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Oxygen Incident Clusters and Nightmares

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ABSTRACT: The causes of fires and explosions in oxygen and other oxidants are not always solved and that argues oxidant fire safety science is not complete. Unexplained events are described as "clusters" and "nightmares" that represent uncertain traps that can ensnare and warrant study to enable control if control is possible.

KEY WORDS: oxygen, oxidant, fire, explosion, safety, cluster, nightmare.

Oxygen fire safety science is not fully settled. Much progress has been made, but both the science and the methods of coping with that science are not complete.

Oxygen, as for other oxidants as well, has a way of humbling those who seek to master its hazards. Two particularly frustrating ways that this writer's comeuppance has experienced is with clusters and nightmares (shock and awe).

"Clusters' and "nightmares" are not common parlance in the field. They are personal history. In a long experience, this worker has come to consider a cluster to be when a series of oxygen fires and/or explosions obtains, possibly mundane in which you exhaust all known redress tactics without success. There are a number of these. A "nightmare" is when at least one or more particularly severe fire episodes obtains and you seek to explain it within the body of oxygen safety practice and "knowledge" and, again, nothing fits. You are left without a resolution. These are what one might call known unknowns. You know that they exist but you also know that you do not know how to prevent them.

Either of these can be insidious for when you think you have found a solution, and the events seem to stop, they might stop for some other reason (even just probability) besides your skillful remedy. And you are left unaware facing the same unmitigated risk as before. In these cases, it has become an unknown-unknown.

These events can be so small in scale that one might never realize they have been exposed. But this shall in very vague terms describe one. In this case (1980s) it was so frustrat-

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[2]Italic numbers in brackets refer to the reference list at the end of the paper.

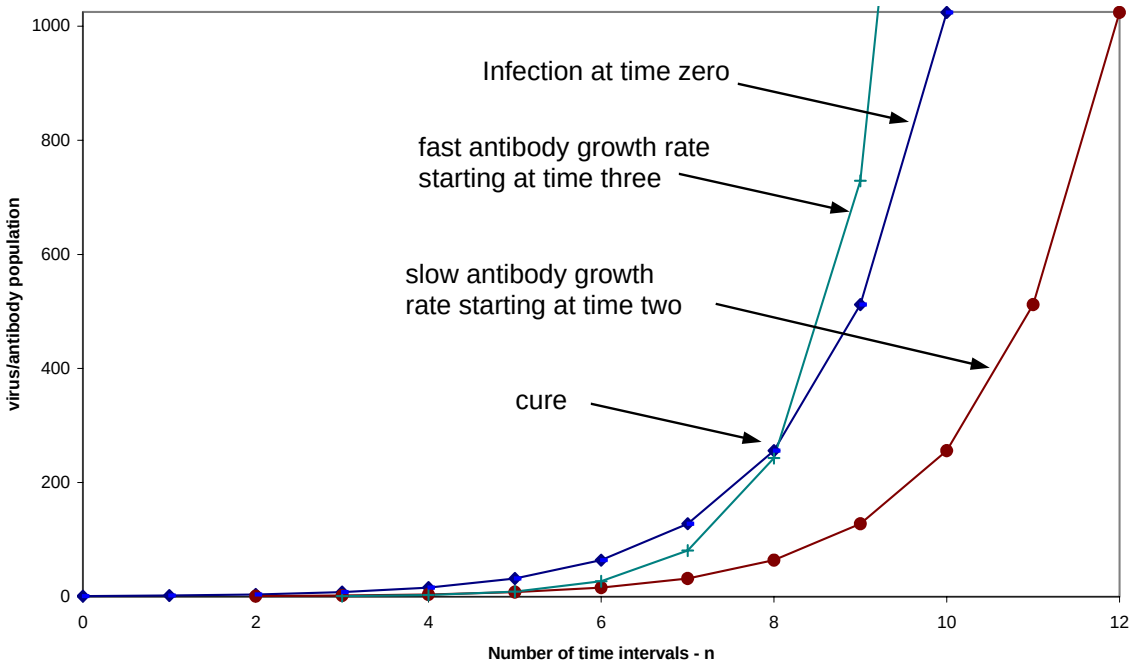

Fig. 1—*Hypothetical Virus growth scenarios.*

ing that that this worker at one point (1980s) roughed out a sarcastic paper "**Virus Induced Fires in Oxygen Systems**". It was known that this title would never pass muster with the Corporate Publication Committee but, hey!, worth a try. Needless to say it never published. But yet its message still has merit.

