ColdFIRE *—A highly effective, environmentally friendly, 21st Century technologically advanced firefighting agent; THE ALTERNATIVE to gels, foams and retardants.*

"YOU PUT GEL IN YOUR HAIR, NOT IN YOUR HOSE."

–Sharon J. Bain

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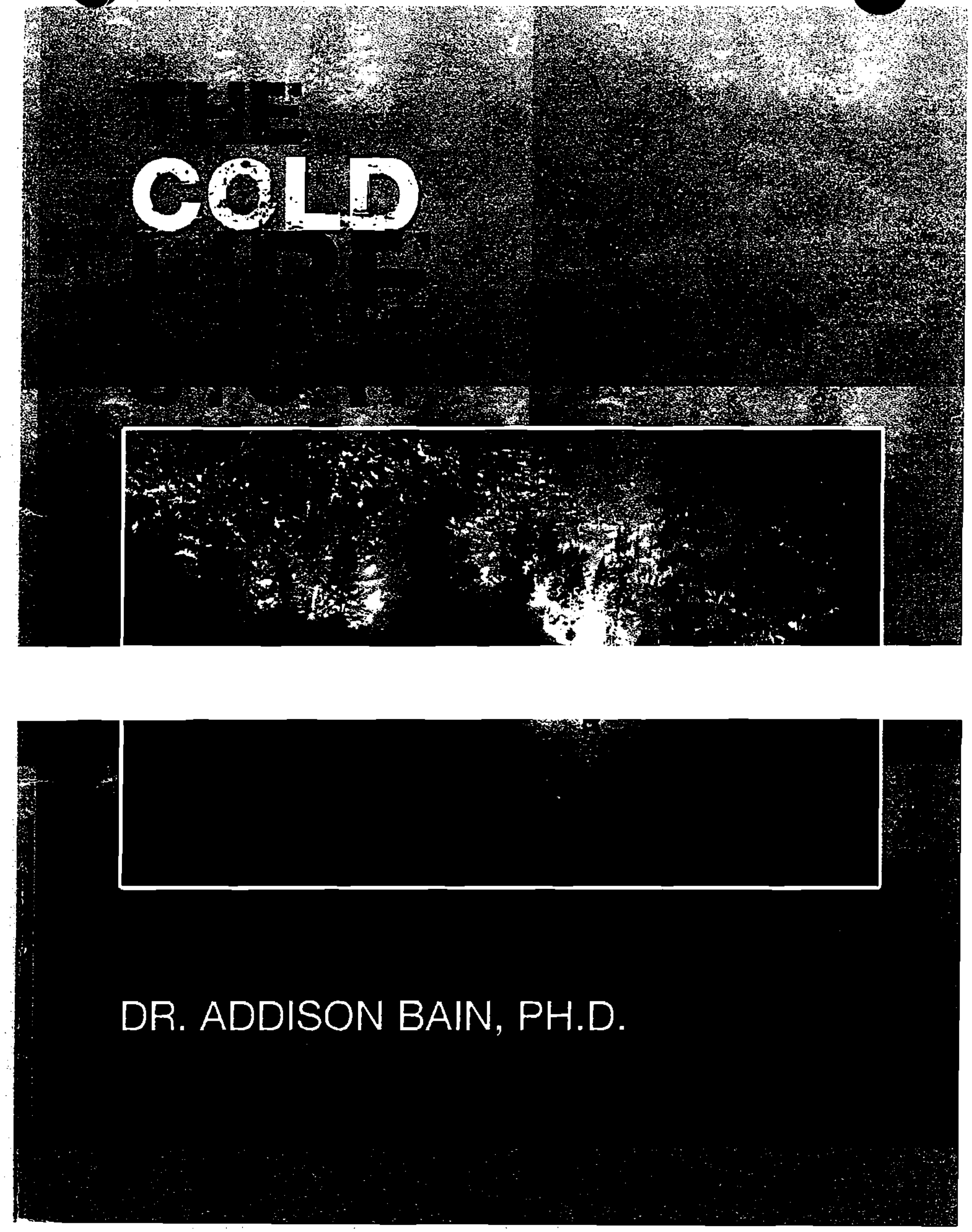
COLD FIRE FORESTRY DIVISION



Cover photo taken in the Bitteroot National Forest in Montana,
Bureau of Land Management, Alaska Fire Service

THE COLD FIRE STORY

by
Dr. Addison Bain, Ph.D.

