Int. J. Chem. Sci. : 3 (3), 2005, 503–506

THE VARIOUS ASPECTS OF THE CARBON MONOXIDE

SAYED MORTEZA MOSTASHARI* and SEYEDEH ZAHRA MOSTASHARI

University of Gilan, College of Science, RASHT, IRAN

ABSTRACT

This study is a summarization concerning the environmental and health effect of carbon monoxide as an atmospheric impact. The production and physiochemical properties of carbon monoxide have also been discussed by a scientific approach to the environmental educated researchers.

Key words : Carbon monoxide, Monoxide, Hemoglobin, Carboxyhemoglobin.

INTRODUCTION

Carbon monoxide is a colorless, poisonous, odorless, tasteless gas and 96.5% as heavy as air[1]. It is very slightly soluble in water and can burn but does not itself support combustion[2].

Carbon monoxide is formed when carbon–containing materials burn in a restricted supply of oxygen.

$$2\,C + O_2 \longrightarrow 2\,CO$$

The oxidation of carbon is of immense importance in metallurgy. The other basic chemical reactions yielding CO are :

(i) Reaction between CO_2 and carbon containing compounds at elevated temperature in industrial processes; e.g. reduction of CO_2 using coke heated above 1070 K[3].

$$CO_2 + C \longrightarrow 2\,CO$$

(ii) Dissociation of CO_2:

$$2\,CO_2 \rightleftharpoons 2\,CO + O_2$$

It has been shown that, at all pressures, there is a fairly wide range of temperature in which CO_2 dissociates directly into CO and O_2 without precipitation of carbon[4,5]. CO is oxidized by a mixture of MnO_2, CuO and Ag_2O at ambient temperatures and this reaction is used in respirators[3]. The emission of carbon monoxide to the atmosphere and its removal from air are classified as:

Natural processes e.g. volcanic action, natural gas emission, seed germination, marsh–gas production, electrical discharge during storms, etc. These play a small role of CO generation into the atmosphere in comparison with considerable amounts generated by *human activities* such as industrial processes, mainly iron and steel, petroleum and paper industries, transportation, etc.[1]

It is noticeable that *soil microorganisms and fungi* remove CO from ambient air. This occurs mainly in the soil, though a small amount is oxidized to carbon dioxide in the lower atmosphere.

Fourteen species of fungi have been identified in the soil as the active agents oxidizing CO to CO_2. The activity of these fungi varies with the type of soil, being least active in desert soils and most active in the tropics. The urban areas have among the poorest soil reservoirs of these fungi which cannot make an effective contribution to lowering the localized high concentrations of anthropogenic carbon monoxide which is released in these areas[6]. The average residence of carbon monoxide in the global atmosphere is between 36 to 110 days[1].

Carbon monoxide has little effect on plants and micro–organisms at the maximum concentrations (about 15 ppm), even in urban areas.

Its high concentrations (100 ppm and above) are lethal to many animals. The approaches to reducing carbon monoxide emission include improvements in engine design, (supplying a stoichiometric air/fuel mixture to the internal combustion engine which will give low carbon monoxide and hydrocarbon emissions, but high emissions of nitrogen oxides). Other approaches to control CO emission can be mentioned as development of substitute fuels and development of new power sources[6].

Carbon monoxide is a powerful poison being dangerous because it is odorless and attacks haemoglobin to from carboxyhaemoglobin. It binds about 100 times more strongly to haemoglobin than does oxygen, the reaction:

$$HbO_2 + CO \rightleftharpoons HbCO + O_2$$

This reaction has an equilibrium constant of approximately 210[1]. The result of the formation of the above mentioned complex is reduction of the red blood's capacity for carrying oxygen[7]. However, the reaction can be reversed by removing the poisoned victim from carbon monoxide source to breathe fresh oxygen, whereby the equilibrium will be moved to the left and conversion of HbCO to HbO_2 will be promoted[1,2].

$$HbCO + O_2 \rightleftharpoons HbO_2 + CO$$

This is fortunate that carbon monoxide binds 2500 times more effectively than oxygen to a free heme, but only about 100 times more when heme is present in myoglobin or haemoglobin[8]. Hence, by administering pure oxygen to the poisoned person, the victim can be rescued.

There is no doubt that levels of carboxyhaemoglobin above 5% of the total haemoglobin have harmful effects, ranging from headache, fatigue and drowsiness to coma, respiratory failure and death. It is possible that levels as low as 1% carbon monoxide can adversely affect physiological function. Allowance must be made for voluntary intake of carbon monoxide from smoking, which increases the basis of blood content of carboxyhaemoglobin 2 to 4 times above the level in non–smokers[6].

Analysis and detecting CO

The basis of quantitative analysis for CO is the oxidation of CO to CO_2 with the I_2 formed, being removed and titrated against thiosulfate[3].

$$I_2O_5 + 5\,CO \longrightarrow I_2 + 5\,CO_2$$

Another method of carbon monoxide concentration monitoring is based on the selective absorption by carbon monoxide in the infrared region of radiation. This instrument is more selective and can be used to measure concentrations in the range of 30–50 ppm[9].

This technique does not lend itself to a domestic market, but capitalizing on the n–type semiconducting properties of SnO_2 has led to its use in gas sensors to domestic markets such as fire alarms, underground car parking garages, automatic ventilation systems and gas–leak detectors.

In the presence of even small quantities of reducing gas such as CO or hydrocarbon, the tin (IV) surface loses oxygen and at the same time, electrons return to the conduction band and a significant increase in electrical conductivity of SnO_2 occurs. For workers, who may be exposed to CO, a Pd– based detector that can be worn as a badge has been developed. The detector contains hydrated $PbCl_2$ and $CuCl_2$. Carbon monoxide reduces Pd (II) to Pd (0)

$$PdCl_2.2\,H_2O + CO \longrightarrow Pd + CO_2 + 2\,HCl + H_2O$$

The presence of CO is conveniently signaled by a color change. i.e. the production of Pd metal causes the chemical patch to darken. After removing the detector from a CO–containing zone, the Pd metal is oxidized to Pd (II) by $CuCl_2$.

$$Pd + 2\,CuCl_2.2\,H_2O \longrightarrow PdCl_2.2\,H_2O + 2\,CuCl$$

$$4\,CuCl + 4\,HCl + O_2 + 6\,H_2O \longrightarrow 4\,CuCl_2.2\,H_2O$$

REFERENCES

1. A. K. De, Environmental Chemistry; New Age International Publishers Ltd: New Delhi, (2001) p. 94, 108.
2. P. O'nill, Environmental Chemistry; George Allen & Unwin publishers Ltd.: London, (1985) p. 151.
3. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry; Pearson Education Ltd.: Essex, (2001) p. 301, 308.
4. N. N. Greenwood and Earnshaw, A. Chemistry of the Elements; Pergamon Press: New York, (1989) p. 326.
5. M. H. Lietzke and C. Mullins, Thermal Decomposition of Carbon Dioxide, J. Inorg. Nucl. Chem., **43** 1769 (1981).
6. J. H. Duffus, Environmental Toxicology; Edward Arnold Publishers Ltd: London, (1983) p. 80.
7. J. D. Lee, Concise Inorganic Chemistry; Chapman & Hall: London, (1991) p. 419.
8. A. G. Massey, Main Group Chemistry; Ellis Horwood Ltd: Chichester (1990) p. 238, 471.
9. S. P. Mahajan, Pollution Control in Process Industries; Tata McGraw Hill publishing Ltd: New Delhi (1985) p. 49.

Accepted : 15.4.2005