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(72) Inventor: **Li, Langen**
Xi'an, Shannxi 710069 (CN)

(71) Applicant: **Li, Langen**
Xi'an, Shannxi 710069 (CN)

(74) Representative: **Martin, Didier Roland Valéry**
Cabinet Didier Martin
50, chemin des Verrières
69260 Charbonnières-les Bains (FR)

(54) **ATMOSPHERE HEAT TREATMENT COCATALYST, METHOD OF ITS APPLICATION, HEAT TREATMENT METHOD AND HEAT TREATMENT ATMOSPHERE OF USING THE COCATALYST**

(57) The present invention provides operation methods of cocatalysts for atmosphere heat treatment. The cocatalyst are dissolved or dispersed into atmosphere material or atmosphere directly or indirectly, and the cocatalyst keep up the form of gas phase or finer dispersion (such as mote) and diffuse into atmosphere in heat treatment equipment or heat treatment gas-producing equipment so that cocatalyst have largest area contact

with atmosphere material and atmosphere and play a catalysis and activation role to the atmosphere in the atmosphere heat treatment. Also the present invention provides a variety kind of cocatalysts for atmosphere heat treatment of metal material and the methods of atmosphere heat treatment.

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Description**Technology Area**

5 [0001] The present invention involves in a kind of atmosphere heat treatment cocatalyst and the application. In the heat treatment equipment or heat treatment gas-producing equipment the cocatalyst is dispersed into atmosphere material or atmosphere in the form of gas phase or finer dispersion (such as mote), or it can release out the substance with similar function of the cocatalyst. The present invention still involves in various of heat treatment methods using said cocatalyst and said method.

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Technology background

[0002] Heat treatment atmosphere, generally refers to heat treatment protection atmosphere and chemical heat treatment atmosphere, consists of H₂, N₂, CO, a few of CH₄, CO₂, H₂O and NH₄ as well as unsaturated hydrocarbons.

15 [0003] Almost all of carbon compound can fission or create to water and air in high temperature to create heat treatment atmosphere. Those carbon compound can be heat treatment atmosphere material such as Methanol, Ethanol, N-butyl Alcohol, Lopropylalcohol, Acetone, Ethyl acetate, Aniline, Toluene, Xylenes, Kerosene, charcoal, Active carbon, Dimethylmethanemethane, Butane, Natural gas, Coal gas etc.

20 [0004] When carbon compound is used as heat treatment atmosphere material, their function is accordant. Viz. certain carbon are provided and fissioned in high temperature or create to water and air to create heat treatment atmosphere with H₂, N₂, CO and a few of CH₄, CO₂, H₂O, NH₄. Therefore, a kind of material can be replaced by another in practice.

25 [0005] In existing technology, mostly employ to aerate atmosphere material with H₂O and air and Methanol into heat treatment equipment, make use of heat treatment process to create heat treatment atmosphere. Many international and Chinese heat treatment enterprises and heat treatment equipment manufacturers adopt this method.

30 [0006] Said method has an advantage of lower investment of the equipment at first time, but as a result of the limitation of workpiece and heat treatment equipment, higher processing temperature may not be selected. People have not been discovering a kind of proper method of using catalyst in the equipment condition for long time. So said method exists widely insufficient of atmosphere material fission and more carbon soot because of lower temperature and a lack of cocatalyst, it brings much limitation and negative effect to production and processing control.

35 [0007] To solve said problem, many international and Chinese heat treatment enterprises and heat treatment equipment manufacturers adopt a method of increasing a sort of special gas-producing facility outside heat treatment equipment. The special gas-producing facility is filled with a lot of various shapes cocatalysts (accelerant) with many holes. The principle of the holes is material has greater contact with gas so that the atmosphere material to contact with the surface of cocatalyst and be catalyzed in production.

[0008] Because of the gas-producing facility can be used in the higher processing temperature plus the usage of the catalysis, the problem of carbon soot can be solved at certain degree.

40 [0009] At present, some people try to coat the cocatalyst directly on the inside wall of heat treatment equipment contacting with atmosphere material, or to make fixtures and inside of furnace in the material with catalyst effect and so on, expects to increase atmosphere fission and decrease carbon soot, however the result is not any better than using gas-producing equipment.

45 [0010] No matter what kind of equipment is used or what form of atmosphere is employed, reducing carbon soot is always the dream of the heat treatment experts. Reducing carbon soot brings a great deals of advantage for the production and its processing control. Especially in chemical heat treatment carburizing and carbonitriding, people expect to accelerate carburizing speed and production efficiency or lower processing temperature to improve the quality of heat treatment production in high carbon potential control, but because of the effect of carbon soot, the expectation can be hardly realized (It is easy to create carbon soot in high carbon potential).

50 [0011] It is inescapable to create carbon soot even if using gas-producing facility in existing technology. Once carbon soot is formed, it would attach on the surface of cocatalysts and obstruct the contact between atmosphere material and cocatalyst, affect catalysis and make cocatalysis be harder to realize.

[0012] In addition, cocatalyst (accelerant) has the property of poisoning and aging inescapably during the process; despite we may take a step to inspirit catalyst termly.

55 [0013] Whether catalyst aging, poisoning or carbon soot attach on its surface will affect the activation of catalyst, make carbon soot increase, further decrease the catalysis or lose the chance of contacting with atmosphere material as the effect of carbon soot, weaken the activation and the production. Therefore, It is necessary to find out a kind of cocatalyst without the effect of aging, poisoning and carbon soot for heat treatment atmosphere

Invention content

[0014] The purpose of the present invention is to invent a kind of cocatalyst compound without the effect of aging, poisoning and carbon soot for heat treatment atmosphere and the operation method of cocatalyst so that the cocatalyst play a part of catalysis and activation in heat treatment atmosphere formed by atmosphere material, reduce carbon soot and fulfill protect atmosphere heating and chemical heat treatment Carburizing, carbonitriding in higher carbon potential with few carbon soot as well as enhance the efficiency, quality and stability of heat treatment process, decrease process cost.

[0015] A operation method of the present invention is that cocatalyst is dissolved or dispersed into heat treatment atmosphere material or heat treatment atmosphere, and cocatalyst keep up the form of gas phase or finer dispersion (such as mote) and diffused into atmosphere material and/or atmosphere in heat treatment equipment or heat treatment gas-producing equipment. In a practice of the present invention, the cocatalyst is dissolved or dispersed directly or indirectly into heat treatment atmosphere material or heat treatment atmosphere, and cocatalyst keep up the form of gas phase or finer dispersion (such as mote) and is diffused in atmosphere material and/or atmosphere in heat treatment equipment or heat treatment gas-producing equipment so that cocatalyst has the contact of largest area with atmosphere material and atmosphere, thereby exerting adequately the cocatalysis and activation of cocatalyst.

[0016] The cocatalysts in the present invention mean to be such compounds that have catalysis to heat treatment atmosphere formed by atmosphere material and activation to heat treatment atmosphere or release a kind of substance with the same function of said substance in the process condition of heat treatment.

[0017] In the present invention, 'finer dispersion' means to be particles or fluid drop that can suspend in heat treatment atmosphere for enough time, wherein experts in this field think 'enough time' to be the time of playing a obvious part of catalysis in said reaction, or equivalent time to practical time.

[0018] An implementary practice in the present invention provides a kind of heat treatment atmosphere cocatalyst. When the cocatalyst is in heat treatment equipment or heat treatment gas-producing equipment, it has a form of gas phase or finer dispersion and diffuses in atmosphere material and /or atmosphere. In a concrete practice of this invention, the cocatalyst exist in the form of gas phase or finer dispersion, diffuse directly in heat treatment atmosphere material or heat treatment atmosphere or the cocatalyst is dissolved or dispersed into a kind or kinds of material as carry agent and is fed into heat treatment equipment or heat treatment gas-producing equipment with carry agent material together.

[0019] It is worth to say, the present invention has not concrete limitation to atmosphere material, and the atmosphere material can be one or more than one of atmosphere materials. As long as cocatalysts can diffuse in atmosphere material and/or atmosphere with the form of gas phase or finer dispersion in heat treatment equipment or heat treatment gas-producing equipment in heat treatment process, the atmosphere material can be used.

