INERGEN
A BREATHABLE GASEOUS EXTINGUISHING AGENT

J.F. Riley
Ansul Fire Protection

The purpose of this paper is to introduce a novel fire extinguishing agent, INERGEN. INERGEN is a breathable gaseous extinguishing agent based on mixtures of various inert type gases. It is the subject of US patent **4,807,706,** dated February **28,** 1989 (1). The composition of INERGEN consists of mixtures of Nitrogen, Carbon Dioxide, and any one of the Inert Gases including Helium, Neon, Argon, Krypton and Xexnon. The most common composition is derived from a mixture of Nitrogen (52%), Argon (40%), and Carbon Dioxide (8%).

The above cited patent is not a composition of matter patent but is a patent that covers the process of obtaining an atmosphere that is non-combustible and yet breathable. In order to make this process more understandable, it's worthwhile to review some basic information about combustibles and the process of combustion.

The four basic prerequisites for combustion or fire to occur are:

*Suitable Fuel
*Suitable Oxidizing Agent
*Source of Ignition
*Chemical Chain Reaction Path

A suitable fuel for combustion is any material that can be easily oxidized. Materials that fall into this category are the common Class R and Class B combustibles *(2).* These include paper, wood, fabrics, and certain polymeric materials such as Rubber, and PVC cable sheathing. The Class B materials include flammable and combustible liquids and gases. Based on the prerequisites for combustion or fire, there are four ways to stop combustion or extinguish a fire (3), including:

*Remove heat (Water)
*Separate Fuel from Oxidizer (Foam)
*Dilute Fuel/Oxidizer Concentration (CO_2)
*Terminate Chain Reaction (Dry Chemical and Halon)

In reality all extinguising agents employ more than one extinguishment mechanism.

We now have a new fire extinguishing agent, **INERGEN,** which basically operates like CO_2 to dilute the oxygen concentration, the third mechanism. Unlike CO_2, **INERGEN** results in a breathable atmosphere.

A normal atmosphere contains 21% oxygen. Most combustibles will bum until the oxygen concentration has been reduced to less than **15% (4).** INERGEN, when discharged into a hazard enclosure, will reduce the oxygen concentration to about **12.5%** which is well below that required to support combustion or fire. A normal atmosphere will also contain 0.03% CO_2. When **INERGEN** is discharged into a hazard enclosure, the CO_2 concentration is increased to about **4%.**

The increased CO_2 concentration results in increased respiration rates. This means that a person who is in that atmosphere will breath deeper and more frequently *(5).* This is the basic process by which a material such as **INERGEN** causes extinguishment of a fire while allowing persons to breath as they egress the hazard area. Thus **INERGEN** functions as both an extinguishing and inerting agent.

Since **INERGEN** does not contain any halogen component, such as chlorine, fluorine, bromine or iodine, it has no ozone depletion potential like the existing halons and some of the announced replacements. Because of its composition, **INERGEN** cannot be considered a chemical toxin like the existing halons and the announced replacements. It is not a mutagen, a teratagen *or* a carcinogen. It does not have an effect on the central nervous system nor does it sensitize the heart as do the existing halons and some of the replacements.

Unlike the existing halons and their announced replacements, **INERGEN** has no resulting decomposition products such as the halogen acids. Because of this, there is no concern over corrosion effects and there is no need for a minimum discharge requirement. The only possible concern with **INERGEN** is in over-concentration applications which could result in CO_2 concentrations in excess of 5-6%. At these levels of CO_2, the onset of asphyxiation occurs and at 8-9% unconsciousness can result. This is an engineering and applications problem and suitable safeguards such as system commissioning discharge testing can validate that the CO_2 level is as designed.

INERGEN is a high pressure gas mixture and, therefore, only suitable for total flooding pre-engineered and engineered systems applications. It is not suitable for local application either from a portable extinguisher or from an extinguishing system.

