Pt and/or Pd. An adsorbent produced by the method can be used for adsorbing an organic halogen compound contained in an exhaust gas and also decomposing it with reliability without re-synthesis of the compound and further for adsorbing and removing So<sub>x</sub>, No<sub>x</sub>, HCl, a heavy metal and the like, in a low temperature range of 130 to 150 ° allowing the use of an active carbon.

### Abstract of the Disclosure

An adsorbent having the capability of decomposing an organic halogen compound, which adsorbent cannot only adsorb organic halogen compounds contained in waste gases but also can assuredly decompose them without synthesizing them as well as a process for producing the same are provided. A salt of Pt and/or Pd, an organic titanium compound and an organic binder are reacted in a solvent, to thereby synthesize a dispersion of an organic metal compound precursor containing Pt and/or Pd and Ti in molecules thereof, a sol of TiO<sub>2</sub> is added to the dispersion to prepare a catalyst-coating solution, an activated carbon is impregnated with the catalyst-coating solution, and the resulting mixture is heated, thereby allowing the activated carbon to carry thereon an organic halogen compound-decomposing catalyst comprising TiO<sub>2</sub> and, dispersed therein, fine particles of Pt and/or Pd. In a low temperature range of 130 to 150°C in which the activated carbon is usable, the organic halogen compounds in the exhaust gases can be decomposed, and SO<sub>x</sub>, NO<sub>x</sub>, HCl and heavy metals can be removed through adsorption.

## Specification

## ABSORBENTS HAVING THE CAPABILITY OF DECOMPOSING ORGANIC HALOGEN COMPOUNDS AND A PROCESS FOR PRODUCING THE SAME

[001]

Technical Field

The present invention relates to absorbents having the capability of decomposing organic halogen compounds and being adapted to be used mainly for treating waste gases from incinerators and also to a process for producing the same.

[002]

Background Art

As measures for reducing organic halogen compounds generated from incinerators for municipal waste and industrial waste, there are improvement of combustion conditions and advancement of waste gas treatment. In general, the temperature is required to be maintained at as high as 1000°C or more in combustion processes for completely decomposing chlorinated organic materials like organic halogen compounds through oxidation. In order to prevent damages of furnace walls, the combustion temperature is commonly set at 800 to 900°C, and therefore it is not easy to completely decompose the organic halogen compounds through oxidation by improving the combustion conditions.

[003]

In stoker furnaces in which a low-temperature portion or an incomplete combustion portion is likely to be locally formed, a re-combustion portion needs to be provided for completely decomposing the organic halogen compound through oxidation. However, there are problems of increase in the total waste gas amount and increase in the running cost due to a re-combustion fuel.

[004]

Further, it is known that among the organic halogen compounds, not only dioxins and brominated dioxins are produced during a combustion process, but also they are synthesized again from remaining unburnt materials not being completely burnt and precursor materials having benzene rings in a wide temperature ranges of about 300 to 500°C. Thus, even if the organic halogen compounds such as the dioxins and the brominated dioxins are intended to be reduced in the

combustion process, the organic halogen compounds such as the dioxins and the brominated dioxins may be synthesized again during the succeeding stage, so that the organic halogen compounds including the dioxins and the brominated dioxins may not be reduced in the waste gases.

[005]

For the above reasons, the organic halogen compounds including the dioxins and the brominated dioxins are required to be reduced by treating the waste gases so that the organic halogen compounds may be stably maintained at a low concentration in the waste gases.

[006]

Among methods for removing the organic halogen compounds including dioxins and brominated dioxins by treating the exhaust gases, an adsorbing method by which such organic halogen compounds are adsorbed with activated carbon is mainly employed. However, the activated carbon having adsorbed the organic halogen compounds becomes a secondary waste, which poses a post treatment thereof.

[007]

In order to solve this problem, the present inventors had been making investigations to prolong the span life span of activated carbon when used particularly in combination with a  $V_2O_5$ - $TiO_2$  based catalyst or a  $V_2O_5$ - $WO_3$ - $TiO_2$  based catalyst known as a catalyst for decomposing organic halogen compounds including the dioxins and brominated dioxins. However, it was confirmed that if the concentration of the dioxins and the brominated dioxins as kinds of the organic halogen compounds is low at a catalyst inlet in the case of the  $V_2O_5$ - $TiO_2$  based catalyst or the  $V_2O_5$ - $WO_3$ - $TiO_2$  based catalyst, the dioxins and the brominated dioxins as the organic halogen compounds are inversely produced. Recently, considering that the concentration of the dioxins in the waste gases is suppressed to not more than 1/10 of the governmental standard value in not a few areas due to residential agreements, etc. it was clarified that use of such conventional organic halogen compound-decomposing catalysts might afford adverse effects.

[008]

Moreover, since the conventional organic halogen compound-decomposing catalysts need to be used at high temperatures of 200 to 500°C, the

waste gases must be heated again. Further, it was clarified that because the activated carbon cannot withstand such high temperatures, the catalyst and activated carbon cannot be used in the same position, and it is not easy to use the catalyst and the activated carbon in combination.

[009]

#### Disclosure of the Invention

The present invention has been accomplished to solve the conventional problems as mentioned above, and to provide an adsorbent having the capability of decomposing organic halogen compounds which adsorbent cannot only adsorb organic halogen compounds contained in waste gases but also effectively decompose them to prolong the life span of the adsorbent and suppress an amount of a secondary waste produced, while having no ability to synthesize again the organic halogen compounds including the dioxins and brominated dioxins at that time. The invention also provides a process for producing the same.

[010]

The adsorbent having the organic halogen compound-decomposing function according to the present invention, which has been made to solve the above problems, comprising an activated carbon, and an organic halogen compound-decomposing catalyst carried on the activated carbon, said organic halogen compound-decomposing catalyst having fine particles of Pt and/or Pd dispersed in  $\text{TiO}_2$  by mixing a dispersion liquid of an organic metal precursor containing Pt and/or Pd and Ti in molecules thereof with a sol of  $\text{TiO}_2$  and producing the catalyst under heating.

[011]

A process for producing a catalyst having a capability of decomposing an organic halogen compound according to the present invention, comprises reacting a salt of Pt and/or Pd, an organic titanium compound and an organic binder in a solvent, to thereby synthesize a dispersion of an organic metal compound precursor containing Pt and/or Pd and Ti in molecules thereof, mixing a sol of  $\text{TiO}_2$  with the dispersion to prepare a catalyst-coating solution, impregnating an activated carbon with the catalyst-coating solution and heating the resulting mixture, thereby allowing the activated carbon to carry thereon an organic halogen compound-decomposing catalyst comprising  $\text{TiO}_2$  and, dispersed therein, fine particles of Pt

and/or Pd. As the organic binder, an amino acid such as L-lysine or L-proline is preferably used. As the organic titanium compound, an alkoxide derivative of Ti is preferably used.