[0020] The heat treatment atmosphere materials mentioned in present invention mean to be all of atmosphere material as we know, for example, Methanol, Ethanol, N-butyl Alcohol, Isopropylalcohol, Xylenes, Toluene, Aniline, Acetone, Ethyl, Acetate, Kerosene, Methane, Ethane, Dimethylmethanemethane, Butane, RX gas, Natural gas, Coal gas, Nitrogen, or they is added water or added air.

[0021] In the implementary practice in invention, said cocatalyst is directly dissolved, dispersed into heat treatment atmosphere material or heat treatment atmosphere and is aerated into heat treatment equipment or heat treatment gas-producing equipment.

[0022] In the practice in the present invention, the cocatalyst is dissolved, dispersed into a kind of material as heat treatment atmosphere material in advance to make the compound (carry agent in the text) such as cocatalyst solution. In practice, the compound such as cocatalyst solution is added into heat treatment atmosphere material or cocatalyst solution is input to heat treatment equipment or heat treatment gas-producing equipment with heat treatment atmosphere material together.

[0023] In implementary practice in the present invention, the cocatalyst is selected from one or arbitrary combination of Compound metal element which takes 0.0003-0.03% weight in heat treatment atmosphere material, optimal selection: 0.0003-0.015%, Compound nitrogen which takes 1-10% weight in heat treatment atmosphere material, optimal selection: 0.1-2%; Compound halogen element which takes 0.1-4% weight in heat treatment atmosphere material, optimal selection: 0.1-1%. Cobalt naphthenateManganese naphthenateNickel Manganese nitrate

[0024] Said Compound metal element is selected from one of Cobalt naphthenate, Manganese naphthenate, Nickel nitrate, Manganese nitrate, Ferrocene, Ferrocene ramification, or arbitrary combination. Optimal selection: Ferrocene and/or Ferrocener amification.

[0025] Said Compound halogen element is selected from one of Chlorobenzene, Trichlorobenzene, Chlorotoluene, Nitrochlorobenzene, Trichloroethylene, Tribromomethane, Iodine, Iodinated Oil, Iodomethane, Freone, Tetrafluoroethylene, or arbitrary combination. Optimal selection: Chlorobenzene, Trichlorobenzene, Chlorotoluene, Nitrochlorobenzene or their combination.

[0026] Said Compound nitrogen is selected from one of P-Amino-Azobenzene Hydrochloride, Nitrobenzene, Toluene

diisocyanate, Nitrochlorobenzene, Nitrobenzene, Trinitrobenzene, Melamine, Tricyanic acid, Dicyandiamide, Guanidine nitrate, Cyclotrimethylenetrinitramine, Pyridine, Pyrazole, Pyraze, or their arbitrary combination. Optimally select from one of P-Amino-Azobenzene Hydrochloride, Nitrobenzene, Toluene, Toluene diisocyanate, Nitrochlorobenzene, Nitrobenzene, Trinitrobenzene, Guanidine nitrate, Cyclotrimethylenetrinitramine, or their arbitrary combination.

5 **[0027]** In a iimplementary practice of the invention, the compound of RE (lanthanum) or RE (cerium) which takes 0.03-3% weight in heat treatment atmosphere material can be added into heat treatment atmosphere material or heat treatment atmosphere. For example, the compound is one of Cerium naphthenates, Lanthanum naphthenates Cerium nitrate, Lanthanum nitrate, Lanthanum chloride, Cerium chloride, lanthanum fluoride, cerium fluoride, Lanthanum Acetate, Cerium Acetate, or their arbitrary compound. Optimal selection: Lanthanum Acetate, Cerium Acetate, Lanthanum oxide, Cerium oxide or their arbitrary compound, because they are not eroded in atmosphere.

10 **[0028]** According to said Compound metal element, Compound halogen, Compound nitrogen and Compound RE (lanthanum) or RE (cerium), although various concrete example are stated above, but the present invention is not limited to said instances and suits for various chemical with as the similar property as said Compounds.

15 **[0029]** In another implementary practice of atmosphere heat treatment method, one or more than one of said four kinds of cocatalysts respectively are adopted with different dosage.

[0030] Another purpose in the present invention is to provide an atmosphere heat treatment method of metal material. The method is practiced in the cocatalys or the active atmosphere of its release substance. The cocatalyst diffuses in the atmosphere in the form of gas or finer dispersion.

20 **[0031]** In an implementary practice of the atmosphere heat treatment in invention, the cocatalyst can be diffused directly into heat treatment atmosphere material or heat treatment atmosphere, or the cocatalyst is dissolved or dispersed into heat treatment atmosphere material in advance to make the admixture such as cocatalyst solution. In usage, the admixture such as cocatalyst solution is added into heat treatment atmosphere material, or is aerated into heat treatment equipment or heat treatment gas-producing equipment with heat treatment atmosphere material together. In an atmosphere heat treatment practice of the present invention, said cocatalyst is used.

25 **[0032]** In an implementary practice of the invention, carburizing and carbonitriding take place in higher carbon potential, optimal selection:0. 25, better optimal selection: 0. 15 carbon potential, or lower obviously temperature, or shorter obviously time in using said cocatalyst than without said cocatalyst.

30 **[0033]** An implementary practice of the present invention narrates a heat treating method of protection atmosphere. The heat treatment processing takes place in the cocatalyst or the active atmosphere released by the cocatalyst, the cocatalysts diffuse into the said atmosphere in gas phase or finer dispersion.

35 **[0034]** Another purpose in the present invention is to provide a kind of heat treatment atmosphere of metal material. The atmosphere comprise the cocatalyst and its release substance that both are diffused into atmosphere material or atmosphere in gas phase or finer dispersion such as mote (suspending for long time) in heat treatment equipment or heat treatment gas-producing equipment as well as play a catalysis to atmosphere material and activation to the atmosphere in heat treatment process.

[0035] The invention also provide a kind of method of raising heat treatment atmosphere carbon potential and falling carbon soot, the characteristic consists in adding a kind of or kinds of the cocatalysts into heat treatment atmosphere or atmosphere material.

40 **[0036]** The invention still provides a kind of carburizing, carbonitriding or nitrocarburizing method in heat treatment. The characteristic consists in putting a kind of or kinds of the said cocatalysts in heat treatment atmosphere or atmosphere material. Proper ammonia gas is may aerated in carbonitriding or nitrocarburizing

[0037] In the present invention, New cocatalyst come into catalyst surroundings and heat treatment atmosphere with atmosphere material together and participate in the reaction, thereby avoiding the problems of cocatalyst aging, poisoning and the problem caused by carbon soot.etc

45 **[0038]** In the method stated in this invention, said cocatalyst is aerated to the equipment and is blended fully with atmosphere material or atmosphere through atmosphere cycle system, accordingly achieve the catalysis of largest area.

[0039] The direct method includes (but does not limits) dispersing cocatalyst into heat treatment atmosphere material and/or atmosphere by various direct mean.

50 **[0040]** For example:

1. The cocatalyst is gasified or atomized by a simple boiling or atomizing system, then is aerated into heat treatment equipment and heat treatment gas-producing equipment with atmosphere material together, and takes place in the reaction.

55 2. Put the cocatalyst and atmosphere material into heat treatment equipment or heat treatment gas-producing equipment together, make the cocatalyst and atmosphere material gasify and take part in the reaction in the high temperature of the equipment.

[0041] The indirect method includes (but not limits) diffusing the cocatalyst into heat treatment atmosphere material and /or atmosphere by every indirect means.

[0042] For example:

5 1. The cocatalyst is dissolved, dispersed into atmosphere material or material and are aerated into equipment together.

2. Selects a kind or kinds of materials as carry agents which may not have negative effect to heat treatment atmosphere or heat treatment process, such as carry agent can be one or more than one of Methanol, Ethanol, 10 Aniline, Toluene, Xylenes, Kerosene, Ethanol, N-butylalcohol, Isopropylalcohol, Acetone, Ethyl Acetate, Dimethylmethanemethane, Butane, Rx-gas, Coal gas, Nitrogen or add water or air into them, dissolve or disperse cocatalyst into the carry agent, then are input to equipment with atmosphere material together.

[0043] In the method stated in the present invention, the cocatalyst is aerated into the equipment and is blended 15 fully with atmosphere material or atmosphere through atmosphere cycle system, accordingly achieve the catalysis of largest contact area.

