FIG. 3

Minoru Takahashi
INVENTOR.

BY Weinberg, Ltd.
and Brack, Attorneys
PROCESS AND APPARATUS FOR TREATING AIR CONTAMINATED WITH RADIOACTIVITY

Minoru Takahashi, Kodaira-shi, Tokyo, Japan, assignor to Taisei Kensetsu Kabushiki Kaisha (Taisei Construction Co., Ltd.), Tokyo, Japan
Filed May 3, 1967, Ser. No. 635,724
Claims priority, application Japan, May 30, 1966, 41/34,442
Int. Cl. G21e 9/00
U.S. Cl. 176—37

4 Claims

ABSTRACT OF THE DISCLOSURE

A process and an apparatus for preventing as much as possible contamination of air by air contaminated with radioactivity by continuously pressing air dispersed within a structure containing an atomic pile or reactor therein and contaminated with radioactivity into a reservoir where the radioactivity is, by a required period of time and then discharging the air contaminated after the radioactivity has been reduced by natural decay of the radioactive substances.

This invention relates to an improvement in a process and an apparatus for treating air contaminated with radioactivity containing radioactive substances.

Hitherto, when, at an atomic power plant, there was an accident involving an atomic pile and radioactive substances were dispersed in a confined space wherein said atomic pile is accommodated, in order to prevent the radioactive substances from leaking out from said space, as soon as an accident occurred, a fan was driven and air inside said container was discharged into the atmosphere through a valve, a filter and a chimney whereby pressure of air inside said space was reduced to below atmospheric pressure.

In said hitherto employed process, among the radioactive substances dispersed into the air and mixed with said air inside the space, solid finely divided particles and liquid drops were caught and collected by said filter. However, gaseous-phase radioactive substances were not removed by said filter, especially chemically very stable radioactive rare gas such as xenon and krypton which cannot be removed by other proper removal devices, and, said gaseous-phase radioactive substances were discharged into the atmosphere by said chimney, dispersing in every direction in the atmosphere, causing a possibility that the inhabitants living in the vicinity of the atomic power plant might suffer from radioactive lesions. Accordingly a very broad discharging area has been required.

In such a method whereby air contaminated with radioactivity inside the space is prevented from leaking out of the space due to difference of pressures inside and outside the space through a gap existing in the wall of the space (such as a door for opening and closing), when an accident happens, by suddenly reducing pressure of air inside the space to below atmospheric pressure, the air contaminated with radioactivity inside the space must be discharged through the chimney at a high level of radioactivity, and when there is a strong wind at the time an accident happens, it must be considered that a large negative pressure may occur in the said space and the inner air contaminated with radioactivity may be discharged to the outside. Moreover, in concomitance with the appearance of a larger atomic pile and concentration of a plurality of atomic piles, the amount of air contaminated with radioactivity discharged at the time of an accident increases. Thus, in Japan, densely populated and small in size it has been very difficult to find a place suitable for an atomic power plant.

And even if a location for an atomic power plant having a very broad discharging area exists at a point distant from the center of consumption of electricity, because the cost for power transmission will become very high it is not possible economically to build a large scale atomic power plant.

One of the primary objects of this invention is to provide an improved process and apparatus for treating air contaminated with radioactivity to prevent contamination of the atmosphere by air contaminated with radioactivity as much as possible by safely and drastically reducing the level of radioactivity of air contaminated with radioactivity discharged into the atmosphere in the method described above.

Another object of this invention resides in preventing air contaminated with radioactivity dispersed inside the compound of a structure wherein an atomic pile is accommodated from leaping out of said structure.

Still another object of this invention resides in providing a process and an apparatus capable of treating radioactive substances which cannot be separated and removed by mechanical or chemical treatment from air contaminated with radioactivity.

A further object of this invention resides in making possible construction of a large scale atomic pile without requiring a very broad discharging area by utilizing this invention.

A still further object of this invention resides in making possible economic construction of a safe and large scale atomic power plant by utilizing this invention.