[012]

The adsorbent having the capability of decomposing the organic halogen compound according to the present invention is produced through mixing the sol of  $\text{TiO}_2$  with the dispersion of the organic metal compound precursor containing Pt and/or Pd and Ti in molecules thereof, followed by heating, thereby allowing the activated carbon to carry thereon the organic halogen compound-decomposing catalyst comprising  $\text{TiO}_2$  and, dispersed therein, fine particles of Pt and/or Pd. Since the number of activated points is extremely large, so that the catalyst can be highly activated. Therefore, while the amount of expensive Pt and Pd is reduced, the organic halogen compound can be decomposed. The mixture of the organic metal compound precursor dispersion and the  $\text{TiO}_2$  sol is heated at a temperature of  $450^\circ\text{C} \sim 500^\circ\text{C}$  in an air atmosphere ordinarily under atmospheric pressure. The heating time is set at such a time in connection with the heating temperature, etc. that the organic binder may be completely burnt out and that Pt and/or Pt may be uniformly dispersed in  $\text{TiO}_2$ .

(013)

Further, the organic halogen compound is not synthesized again unlike the  $\text{V}_2\text{O}_5\text{-TiO}_2$  based catalyst or the  $\text{V}_2\text{O}_5\text{-WO}_3\text{-TiO}_2$  based catalyst. In addition, the adsorbent can exhibit excellent function at the use temperature of the activated carbon of  $130 \sim 150^\circ\text{C}$ , so that the use life of the activated carbon can be prolonged to a few times as long as that of the conventional adsorbent, while the waste gases need not be heated again.

[014]

#### Brief Description of the Drawings

Fig. 1 is a graph showing orthochlorotoluene-removing characteristics with activated carbons carrying Pt thereon.

Fig. 2 is a graph showing the concentration of orthochlorotoluene in adsorbents carrying Pt thereon.

Fig. 3 is a graph showing orthobromotoluene-removing characteristics with activated carbons carrying Pt thereon.

Fig. 4 is a graph showing the concentration of ortobromotoluene in adsorbents carrying Pt thereon.

Fig. 5 is a graph showing orthochlorotoluene-removing characteristics of activated carbons carrying Pd thereon.

Fig. 6 is a graph showing the concentration of orthochlorotoluene in adsorbents carrying Pd thereon.

Fig. 7 is a graph showing orthobromotoluene-removing characteristics with activated carbons carrying Pd thereon.

Fig. 8 is a graph showing the concentration of ortobromotoluene in adsorbents carrying Pd thereon.

(015)

[Best Mode of Carrying Out the Invention]<sub>2</sub>

In the following, preferable embodiments of the present invention.

First, an Ti alkoxide derivative as an organic Ti compound (for example, a derivative in which a part of a Ti alkoxide is replaced by an acetyl acetate group or a derivative in which a part of the Ti alkoxide is replaced by a triethanol aminate group), and a soluble salt of Pt and/or Pd are dissolved into a solvent containing an organic binder. As the soluble Pt salt, chloroplatinic acid, chloroplatinic acid hexahydrate, platinum dichloride, platinum tetrachloride, etc. may be used. As the Pd salt, palladium chloride, palladium nitrate, etc. may be used.

[0016]

In the present invention, an amino acid such as L-lysine or L-proline may be used as the organic binder for Ti and the noble metal. Particularly, L-proline is preferred, because it has a high solubility in methanol to be used as a solvent. The organic binder is a substance which bonds Ti ions and Pt and/or Pd ions with molecules of the organic binder, fixes them in the molecules and is removed by heating to produce bound fine particles of TiO<sub>2</sub> and Pt and/or Pd, while not affording adverse effects upon the physical properties such as catalytic poison of the resulting organic halogen compound-decomposing catalyst. The organic binder binds the Ti ions and the Pt and/or Pd ions, and fixes them in the molecules.

[017]

The mixing rates of the constituent ingredients are 100 wt. parts of the Ti alkoxide derivative, 0.5 to 5 wt. parts of the Pt and/or Pd salt, 100 to 200 parts of

methanol, and 0.1 to 1.5 parts of the amino acid. When they are reacted at 70 to 80°C, a dispersion of an organic metal compound precursor in which the above ingredients are uniformly dispersed in a molecular level is obtained. The organic metal compound precursor means a compound which Ti ions and Pt and/or Pd ions are bound inside one molecule via chemical bonds and the above ions have a fixed positional relationship different from a state in which the ions are dissolved in a solvent. In the dispersed state, Ti and Pt and/or Pd are bound together via the amino acid. A catalyst-coating solution is obtained by mixing the dispersion with 50 wt. parts of a sol of Ti acting as a glue. When activated carbon is impregnated with the catalyst-coating solution and the resulting activated carbon is heated at 450 to 500°C, the amino acid as the organic binder is burnt out to decompose the organic metal compound precursor. As a result, an adsorbent having the capability of decomposing an organic halogen compound in which on the activated carbon is carried an organic halogen compound catalyst itself in which Pt and/or Pd are converted to super fine particles, which are highly dispersed in TiO<sub>2</sub> can be obtained. In this adsorbent, 1 part of TiO<sub>2</sub>, 0.01 part of Pt and/or Pd are combined with 100 wt. parts of the activated carbon. The activated carbon is preferably a granular activated carbon having particles of around 3 mm ~ 10 mm and a BET specific surface area of 300 m<sup>2</sup>/g or more.

(018)

In the TiO<sub>2</sub> sol, TiO<sub>2</sub> fine particles having primary particle diameters of around 10 nm are dispersed in an acidic solution. For example, the TiO<sub>2</sub> sol contains around 30% of TiO<sub>2</sub> itself. As the solution, a solution of nitric acid or that of hydrochloric acid may be recited. Considering an effect upon the activity of the catalyst itself, it is desirable to use the nitric acid solution of TiO<sub>2</sub>.

(019)

The above organic halogen compound-decomposing catalyst has improved catalytic activity, because the number of activated points is largely increased by the super fine particles of Pt and/or Pd. For this reason, the use amount of expensive Pt and/or Pd can be largely reduced as compared with a case where TiO<sub>2</sub> powder or its sintered powder is coated or impregnated with an aqueous solution of a Pt and/or Pd salt and Pt and/or Pd is precipitated by thermal decomposition. Further, since the invention catalyst has the capability to



decompose the organic halogen compounds even at lower temperatures different from the conventional organic halogen compound-decomposing catalysts, the invention catalyst can exhibit excellent performance in a temperature range of 130 ~ 150°C in which activated carbon is usable. Consequently, the use life of activated carbon can be prolonged to a few times as long as that of the conventional cases. Further, the waste gases need not be heated again. The organic halogen compounds can be decomposed without fear of re-synthesis of the organic halogen compounds such as dioxins or the brominated dioxins. Also, heavy metals, SOx, NOx, HCl, etc. in the waste gases can be removed by adsorption.