[0044] The cocatalyst used in the present invention include principally four kinds of cocatalysts as following:

20 1. All of material that have catalysis to heat treatment atmosphere formed by atmosphere material. For example, one or more than one of compounds metal element can selected as the cocatalyst from Cobalt naphthenate, Manganese naphthenate, Nickel nitrate, Manganese nitrate, Ferroceneas well as as Ferrocene ramification (such as Tert-butyl Ferrocene, Acetyl Ferrocene, Ferrocenyl ketone, Ferrocene Formic Acid, Butyl Ferrocene etc. Optimal selection: Ferrocene and Ferroceneramification. The cocatalyst takes 0.0003 ~ 0.03% weight in atmosphere material. Optimal selection: 0.0003~0.015%.

25 2. Compound halogen element which takes 0.1~4% weight in atmosphere material, Optimal selection: 0.1-1%. For example, one or more than one of compounds are selected as the cocatalyst from Chlorobenzen, Trichlorobenzene, Toluene, Chlorotoluen, Nitrochlorobenzene, Trichloroethylene, Tribromomethane, Iodine, Iodinated Oil, Iodomethane, Freone, Tetrafluoroethylene. Optimal selection: Chlorobenzene, Trichlorobenzene, Nitrochlorobenzene. Compound halogen element can release out ions in high temperature, and the ions combine with the hydrogen in atmosphere to create halogenate hydrogen which can activize the surface of workpiece and speed up chemical heat treatment reaction on the phase interface. In order to control the corrosion of halogenate hydrogen to proper limit, It is better to selected more lower dosage. (There are the use of some said material in existing technologh, but the dosage is big, thereby affect signal measure of carbon potential sensor probe, the application is limited)

30 3. Compound nitrogen which takes 1~10% weight in atmosphere material, optimal selection: 0.1-2%. For example, one or more than one of compounds are selected as the cocatalyst from P-Amino-Azobenzene Hydrochloride, Nitrochlorobenzene, Nitrobenzene, Trinitrobenzene, Melamine, Tricyanic acid, Dicyandiamide, Guanidine nitrate, Nitrobenzene, Toluene, Toluene diisocyanate, Cyclotrimethylenetrinitramine, Pyridine, Pyrazole, Pyraze. Optimal selection: P-Amino-Azobenzene Hydrochloride, Nitrobenzene, Toluene, Toluene diisocyanate, Nitrochlorobenzene, Nitrobenzene, Trinitrobenzene, Guanidine nitrate, Cyclotrimethylene trinitramine. Carburizing and carbonitriding in chemical heat treatment, cocatalyst release active nitrogen in heat treatment processing to accelerate each other with the carbon in atmosphere.

45 4. Using three kinds of said cocatalysts, It is better to add the compound of RE(lanthanum) or RE(cerium) which take 0.03~3% weight in atmosphere material fed into heat treatment equipment into atmosphere material or atmosphere. One of the compounds can be selected such as Cerium naphthenates, Lanthanum Naphthenates, Cerium nitrate, Lanthanum Nitrate, Lanthanum chloride, Cerium chloride, Lanthanum fluoride, Cerium fluoride, Lanthanum acetate, Cerium acetate, Lanthanum oxide, Cerium oxide. Optimal selection: Lanthanum acetate, Cerium acetate, Lanthanum oxide, and Cerium oxide. To optimally select is for decreasing the corrosion

[0045] The present invention is suitable for the heat treatment atmosphere producing and heat treatment production. Heat treatment atmosphere comprising H₂, N₂, CO as well as a few CH₄, CO₂, H₂O, NH₄ that are made of atmosphere 55 materially any means.

[0046] The four kinds of said cocatalysts in the present invention have equivalent function in operation. One or more than one of combinations can be used in chemical heat treatment. The Compound metal element should be selected mostly in protective atmosphere heating or protective atmosphere producing.

[0047] Making use of the method stated in the present invention, it can be achieved to raise the gas-producing quantity of heat treatment atmosphere material, reduce carbon soot, lower processing temperature of chemical heat treatment and speed up carburizing, carbonitriding and nitrocarburizing of chemical heat treatment.

[0048] To make use of the present invention can obtain the achievements as following:

5 1. Atmosphere material can be fissioned fully, carbon soot is decreased and the gas-producing quality tends to be stable in heat treatment.

10 2. The controllable property and the stability in heat treatment process is strengthened.

3. It can be leaved out to invest heat treatment atmosphere generator, atmosphere material and energy sources can be saved.

15 4. The carbon soot is hardly created in higher atmosphere carbon potential in heat treatment.

5. Lower process temperature in chemical heat treatment by about 50 degree C. Thereby decrease metallography structure to tend to rough, reduce the distortion of worepiece.

20 6. Speed up carburizing, carbonitriding more than about 40% in the same process temperature with ordinary chemical heat treatment. Obviously increase efficiency of production, save electricity cost.

Fig illustrates

[0049]

25 - Fig 1 is a sketch that illustrates cocatalyst to be gasified and atomized by the system and entering into heat treatment equipment or heat treatment gas-producing equipment with atmosphere material together.

30 - Fig.2 is a sketch that illustrates cocatalyst and atmosphere material entering into heat treatment equipment or heat treatment gas-producing equipment together.

- Fig.3 is a sketch that illustrates cocatalyst to be dissolved, dispersed into atmosphere material, and aerated into heat treatment equipment with atmosphere material together.

35 - Fig.4 is a sketch that illustrates cocatalyst to be dissolved, dispersed into carry agent and aerated heat treatment equipment or heat treatment gas-producing equipment with atmosphere material together.

Example of Practice (method and compound):

40 **[0050]** In the atmosphere material (except Methanol) enumerated below, one kind of kinds of carbon compound can be used as atmosphere material. The carbon compound are Kerosene, Ethanol, N-butyl alcohol, Lsopropylalcohol, Xylenes, Toluene, Aniline, Acetone, Ethyl acetate, Methane, Ethane, Dimethylmethane, Butane, RX gas, Natural gas, Coal gas.

45 **A. Method and Example (hatching part in attached drawing is new content increased in original drawing)**

[0051]

50 1. Fig.1 illustrate cocatalyst to be gasified and atomized by the system and entering into heat treatment equipment or heat treatment gas-producing equipment with atmosphere material together.

2. Fig.2 illustrate cocatalyst and atmosphere material entering into heat treatment equipment or heat treatment gas-producing equipment together. Cocatalyst and atmosphere material are gasified together making use of high temperature of heat treatment.

55 3. Fig.3 illustrate cocatalyst to be dissolved, dispersed into atmosphere material, and aerated into heat treatment equipment with atmosphere material together.

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4. Fig.4 illustrate selecting a kind of impregnant, which has not negative effect to heat treatment atmosphere or heat treatment process. Such as impregnant can be selected from below: Methanol, Ethanol, Aniline, Toluene, Xylenes, Kerosene, Kerosene, Ethanol, N-butyl alcohol, Lsopropylalcohol, Acetone, Ethyl acetate, DimethylMethane, Butane, RX gas etc. Cocatalyst is dissolved, dispersed into the impregnant, and are fed into heat treatment equipment with atmosphere material together.

5. In existing technology, the catalyst should be activated in heat treatment gas-producing generator in 30 days, and be changed in about a year, meanwhile it needs to stop equipment. In present invention, it should not need to spend extra time to specially activize and change cocatalyst. In original technology, the temperature of gas-producing equipment should be controlled at above 1000°C, gas-producing quality can be stable, eligible.

Atmosphere keep at the scope $CO_2 \leq 0.5\%$, $CH_4 \leq 0.04\%$. Adopting the cocatalyst in present invention, the lowest heat treatment temperature can be decreased to about 800°C, still gain the same gas-producing quality.

a) Natural gas and air are aerated into heat treatment gas-producing equipment filled with Nickel cocatalyst in 1050°C, run successively heat treatment equipment for 35 days, CO_2 is 0.43%, CH_4 is 0.038% in the atmosphere through measure; Run successively heat treatment equipment for 40 days, CO_2 is 0.63%; CH_4 is 0.1% in the atmosphere. It is shown for the catalyst to be poisoning severely. Taking out the catalyst, the catalyst has been surrounded almost completely.

b) Natural gas, air and cocatalyst compound in present invention are aerated into heat treatment gas-producing generator without accelerant in 950°C together, and check atmosphere after run successively in 35days, the CO_2 of the atmosphere is 0.33%, CH_4 is 0.03%, after run successively in 45days, the CO_2 of the atmosphere is 0.35%, CH_4 is 0.03%, after run successively in 60 days, the CO_2 of the atmosphere is 0.34%, CH_4 is 0.03%.

