Health effects of increase in concentration of carbon dioxide in the atmosphere

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The toxic effects, to humans and other mammals, of concentrations of carbon dioxide in the atmosphere which are below the safe working level but above the present level are described. The likely physiological effects of the predicted increase in concentration of carbon dioxide in the atmosphere over the next 50 years are detailed.

Keywords: Atmosphere, carbon dioxide, health effects, toxicity.

A great deal of effort is presently devoted to identification and control of atmospheric pollutants. Carbon dioxide is not only a gas which affects heat flow to and from the atmosphere of the earth, but is also a serious pollutant in its own right. The question therefore naturally arises as to the likely physiological effects of the increasing carbon dioxide content in the atmosphere. The concentration of this gas in the atmosphere is not known to have risen above 320 ppm over the last 40,000 years[1]. Another evidence demonstrates this to be the case for the past 420,000 years[2]. Geological studies show that an increase in the atmospheric concentration of carbon dioxide above 320 ppm last occurred 27 million years ago[3]. Unless evidence to the contrary becomes available, these results prove that the present rise in the atmospheric concentration of carbon dioxide is not a natural phenomena caused by the gas being released from volcanoes and other natural sources. The cause is therefore likely to be human activities such as fossil-fuel burning. With the present value for the concentration of carbon dioxide in the atmosphere at 373 ppm, humans and other mammals are already in unknown territory with regard to physiological effects of an atmosphere with a much higher concentration of carbon dioxide.

Physiological effects of carbon dioxide

Although the safe working level of carbon dioxide is presently set at 5000 ppm for an 8 h day 40 h working week, no human ever endures such a level of carbon dioxide in the atmosphere for 24 h a day, 365 days a year, for an entire lifetime nor has any human ever bred offspring under these conditions. This includes workers in breweries and the greenhouse industry, where the concentration of carbon dioxide in the atmosphere either commonly reaches or is set at a maximum of 900 ppm. The exposure in these cases is intermittent. The safe working level or intermittent occupational level is therefore not relevant in discussing the long-term effects of exposure to elevated levels of carbon dioxide in the atmosphere, which are above the present level but below the toxic level. Recent examination of the standard medical explanation of the effects of carbon dioxide on human metabolism has demonstrated that the explanation requires revision, principally on the grounds that carbonic acid is taken to exist as a free acid in blood serum, which is an alkaline fluid[4]. This work demonstrates that the level of carbon dioxide in the atmosphere at which humans can survive indefinitely, is much lower than expected. The estimated toxic level of carbon dioxide in the atmosphere under lifetime exposure is 426 ppm (Figure 1)[4]. At the present rate of increase of carbon dioxide in the atmosphere, the toxic limit will be attained in AD 2050 based on extrapolation of the measured results from Mauna Loa[5]. The effects of carbon dioxide are a reduction in the pH value of blood serum leading to acidosis[4]. The minimum effects of acidosis are restlessness and mild hypertension. As the degree of acidosis increases, somnolence and confusion follow. One of the effects of these changes is a reduced desire to indulge in physical activity. Other metabolic effects of acidosis have been reviewed and shown to be extensive[6]. Embryonic or foetal abnormalities are also possible as the increase in atmospheric carbon dioxide affects maternal metabolisms in succeeding generations.

Atmospheric toxicity levels

Relationships between detrimental health effects and high indoor carbon dioxide concentrations have been studied[7]. These studies were made in the range 300–700 ppm above ambient carbon dioxide levels. At a carbon dioxide concentration of 600 ppm in an indoor atmosphere, the occupants become aware of deterioration in the atmosphere. At and above this level, some occupants began to display one or more of the classic symptoms of carbon dioxide

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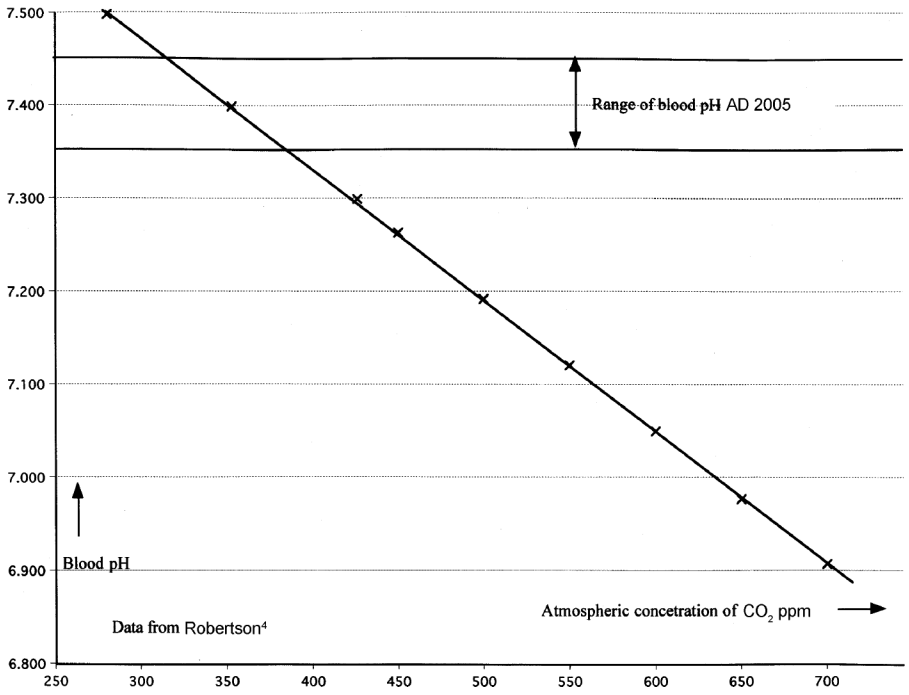