In order to achieve the aforementioned various objects, the process for treating air contaminated with radioactivity of this invention is characterized in that when there is an accident involving an atomic pile and radioactive substances disperse inside the structure wherein said atomic pile is accommodated, air contaminated with radioactivity and containing the radioactive substances dispersed inside said structure containing the atomic pile is continuously pressed into a high pressure air reservoir, wherein said air contaminated with radioactivity is made to stay for a long period and the air contaminated with radioactivity which has been reduced by natural decay of the radioactive substances is discharged into the atmosphere.

As mentioned above, when there is an accident involving an atomic pile and radioactive substances disperse in the structure wherein the atomic pile is accommodated, this invention prevents air contaminated with radioactivity and containing said radioactive substances dispersed in the structure containing the atomic pile into a high pressure air reservoir to reduce the pressure of air inside said structure containing the atomic pile to below atmospheric pressure, maintaining the low pressure for preventing the air contaminated with radioactivity from leaking out from inside said structure containing the atomic pile, storing said air contaminated with radioactivity inside said high pressure air reservoir for a required period and to discharge said air contaminated with radioactivity which has been reduced due to natural decay of said radioactive substances into the atmosphere so that the air contaminated with radioactivity whose radioactive level is especially high at the time the accident happens is not directly discharged into the atmosphere but is discharged after said radioactivity has been reduced in said high pressure air reservoir. Therefore, by this invention it is possible to drastically reduce the radioactive level of the air contaminated with radioactivity when it is discharged as compared with the hitherto employed process and apparatus. Thus, it is possible to build a large scale atomic power plant in a densely populated area than hitherto. Also this invention comprises a structure accommodating an atomic pile therein, a high pressure air reservoir capable of accommodating air from inside said structure as
well as a device for transmitting air under pressure and a back flow preventing device provided between said structure and said high pressure air reservoir, characterized in that when there is an accident involving the atomic pile and radioactive substances disperse inside said structure containing the atomic pile, air flowing through containing said radioactive substances is pressed into said high pressure air reservoir so that said process of treatment carried out smoothly and completely. Moreover, because there is no direct contact between a gas contaminated with radioactivity and the air, for instance, inflating air pressure outside the structure due to a strong wind can be completely excluded.

Other novel aspects and other objects of this invention will be made clear by the description of an embodiment described hereinbelow.

In the drawings:

FIG. 1 is a diagrammatic view showing an embodiment of this invention. FIG. 2 is a fragmentary perspective view thereof. FIG. 3 is a plan view thereof. FIG. 4 is a longitudinal sectional view of the essential parts thereof. FIG. 5 is a fragmentary perspective view of an embodiment of a high atomic power plant apparatus of this invention. FIG. 6 is a diagrammatic view of the hitherto employed apparatus for treating air contaminated with radioactivity.

In the prior art system, as shown in FIG. 6, the chamber 12 containing an atomic pile 11 is connected to a chimney 13 by a pipe 14. The pipe 14 contains a fan 15, a valve 16 and a filter 17. When an accident occurs in the chimney 13 after passing through the filter 17. The fan is driven rapidly enough so that the pressure within chamber 12 is reduced to below atmospheric.

In FIG. 1, an atomic pile chamber 21 has therein an atomic pile 35. A fan 22 and a backstream preventing device 23 are connected between said chamber 21 and a low pressure air reservoir 24, and said low pressure air reservoir 24 is connected to a high pressure air reservoir 26 by a device 25 for transmitting and increasing the pressure of air. When an accident involving said atomic pile 35 inside said atomic pile chamber 21 occurs following the occurrence of any sudden pressure surge following a major accident, or as the result of a minor accident, radioactivity substances disperse inside said atomic pile chamber 21, said fan 22 and device 25 are driven so that air contaminated with radioactivity containing the radioactive substances disperses inside said atomic pile chamber 21 is forced into said low pressure air reservoir 24, and thereafter said air is pressed into high pressure air reservoir 26.

Said high pressure air reservoir 26 has a discharge cock 28 communicating with a discharge adjusting chamber 27 and inside said discharge adjusting chamber 27 a fan 29 is accommodated. The outlet side of said fan 29 communicates with a chimney 30, whereby air contaminated with radioactivity compressed and stored inside said high pressure air reservoir 26 for a required period is discharged and diffused into the atmosphere.