6. In the chemical heat treatment of existing technology, the highest carbon potential is less than 1.25% under the 920 °C process temperature, the highest carbon potential is less than 1.15% under the 880 °C process temperature, the highest carbon potential is less than 1.05% under the 850°C process temperature, unless the carbon potential control of oxygen probe will be failure as a effect of carbon soot and the production would not be gone along. Using the method and cocatalyst of present invention, the higher carbon potential can be increased by about 0.20% and carbon soot is not raised. Refer to table 1.

7. Example: Natural gas and air are aerated into 90kw of pit furnace or a 600 type of multi-furnace, use oxygen probe to control atmosphere carbon potential, turn off auto carbon-burning switch, test oxygen probe failure time in different temperature carbon potential and in adding and not adding the cocatalyst compound in the present invention. The result is shown in table 1.

Table 1:

	Temperature	Carbon Potential	Cocatalyst	Failure time of oxygen probe	Hardness in 4hours strengthen carburizing (mm)		
					20	20Cr	20CrMnTi
1	920°C	1.25%	N	<1hour	0.84	0.87	0.89
			Y	>1hour	0.99	1.03	1.05
		1.40%	N	< 0.5hour	0.70	0.73	0.75
			Y	>1hour	1.33	1.35	1.39
2	880°C	1.15%	N	<1hour	0.70	0.72	0.73
			Y	>1hour	0.83	0.84	0.86
		1.35%	N	< 0.5hour	0.59	0.63	0.65
			Y	>1hour	1.12	1.15	1.19

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Table 1: (continued)

	Temperature	Carbon Potential	Cocatalyst	Failure time of oxygen probe	Hardness in 4hours strengthen carburizing (mm)		
					20	20Cr	20CrMnTi
3	850°C	1.00%	N	< 0.5hour	0.53	0.52	0.55
			Y	>1hour	0.72	0.73	0.76
		1.25%	N	< 0.5hour	0.51	0.53	0.55
			Y	>1hour	1.00	1.05	1.10
4	830°C	0.75%	N	< 0.5hour	0.21	0.22	0.25
			Y	>1hour	0.61	0.63	0.65
		1.00%	N	< 0.5hour	0.21	0.19	0.20
			Y	>1hour	0.74	0.78	0.80

8. Under the 850°C of condition, Natural gas and air are aerated Natural gas into 90kw of pit furnace or 600-type multi- furnace without cocatalyst compound of the present invention. Atmosphere carbon potential is 1.00% with oxygen probe control. After 15 minutes, oxygen probe seize up. The reason is much more carbon enwrap oxygen probe. Put respectively 10 samples that the material are No.20, 20Cr, 20CrMnTi (equivalent 8620 AISI), high 20 mm, diameter 90 mm, in said atmosphere to carry through Carburizing experiment. The results we discover through 4 hours keeping temperature are: 1.The carbon thickness attached on the samples reach to about 1 mm, 2. The table 1 shows the hardness result of three kinds of material.

9. Natural gas and air are aerated Natural gas into 90kw of pit furnace or 600 type of multi-furnace respectively under 920°C, 880°C, 850°C, 830°C of condition without cocatalyst compound of the present invention, using oxygen probe control atmosphere carbon potential. Put respectively 10 samples that the material are 20, 20Cr, 20CrMnTi, diameter 90mm, height 20mm into atmosphere to do Carburizing experiment. The table 1 shows the three kind of Carburizing result of samples after 4 hours of heat preservation.

10. Natural gas, air and cocatalyst compound of present invention are aerated Natural gas into 90kw of pit furnace or 600 type of multi-furnace respectively under 920°C, 880°C, 850°C, 830°C of condition, using oxygen probe control atmosphere carbon potential. Put respectively 10 samples that the material are 20, 20Cr, 2CrMnTi, diameter 90mm, height 20mm to do Carburizing experiment. The three kind of Carburizing result of samples is shown below after 4 hours of heat preservation.1. There is not carbon soot obviously. 2. The three kind of Carburizing result of samples is shown in the table 1.

11. Natural gas, air and cocatalyst compound of the present invention are aerated Natural gas into 90kw of pit furnace or 600 type of multi-furnace together respectively under 920°C, 880°C, 850°C, 830°C of condition, using oxygen probe control atmosphere carbon potential. Put respectively 10 samples that the material are 20, 20Cr, 2CrMnTi, diameter 90mm, height 20mm into atmosphere fed a few ammonia gas to do Carburizing experiment, The three kind of Carburizing result of samples after 4 hours of heat preservation is shown below.1. There is not carbon soot obviously. 2. The three kind of Carburizing result of samples is shown in the table 1.

12. Aerate Natural gas and air Natural gas into 105kw of pit furnace or 1000 type multi-furnace, carry through the experiment of protect atmosphere heat treatment for 2 hours under 920,880,850,830°C condition. The atmosphere-protecting effect is much better after adding cocatalyst compound of the present invention than before.

13. Aerate Natural gas and air into 105kw of pit furnace or 1000 type of multi-furnace respectively under 920°C, 880°C, 850°C, 830°C of condition, control atmosphere carbon potential as 0.85% using oxygen probe, put respectively 10 samples after carburizing that the material are 20, 20Cr, 20CrMnTi, diameter 90mm, height 20mm to do atmosphere-protecting heating quench experiment for 2 hours. The result is shown that the hardness is higher 1 to 2 degree after adding the cocatalyst compound of the present invention than before. And oxidation decarbonization does not take place.

B. The explanation of cocatalyst application

[0052]

1. The condition, method and result of experiment and contrast in the practice 11, 13, 16, 18, 20, 22, 25, 27 refer to practice 5, 6, 7, 12.

2. The experiment condition, method, measure result and contrast in other practice refer to the practice 8, 9, 10, and 11.

3. There is an equivalent function in the compound halogen element in the practice below such as Trichlorobenzene, Chlorotoluene, chlorobenzene, Nitrochlorobenzene Carbon tetrachloride, Dichloroethane, Trichloroethane, Trichloroethylene, TTri bromomethanemethane, Iodine, Iodinated Oil, Iodomethane, Freone, and Tetrafluoroethylene. They can be replaced each other in practice.

4. There is an equivalent function in the material such as metal element volatile organic compounds that have catalysis to atmosphere material in the process of high temperature fission and oxidation. The material below can be replaced each other. The metal element volatile organic compounds can be Cobalt naphthenate, Manganese naphthenate, Nickel nitrate, Manganese nitrate, Ferrocene as well as Ferrocene ramification (such as Tert-butyl Ferrocene, Acetyl Ferrocene, Ferrocenyl ketone, Ferrocene formic acid, Butyl Ferrocene etc.).

5. There is an equivalent function in the material such as nitrogen volatile organic compounds that have been listed in the practice below. The material below can be replaced each other. The nitrogen volatile organic compounds can be P-Amino-Azobenzene Hydrochloride, Nitrochlorobenzene, Nitrobenzene, Trinitrobenzene, Melamine, Tri-cyanic acid, Dicyandiamide, Guanidine nitrate, Aniline, Toluene diisocyanate, Cyclotrimethylenetrinitramine, Pyridine, Pyrazole, Pyraze, Formamide, Acetamide, Carbamide, Ammoniumnitrateetc.

6. The atmosphere carbon potential can be set up by Methanol, water and air in the practice below.

7. The cheaper inertia gas such as nitrogen gas is added to decrease the costs of production, and ammonia gas is aerated to make carbonitriding in the practice below.

C. The example of the cocatalyst

The practice 1

[0053] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add 2% weight of Chlorobenzene into Ethyl acetate as atmosphere material and add Methanol, water and air to set up carbon potential.

The practice 2

[0054] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add 1% weight of Trichloroethylene into Methanol as atmosphere material and add kerosene to set up carbon potential.

