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Process for purification of gases and waste gases

The invention relates to the use of finely powdered calcium hydroxide containing surface-active substances for the purification of gases and waste gases.

Numerous processes are employed in the field of waste gas purification. Besides wet waste gas purification dry waste gas purification is applied, in which process powdered calcium hydroxide is blown into the waste gas stream to be purified. The object is to neutralize the acid pollutants in the waste gas stream, such as sulphur dioxide, hydrogen chloride and hydrogen fluoride, and to separate the resulting neutral salts at appropriate separating apparatus, e.g. electrostatic precipitators and fabric filters.

Dry waste gas purification is applied in several variants. The most important field of application is the cleaning of waste gases from coal and lignite-fired power plants, waste incinerators, toxic waste incinerators and firing plants using the most varied materials.

The noxious waste gases can be substantially cleaned by way of dry waste gas purification. A drawback of this process is, however, that calcium hydroxide consumption is very high. In general, the stoichiometric factor is 3.5 - 6. In waste incinerating plants, for instance, more than 30 kg calcium hydroxide per ton of waste material is required as compared to 10-12 kg hydroxide per ton of waste material. The poor efficiency of dry waste gas purification is due to the fact that the single calcium hydroxide particles do not thoroughly react. On the calcium hydroxide a layer of reaction products is formed which prevents the acid

pollutants to be separated from further penetrating thereinto.

Repeated attempts have been made to reduce the high calcium hydroxide consumption. According to one process the product separated after waste gas purification, which consists of unreacted calcium hydroxide and the reaction products formed, is mechanically recycled by a grinding process. The grinding process has the purpose of separating the outer non-reactive layers. In another process, the reaction product is intermediately stored and, after 1 - 2 days, used again.

None of said processes is satisfactory with regard to an increase in reactivity of calcium hydroxide, however.

An increase in reactivity of $\text{Ca}(\text{OH})_2$ means a reduction of the amount of $\text{Ca}(\text{OH})_2$ required for achieving a specific degree of separation of the acid pollutants. A low stoichiometric factor of $\text{Ca}(\text{OH})_2$ /acid pollutants indicates higher reactivity.

It is therefore an object of the present invention to indicate the use of calcium hydroxides having an increased reactivity to the acid pollutants of the waste gases. Moreover, the calcium hydroxides shall separate further pollutants besides the acid components from the waste gas, particularly nitrogen oxides and the heavy metals mercury, arsenic, antimony and thallium which are already volatile in the temperature range of 20° to 200°C . According to the state of the art, separation of said substances from waste gases is effected by cooling the waste gas stream until water condensates. Said cooling step does not only require specific apparatus but also energy.

According to a conventional method of reducing the mercury contents of waste gases, the waste gas temperature is



lowered by adding water until bonding is effected between the mercury and the calcium hydroxide. However, this process suffers from the drawback that significant amounts of mercury remain in the waste gas and, if water is added in an uncontrolled manner, malfunctions may occur in the subsequent separating apparatus.

Separation of those substances should not be effected in separate steps but in a single step together with the acid pollutants.

Another problem is the separation of hydrocarbons and chlorinated hydrocarbons, such as dioxines, hexachlorobenzene and pentachlorophenol.

This object is solved according to the invention by the use of finely powdered calcium hydroxide containing surface-active substances as claimed in independent claims 1 and 2.

In this process, finely powdered calcium hydroxide containing activated carbon and/or open hearth lignite coke as surface-active substances is used to eliminate acid pollutants, nitrogen oxides, hydrocarbons, chlorinated hydrocarbons, such as dioxines, hexachlorobenzene and pentachlorophenol, and volatile heavy metals from gases and waste gases; finely powdered calcium hydroxide containing the surface-active substances is added to the gas or waste gas stream, purification is carried out at a temperature in the range of from 20 to 400°C, and the hydroxide charged with pollutants is separated at dust separating apparatus.

Besides, finely powdered calcium hydroxide containing activated aluminum oxide and/or silica gel as surface-active substances is used to eliminate acid pollutants, nitrogen oxides, hydrocarbons, chlorinated hydrocarbons, such as dioxines, hexachlorobenzene and pentachlorophenol, and volatile heavy metals from gases and waste gases;



finely powdered calcium hydroxide containing the surface-active substances is added to the gas or waste gas stream, purification is carried out at a temperature in the range of from 20 to 400°C, and the hydroxide charged with pollutants is separated at dust separating apparatus.