(020)

The adsorbent having the capability of decomposing the organic halogen compounds according to the present invention can be used in the state that it is placed in a low temperature zone at less than 200°C in the waste gas-treating system. The most preferable temperature range is 130 ~ 150°C as the waste gas temperature. The way of use is not particularly limited. The adsorbent can be used for the treatment of the waste gases, for example, in the state that it is bonded to filter clothes in a bag filter. By so doing, while dust in the waste gases can be filtered off with the bag filter, the organic halogen compounds in the waste gases can be decomposed with the organic halogen compound-decomposing catalyst. Consequently, SOx, NOx, HCl, etc. can be adsorbed with the activated carbon, and heavy metals in the waste gases can be removed by adsorption. In this way, the adsorbent having the capability of decomposing the organic halogen compound according to the present invention can simultaneously decompose and adsorb the poisonous components contained in the waste gases. The poisonous components once adsorbed with the activated carbon can be gradually decomposed with the organic halogen compound-decomposing catalyst. As mentioned above, the use life of the adsorbent having the capability of decomposing the organic halogen compounds can be largely prolonged as compared with a case where activated carbon is used alone. Thereby, an amount of the secondary waste produced can be suppressed.

(021)

#### Example 1

In order to confirm the effects of the present invention, orthochloro-toluene, which is considered as a substitute of the dioxins in the catalyst engineering

was used, and its adsorption removal performance was measured. A catalyst-coating solution was prepared by adding 50 wt. parts of a  $\text{TiO}_2$  sol into a dispersion of an organic metal compound precursor which had been synthesized by mixing into 100 wt. parts of an alkoxide derivative of Ti chloroplatinic hexahydrate as a Pt salt in an amount of 1 wt. parts as calculated in the form of Pt, and dissolving the resultant mixture into methanol containing 1 wt. part of L-lysine as an amino acid. What was used in experiments was obtained by impregnating activated carbon with the catalyst-coating solution and producing an organic halogen compound-decomposing catalyst under heating such that the ratio was 1 wt. part of  $\text{TiO}_2$  and 0.01 part of Pt relative to 100 wt. parts of the activated carbon. For comparison purpose, activated carbons carrying no catalyst thereon were used.

(022)

Totally four kinds: two kinds of activated carbon adsorbents, each kind consisting of two adsorbents, one being carried with a catalyst and the other with no catalyst were used, and set inside a device in which the adsorbents were kept at a temperature of  $200^\circ\text{C}$  and simulated combustion waste gases including orthochlorotoluene were flown. The concentrations of the orthochlorotoluene were measured at inlets and outlets of the adsorbents and in the adsorbents.

(023)

First, analysis results of the totally four kinds of the adsorbents are shown in Table 1. A catalyst on which  $\text{Pt/TiO}_2$  was carried had naturally had increased amounts of Pt and Ti. In case that the catalysts were carried on the activated carbons, their specific surface areas were not reduced and their pore distributions were not largely changed.

Table 1

Items analyzed		Unit	No. 1		No. 2	
			blank	Pt/TiO <sub>2</sub> carried	blank	Pt/TiO <sub>2</sub> carried
Specific surface area		m <sup>2</sup> /g	292	319	637	575
Pore distribution	Total absorbed amount	ml/g	0.316	0.325	0.422	0.474
	Maximum pore diameter	Å	7.24	6.28	7.27	5.57
Iodine-absorbing ability		mg/g	400	380	850	700
Ignition point		°C	700	700	687	700
Ash		wt%	13.7	17.7	7.2	12.2
Solid carbon		wt%	83.4	76.1	90.8	81.5
Pt		wt%	<0.01	0.02	<0.01	0.02
Ti		wt%	0.07	1.2	0.03	1.1

(024)

Fig. 1 is a graph showing an orthochlorotoluene adsorption-removing characteristics. Fig. 2 shows the concentrations of orthochlorotoluene in the adsorbents. It is seen from these figures that although the orthochlorotoluene adsorption-removing percentages were as very high as not less than 99%, the organic chlorine compound existed inside the adsorbents carrying no catalyst thereon. However, a large amount of the organic chlorine compound did not remain inside the adsorbent with the catalyst, which revealed that the organic chlorine compound was disposed of.

(025)

From the above, the residual amounts of the organic chlorine compound in the used adsorbents can be reduced. The activated carbon can be regenerated at a high temperature of around 500°C in such a reducing atmosphere that the activated carbon may not be burnt. The higher the temperature in the reducing atmosphere, the higher is the effectiveness of the Pt/TiO<sub>2</sub> catalyst. Thus, under the above condition, the activated carbon carrying Pt/TiO<sub>2</sub> thereon is more readily regenerated.

(026)

(Example 2)

In Example 2, orthobromotoluene was used and its absorption-removing characteristics were measured, considering organic bromine compounds including brominated dioxins as other organic halogen compounds, while Example 1 is an

example carried out considering the organic chlorine compounds including the dioxins. A catalyst-coating solution was prepared by adding 50 wt. parts of a sol of  $\text{TiO}_2$  to an organic metal compound precursor, which had been synthesized by mixing into 100 wt. parts of an alkoxide derivative of Ti chloroplatinic acid hexahydrate as a Pt salt in an amount of 1 wt. part as measured in the form of Pt, and dissolving the resulting mixture into methanol containing 1 wt. part of L-lysine as an amino acid. What was used in experiments were prepared by impregnating activated carbon with the above catalyst-coating liquid and producing an organic halogen compound-decomposing catalyst under heating. Relative to 100 wt. parts of the activated carbon were contained 1 wt. part of  $\text{TiO}_2$  and 0.01 wt. part of Pt. For a comparison purpose, activated carbons carrying no catalyst thereon were used.

(027)

Totally four kinds: two kinds of activated carbon adsorbents, each kind consisting of two adsorbents, one being carried with a catalyst and the other with no catalyst were used, and set inside a device in which the adsorbents were kept at a temperature of  $200^\circ\text{C}$  and simulated combustion waste gases including an orthobromotoluene were flown. The concentrations of the orthobromotoluene were measured at inlets and outlets of the adsorbents and in the adsorbents.

(028)

Fig. 3 is a graph showing an orthobromotoluene adsorption-removing characteristics. Fig. 4 shows the concentrations of orthobromotoluene in the adsorbents. It is seen from these figures that although the orthobromotoluene adsorption-removing percentages were as very high as not less than 99%, the organic bromine compound existed inside the adsorbents carrying no catalyst thereon. However, a large amount of the organic bromine compound did not remain inside the adsorbent with the catalyst, which revealed that the organic bromine compound could be disposed of.