The pressure of the INERGEN gas mixture at normal temperatures is dependent only on the volume of the storage container. At 150bar (2205 psia) the cylinder size would be 80l(400ft^3 N_2 or 100 LB CO_2). If the pressure were doubled, the cylinder size could be cut in half. INERGEN, like CO_2, requires the use of heavy duty (Schedule 80) pipe and fittings. At higher pressures heavier duty (Schedule 160) pipe and fittings are required.

It is important to note here that the US Fire Codes require the use of ANSI B 31.1 (6) for pipe stress calculations. The Power Piping Code lays down requirements for pipe under continuous duty. This is not the normal or intended use for pipe in a fixed fire suppression system. It is believed that the concern over pipe failure at these higher pressures could be satisfied by incorporating pressure relief devices downstream of the manifold at the top of the riser inside the hazard area.

A gas mixture such as INERGEN could be used as a drop-in replacement for low pressure CO_2 systems with the system pressurized at 150bar. It can also be considered as a replacement for Halon 1301, provided the pressure relief value is incorporated and the manifold capacity is increased to accommodate the increased number of required cylinders. The amount of INERGEN required is .4ft^3/ft^3 of space. The concentration of INERGEN required is comparable to the amount of CO_2 required for most Class A and B hazards.

INERGEN total flooding systems are not yet commercially available in North America. Plans are to have such systems approved and available in North America by the end of calendar year 1992. INERGEN systems are approved and available in Scandinavia, Germany, Switzerland, and Ausma under an exclusive license in the latter three counmes from Total Walther, a subsidiary of Wormald Europe.

There are 50-75 INERGEN total flooding systems currently in service. The cost of an installed INERGEN system is estimated to be 1.5-1.6 times that of an installed Halon 1301 system.

In order to keep this cost comparison in perspective, we need to point out that this cost is based on current pricing for Halon 1301 and on its availability. Halon 1301 production will be

phased out on a world-wide basis by the end of 1993. The Montreal Treaty (7) is expected to be revised in 1992 to require an immediate 50-85% production phase in 1994 and complete phase out by 1995. In the United States, an excise tax will be in effect of between 26.50$/lb and 42.40$/lb depending on ODP value (8). When this tax takes effect, the installed cost comparison will shift drastically in favor of INERGEN.

The most likely applications for INERGEN total flooding systems will be EDP/Computer facilities, telecommunications facilities, other essential electronics applications, selected oil and gas production facilities, and historical/valuable record storage facilities. INERGEN total flooding systems will replace many of the traditional Halon 1301 systems, especially in light of the fact that all of the announced replacements for Halon 1301 are 2-3 years away from commercialization. The status of the announced replacements is as follows (9).

FE-25-Dupont-Unacceptable cardiac sensitization.

FE-13-Available at 4.00$/lb, requires high concenmtion i.e. like CO_2.

PFC-410-Green house gas, atmospheric lifetime estimated at 3000-10,000 years.

FM-200-Toxicity not completely resolved, cost estimated at 12-14$/lb.

In summary, it appears that INERGEN offers the best near-term solution to the problem of providing a clean, electrically non-conductive, effective, non-corrosive, total flooding agent that affords documented life safety features while having no environmental impact now or in the foreseeable future.

BIBLIOGRAPHY

1. **U.S.** Patent 4,807.706. Lambertsen et al, Breathable Fire Extinguishing Gas Mixtures, Feb. 28, 1989.

2. ANSI/UL 711, Standard for Fire Testing.

3. R.L. Tuve, Principles of Fire Protection Chemistry, National Fire Protection Association.

4. Fire Protection Handbook, 17th Edition, National Fire Protection Association.

5. C.J. Lambertsen, "Respiration", Medical Physiology, 14th Edition, Mosby, St. Louis, 1980.

6. ANSI B 31.1, The Power Piping Code, American National Standards Institute.

7. The Montreal Protocol on Substances that Deplete the Ozone Layer, Final Act 1989.

8. Omnibus Budget Reconciliation Act of 1989. **U.S.** Congressional Record.

9. J.F. Riley, Internal Report, Halon Replacement Summary, Ansul Fire Protection, May, 1992.