PURPOSE

The purpose of this booklet is to provide interested parties pertinent information about the product called **Cold Fire**. The primary focus includes those entities responsible in the management of wildland fires.

BACKGROUND

FireFreeze Worldwide, Inc. in Rockaway, New Jersey. The author, a former Forest Service employee and 30-year veteran with NASA, was introduced to the product in the fall of 2000. Up to that time **CF** had been used as a firefighting agent for local fire departments, the racecar industry, as a cool-down agent for plumbers/welders and for wildland firefighting interests in other countries. Seeing **CF** as a valuable tool for use in wildland firefighting the challenge was undertaken to work with the US Forestry Service (FS) to obtain their approval, with the objective of getting **CF** on the FS Qualified Product

List (QPL). The policy of federal agencies is to use only qualified products (NFES 2724 chapter 12). Although a significant amount of testing of CF had been performed by a number of US and Canadian laboratories, this was not an acceptable substitute by the FS who use a specific test protocol.

CF is a very unique product, derivative of German origin, constituting a well-formulated mix of several plant species. Aside from the plant extracts are the mineral and salt makeup naturally adsorbed from the respective unique soils. No chemicals are added. The product does not contain any phosphate or bromine derivatives, or polymers common to many retardant and extinguishing agents. It is the discovery that the final product mix when blended with water takes on special characteristics to enhance the overall efficiency of controlling Class A, Class B and Class D fires that make CF an effective, safe and environmentally friendly agent.

The following outlines the timing, sources and type of testing done in accordance with regulatory specifications and requirements.

CF successfully passed the performance criteria in all cases.

- 1993, USTC/Biological Services, eye and dermal irritation, acute oral toxicity, aquatic toxic on rainbow trout, water flea and alga. Per EPA Health Effects Test Guidelines.
- 1994, UL Inc., Certificate granted 10/1996. Class A & B per NFPA 18, Standard for wetting agents.

- 1995, UL of Canada. Class A & B certifications.
- 1996, SGS US Testing Co. Inc., Aluminum and carbon steel corrosion rate evaluation per 49 CFR 173.120.
- 1996, USGS, acute dermal toxicity study on rabbits, skin sensitization study on Guinea pigs.
- 1997, SGS, acute inhalation toxicity on test animals (rats).
- 1998, EPA Significant New Alterative Policy (SNAP) program, acceptable substitute for the Halons.
- 1998, Intertek Testing Service, thermal surface cool-down comparisons for metals and glass.
- 1999, UL of Canada, CF testing for Class D performance.

TESTING PROGRAM IN SUPPORT OF THE QPL

The Forest Service classifies the Fire Chemicals as:

- Water Enhancers

CF was evaluated as a water enhancer to FS specification 5100-306a(12/02).

The evaluation program was initiated in May 2003.

CF was approved and initially added to the QPL on April 5, 2005.

It is noted: CF is not a Gel as are the other water enhancers listed.

The following outlines the FS test protocol. Performance requirements and certain parameters had to be met in order to be placed on the QPL.

A. Health and Safety
   1. Mammalian Toxicity and Irritation Tests
   2. Open Cup Flash and Fire Point
B. Environmental Effects
   1. Biodegradability
   2. Fish Toxicity
C. Physical Properties
   1. Density
   2. pH
   3. Viscosity
   4. Pour Point
   5. Miscibility
   6. Marsh Funnel Flow-Through Time
D. Fire Effectiveness
E. Product Stability
   1. Outdoor Storage Test
   2. Effect of Temperature on Viscosity
   3. Effect of Temperature on Marsh Funnel Flow Through
   F. Corrosion Testing
   1. Metals – Uniform Corrosion
   2. Metals – Intergranular Corrosion
   3. Non Metals

Testing was done at the Missoula Technology Development Center (MTDC) in Missoula, Montana as well as back-up

testing for correlation at the San Dimas facility in California.