(029)

(Example 3)

In Example 3, Pd was used as a catalyst component. A catalyst-coating solution was prepared by adding 50 wt. parts of a sol of  $\text{TiO}_2$  to an organic metal compound precursor, which had been synthesized by mixing, into 100 wt. parts of an alkoxide derivative of Ti, palladium nitrate as a Pd salt in an amount of 1 wt. part

as measured in the form of Pd, and dissolving the resulting mixture into methanol containing 1 wt. part of L-lysine as an amino acid. What was used in experiments were prepared by impregnating activated carbon with the above catalyst-coating solution and producing an organic halogen compound-decomposing catalyst under heating. Relative to 100 wt. parts of the activated carbon were contained 1 wt. part of  $\text{TiO}_2$  and 0.01 wt. part of Pd. For a comparison purpose, activated carbons carrying no catalyst thereon were used. According to the testing method in Example 1, the concentrations of orthochlorotoluene and that of orthobromotoluene were measured at inlets and outlets of the adsorbents by flowing simulated combustion waste gases containing orthochlorotoluene or orthobromotoluene. Fig. 5 is a graph showing the orthochlorotoluene adsorption-removing characteristics. Fig. 6 shows the concentrations of orthochlorotoluene in the adsorbents. Fig. 7 is a graph showing the orthobromotoluene adsorption-removing characteristics. Fig. 8 shows the concentrations of orthobromotoluene in the adsorbents. It is seen from these figures that although the orthobromotoluene and orthochlorotoluene adsorption-removing percentages were as very high as not less than 99%, but the organic halogen compound existed inside the adsorbents carrying no catalyst thereon. However, a large amount of the organic halogen compound did not remain inside the adsorbent with the catalyst, which revealed that the organic halogen compound could be disposed of.

(030)

#### Industrial applicability

As mentioned above, the adsorbent having the capability of decomposing the organic halogen compound as claimed in claim 1 cannot only adsorb and decompose the organic halogen compounds contained in the waste gases, but also can remove heavy metals,  $\text{SO}_x$ ,  $\text{NO}_x$ , HCl, etc. by adsorption. Consequently, the adsorbent can prolong its use life and suppress an amount of a secondary waste produced as compared with a case of activated carbon alone. Further, even if the concentrations of the organic halogen compounds including the dioxins, the brominated dioxins, etc. at the inlet of the catalyst is low, it is not feared that they are synthesized again. Therefore, such an adsorbent is suitably used for treating the waste gases from the incinerators. The processes for producing the organic halogen compound-decomposing catalyst having the capability of decomposing the

organic halogen compound as claimed in claims 4 to 6 can readily produce the above adsorbent having the capability of decomposing the organic halogen compound.

What is claimed is:

1. An adsorbent having the capability of decomposing an organic halogen compound, comprising an activated carbon, and an organic halogen compound-decomposing catalyst carried on the activated carbon, said organic halogen compound-decomposing catalyst having fine particles of Pt and/or Pd dispersed in  $TiO_2$  by mixing a dispersion liquid of an organic metal compound precursor containing Pt and/or Pd and Ti in molecules thereof with a sol of  $TiO_2$  and producing the catalyst under heating.

2. The adsorbent set forth in claim 1, wherein an amino acid is used as an organic binder.

3. The adsorbent set forth in claim 1 or 2, wherein an alkoxide derivative of Ti is used as an organic compound of Ti.

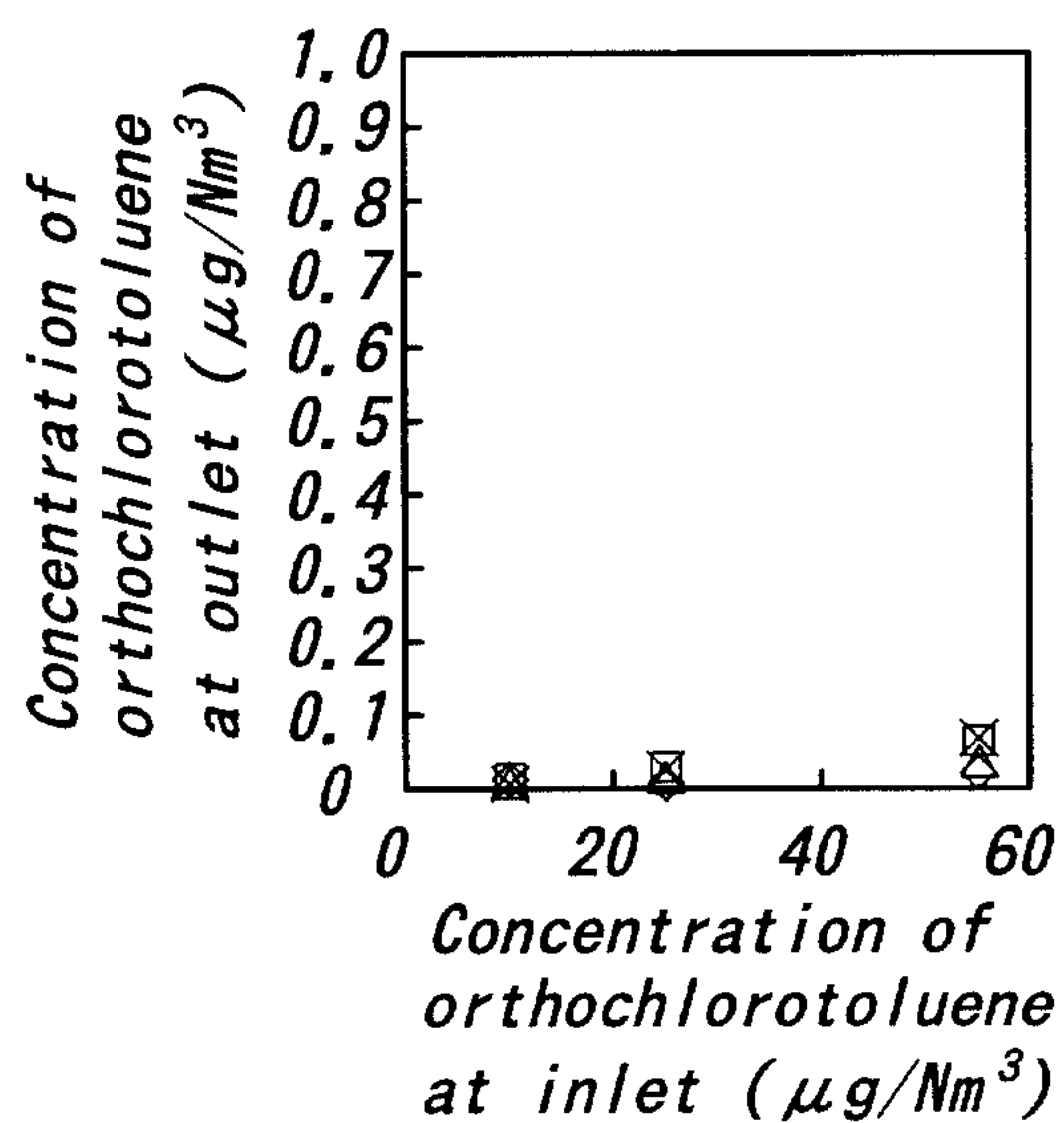
4. A process for producing an adsorbent having the capability of decomposing an organic halogen compound, comprising reacting a salt of Pt and/or Pd, an organic titanium compound and an organic binder in a solvent, to thereby synthesize a dispersion of an organic metal compound precursor containing Pt and/or Pd and Ti in molecules thereof, mixing a sol of  $TiO_2$  with the dispersion to prepare a catalyst-coating solution, impregnating an activated carbon with the catalyst-coating solution and heating the resulting mixture, thereby allowing the activated carbon to carry thereon an organic halogen compound-decomposing catalyst comprising  $TiO_2$  and, dispersed therein, fine particles of Pt and/or Pd.