Further, said atomic pile chamber 21 is connected to said chimney 30 by a conduit 34 provided with a fan 31, a valve 32 and a filter 33, whereby air contaminated with radioactivity inside said atomic pile chamber 21 can also be discharged at once.

Said atomic pile chamber 21, low pressure air reservoir 24 and said high pressure reservoir 26 can be, as illustrated in FIG. 2 and FIG. 3, provided inside a concrete structure A constructed in the sea.

Said concrete structure A is a huge one, namely, 1800 meters long, 170 meters wide and 60 meters high, divided in the direction of length into 12 sections A1, the outer peripheral wall A2 and partition wall A3 are 20 meters thick, and as shown in FIG. 5, said each section A1 is sealed by a double-slab roof 36.

And in each section A1 are disposed said atomic pile chamber 21 accommodating said atomic pile 35, a turbine and generator chamber accommodating a steam turbine 37 and a generator 38, a control room 39 and an office 40.

Further, inside said outer peripheral wall A2 through-out its length, as illustrated in FIG. 2, the high pressure air reservoir 26 is provided. The concrete wall surrounding said high pressure air reservoir 26 is so thick that high pressure compressed air stored inside will not leak to the outside, and in said partition wall A3, a low pressure air reservoir 24 forms roughly the same as said high pressure air reservoir 26 is provided.

Said backstream preventing device 23 for preventing backflow into said atomic pile chamber 21 can be, as illustrated in FIG. 4, a pipe bent in an inverted U-shape in a position higher than said low pressure air reservoir 24, the lower end of a vertical portion at the outlet side 23c of said pipe 22 opens into water remaining at the bottom of said low pressure air reservoir 25d, and when the pressure of air inside said low pressure air reservoir 25d is increased to a high pressure as will be mentioned later, a water column opening with the device 23 floats up, and as shown in FIG. 5, said compressed air rises inside the vertical portion at the outlet side 23c of said pipe 23. However, said vertical portion at the outlet side 23c of said pipe 23 is made sufficiently long as not to permit such water pillar to pass through the upper end portion 23b to flow into the vertical portion at the inlet side 23c. Thus air is unable to flow back from said low pressure air reservoir to said atomic pile chamber 21.

Also said high pressure air reservoir 26 and said low pressure air reservoir 25d communicate with each other at the bottom via an opening and closing valve 25e of the device 25 for transmitting and increasing pressure and at the same time, they are connected to each other, via a pump 25b, and are connected with each other in a back flow preventing pipe 25c opening at the top portion of said low pressure air reservoir 24 and at the bottom portion of said high pressure air reservoir 26.

The high pressure air reservoir 26 has a very large volume as compared with said low pressure air reservoir 25d and the volume of water sealed in said high and low pressure air reservoirs 26 and 24 is about the same as the volume of said low pressure air reservoir 25d. Therefore, when the said low pressure air reservoir 24 is filled with water in advance, and said pump 25b is driven to pump the water inside the low pressure air reservoir 25d into the high pressure air reservoir 26, pressure inside the low pressure air reservoir is reduced and said atomic pile chamber 21 is driven into the low pressure air reservoir 25d via the backstream preventing device 23. At that time, it is true that said high pressure air reservoir 25d communicates with said high pressure air reservoir via the backstream preventing pipe 25c. However, because the water level of the inside the high pressure air reservoir is always kept at a low position the water pillar inside the backstream preventing pipe 25c does not get very high and does not reach the upper end opening of said pipe. Thus the water inside the low pressure air reservoir 25d is positively transferred to the high pressure air reservoir 26.

Next, by reversely rotating said pump 25d thereby returning the water inside the high pressure air reservoir 26 to the low pressure air reservoir 25d, it is possible to press the air inside the low pressure air reservoir 25d into the high pressure air reservoir 26 via the backstream preventing pipe 25c.

By repeating such operations, it is possible to press air inside the atomic pile chamber 21 into the high pressure air reservoir 26 and store the air therein.

Because the illustrated embodiment is constructed as described above, when an atomic pile 35 inside a section A1 in said atomic power plant is involved in an accident, by utilizing a low pressure air reservoir 25d adjoining
an atomic pile chamber 21 accommodating the out-of-order atomic pile 35, it is possible to forward air contaminated with radioactivity from inside said atomic pile chamber 21 into a high pressure air reservoir 26.