The CF concentrate, as well as the recommended field mixture, was evaluated. The outdoor storage consisted of one year subject to a freeze – thaw environment. Many of the test parameters were repeated in order to demonstrate no detrimental effect after long-term storage. Special testing was done by outside labs at Pacific Metallurgical Company, Stillmeadow Inc., U.S. Geological Survey and Underwriters Laboratory, Inc.

CREATION OF CFD

In anticipation of the successful program with the FS the corporation of the ColdFire Forestry Division, Inc. (CFD) was formed. In view of the expense and time consuming process of achieving QPL status, on behalf of CFD, an exclusive agreement with FireFreeze was entered into. CFD provides [illegible]

For additional detail about CF not addressed in this paper, such as the many testimonials from firefighting organizations, recommended dilution rates and the CF Material Safety Data Sheet (MSDS) or product videos please visit the CFD web page or contact the author at addbain@juno.com.

FS TESTING POST INITIAL QPL STATUS

The QPL listing of 4/5/05 approves CF for helicopter bucket and ground engine applications. Since then specialized tests of CF with aluminum coupons has proven successful. Therefore the QPL was updated 2/6/06 to reflect conditional approval for fixed-wing airtanker and single engine air tanker (SEAT) applications. The remaining tests involved the evaluation of CF for magnesium corrosion (uniform and intergranular), a requirement for the fixed-tank helicopter application. CF is the only water enhancer approved for this application.

The Bureau of Land Management sponsors field operational evaluations for QPL listed water enhancers. The evaluations are on going during the fire seasons. The principal goal is to evaluate, and compare, the effectiveness of water enhancers, using aerial applications (SEAT) to support suppression tactics in grass, brush, and timber fuel types.

Some state agencies such as the California Division of Forestry (CalFire) support the field evaluation of products for the helicopter bucket and ground engine applications during

The author suggests there are really two aspects of a field evaluation.

a) Experimental, as measured against preconceived *and desired* parameters.

b) Direct visual experience (subjective) to observe and document observations; identifying special attributes, handling characteristics, field set up restrictions, adaptability to the various applications, operational and logistical considerations and lastly a valid *overall comparative economical analysis.*

OTHER RELATED TEST PROGRAMS

The research laboratory of FM Global, one of the world's largest property insurance and risk management organizations, has evaluated CF. They have found CF acts as a surfactant encouraging the formation of fine droplets when sprayed on a fire providing better cooling, good penetration and more rapid extinguishment. A special formulation is effective as an additive for anti-freeze fire suppression applications. FM Global found CF "has a remarkably high specific heat at temperatures between 32 and 68 degrees F explaining its good cooling properties." The CF enhances the water viscosity to a certain degree. Viscosity is significant for aircraft water drops to help hold a tight pattern of the water mix. FM Global also found that CF spreads very rapidly over surfaces of mineral oil and other liquid fuels. Thus they would anticipate that it would be a very effective extinguishing agent for Class B fires. These [illegible] organization (formally Factory Mutual).

Rubber tire fires have been notoriously difficult to extinguish. In 2003 under the auspices of Underwriters Laboratory the Michelin Tire Company conducted tests to develop data relative to the fire protection of rubber tires stored on pallets in a warehouse. A typical warehouse overhead sprinkler system was used. Ceiling height was 30 feet. A test with water only was done to establish a reference point. A one-minute average air temperature of 1,600 deg. F and a 1,000 deg. F for overhead steel structural components was the test criteria. With water only, the steel beam temperature above ignition exceeded 1,000 deg. F. Using an aqueous solution consisting of 3% CF the maximum temperature was 379 deg. F for the one-minute test. Interesting to note that the water only test had to be put out using a fire hose supplied with a CF mix to prevent destruction of the test facility.

FireFreeze the manufacturer of CF sponsored the UL testing in 2007 for extinguisher and sprinkler applications. This test program was a result of the updated requirements imposed by the NFPA.