The practice 3

[0055] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add 4% weight of Chlorotoluene into Methanol as atmosphere material.

The practice 4

[0056] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve Dichloroethane into Methanol or other solvent, aerate it into the furnace with atmosphere material together and control the weight of Dichloroethane to be 0.1 % of atmosphere material fed into the furnace using one of Methane, Ethane, Dimethyl methane, Butane, RX gas and Natural gas etc.as atmosphere material.

The practice 5

5 [0057] It can accelerate carbonizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the Freone which takes 2% of weight in the atmosphere material fed into the furnace into gas phase material and add Methanol, water and air to set up carbon potential using one of Methane, Ethane, Dimethyl methane, Butane, RX gas, Natural gas and Coal gas etc.as atmosphere material.

The practice 6

10 [0058] It can accelerate carbonizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cerium flouride (with double function of rare earth and halogen) which takes 1.3% of weight in the atmosphere material fed into the furnace into Ethanol as atmosphere material and add Methanol, water and air to set up carbon potential.

15 **The practice 7**

20 [0059] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Lanthanum flouride (with double function of rare earth and halogen) which takes 1.9% of weight in the atmosphere material fed into the furnace into Methanol as atmosphere material and add kerosene to set up carbon potential.

The practice 8

25 [0060] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Cerium naphthenates which takes 2% of weight in the atmosphere material fed into the furnace and the Trichloroethylene which takes 1% of the atmosphere material into Methanol and Benzene as atmosphere material.

30 **The practice 9**

35 [0061] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve Tribromomethane and Lanthanum nitrate into Methanol or other solvent, aerate them into the furnace with atmosphere material together and control the weight of Tribromomethane to be 1% of the atmosphere material fed into the furnace and the weight of Lanthanum nitrate to be 0.6% of the atmosphere material using one of Methane, Ethane, Dimethylmethane, Butane, RX gas and Natural gas etc.as atmosphere material.

The practice 10

40 [0062] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the Iodine which takes 1.5% of weight in the atmosphere material fed into the furnace and the Cerium naphthenates which takes 1.5% of weight in the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together using one of Methane, Ethane, Dimethylmethane, Butane, RX gas and Natural gas etc. as atmosphere material

45 **The practice 11**

[0063] Add the Cobalt naphthenate that takes 0.015% of weight in the atmosphere material fed into the furnace into kerosene as atmosphere material to make heat treatment atmosphere or process atmosphere heat treatment protection. It can decrease carbon soot and increase gas-producing quantity.

50 **The practice 12**

55 [0064] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Manganese naphthenate which takes 0.02% weight of the atmosphere material fed into the furnace into Toluene as atmosphere material and add Methanol, water and air to set up carbon potential.

The practice 13

5 [0065] Add the Manganese nitrate that takes 0.01% of weight in the atmosphere material fed into the furnace into Methanol as atmosphere material to make heat treatment atmosphere or process atmosphere heat treatment protection. It can decrease carbon soot and increase gas-producing quantity.

The practice 14

10 [0066] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Nickel nitrate which takes 0.008% weight of the atmosphere material fed into the furnace into Methanol as atmosphere material and add Ethyl acetate to set up carbon potential.

The practice 15

15 [0067] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Ferrocenyl ketone which takes 0.0003% weight of the atmosphere material fed into the furnace into Methanol and Acetone as atmosphere material.

The practice 16

20 [0068] Using one of Methane, Ethane, Dimethylmethane, Butane, RX gas and Natural gas etc.as atmosphere material, dissolve the Cobalt naphthenate into Acetone or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Cobalt naphthenate to be 0.005% weight of the atmosphere material fed into the furnace, add Methanol, water or air to set up carbon potential, make heat treatment atmosphere or process atmosphere heat treatment protection. It can decrease carbon soot and increase the atmosphere- producing quantity.

The practice 17

30 [0069] Nickel Nickel It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Nickel nitrate into Methanol or other solvent, aerate it into the furnace with atmosphere material together, control the quantity of Nickel nitrate to be 0.0008% weight of the atmosphere material fed into the furnace using one of Methane, Ethane, Dimethylmethanemethane, BButane, RX gas and Natural gas etc. as atmosphere material.

The practice 18

35 [0070] It can decrease carbon soot, increase gas-producing quantity to diffuse the Butyl Ferrocene which takes 0.008% of weight in the atmosphere material fed into the furnace into gas phase, aerate it into the furnace with atmosphere material together, add Methanol, water or air to set up carbon potential and make heat treatment atmosphere or process atmosphere heat treatment protection using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc.as atmosphere material.

The practice 19

45 [0071] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the acetyl ferrocene which takes 0.004% of weight in the atmosphere material fed into the furnace into gas phase and aerate it into the furnace with atmosphere material together using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc.as atmosphere material.

The practice 20

50 [0072] It can decrease carbon soot, increase gas-producing quantity to add the Ferrocenyl ketone which takes 0.03% weight of the atmosphere material fed into the furnace and the Lanthanum chloride which takes 3% weight of the atmosphere material into Acetone as atmosphere material, add Methanol, water or air to set up carbon potential and make heat treatment atmosphere or process atmosphere heat treatment protection.

The practice 21

5 [0073] Cerium chloride It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Ferrocene formic acid which takes 0.0003% weight of the atmosphere material fed into the furnace and the Cerium chloride which takes 2% weight of the atmosphere material into Xylenes as atmosphere material and add Methanol, water or air to set up carbon potential.

The practice 22

10 [0074] It can decrease carbon soot, increase gas-producing quantity to add the butyl ferrocene which takes 0.03% weight of the atmosphere material fed into the furnace and the Lanthanum nitrate which takes 0.6% weight of the atmosphere material into Methanol as atmosphere material to make heat treatment atmosphere or process atmosphere heat treatment protection.

15 **The practice 23**

20 [0075] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.002% weight of the atmosphere material fed into the furnace and the Cerium nitrate which takes 3% weight of the atmosphere material into Methanol as atmosphere material and add kerosene to set up carbon potential.

The practice 24

25 [0076] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.08% weight of the atmosphere material fed into the furnace and the Lanthanum nitrate which takes 0.1% weight of the atmosphere material into Methanol and Ethyl acetate as atmosphere material.

30 **The practice 25**

35 [0077] It can decrease carbon soot, increase gas-producing quantity to dissolve Manganese nitrate and Lanthanum naphthenates into Methanol or other solvent, aerate them into the furnace with atmosphere material together and control the weight of Manganese nitrate to be 0.01% of the atmosphere material fed into the furnace and the weight of Lanthanum naphthenates to be 0.5% of the atmosphere material and add Methanol, water or air to set up carbon potential to make heat treatment atmosphere or process atmosphere heat treatment protection using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material

The practice 26

40 [0078] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve Lanthanum acetate and Cerium acetic acid into Methanol or other solvent, aerate them into the furnace with atmosphere material together and control the weight of Lanthanum acetate to be 0.003% of the atmosphere material fed into the furnace and the weight of Cerium acetic acid to be 1% of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

45 **The practice 27**

50 [0079] It can decrease carbon soot, increase gas-producing quantity to diffuse the Ferrocene which takes 0.0015% of weight in the atmosphere material fed into the furnace and the Cerium naphthenates which takes 0.3% of weight in the atmosphere material into gas phase, aerate it into the furnace with atmosphere material together, add Methanol, water or air to set up carbon potential to make heat treatment atmosphere or process atmosphere heat treatment protection using one of Methane, Ethane, Dimethylmethane, Butane, RX gas and Natural gas etc. as atmosphere material.

55 **The practice 28**

[0080] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the acetyl ferrocene which takes 0.006% weight of the atmosphere material fed into the furnace and

the Cerium naphthenates which takes 1.5% weight of the atmosphere material into gas phase as atmosphere material using one of Methane, Ethane, Dimethylmethane, Butane, RX gas, coal gas and Natural gas etc.as atmosphere material.

5 **The practice 29**

[0081] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the P-amino-azobenzene hydrochloride which takes 0.002% weight of the atmosphere material fed into the furnace into kerosene as atmosphere material and add Methanol, water and air to set up carbon potential.

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The practice 30

[0082] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Pyrazewhich takes 2% weight of the atmosphere material fed into the furnace into Methanol as atmosphere material and add N-butyl alcohol to set up carbon potential.