5. The producing process set forth in claim 4, wherein an amino acid is used as the organic binder.

6. The producing process set forth in claim 4 or 5, wherein an alkoxide derivative of Ti is used as the Ti organic compound.

**FIG. 1**

Concentration of orthochlorotoluene at inlet ( $\mu\text{g}/\text{Nm}^3$ )	Adsorbent No. 1		Adsorbent No. 2	
	No catalyst	Pt/TiO <sub>2</sub> carried	No catalyst	Pt/TiO <sub>2</sub> carried
10	0.012	0.015	0.003	0.003
25	0.018	0.032	0.014	0.028
55	0.020	0.060	0.030	0.061



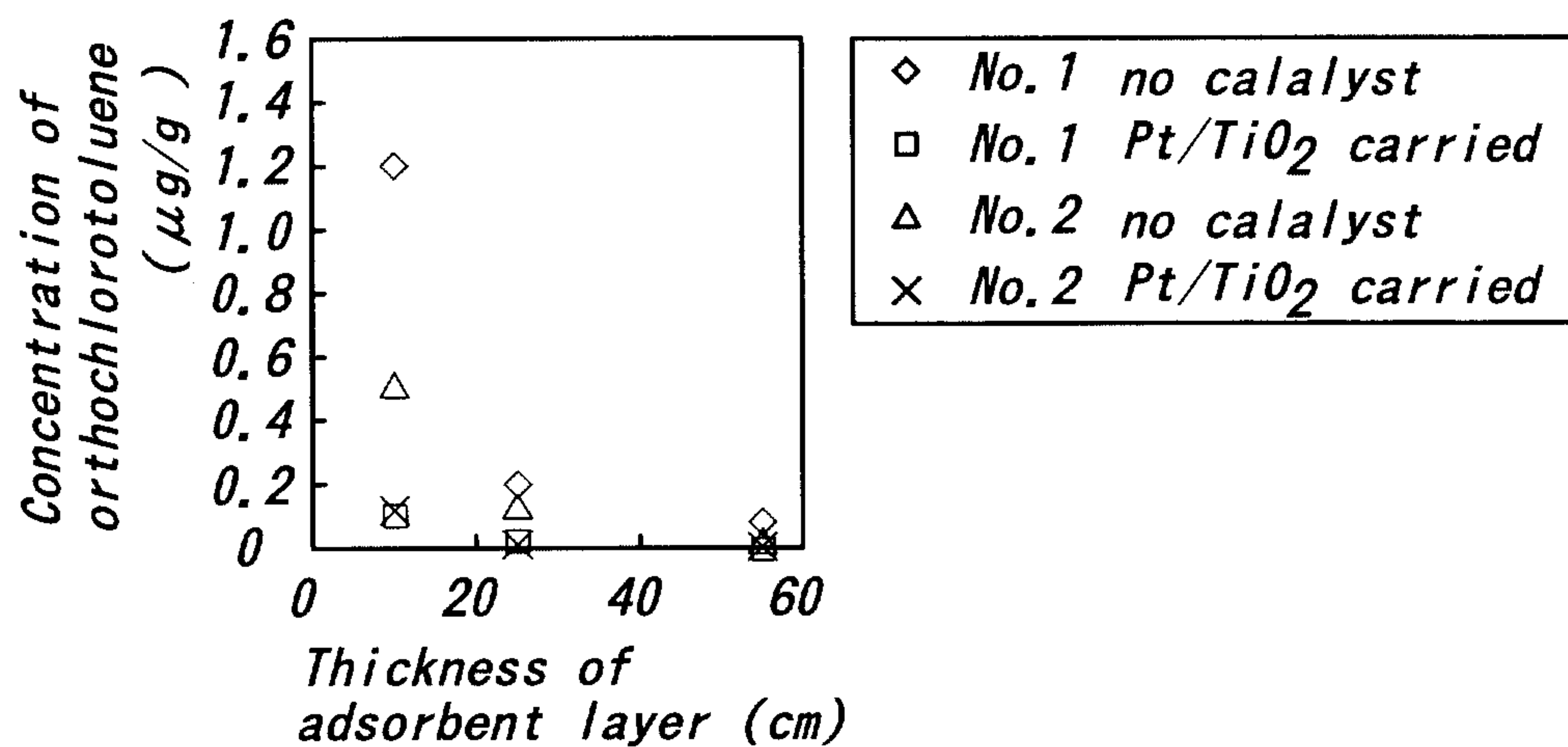
- ◇ No. 1 no catalyst, at outlet
- No. 1 Pt/TiO<sub>2</sub> carried, at outlet
- △ No. 2 no catalyst, at outlet
- × No. 2 Pt/TiO<sub>2</sub> carried, at outlet



**FIG. 2**

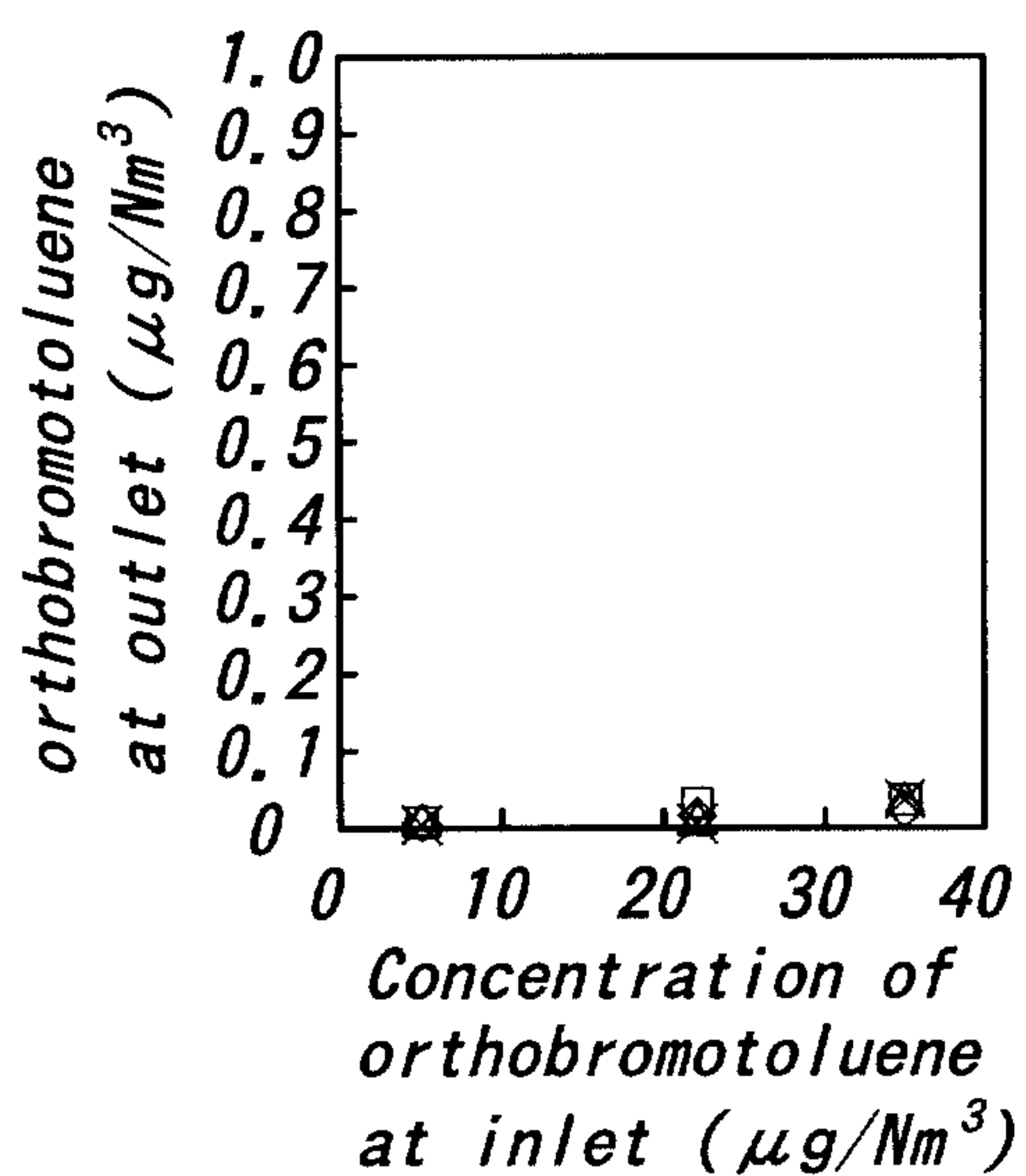
Concentration of  
orthochlorotoluene  
in adsorbent