A LITTLE FIRE SCIENCE

Water is the most effective fire-suppressing agent known to man. When water is exposed to the flame combustion temperature it vaporizes. The change in phase from a liquid to a vapor under goes a "heat of vaporization" process in which

of heat. Thus the cooling process. Applied properly one volume of water will cool 300 volumes of burning fuel. But the trick is to do this effectively and not "waste" a lot of water. One is the firefighter technique; his ability to manipulate the hose nozzle to provide a straight-stream, spray or fog as the situation may dictate is essential. Then comes the science.

For years it has been the challenge of the scientific community to come up with strategies to enhance the capability of water. The use of additives (agents) to reduce surface tension, increase the surface area and regulate droplet

size have been investigated. The problem is to have a final product that is not overly toxic or harmful to the environment, easy to use in the field and not cost prohibitive. As such some products have proven to be satisfactory while others had to be taken off the market.

Water has a surface tension of 73 dynes/cm. CF, like some foams, can drop that by several factors. This allows the water molecules to penetrate the fuel more effectively and spread the coverage. There is what is known as fuel limited fires. Examples are a burning pile of rubble or a burning pile of tires. Tests by the Michelin Tire Company show that CF has the deep-seated fire cooling capability needed for fuel-limited situations. Large piles of rubble as a result of post Katrina clean-up operations have also proven CF unique. The piles caused spontaneous combustion. Water alone was not efficient in putting out the resulting fires. Also very important is its ability to prevent re-ignition of hot spots. The surfactant ingredients

high affinity for carbon, as demonstrated by the Michelin testing, where tires have a high fraction of carbon. Ingredients in CF provide condensation nuclei to promote droplet formation of the water and increase effectiveness. It is noted the breakup of the water droplets to a finer configuration exposes more surface area.

Controlled cooling testing, by Intertek, showed timeline factors of CF versus water in surface/mass cooling comparisons ranging from 5:1 for glass up to 21:1 for metals. Thus the cooling aspect is significant (enhanced by the wetting effect).

During the burning process a chemical chain reaction takes place in which new products form, the key to the reaction that produces fire, an important aspect of the fire tetrahedron (fuel, heat and oxygen are the other aspects). The traditional role for the use of water/agents is to interrupt one or more of these aspects to put out or control the fire. CF goes beyond this relationship as will be discussed.

THE SCIENCE BEHIND COLD FIRE

The influence of CF has been explained up to now in the sense of the resulting physical appearance of its effect in certain applications. However the story goes deeper when we visit what is happening on a chemical/biological basis. The following itemizes these characteristics based on laboratory experimentation.

• In Mother Nature certain plant life has the ability to

reduce the intensity of the heat and protect the cellulose structure. CF is made up of a number of selected plant extracts (saps) in a special formulation developed over years of experimentation.

• The organic plant-sap source also endows CF with additional characteristics associated with the maximization and maintenance of stabilized enzymatic levels and activities. As documented in the published U.S. Army's research in chemical and biological warfare decontamination [dual-use enzyme-based decontaminant (Advanced Catalytic Enzyme System –

ACES)], CF enhanced the enzymatic decontamination by up to 95%. This surfactant/enzyme-enhanced action helps breakup the water tension and increases osmotic open-grain penetration.

• To test the rate (amount) of penetration, a visual experiment was conducted using organic food dyes. Two pieces of wood are used from the same stock. One was placed in a container with colored CF mix and the other in a container of colored water. The dye penetrated the cellulose structure differently. The piece of wood placed in the container with colored CF showed a dramatic difference in the level of penetration compared to the colored water. The CF penetration was up to six times that of the water test coupon.

• It is important to note that in the process of testing the penetration level another characteristic of CF was confirmed, namely, breaking of molecular bonding of hydrocarbons. It was noted that all oil-based and synthetic colors and dyes were

hours for the colors to disappear.