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The practice 31

[0083] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Cyclotrimethylenetrinitramine which takes 1% weight of the atmosphere material fed into the furnace into Methanol and kerosene as atmosphere material.

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The practice 32

[0084] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Acetamide into Methanol or other solvent, aerate it into the furnace with atmosphere material together, control the quantity of Nickel nitrate to be 6% weight of the atmosphere material fed into the furnace using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

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30 **The practice 33**

[0085] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add Formamide which takes 3% weight of the atmosphere material fed into the furnace into gas phase, aerate it into the furnace with atmosphere material together and add Methanol, water and air to set up carbon potential.

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The practice 34

[0086] Cerium oxide It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cerium oxide which takes 2% weight of the atmosphere material fed into the furnace and the pyrazole which takes 1% weight of the atmosphere material into Lsopropylalcohol as atmosphere material, and add Methanol, water and air to set up carbon potential.

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The practice 35

[0087] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Lanthanum oxide which takes 1.2% weight of the atmosphere material fed into the furnace and the melamine which takes 2% weight of the atmosphere material into Methanol as atmosphere material, and add kerosene to set up carbon potential.

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50 **The practice 36**

[0088] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Cerium oxide which takes 1% weight of the atmosphere material fed into the furnace and the Dicyandiamide which takes 1% weight of the atmosphere material into Methanol and N-butyl alcohol as atmosphere material.

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The practice 37

5 [0089] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Pyridine and Cerium naphthenates into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Pyridine to be 1% weight of the atmosphere material fed into the furnace and the quantity of Cerium naphthenates to be 0.6% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

10 **The practice 38**

15 [0090] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse Cyclotrimethylenetrinitramine which takes 1% weight of the atmosphere material fed into the furnace and the Cerium naphthenates which takes 1% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together.

The practice 39

20 [0091] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.003% weight of the atmosphere material fed into the furnace and the chlorobenzene which takes 2% weight of the atmosphere material into Ethyl acetate as atmosphere material, and add Methanol, water and air to set up carbon potential.

The practice 40

25 [0092] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Nickel nitrate which takes 0.006% weight of the atmosphere material fed into the furnace and the Trichloroethylene which takes 1% weight of the atmosphere material into Methanol as atmosphere material, and add kerosene to set up carbon potential.

30 **The practice 41**

35 [0093] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Ferrocene which takes 0.0009% weight of the atmosphere material fed into the furnace and the Chlorotoluene which takes 2% weight of the atmosphere material into Methanol and kerosene as atmosphere material.

The practice 42

40 [0094] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Manganese nitrate and Dichloroethane into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Manganese nitrate to be 0.01 % weight of the atmosphere material fed into the furnace and the quantity of Dichloroethane to be 1% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

45 **The practice 43**

50 [0095] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse Ferrocene which takes 0.006% weight of the atmosphere material fed into the furnace and the Freone which takes 2% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together, and add Methanol, water and air to set up carbon potential.

The practice 44

55 [0096] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate takes 0.009% weight of the atmosphere material fed into the furnace, the Cerium naphthenates which takes 1% weight of the atmosphere material and the Nitrochlorobenzene which takes 2% weight of the atmosphere material into Ethanol as atmosphere material, and add Methanol, water and air to set up carbon potential.

The practice 45

5 [0097] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate takes 0.07% weight of the atmosphere material fed into the furnace, the Lanthanum nitrate which takes 0.9% weight of the atmosphere material and the Trichloroethane which takes 2% weight of the atmosphere material into Methanol as atmosphere material, and add Methanol, water and air to set up carbon potential.

The practice 46

10 [0098] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Ferrocene takes 0.001% weight of the atmosphere material fed into the furnace, the Cerium naphthenates which takes 2% weight of the atmosphere material and the Trichloroethylene which takes 1% weight of the atmosphere material into Methanol as atmosphere material.

The practice 47

15 [0099] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Manganese naphthenate, Tribromomethanemethane, and Lanthanum nitrate into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Manganese naphthenate to be 0.006% weight of the atmosphere material fed into the furnace, the quantity of Tribromomethanemethane to be 1% weight of the atmosphere material and the quantity of Lanthanum nitrate to be 0.6% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

The practice 48

20 [0100] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse Ferrocene which takes 0.006% weight of the atmosphere material fed into the furnace, the Iodine which takes 1.5% weight of the atmosphere material and the Cerium naphthenates which takes 1% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together.

The practice 49

25 [0101] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Iodinated oil takes 1% weight of the atmosphere material fed into the furnace and the Guanidine nitrate which takes 2% weight of the atmosphere material into Methanol as atmosphere material, add Methanol, water and air to set up carbon potential.

The practice 50

30 [0102] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Tribromomethanemethane takes 2% weight of the atmosphere material fed into the furnace and the Nitrobenzene which takes 1% weight of the atmosphere material into Methanol as atmosphere material, add Methanol, water and air to set up carbon potential.

The practice 51

35 [0103] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Iodomethane takes 2% weight of the atmosphere material fed into the furnace and the Tricyanic acid which takes 1% weight of the atmosphere material into Methanol and kerosene as atmosphere material.

The practice 52

40 [0104] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Tetrafluoroethylene and Tricyanic acid into Methanol or other solvent, aerate them into the furnace with atmosphere material together, ontrl the quantity of tetrafluoroethylene to be 2% weight of the atmosphere material fed into the furnace and the quantity of tricyanic acid to be 1% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc.as atmosphere material.

The practice 53

5 [0105] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the Carbon tetrachloride which takes 2% weight of the atmosphere material fed into the furnace and the Toluene diisocyanate which takes 3% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together, and add Methanol, water and air to set up carbon potential.

The practice 54

10 [0106] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Lanthanum naphthenates which takes 2% weight of the atmosphere material fed into the furnace, the Iodinated oil which takes 2% weight of the atmosphere material and the Nitrochlorobenzene which takes 1% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together, and add Methanol, water and air to set up carbon potential.

The practice 55

15 [0107] Cerium chloridelt can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cerium chloride (with double function of rare earth and halogen) which takes 1.6% of weight in the atmosphere material fed into the furnace and the Nitrobenzene which takes 1% of weight in the atmosphere material into Methanol as atmosphere material and add kerosene to set up carbon potential.

The practice 56

20 [0108] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Lanthanum naphthenates which takes 1.6% of weight in the atmosphere material fed into the furnace and the Nitrochlorobenzene (with double function of rare earth and halogen) which takes 1% of weight in the atmosphere material into Methanol as atmosphere material.

The practice 57

25 [0109] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Carbon tetrachloride, Pyridine and Cerium naphthenates into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Carbon tetrachloride to be 1% weight of the atmosphere material fed into the furnace, the quantity of Pyridine to be 1% weight of the atmosphere material and the quantity of Cerium naphthenates to be 0.2% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

The practice 58

30 [0110] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the Iodomethane which takes 1.1% weight of the atmosphere material fed into the furnace, the Freone which takes 2% weight of the atmosphere material and the Cerium naphthenates which takes 0.1% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together, and add Methanol, water and air to set up carbon potential.

The practice 59

35 [0111] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.002% weight of the atmosphere material fed into the furnace and the P-amino-azobenzene hydrochloride which takes 2% weight of the atmosphere material into kerosene as atmosphere material, add Methanol, water and air to set up carbon potential.

The practice 60

40 [0112] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.02% weight of the atmosphere material fed into the furnace and the Pyrazewhich takes 2% weight of the atmosphere material into Methanol as atmosphere material, add N-butyl

alcohol to set up carbon potential.

The practice 61

5 [0113] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Ferrocene ramification which takes 0.0009% of weight in the atmosphere material fed into the furnace and the Cyclotrimethylenetrinitramine which takes 1% of weight in the atmosphere material into Methanol and kerosene as atmosphere material.

10 **The practice 62**

[0114] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Manganese nitrate and acetamide into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Manganese nitrate to be 0.006% weight of the atmosphere material fed into the furnace and the quantity of Acetamide to be 2% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

The practice 63

20 [0115] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the Acetyl ferrocene which takes 0.006% weight of the atmosphere material fed into the furnace and the Formamide which takes 1% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together, and add Methanol, water and air to set up carbon potential.

