

# THE SCIENCE OF GELLING FOR IMPROVED HFC GAS PERFORMANCE

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## INTRODUCTION

Over the past 10+ years, several fire extinguishing powders have been suspended in liquefied CFC, HCFC, and HFC gases through the use of gelling compounds. These gels have shown increased extinguishing performance, reduced toxicity, and reduced cost without penalty of sight obscuration, corrosion, or cleanup expense. In fact, at least two combinations of powders and HFC replacement gases have equaled or exceeded the performance of halon, and at least one of these has been EPA SNAP approved for use in occupied space. Powder extinguishants are frequently frowned upon because they need to be cleaned up in case of false alarm, or because they cause corrosion if left around or because they are “likely to create havoc in an electrical system or gum up an engine.” Surprisingly, there are some good answers to these perceived negatives about powder gas combinations, which we will try to address below.

When powders are properly suspended in a liquefied halocarbon gas, and the liquefied gas experiences atmospheric pressure, an event called “flash atomization” occurs. The gas at the time of expulsion from its container carries the powder wherever the gas goes. In gellation, the powder particles are individually loosely linked to the surrounding liquid and will become a gas/powder mixture thus permitting the powder to give its added tire killing, toxicity reduction, and re-ignition prevention powers to the fire in an evenly distributed flow. If powders are not gelled and thus unevenly suspended, the powders will sink to the bottom of the container and pack down and cake over time preventing smooth operation and even and thorough dispersion. Nevertheless, there are real and important synergies in halon replacement gas/powder combinations. In addition gas-like behavior, these extinguishment synergies, include the following: cost reduction; weight and volume reduction; toxicity reduction; fire re-ignition reduction; and, in many cases, halon or equivalency or better

## ILLUSTRATIONS OF SUCCESSFUL GELS

A gel of sodium bicarbonate and FE-36 exceeded Halon 1211 performance in FAA conducted “Hidden Fire” tests where the powder must be delivered around a baffle to telltale fires spread throughout a container. The hidden fire tests illustrated that the gas could carry the powder where the gas itself was able to go and the gel exceeded the halon performance on average of 44% for five tests. The gel also equaled halon in FAA “seat fires” [1].

Ansul and ATC conducted pan fire tests [2] (2.5-lb. extinguishers put out 5B and crib fires). Since about twice as much agent is needed with neat hydrofluorocarbon gases, the cost of gelled extinguishers is about half as much. Example: It takes 4.75 lbs of FE-36 to put out the same fire that 2.5 lbs of the gel extinguish. At \$11.00/lb x 4.75 = \$52.25 plus a larger canister for is required for FE-36 neat versus \$12.00/lb x 2.5 = \$30.00 is required for the gel giving a saving of \$22.25 per extinguisher. In addition, more than 2.25 lbs are saved per extinguisher on a plane that uses 8 extinguishers, equaling 18 lbs per plane. (Hidden fire tests are illustrated in the accompanying video.)

A gel of non-corrosive ammonium polyphosphate (APP) and FE-36 exceeded halon by 10 to 14 lbs in FAA-designed air cargo container tests conducted for FedEx. Although the weight reduction is important to the user, the ability of the gel to further prevent re-ignition as compared to even halon gas alone is critical when the plane is on an ocean crossing or other venture where rapid emergency landing is not available. The gelled agent subdued deep-seated / smoldering fires and prevented re-ignition, eliminating any need for metering more agent to maintain protective concentrations.

To use a HFC gas neat in this illustration in the automatic tubes shown would have required tubes holding at least 19 lbs. of FE-36 (even more of FM-200) and tube lengths of 27 ft compared with 14 ft for the gelled product. (The tube holding gel against fires in air cargo compartment is illustrated in the accompanying video.)

A gel of APP and FE-36, another gel of APP and FM-200 and another of sodium bicarbonate and FE-36 put out fires without generating the unacceptable amounts of hydrogen fluoride that occur from using HFC gases neat [3].

In addition, the APP passed acute inhalation tests under the auspices of the EPA thereby prompting the EPA to produce written advice that the gelled agent will soon receive EPA approval for use in occupied spaces.\* These enhanced gases also passed obscuration tests conducted by Aberdeen Test Center during the same time. The synergies are obvious here, but it is interesting to note that as little as 5% powder added to an HFC gas has curtailed hydrogen fluoride generation. But a 5% addition does not give the other synergies of weight reduction, cost reduction, and prevention of reignition that are offered by a gel of 40% powder with 60% gas.

A gel of mono ammonium phosphate and Halon 1211/1301 enabled the user to put out a 2B fire with 1 lb of total agent producing one of the most effective fire-killers ever found. (The cease fire extinguisher containing Halon 1211/1301 and MAP are illustrated in the accompanying video.)

Gelling of a liquefied gas is not a thickening process, but a loose chemical bonding of the powder particle to its surroundings. Gelling is a long involved process using agents and ingredients such as polymers, surfactants, silicates, and deflocculants. There is no molecular change in the gas or the powder. Each HFC gas/powder combination requires a different combination of gelling agents. Long-term stability tests must be performed and periodic expulsion testing of samples is essential to verify gel stability. However, the results have brought a more efficient method of dispersing the desired ingredients safely and efficiently on to a fire.

## CONCLUSIONS

If "Son of Wonder Gas" (halon) is ever discovered, a gel with a good fire-killing powder will improve its performance, prevent further reignition, reduce its cost, and probably prevent toxic byproducts if they exist.

## REFERENCES

1. Webster, Harry, "Hidden and Seat Fire Testing," FAA Research Center, Atlantic City, NJ, 7/13/00.
2. Bolt, William, and Hammel, Howard, "Portable Testing," ATC, Aberdeen Test Center, Aberdeen Proving Grounds, MD, 6/14/00.
3. Bolt, William, Skaggs, Reed, and Horton, Donald, "Hydrogen Fluoride Control Testing," TECOM Projects Nos. 1-CO-160-000-189(3/17/99) and 9-CO-160-000-422(1/5/99), Aberdeen Test Center, Aberdeen Proving Grounds, MD.

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\* Jeff Cohen, Chief, EPA, Analysis and Review Branch, 8/7/00.