• The fore-mentioned characteristic was noted in the effect of CF on hydrocarbon mass. CF as a surfactant emulsifies oil-based materials and fuel source and breaks down the molecular bonding, followed by a leaching process. An experiment to demonstrate this, involves the use of used motor oil. The oil is mixed with clean sand and then mixed with the CF. After applying warm/hot water to the mix, it can be observed that the oil begins to break away from the sand and moves to the surface of water and floats on the surface. After six hours almost all the oil is leached from the sand and floats on the surface. It is noticed that a milky film begins to form at the bottom of the floating oil film. After 72 hours this becomes prominent indicating that the oil is decomposing. Then the mixture is agitated and half of that mixture is poured on a sunny spot on a ground-soil and the other half is left in the container. After 28 to 36 days all the oil film in the container will decompose into a white film on the water surface. This film will have exceptionally low or no viscosity while the one on the ground disappears in a clear process of bio-degradation.

• Through the fore-mentioned emulsification process, molecules are isolated and encapsulated. Therefore, there is no heat transfer between them. While simultaneously cooling the fuel source below the ignition point (flash-point) and preventing heat transfer between the molecules there will be no ignitable fuel vapor. This explains why there is no re-ignition

So what happens when CF is used is actually a simultaneous process involving all its chemical/physical/ biological properties.

ADDRESSING QUESTIONS FROM THE FIELD AND GENERAL PUBLIC

There continues to be more interest in the environmental implications of firefighting chemicals.

Fire retardants and suppressants are used extensively for suppression and control of range and forest fires. Each year, fire control agencies utilize millions of gallons of these mixtures on a wide array of ecosystems. These chemicals are often applied in environmentally sensitive areas, which may contain endangered, threatened, or economically significant plant and animal species. The study of the potential impact of these chemicals is on going. It is a very difficult problem in balancing the benefit of the chemical mixture to accomplish its primary mission to control a fire and to minimize the extent of the environmental impact.

Being of common plant origin, CF will meet this challenge.

Please explain the cooling mechanism.

CF absorbs heat, retains it, and then releases it through a diffused moisture-air release. This diffusion release is slow and

capacity of CF is best demonstrated by the following experiment:

A common white cotton hand towel placed over the experimenter's hand is sprayed with CF. A handful of magnesium chips is placed on the towel. A propane cylinder soldering-torch is used to ignite the magnesium. After about one minute the magnesium has burnt and during that time reached a peak temperature of 5,600 degrees F., however leaving the towel still intact, albeit slightly scorched.

Address the specific volume relationship of CF/water and burning fuel volumes.

There is no single statistic to equate the volumetric mix of CF due to all the variable performance parameters that have been observed in the field. The total volume and percentage of CF in the water varies according to the application. Perhaps the best way to address this topic is to cite two examples:

1) In a house fire a firefighter was able to knock down the flames using a three percent solution. He explained it took only about 25 gallons of the mix, whereas he would estimate it would have normally taken about 100 gallons of plain water.

2) A brush truck was used in an attempt to put out a palmetto-based fire in Florida. The fire chief indicated that after using a "considerable" amount of water he was having no luck in keeping the fire under control as the fire kept rekindling. He mixed in a two percent solution of CF and was then

brush fires. Because of the high oil content of the palmetto, FireFreeze recommends a ratio of two to three percent.

There are concerns about the use of existing firefighting apparatus.

CF is used in and with the following applications/ equipment:

It is added directly into fire truck booster tanks, fixed units, CAF (compressed air foam) machines, injectors, inductors, sprinkler systems, automatic fire extinguishing systems, closed

loop systems, water mist systems, hand-held extinguishers, dust collector systems, forestry equipment and firefighting IFEX systems, Bambi-bucket applications and deluge systems. In UL Certificate of Compliance, UL 2000 Directory for firefighting agents in accordance with NFPA 18 Standard for Wetting Agents, HYPRO and WS Darley (major equipment manufacturers) confirm that and show CF to be compatible and pumpable through hoses and pumps.

CF can be used in standard firefighting equipment without fear of corrosion or clogging of lines and hoses as is very common when using foams, gels and other high viscosity agents. Before introducing CF it is important to clean the equipment to eliminate residue of these products as CF performance is severely compromised.