Thickness of adsorbent layer (cm)	Adsorbent No. 1		Adsorbent No. 2	
	No catalyst	Pt/TiO <sub>2</sub> carried	No catalyst	Pt/TiO <sub>2</sub> carried
10	1.2	0.1	1.5	0.13
25	0.2	0.032	0.14	0.028
55	0.08	0.002	0.03	0.005



**FIG. 3**

Concentration of orthobromotoluene at inlet ( $\mu\text{g}/\text{Nm}^3$ )	Concentration of adsorbent at outlet			
	Adsorbent No. 1		Adsorbent No. 2	
	No catalyst	Pt/TiO <sub>2</sub> carried	No catalyst	Pt/TiO <sub>2</sub> carried
5	0.006	0.009	0.002	0.004
22	0.017	0.03	0.005	0.007
35	0.022	0.035	0.03	0.037

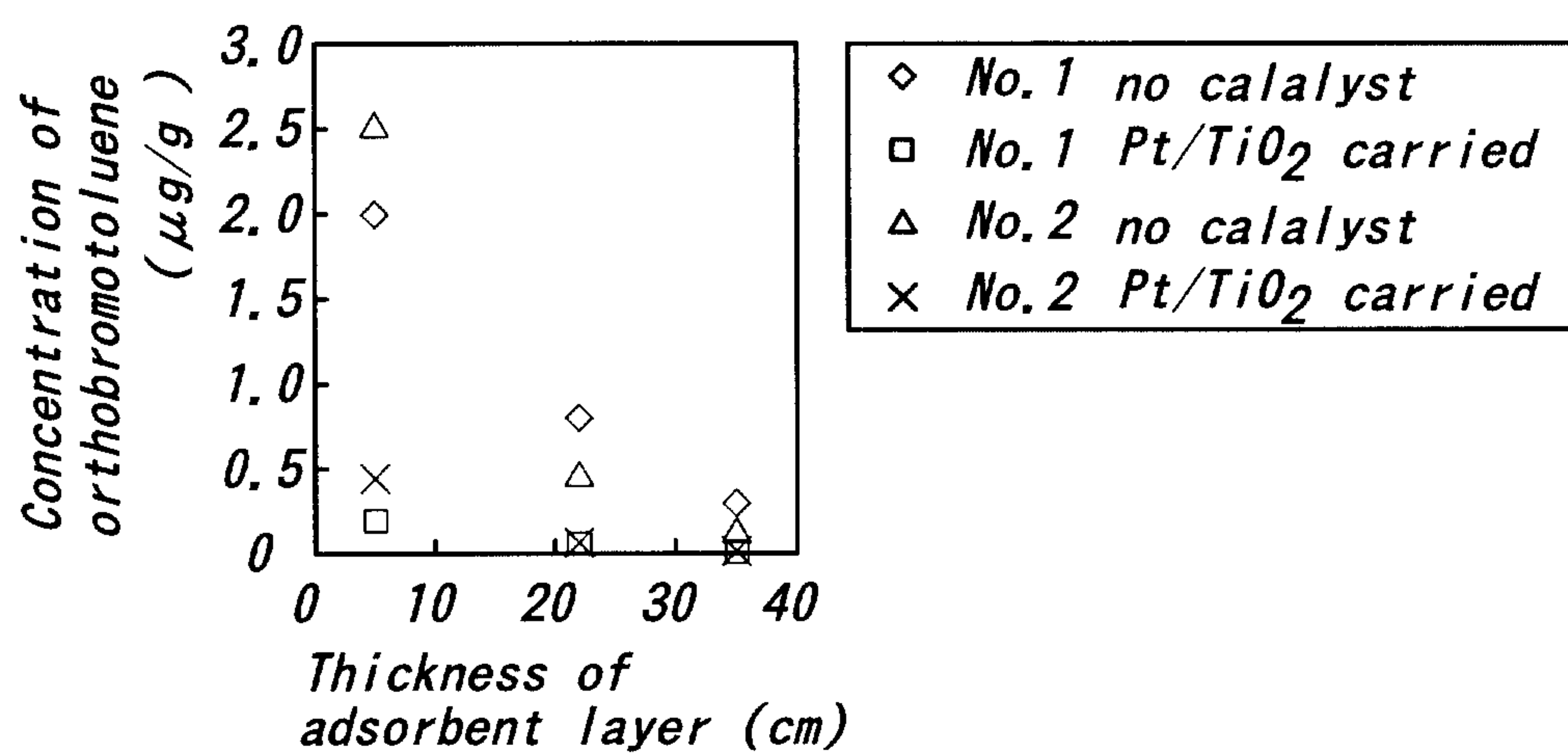


- ◇ No. 1 no catalyst, at outlet
- No. 1 Pt/TiO<sub>2</sub> carried, at outlet
- △ No. 2 no catalyst, at outlet
- × No. 2 Pt/TiO<sub>2</sub> carried, at outlet