The surface-active substances employed in the means used according to the invention are finely divided activated carbon, open hearth lignite coke, activated aluminum oxide and/or silica gel. These surface-active substances effect the separation of residual contents of organic substances, particularly chlorinated hydrocarbons, such as dioxines, hexachlorobenzene, pentachlorophenol and the like, and polycondensated aromatic hydrocarbons, such as benzo(a)pyrene, dibenz(a,h)anthracene and the like, from the waste gas stream. These substances are generally contained in gases and waste gas streams in extremely small concentrations. The separation thereof at conventional separating apparatus, e.g. washing apparatus or electrostatic precipitators or fabric filters, is difficult. By using calcium hydroxide containing surface-active substances the trace substances can be bonded to the surface-active substances and removed from the waste gas stream.

The initially mentioned problem concerning the separation of heavy metals is solved according to the invention by using the means stated in the patent claims.

On account of the surface-active substances, the highly volatile heavy metals can also be bound and separated at temperatures of from 100 - 200°C.

The surface-active substances are particularly suited for the process according to the invention. Activated carbon is especially useful for binding organic substances and also mercury. Silica gel and aluminum oxide are particularly



suited for separating polar substances, such as oxidized organic compounds, and inorganic pollutants, such as hydrogen chloride and sulphur dioxide.

Catalytically active substances, such as vanadium, tungsten, molybdenum, manganese, iron, nickel, cobalt, chromium and/or titanium compounds, are advantageously added to the surface-active substances before the quicklime is slaked. The surface area of the catalytically active substances is thus very large, which enables said substances to exhibit their effectiveness in waste gas purification in a particularly high degree.

The subject matter of the invention is a process for eliminating acidic pollutants, such as hydrogen chloride, hydrogen fluoride, sulphur dioxide, hydrogen cyanide and the like, nitrogen oxides, hydrocarbons, chlorinated hydrocarbons and volatile heavy metals, e.g. mercury, arsenic, antimony, cadmium and thallium, from gases and waste gases by adding to the gas or waste gas stream finely powdered calcium hydroxide containing surface-active substances, such as activated carbon, open hearth lignite coke, silica gel and/or activated aluminum oxide, the hydroxide charged with pollutants being subsequently separated at dust separating apparatus.

As an advantageous alternative, the gas or waste gas to be purified can be passed through a firm or moving Ca(OH)_2 layer containing the above-mentioned further components.

The amount of substances to be used depends on the amount of pollutants to be separated.

In the case of the calcium hydroxide used according to the invention, the reactivity of Ca(OH)_2 has been significantly increased, i.e. Ca(OH)_2 consumption for separating acid pollutants can be considerably decreased. At the same time,



volatile heavy metals, e.g. mercury, cadmium and the like, can be separated from the waste gas stream. Another significant advantage is the simultaneous separation or decrease in concentration of acid pollutants and nitrogen oxides, which may be combined with the separation of heavy metals at the same time.

Example:

28 g quicklime was slaked with 15.2 g water in which 1.4 g activated carbon having a surface area of 700 m²/g had been suspended. A grey powder exhibiting good flow properties was obtained.

A gas having the following content parameters was passed over 252 mg of said substance in the form of a firm layer:

moisture	0.26 g/l
HCl	22.5 mg/l
HgCl ₂	1.29 µg/l.

A total of 11.2 l gas was passed over the modified Ca(OH)₂.

Out of a total of 14.4 µg/l HgCl₂ 76.5% was absorbed by the activated carbon.



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Patent Claims

1. Use of finely powdered calcium hydroxide containing activated carbon and/or open hearth lignite coke as surface-active substances for the elimination of acidic pollutants, nitrogen oxides, hydrocarbons, chlorinated hydrocarbons, such as dioxines, hexachlorobenzene and pentachlorophenol, and volatile heavy metals from gases and waste gases, wherein finely powdered calcium hydroxide containing the surface-active substances is added to the gas or waste gas stream, purification is carried out at a temperature in the range of from 20 to 400°C and the hydroxide charged with pollutants is separated at dust separating apparatus.

2. Use of finely powdered calcium hydroxide containing activated aluminium oxide and/or silica gel as surface-active substances for the elimination of acidic pollutants, nitrogen oxides, hydrocarbons, chlorinated hydrocarbons, such as dioxines, hexachlorobenzene and pentachlorophenol and volatile heavy metals from gases and waste gases, wherein finely powdered calcium hydroxide containing the surface-active substances is added to the gas or waste gas stream, purification is carried out at a temperature in the range of from 20 to 400°C and the hydroxide charged with pollutants is separated at dust separating apparatus.

3. Use of finely powdered calcium hydroxide according to any one of claims 1 or 2, wherein volatile heavy metals are bound and separated at temperatures between 100 and 200°C.

4. Use of finely powdered calcium hydroxide according to any one of claims 1 or 2, wherein the surface-active substances are charged with vanadium, tungsten, chromium, molybdenum, iron, nickel, cobalt and/or titanium compounds.