In aerial applications there is the problem of shearing of the falling mass that to some degree can be reduced by

CF breaks down water-tension and molecular bonding. Accordingly, water no longer falls as attached molecular mass; but semi-separate molecules. This means less air resistance. Field-testing is necessary to address wind drift.

Thickeners made up of polymers and/or gums could cause other problems. Super-absorbent polymers themselves ignite after a certain point. This might cause re-ignition. The issue should be studied further by subjecting these polymers to high-intensity temperatures. Similarly some gums, which are not 100% soluble in water, also ignite at certain temperatures.

There appears to be some confusion over your product as it relates to the gels.

Perhaps the best way to address this is that the original FS specification was entitled "Gels and Elastomers." Later the specification was changed to "Water Enhancers." The products listed on the QPL, in general, use the term gel in their product name thus the reader is led to assume all of the listed products are gels. CF, being relatively new to the FS evaluation program, got caught up in this terminology debacle.

Tell us about the use of your product for structure protection.

Normally the process of applying CF mixed with water to a structure enhances the effectiveness of the water. In theory this mixture is effective until the water has evaporated. Field experience is demonstrating that the residual left on the

Based on field evaluations and feedback from users there is evidence that CF is providing various degrees of protection depending on a number of factors such as weather and other conditions. Thus the product may provide a protective barrier from oncoming wildfires for a period of time. The longevity of course would be influenced by wind, rain and the natural biodegradability of the product.

It seems the product would be useful in other countries.

Indeed, over the years, countries such as Mexico, Australia and Saudi Arabia have used CF extensively. It is interesting to note that the U.S. and Australia have a Wildland Firefighting Partnership. The arrangement allows both nations to save lives and property by using personnel and equipment from the other country, thus taking advantage of the countries' differing fire seasons.

Please address the apparent reluctance of some agencies to use your product.

Setting the controversy of the Gel nomenclature debacle aside there is a very important aspect to address. There is the unwritten, unspoken code of the tight – brotherhood of firefighters. Fires mean jobs. Fires mean overtime pay. Small independents providing secondary support such as the food and beverage mobile canteens look forward to the fire season

ecological process. It has been said, "CF works too good." This is one side of the coin.

The other side of the coin: loss of life, unwanted destruction of property, natural and cultural resources—requires no further elaboration.

Federal policy is founded on certain guiding principles. That is, the firefighter and public safety is the first priority in every fire management activity. The fire management plans should be based on the best available science.

FAVORABLE COMMENTS FROM THE FIELD

• George Faust, owner of Professional Fire and Safety, Brookhaven, MS: "After Hurricane Katrina we were called to help extinguish a debris fire in Petal that had been burning for weeks. We could not get there for two days but once we got there, we used 30 gallons of **Cold Fire** and extinguished the fire in 45 minutes."

• Jeff Guite, Success Marketing, Seattle, WA: "The problem I have with the foams is that they have a shelf life, can congeal, takes the paint off my trucks, damages the pumps and has to be dealt with as a hazardous waste." "I have used **Cold Fire** for years and am now pleased to see it is on the QPL."

• Greg Smith is a Fire Chief in Genola, Utah. He's demonstrated it on car fires and said it cools the metal off so the fire doesn't restart. "There's no stink afterward, usually car fires smell really bad. We use it on brush fires instead of Class

• John Miner, a **CF** distributor in Utah, does a demonstration in which he puts a tire in the front seat and another tire in the back seat of a junk car, sprinkles them with petrol and then lights it. After the car is engulfed in flames, he douses the fire in short order with one or two 2-1/2 gallon **CF** extinguishers. "It would take a 150-500 gallon fire truck to do the same thing."

• Gary Mahugh, of Mahugh Fire & Safety, LLC, the **CF** distributor in Kalispell, Montana has used the product for years. "It is one of the few products suitable for batch mixing and

has not caused damage to equipment as other products have done. Local residents are now coming to me to set up their own home protection capabilities."