**FIG. 4**

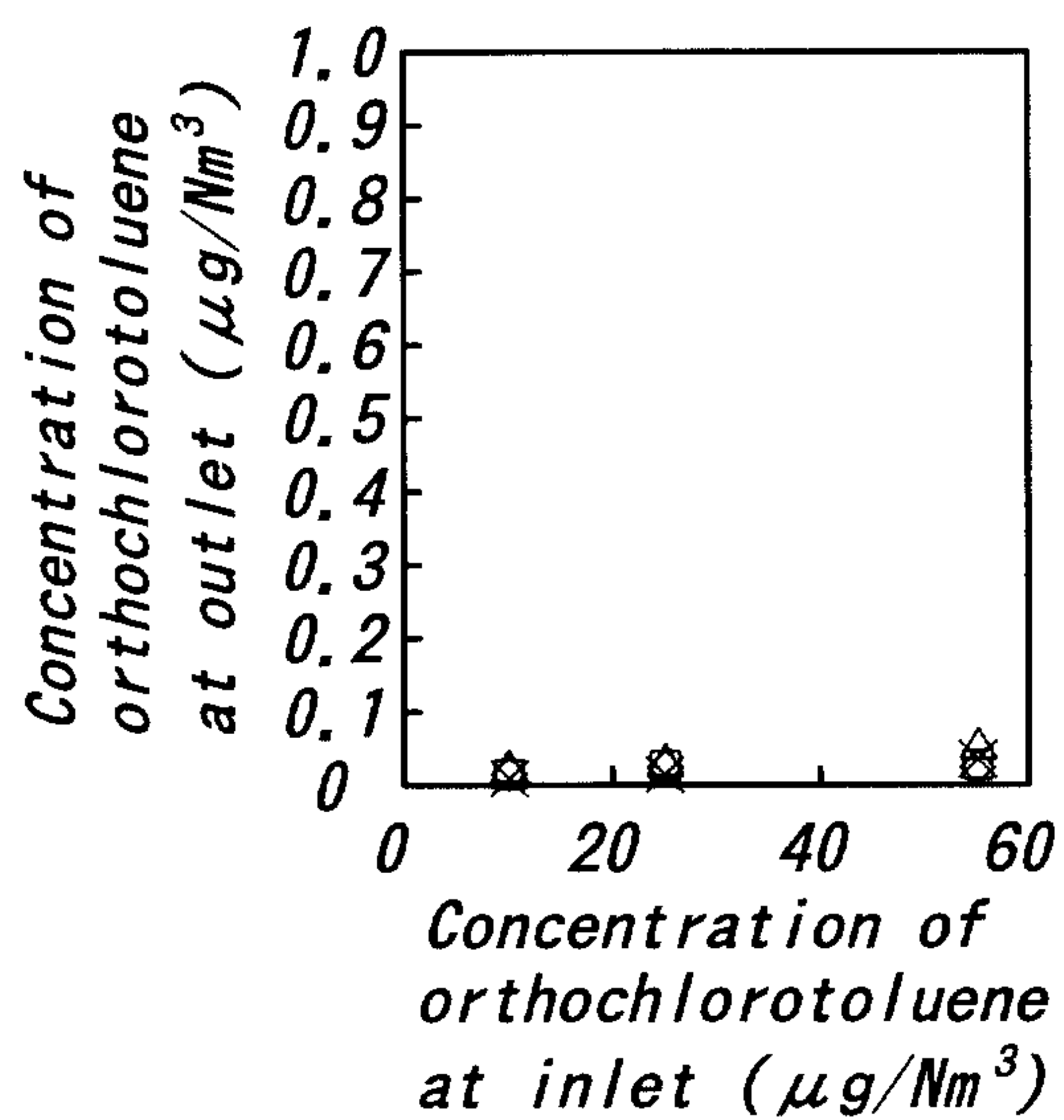
Concentration of  
orthobromotoluene  
in adsorbent

Thickness of adsorbent layer (cm)	Adsorbent No. 1		Adsorbent No. 2	
	No catalyst	Pt/TiO <sub>2</sub> carried	No catalyst	Pt/TiO <sub>2</sub> carried
5	2	0.2	2.5	0.45
22	0.8	0.056	0.45	0.07
35	0.3	0.009	0.12	0.01



**FIG. 5**

Concentration of orthochlorotoluene at inlet ( $\mu\text{g}/\text{Nm}^3$ )	Concentration of adsorbent at outlet			
	Adsorbent No. 1		Adsorbent No. 2	
	No catalyst	Pt/TiO <sub>2</sub> carried	No catalyst	Pt/TiO <sub>2</sub> carried
10	0.016	0.015	0.020	0.009
25	0.025	0.030	0.028	0.015
55	0.024	0.030	0.050	0.037