That paper was based on an understanding of how viruses behave (and this was decades before COVID). When a common cold (coronavirus like COVID) invades a human, it starts to multiply, and exponential growth occurs as the number of viruses reproduce. The body detects the virus and start manufacturing warriors (antibodies) to kill it. And the antibodies also grow with their own exponential curve. Fig. 1 crudely models the mechanism for three exponents; one exponent for virus growth, one exponent for curative antibody growth, that cures you and one exponent for a too-slow fatal antibody growth rate).

A Cluster

Imagine this same scenario applied to a cluster of small-scale oxygen fires. To begin, a minor component change was made in an oxygen system. No new material, just literally a small change in a spring coefficient. A world-wide system adopted the change. Within days an altered component experienced a fire. Did a less stiff spring cause the fire or was it another mechanism? So a standard investigation began to include all the common approaches. The pre-fire specific and corporate system was well proved without problem, one could argue it had a statistically significant history of safe use. So contamination became the tradi-

tional leading candidate cause, but perhaps a manufacturing error had been made in the component that contained the spring. Among the resolution actions was scrupulous system-wide careful cleaning and extensive verification of the correct component materials and assembly. Then fire #2 resulted. This time in a different system at a different location that had been modified. It was investigated with the same procedure. And all systems again revised. Then Fire #3. Now materials were upgraded and more extensive cleaning applied. Then fire #4 resulted. To make a long story short the struggle to find and fix the problem that had never been seen before in decades of operating these exact systems in various countries on disparate parts of the globe went on to experience something more than two dozen fires. At one point the original spring designs were returned to no avail. Something had changed. Finally the component manufacturer was called in and a maximum all out fire-proof design was demanded, one whose performance was less effective and whose cost was high but brute force was employed to end the fires. Upon conversion of the system to the new components, within a week a fire occurred in one of the "bullet-proof" valves .....and then they stopped.

It was just like the system had become infected, a pandemic resulted, and everything was tried to find a cure and never did but then somehow the system cured itself just like when one's antibodies finally kill all the COVID. An experience like this leaves one changed. However, it helps to boost one's humility.

A Nightmare

A terrible fire with a fatality occurs. As with the small fire a massive investigation is launched to explore every identifiable potential cause and test it and nothing is found. Then many years later, a second fire occurs with more fatalities. Another more massive study is launched. Over years of study, at a cost perhaps north of a million dollars, again no cause can be identified. Enormous amounts of highly valuable data are developed that affect many oxygen systems and industry practices in general and yet the cause of the fires is not proven apparently to this day decades later and as a result more millions were spent to remove *every* similar system from service and replace it with new different systems that have not had similar statistical experience. The incident apparently did not repeat ...yet.

Flow Friction

The writer is not alone in this experience. To within his knowledge, more than three decades ago, in the ASTM Committee G4 Technical and Professional Training course, descriptions of similar events posed a problem for instructors. In an effort to tease out an explanation/cause for known fires that were not explainable, friction due to gas flow (flow friction) was cited as a plausible cause (like unproven dark matter is cited as a galactic cause). Over time its use became so common that it seemed likely that it must be a valid cause. Yet during associated controversy, followed by laboratory tests to demonstrate a flow-friction induced component fire [***1,2***], none has been achieved. Even to this day, again decades later. Since 2005, ASTM Standard G88 Design Guide has listed this putative cause as

"speculative". Worth considering but unproven, and not for not trying. Today (2026) it appears once again, it is being considered for certification.

Cosmic Ray and Atom Decay.

Because of events like these, in perhaps an act of desperation, the writer has examined the possibility that high-energy particles (alpha rays, beta rays, gamma rays, x-rays, cosmic rays) resulting from cosmic events (sun spots, novas, gamma ray beams, atom decay, etc.) may bathe the earth or spontaneously erupt thereon (as random radioactive decay) as triggering events [***3,4***]. Like flow friction, the prospects are again speculative but these cosmic events are common. They are plausible. They do transfer energy, indeed spectacularly intense energy. However, their total energies seem to be on the low side as solitary sources of ignition compared to common minimum ignition energies. However, to date (nearly two decades later), there has been no study of them for more than a decade, and the skeptic powers-that-be within ASTM Committee G4 have resisted citing them even as speculative prospects in its standards. But they are real. Again, worth considering but unproven, though in this case apparently possibly for not trying.

Closure

There are known incidents that have not been reconciled. Those listed here and elsewhere. Furthermore, no one knows how many incidents that were explained with plausible reconciliation's, even demonstrations, are simply wrong. Notwithstanding the clear success of ASTM Committee G4 in fighting oxygen system fires, its body of technology is incomplete. There are still incidents to solve, work to do.

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