Figure 1. Change in blood pH with rising concentration of carbon dioxide in the atmosphere.

poisoning, e.g. difficulty in breathing, rapid pulse rate, headache, hearing loss, hyperventilation, sweating and fatigue. At 1000 ppm, nearly all the occupants were affected. These effects were observed in humans with only a transient exposure to an atmosphere containing increased levels of carbon dioxide and not a lifetime exposure. At present, the conditions giving rise to these symptoms can be readily reversed by moving into the outdoor atmosphere. In the event that the atmospheric concentration of carbon dioxide reaches 600 ppm, the planet will have a permanent outdoor atmosphere exactly like that of a stuffy room. The conditions indoors in buildings of the type now available will become even more unpleasant and could easily reach 1000 ppm permanently with the results outlined above. Office buildings exist which are described as 'sick', in which workers display symptoms of carbon dioxide poisoning[8]. Office levels of carbon dioxide presently reach 800 to 1200 ppm and in overcrowded conference rooms, the level can reach 2000 ppm. These conditions will be greatly elevated under conditions where the general atmosphere has reached a carbon dioxide concentration of 600 ppm.

Further evidence that increased concentrations of carbon dioxide are detrimental to human health is provided by a large number of studies in the field of epidemiology. These studies deal with the effects of widespread use of biomass fuels in India and other Asia and African societies[9]. Biomass fuels produce other noxious products besides a large amount of carbon dioxide, and there is a high level of endemic disease and poverty in both rural and urban India. However, it would be expected that a difference would be observed between the physiological effects of the use of biomass fuel on these two populations. The grounds for this are that the general level of air pollutants, particularly carbon dioxide, should be lower in rural areas than in comparable crowded urban areas. Studies indicate the reverse[9]. Thus in rural areas the intensity of biomass fuel use is higher. This means a higher exposure to high levels of carbon dioxide. The indoor level of carbon dioxide involved in each case will vary throughout the day and from day to day. However, a reasonable estimate of the mean level is 500 ppm based on the figures for carbon dioxide levels in offices recorded above. This level of carbon dioxide will lead to changes in the metabolism as predicted, such as lowering of pH of the blood serum, making acidosis widespread. This in turn will increase susceptibility to other deleterious conditions[9].

Primate susceptibility to high levels of carbon dioxide in the atmosphere is supported by the geological–palaeontological record. During the Eocene epoch, the temperature of the earth was much higher than at present, while the amount of carbon dioxide in the atmosphere was about the same as that at present. The fossil record shows that during the Lutetian and Bartonian ages of the Eocene epoch, primates were abundant on the Eurasian continent. The geological record shows that by the Priabonian age of the Eocene epoch (27 million years BP), the carbon dioxide content of the atmosphere had risen to three times that of the present day[4]. The fossil record then shows that virtually all the primates of the Eurasian continent had

disappeared[10]. Although it is accepted that these events predate the existence of humans, some primates alive today can be shown to be direct linear descendants of those involved, such as the lemurs. It is a reasonable conclusion from these observations that primates can survive in hot climates, but are unable to endure high levels of carbon dioxide in the atmosphere.

Physical adaptation to increased carbon dioxide in the atmosphere

There will be no human or other mammal physiological adaptation to this situation. It has been established over many decades that humans in particular and mammals in general do not adapt to the effects of a long-term intake of a toxic material as demonstrated by: (1) Generation deaths from arsenic poisoning in parts of the Indian subcontinent[11]; (2) Generation deaths due to effects of lead water pipes[12]; (3) Deleterious effects over generations of volatile organo-lead compounds in petrol[13] and the effects of DDT on generations of the small mammal population[14]; and (4) Generation deaths from flour made from cycad tissue[15].

Conclusion

The lowest value at which the atmospheric concentration of carbon dioxide could be stabilized by reduction of additions made by human activity (fossil fuel-burning, etc.) is estimated[16] as 550 ppm. To achieve this, severe limitations are required on the latter activities. The most often quoted[16] desirable/attainable stable concentration is 750 ppm. This concentration level is not related in any way to health considerations and is above the estimated dangerous level of 426 ppm. The value is also above the 600 ppm level, which results in the 'stuffy room' conditions described above. At the very least, 600 ppm of carbon dioxide in the atmosphere will be unpleasant and there will be no readily available means of reversing the changes giving rise to the above symptoms. Such a situation is unlikely to be tolerable for a lifetime by humans (and other mammals with the possible exception of seals) without deterioration in general health along with serious curtailing of physical activity presently taken as normal. The health effects of low-level carbon dioxide poisoning are likely to be first observed in the results of athletic events, where maintenance of present performance records becomes difficult and the establishment of improved performance records never occur. It is possible that the performance of some athletes in the 2003 World Games already shows the predicted effects. It is also possible that the deaths in France in 2003 were the result of high ambient temperatures in buildings, with higher than ambient carbon dioxide concentrations. It is likely that when the concentration of carbon dioxide in the atmosphere reaches 426 ppm in less than two generations from the present date, the health of at least some sections of the world population will deteriorate, including those of the developed nations. It is also obvious that if the extremes of conditions described above come to pass, then the biosphere and humankind are seriously threatened.

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Received 13 July 2005; revised accepted 15 January 2006