• Alan Marble, Director of the Office of Emergency Services for Flathead County, Montana: "**Cold Fire** takes no special training, can be batch mixed and no clean-up was required, just figure the percent you need dump it in and go." He also stated they used **CF** on wood bridges that had creosol ties and did not lose a bridge. One of the fire crew had sprayed a cabin, being used as a camp, and the surrounding area with CF. As a fire approached they decided the safest place was the cabin. The fire simply burnt around them.

COMPARISON DISCUSSION

<u>Water enhancers</u>. CF is the only ***non-gel*** water enhancer on the QPL. All others are a very viscous gel formulation.

primarily intended as a temporary structure protection for advancing wildland fires. Experiences from many state officials indicate that the gel is not living up to its original expectations and causing many problems in the field, such as clogging up equipment. Gels are very slippery. It has been observed that they can cause detrimental effects on painted surfaces, shingles and related structural materials. The gels, like **CF**, improve the ability of water to cling to vertical and smooth surfaces.

The FS has issued a precautionary "measure" about the water enhancers as follows:

• When batch mixing is used, all equipment coming into contact with the water enhancers should be thoroughly cleaned at the end of each work day.

• Some of these products contain ingredients that may reduce the effectiveness of other products.

• Ingredients in some products promote rapid bacterial or mold growths in a water solution.

• These products may build up a layer of material that resists removal from mixing and application equipment when cleaning with plain water.

— Not so for Cold Fire —

<u>Class A foams</u>. Now very popular and widely used. Twenty-five years ago, foam was a "hard-sell." Although they are on the QPL their use is restricted in that special personnel protective gear needs to be used. They can be irritating to eyes and skin. Foam concentrates typically consist of three major

to blanket and smother the fire. Some are corrosive to metals, speed deterioration of sealing materials, and are harmful to the environment in high concentrations. Most post-field operations require the equipment to be flushed with clean water to remove the foam residuals. Care must be taken to prevent cross mixing of various manufacturer's products in one system. Foam concentrates exhibit considerable variations in viscosity as a function of temperature. (In the case of the five Class B foams there is the hazard of selecting the wrong one, generating a far greater and more hazardous vapor cloud).

<u>Fire Retardants</u>. A substance that, by chemical or physical action, reduces or slows combustion, thus "retarding" the rate of spread of the flame front. They consist of a mix of water, several chemicals and a coloring agent. The main chemical ingredient is a fertilizer. They are most effective when applied in front of the flame front, not directly on it. So-called long-term retardants contain chemicals, which continue to retard fire even after the water has evaporated.

<u>Forest Service Wildfire Management Policy</u>. The common opinion concerning a forest fire is to allow it to burn and consume the residual fuel on the forest floor and in the underbrush. Experience has shown the forest has a remarkable recovery from such "destruction." Prescribed burns are common to reduce the fuel on certain terrains. However, when advancing fires pose a threat to structures, preserves or people, then the policy is to "control" the fire in a manageable direction

Cold Fire can be used to accomplish these desires.

THE MYSTERIOUS WILDLAND FIRE FURY

The trained firefighter knows about what is called "flashover." In say a house fire where furniture and other household items are heated in a closed space with limited oxygen, there is a build up of pyrolysis products. When these products cannot find enough oxygen to burn, they rise and concentrate near the ceiling. Then if more oxygen enters the room, say from a door opening or someone smashing a window, the unburnt gases ignite in an explosive manner. But in an open forest area sometimes over bare earth and/or in thin air? Here are some interesting stories:

• The South Canyon Colorado fire, 1994, 14 firefighters were killed who tried to escape as the fire raced up the canyon towards them. The evidence hints of a sudden and explosive event.

• The McDonald Creek Glacier National Park fire, 1998, a sudden explosion from the fire front, "shot forward 150 meters at 100 kilometers per hour."

• The Canberra Australia firestorm, 2003, the unexpected ferocity of the blaze killed four people and destroyed almost 500 homes.

Scientists are in debate as to the foundation of this type of phenomenon. Understanding this issue is under investigation

possibility of such an event and to immediately select the best way to mitigate the problem.

ECONOMIC ASPECTS

And the bottom line is ... ? Cost is a relative thing that can create a lot of debate. Comparing apples to apples is a challenge. Competition among products must be evaluated from many aspects, including the intended application.