Accordingly, inside said atomic pile chamber 21 pressure is maintained below atmospheric pressure, therefore, there is no fear whatsoever that said air contaminated with radioactivity will leak out to another section A1 of the resulting structure A.

Moreover, because the atomic pile chamber 21 inside said section A1 is surrounded by the adjoining chamber, etc. and not directly exposed to the atmosphere, even when a wind blows and pressure of the atmosphere located downstream of said concrete structure A is reduced by the occurrence of a swirl, it is unnecessary to reduce the pressure of air inside said atomic pile chamber 21 as compared with pressure of the atmosphere reduced by the wind. Therefore, as compared with the case of the existing atomic power plant provided with an atomic pile and exposed to the atmosphere, in the atomic power plant in accordance with this invention even when air contaminated with radioactivity inside the atomic pile chamber is gradually discharged, it is possible to positively prevent the air contaminated with radioactivity from leaking from the atomic pile chamber 21 by storing air contaminated with radioactivity whose radioactive level is high at the time the accident happens inside said high pressure air reservoir for a long period to wait reduction of the radioactivity due to natural decay of the radioactive substances, it is possible to mix said air with air contaminated with radioactivity whose radioactive level has been reduced to a sufficiently low degree and discharge the mixture from the chimney 30 in the atmosphere high in the sky.

A specific example of the case wherein the apparatus of this invention is incorporated into an atomic power plant structure is shown in FIG. 5. In FIG. 5, the high pressure air reservoir 26 constituting a primary portion of this invention is provided inside a strong concrete wall of an oceanic structure. FIG. 5 shows a double-slab roof and a situation wherein an atomic pile section is completely isolated from the atmosphere.

So far, this invention has been explained with reference to one embodiment. However, this invention is not to be limited to such an embodiment only, but various changes of design are possible within the scope of the appended claims without departing from the spirit of this invention.

What is claimed is:

1. A process for treating air contaminated with radioactivity as a result of an accident involving an atomic pile or atomic reactor, comprising pumping air, which is under near atmospheric pressure in the space in which the accident occurs and which air remains after any initial pressure surge and which air is contaminated with radioactivity and containing radioactive substances dispersed therein, from the space into a high pressure air reservoir while increasing its pressure, storing said contaminated air in said high pressure air reservoir for a period of time sufficient to reduce the radioactivity by natural decay of the radioactive substances; and then discharging the stored air into the atmosphere.

2. An apparatus for treating air contaminated with radioactivity and which is under near atmospheric pressure and which remains in the space after any initial pressure surge as a result of an accident involving an atomic pile for atomic reactor, said apparatus comprising a structure having a chamber accommodating an atomic pile for atomic reactor, said apparatus comprising a device for transmitting and increasing the pressure of air and a back flow preventing device coupled between said chamber and said high pressure air reservoir, whereby when there is an accident involving said atomic pile and radioactive substances are dispersed inside said chamber after any initial pressure surge, the air in said chamber which is contaminated with radioactivity containing said radioactive substances can be pressurized into said high pressure air reservoir.

3. An apparatus as claimed in claim 2 in which said structure has a double-wall construction within which said high pressure air reservoir is accommodated.

4. An apparatus as claimed in claim 2 in which said device for transmitting and increasing the pressure of air comprising a low pressure reservoir between said chamber and said high pressure reservoir, said back flow preventing device being coupled between said low pressure reservoir and said chamber, said air transmitting and pressure increasing means further comprising a back flow preventing pipe connected between said reservoirs and reversible pump means connected between said reservoirs for pumping a volume of water substantially equal to the volume of said low pressure reservoir back and forth between said reservoirs for creating a low pressure in said low pressure reservoir and a high pressure in said high pressure reservoir.

References Cited

UNITED STATES PATENTS

3,056,736 10/1962 Went et al. 176—37
3,232,843 2/1966 Went et al. 176—37
3,248,298 4/1966 Norman 176—38

FOREIGN PATENTS

862,624 3/1961 Great Britain 176—37
1,449,804 7/1966 France 176—Shd. Dig.

CARL D. QUARFORTH, Primary Examiner
H. E. BEHRENDS, Assistant Examiner