25 **The practice 64**

[0116] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.002% weight of the atmosphere material fed into the furnace, the Cerium nitrate which takes 2% weight of the atmosphere material and the Pyrazole which takes 1% weight of the atmosphere material into Isopropylalcohol as atmosphere material, add Methanol, water and air to set up carbon potential.

The practice 65

35 [0117] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.02% weight of the atmosphere material fed into the furnace, the Lanthanum nitrate which takes 1.2% weight of the atmosphere material and the Melamine which takes 2% weight of the atmosphere material into Methanol as atmosphere material, add kerosene to set up carbon potential.

40 **The practice 66**

[0118] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Ferrocene formic acid which takes 0.0009% weight of the atmosphere material fed into the furnace, the Cerium naphthenates which takes 1% weight of the atmosphere material and the Dicyandiamide which takes 1% weight of the atmosphere material into Methanol and N-butyl alcohol as atmosphere material.

The practice 67

50 [0119] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Manganese nitrate, Pyridine and Cerium naphthenates into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Manganese nitrate to be 0.02% weight of the atmosphere material fed into the furnace, the quantity of Pyridine to be 1% weight of the atmosphere material and the quantity of Cerium naphthenates to be 0.6% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

55 **The practice 68**

[0120] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to

rizing to diffuse the Tert-butyl ferrocene which takes 0.006% weight of the atmosphere material fed into the furnace, the Guanidine nitrate which takes 1% weight of the atmosphere material and the Cerium naphthenates which takes 1% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together.

5 **The practice 69**

[0121] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.003% weight of the atmosphere material fed into the furnace, the Iodinated oil which takes 1% weight of the atmosphere material and the Guanidine nitrate which takes 2% weight of the atmosphere material into acetone as atmosphere material, add Methanol, water and air to set up carbon potential.

The practice 70

15 [0122] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.002% weight of the atmosphere material fed into the furnace, the Tribromomethanemethane which takes 2% weight of the atmosphere material and the Nitrobenzene which takes 1% weight of the atmosphere material into Methanol as atmosphere material, add kerosene to set up carbon potential.

The practice 71

20 [0123] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add respectively the Ferrocene which takes 0.004% weight of the atmosphere material fed into the furnace, the Iodomethane which takes 2% weight of the atmosphere material and the tricyanic acid which takes 1% weight of the atmosphere material into Methanol and kerosene as atmosphere material.

25 **The practice 72**

[0124] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Manganese nitrate, tetrafluoroethylene and tricyanic acid into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Manganese nitrate to be 0.006% weight of the atmosphere material fed into the furnace, the quantity of Tetrafluoroethylene to be 2% weight of the atmosphere material and the quantity of tricyanic acid to be 1% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

35 **The practice 73**

[0125] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the Manganese naphthenate which takes 0.003% weight of the atmosphere material fed into the furnace, the toluene which takes 2% weight of the atmosphere material and the Toluene diisocyanate which takes 3% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together, and add Methanol, water and air to set up carbon potential.

The practice 74

45 [0126] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate which takes 0.003% weight of the atmosphere material fed into the furnace, the Lanthanum naphthenates which takes 2% weight of the atmosphere material and the Trichlorobenzene which takes 0.004% weight of the atmosphere material into kerosene as atmosphere material, add Methanol, water and air to set up carbon potential or add ammonia gas.

50 **The practice 75**

[0127] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Cobalt naphthenate takes 0.02% weight of the atmosphere material fed into the furnace, the Cerium chloride (instead rare earth and halogen) which takes 1% weight of the atmosphere material and the Nitrobenzene which takes 1% weight of the atmosphere material into Methanol as atmosphere material, add kerosene to set up carbon potential.

The practice 76

5 [0128] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Butyl ferrocene which takes 0.0009% weight of the atmosphere material fed into the furnace, the Lanthanum naphthenates which takes 2% weight of the atmosphere material, the Carbon tetrachloride which takes 2% weight of the atmosphere material and the Trinitrobenzene which takes 1% weight of the atmosphere material into Methanol and Kerosene as atmosphere material, add Methanol, water and air to set up carbon potential.

The practice 77

10 [0129] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Manganese nitrate, Carbon tetrachloride, Pyridine and Cerium naphthenates into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Manganese nitrate to be 0.01% weight of the atmosphere material fed into the furnace, the quantity of Carbon tetrachloride to be 1% weight of the atmosphere material, the quantity of Pyridine to be 1% weight of the atmosphere material the quantity of Cerium naphthenates to be 0.2% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

The practice 78

20 [0130] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the Butyl Ferrocene which takes 0.006% weight of the atmosphere material fed into the furnace, the Iodomethane which takes 1.1% weight of the atmosphere material, the Freone which takes 2% weight of the atmosphere material and the Cerium naphthenates which takes 0.1% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together.

The practice 79

30 [0131] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to diffuse the Butyl Ferrocene which takes 0.006% weight of the atmosphere material fed into the furnace, the P-Amino-Azobenzene Hydrochloride which takes 1% weight of the atmosphere material, the Freone which takes 2% weight of the atmosphere material and the Cerium naphthenates which takes 0.1% weight of the atmosphere material into gas phase, aerate them into the furnace with atmosphere material together.

The practice 80

35 [0132] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Chlorobenzene which takes 2% weight of the atmosphere material fed into the furnace into Ethyl acetate as atmosphere material, add Methanol, Water and Air to set up carbon potential.

The practice 81

40 [0133] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to add the Iodomethane which takes 2% weight of the atmosphere material fed into the furnace and the Ammoniumnitrate which takes 1% weight of the atmosphere material into Methanol and Kerosene as atmosphere material.

The practice 82

50 [0134] It can accelerate carburizing and lower processing temperature in carburizing, carbonitriding and nitrocarburizing to dissolve the Tetrafluoroethylene and Carbamide into Methanol or other solvent, aerate them into the furnace with atmosphere material together, control the quantity of Tetrafluoroethylene to be 2% weight of the atmosphere material fed into the furnace and the quantity of Carbamide to be 1% weight of the atmosphere material using one of Methane, Ethane, Dimethylmethanemethane, Butane, RX gas and Natural gas etc. as atmosphere material.

Claims

55 1. An operation method of a kind of heat treatment atmosphere cocatalyst. The characteristic consists in that the

cocatalyst is dissolved or dispersed into heat treatment atmosphere material and atmosphere, and the cocatalyst keep up the form of gas phase or finer dispersion (such as mote) and diffuse into atmosphere in the heat treatment equipment or heat treatment gas-producing equipment.