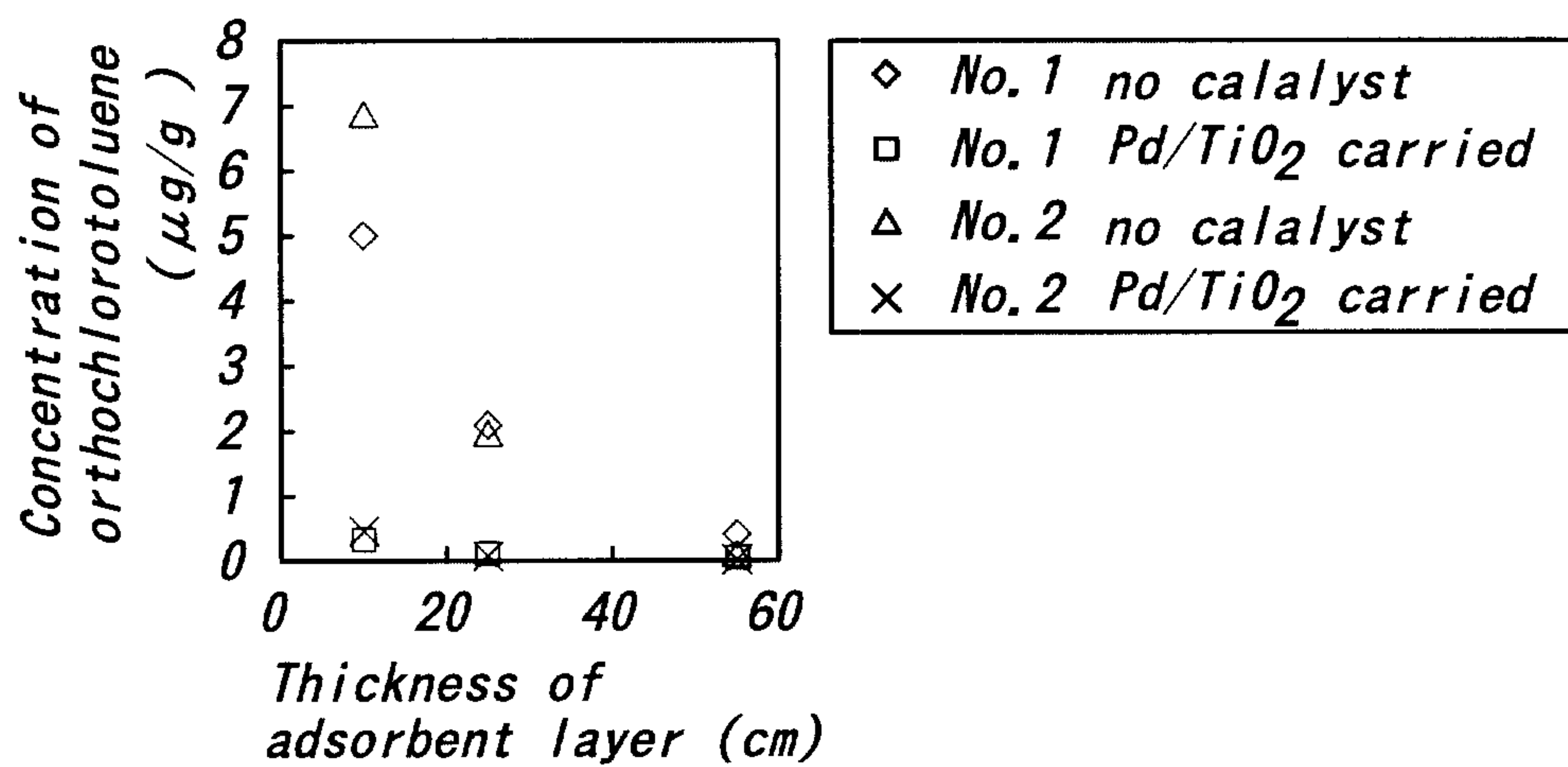


- ◇ No. 1 no catalyst, at outlet
- No. 1 Pd/TiO<sub>2</sub> carried, at outlet
- △ No. 2 no catalyst, at outlet
- × No. 2 Pd/TiO<sub>2</sub> carried, at outlet

FIG. 6

Concentration of  
orthochlorotoluene  
in adsorbent

Thickness of adsorbent layer (cm)	Adsorbent No. 1		Adsorbent No. 2	
	No catalyst	Pt/TiO <sub>2</sub> carried	No catalyst	Pt/TiO <sub>2</sub> carried
10	5.000	0.340	6.800	0.470
25	2.100	0.067	1.900	0.080
55	0.500	0.007	0.400	0.008



**FIG. 7**

Concentration of orthobromotoluene at inlet ( $\mu\text{g}/\text{Nm}^3$ )	Concentration of adsorbent at outlet			
	Adsorbent No. 1		Adsorbent No. 2	
	No catalyst	Pt/TiO <sub>2</sub> carried	No catalyst	Pt/TiO <sub>2</sub> carried
5	0.050	0.020	0.002	0.007
22	0.067	0.041	0.006	0.014
35	0.100	0.087	0.020	0.022

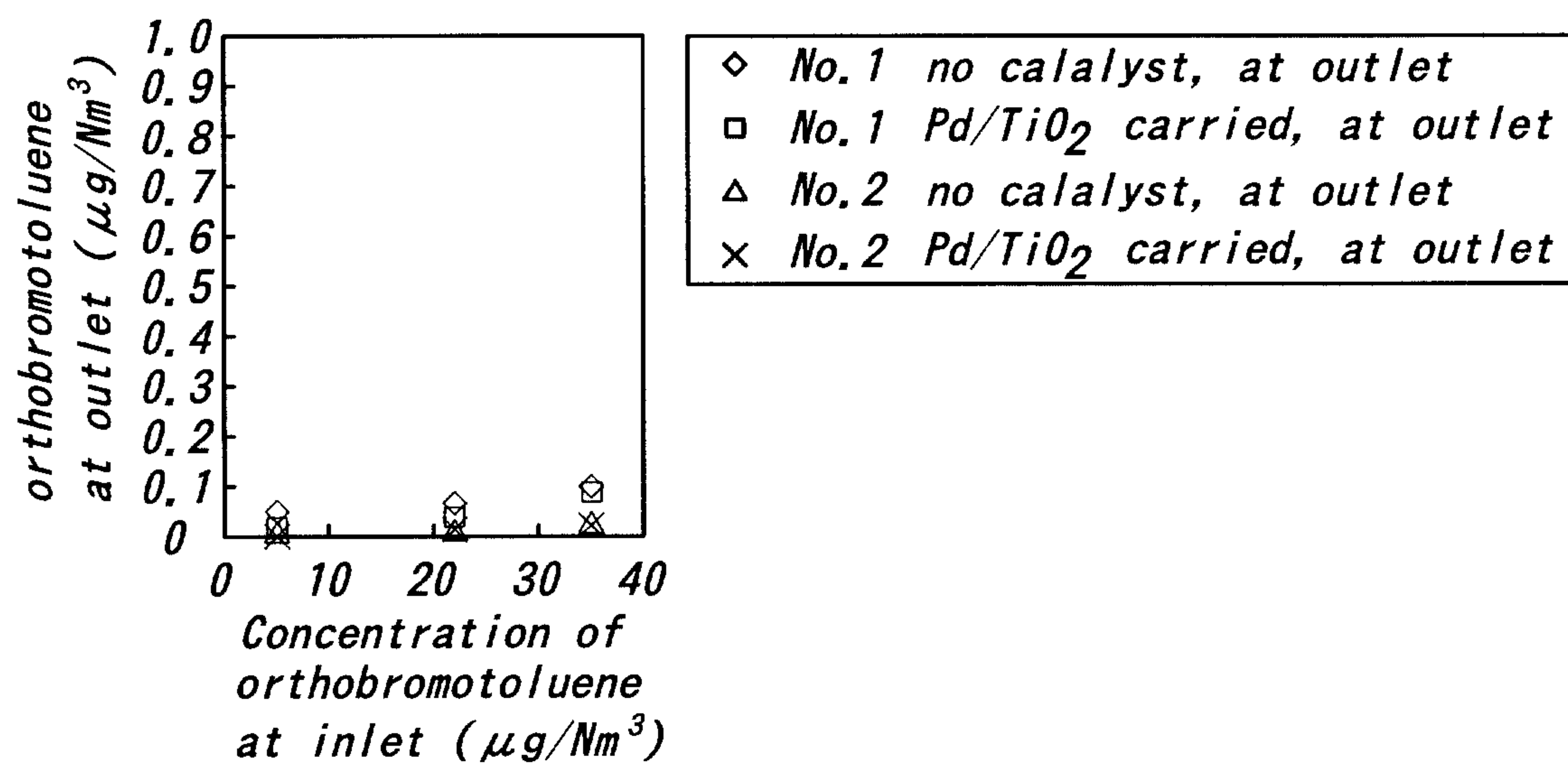


FIG. 8

Concentration of  
orthobromotoluene  
in adsorbent

Thickness of adsorbent layer (cm)	Adsorbent No. 1		Adsorbent No. 2	
	No catalyst	Pt/TiO <sub>2</sub> carried	No catalyst	Pt/TiO <sub>2</sub> carried
5	4.000	0.300	5.600	0.530
22	1.500	0.020	3.500	0.020
35	0.700	0.009	1.400	0.009