- 5 **2.** The method of using heat treatment atmosphere cocatalyst according to claim 1. The characteristic consists in that the cocatalyst is diffused directly into heat treatment atmosphere material or heat treatment atmosphere in the form of gas phase or finer dispersion, or it is dissolved or dispersed into a kind of or kinds of heat treatment atmosphere material as carry agent, and is fed into heat treatment equipment or heat treatment gas-producing equipment with atmosphere material together.
- 10 **3.** A kind of heat treatment atmosphere cocatalyst. The characteristic consists in that the cocatalyst keep in the form of gas phase or finer dispersion (such as mote), and diffuse into atmosphere material or atmosphere in heat treatment equipment or heat treatment gas-producing equipment.
- 15 **4.** The heat treatment atmosphere cocatalyst according to claim 3. The characteristic consists in that the cocatalyst is dispersed directly into heat treatment atmosphere material or heat treatment atmosphere in the form of gas phase or finer dispersion, or the cocatalyst is dissolved or dispersed into a kind of or kinds of carry agent, then they are fed into heat treatment atmosphere material together in heat treatment equipment or gas-producing equipment.
- 20 **5.** The heat treatment atmosphere cocatalyst according to claim3 or 4. The characteristic consists in that the cocatalyst is selected from Compound halogen element which takes 0.1~4% weight in heat treatment atmosphere material, optimal selection: 0.1~1%; Compound metal element which takes 0.0003~ 0.03% weight in heat treatment atmosphere material, optimal selection: 0.0003~0.015%; Compound nitrogen which takes 1~10% weight in heat treatment atmosphere material, optimal selection 1~2%; Or said arbitrary combination. Wherein, the Compound metal element is selected from one or arbitrary combination of Cobalt naphthenate, Manganese naphthenate, Nickel nitrate, Manganese nitrate, Ferrocene as well as Ferrocene ramification, optimal selection: Ferrocene, Ferroceneramification; Said Compound halogen element selected from one or their combination of Chlorobenzene, Trichlorobenzene, Chlorotoluene, Nitrochlorobenzene, Trichloroethylene, Ribromomethane, Iodine, Iodinated oil, Iodomethane, Freone, Tetrafluoroethylene. Optimal selection: Chlorobenzene, Trichlorobenzene, Chlorotoluene, Nitrochlorobenzene, or their combination. Said Compound nitrogen selected from one or arbitrary combination of P-Amino-Azobenzene Hydrochloride, Nitrobenzene, Toluenediisocyanate, Nitrochlorobenzene, Nitrobenzene, Trinitrobenzene, Melamine, Tricyanic acid, Dicyandiamide, Guanidine nitrate, Cyclotrimethylenetrinitramine, Pyridine, Pyrazol, Pyraze. Optimal selection: P-Amino-Azobenzene Hydrochloride, Nitrobenzene, Toluene diisocyanate, Nitrochlorobenzene, Nitrobenzene, Trinitrobenzene, Guanidinenitrate, Cyclotrimethylenetrinitramine or their combination.
- 25 **6.** The kind of heat treatment atmosphere cocatalyst according to claim3 or 4. The characteristic consists in adding certain compound of RE(lanthanum) or RE(cerium) which takes 0.1-3% weight in atmosphere material into heat treatment atmosphere or atmosphere material, such as Cerium naphthenates, Lanthanum naphthenates, Cerium Nitrate, Lanthanum nitrateinto, Lanthanum chloride, Cerium chloride, lanthanum fluoride, Cerium fluoride. Optimal selection: Lanthanum Acetate, Cerium Acetate, Lanthanum Oxide, Cerium Oxide or their combination.
- 30 **7.** A method of atmosphere heat treatment of metal material. The method includes heat treating metal material in the atmosphere with cocatalyst or the active atmosphere produced by the cocatalyst. The characteristic consists in said cocatalyst diffusing into atmosphere in the form of gas phase or finer dispersion, and releasing out active substance.
- 35 **8.** The kind of method of atmosphere heat treatment according to claim 7. The characteristic consists in the cocatalyst being dispersed directly into heat treatment atmosphere material or heat treatment atmosphere in the form of gas phase or finer dispersion. Or said cocatalyst said being dissolved or dispersed into a kind of or kinds of heat treatment atmosphere material as carry material, and fed into heat treatment gas-producing equipment or heat treatment equipment with carry material together.
- 40 **9.** The kind of method of atmosphere heat treatment in claim7. The characteristic consists in how to use the cocatalyst in claim5 or 6.
- 45 **10.** The method of atmosphere heat treatment in claim 7 - 9. The characteristic consist in using the cocatalyst, carbu-
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rizing or carbonitriding can be processed in a higher obviously carbon potential, optimal selection:0. 25, better optimal selection:0. 15, or in lower obviously temperature, or in short obviously time than without said cocatalyst.

5 **11.** A kind of metal material heat treatment atmosphere. Wherein the atmosphere includes a kind of material cocatalyst which is diffused into said atmosphere in the form of gas phase or finer dispersion and release a kind of material which play a part catalysis and activation to said atmosphere in heat treatment gas-producing equipment or heat treatment equipment. Said cocatalyst is selected from the cocatalyst in claim3 or 4.

10 **12.** A kind of method raising carbon potential and/or depressing the produce of carbon soot, or lowering process temperature in the atmosphere heat treatment of metal material. The characteristic consist in adding the cocatalyst in claim3-6 into heat treatment atmosphere or heat treatment atmosphere material.

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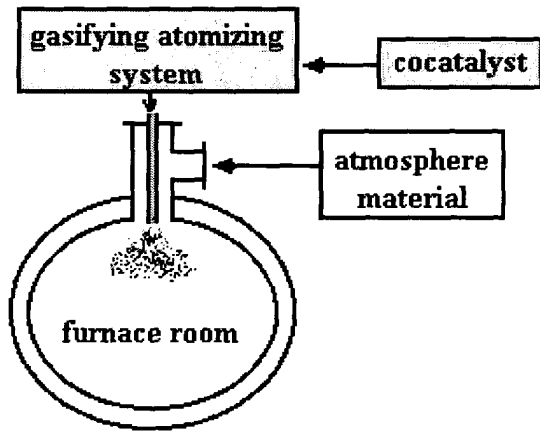


Fig.1

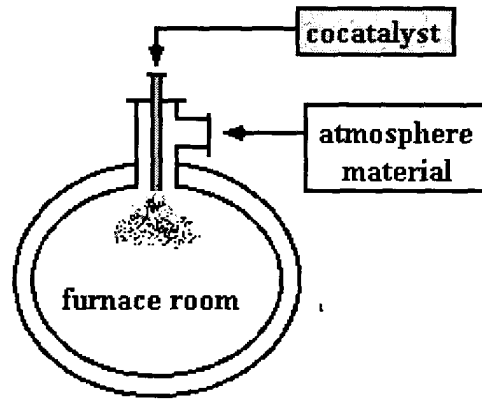


Fig.2

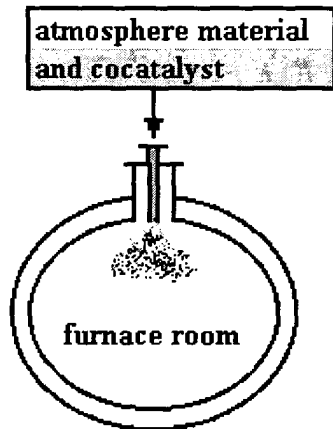


Fig. 3

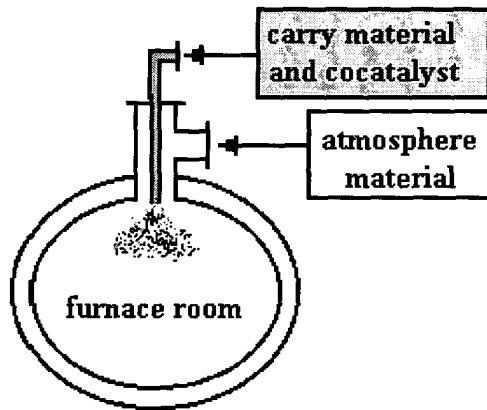


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN02/00486

A. CLASSIFICATION OF SUBJECT MATTER		
IPC7C23C8/20 C23C8/24 C23C8/30		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC7C23C8/20 C23C8/24 C23C8/30 C23C8/06		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
CNPAT WPI EPODOC PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1191885A(CHUGAI RO KOGYO KAISHA LTD) 02.Sep1998, Referring to the whole document	1-12
A	CN1067258A(CHEVRON RES&TECHNOLOGY CO) 23.Dec1992, Referring to the whole document	1-12
A	CN1036232A(WUHAN RES INST MAT) 11.Oct1989 Referring to the whole document	1-12
A	EP0947599A(LINDE AG) 06.Oct1999 Referring to the whole document	1-12
A	RU2048599C(EMEL'YANOV P P) 20.Nov1995 Referring to the English abstract	1-3
A	RU2038412C(ALFA VAMI ENTERP) 27.Jun1995 Referring to the English abstract	1-3
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
"A" document defining the general state of the art which is not considered to be of particular relevance		
"E" earlier application or patent but published on or after the international filing date		
"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)		
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search	Date of mailing of the international search report	
24 Oct 2002(24.10.02)	21 NOV 2002 (21.11.02)	
Name and mailing address of the ISA/CN	Authorized officer	
6 Xitucheng Rd., Jimen Bridge, Haidian District, 100088 Beijing, China	星付印明	
Facsimile No. 86-10-62019451	Telephone No. 86-10-62093882	

INTERNATIONAL SEARCH REPORT
 Information on patent family members

International application No.
 PCT/CN02/00486

CN1191885A	02 Sep1998	none	
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		AU1580192A	06 Oct1992
		EP0576571A	05 Jan1994
		US5863418A	26 Jan1999
		KR230727B	15 Nov1999
CN1036232A	11 Oct1989	none	
EP0947599A	06 Oct1999	DE19814451a	07 Oct1999
RU2048599C	20 Nov1995		
RU2038412C	27 Jun1995	none	