1) Performance.

The operators can only really judge field performance of CF versus a popular Class A foam. To date there does not seem to be a good demonstration comparison of products. One important aspect is of course, what does it take in terms of product percentage mix to represent the same success (same fire, same time to put out, etc).

If it takes a foam at 1% (at $60/pail) to do the same as CF at 0.5% (at $120/pail) then it is a toss up, except for another aspect. The foam selected in this case is made up of fatty alcohol ether sulfates with diethylene glycol monobutyl ether (18%) and ethanol (8%). Of course exposure controls/personnel protection is necessary and care is needed to prevent the product from being washed into surface waters. The Hazardous Material Identification System (HMIS) rating is 1,2,0.

That is, a slight hazard to health and moderate hazard in

The Cold Fire HMIS rating is 0,0,0.

The performance of CF for a Class D (magnesium) fire (exceeding 5,000 degrees F) demonstrates its penetration and cooling ability for dangerous post fire situations such as bog or muck hot spots.

2) Mixed agent value

Assume the fire department has a rig loaded with 1,000 gallons of water on standby. (The 600-gallon brush truck is common for brush fires). It is the "value" of the water that counts. That is, the labor, energy used, other resources used, maintenance of the rig, overhead, and similar costs that gets the water ready for action, not to mention the cost of getting to the fire scene. Add 5 gallons of CF and the rig is ready to fight a brush fire where the water can then get the best "bang for the buck."

3) Examples of added value overlooked

• For CF use, specialized personnel protective equipment is not required (barring the need for equipment to protect against the fire, smoke, etc of the fire itself and standard operating procedures).

• The logging industry uses CF to reduce the premiums on their insurance (United Loggers Insurance Agency,

insurance underwritten by Lloyd's of London as a result of carrying CF extinguishers on board their equipment.

• Some products have expirations on storage and after time must be disposed of (and not down the drain). There are those in five gallon containers that must be "turned upside down" periodically to prevent "problems." CF that was stored over ten years showed no sign of stratification or other detrimental aspects, thus minimizing frequent inventory replacement.

• Post operation clean up is a very important cost consideration.

• Additives, like CF, make more effective use of limited water resources especially in rural or undeveloped areas. They minimize structural stress (and thus the danger of collapse), since there is far less weight of water being placed on the structure. They lessen the potential for water damage, and damage from smoke.

• One can place costs on structure loss, people displacement, etc.

• If a fire commander can stop a three-acre fire (using CF) from spreading to a sixty-acre problem—that has value.

RELATED CONSIDERATIONS AND CONSEQUENCES

• We are all too familiar with the demise of the Halon extinguishing agents due to their effect on the ozone layer.

• One reads more and more about the consequences of

To the dismay of the Forest Service a district judge in October 2005 from Missoula, Montana, wrote in a decision, as a result of a lawsuit, "wildfire retardant drops violate environmental law." The saga continues. This is further accented by the premise that failure to use the latest "best" technology is in fact grounds for litigation.

• The FS cautions about the use of foams/retardant near aquatic areas. "Retardant drops should not be made within 300 feet of a waterway" per FS policy.

• A recent article indicates that scientists have found that the flame retardant polybrominated diphenyl ether (PBDE) is linked to a number of new diseases attacking the dolphin family.

• Mention has been made of the possible chemical reactions (using certain agents) exposed to extreme fire temperatures forming carcinogenic materials that become airborne. A 2003 study by Labat-Anderson, Inc. quotes, "There are 21 chemical ingredients in products on the Qualified Products List [7/5/02] that meet one or more of the criteria of carcinogenicity, low LD_{50}s [lethal dose], or reportability to EPA and/or OSHA. Many of these chemicals are contained in more than one formulation." It is noted the risk is low but not really quantifiable.

• Wildfires in high-latitude forests are releasing mercury (300+tons/year).

• Arson is a major cause of fires. Firefighting chemicals may mask the evidence. It has been reported the olfactory

• Brush fires can have an impact on the local economy. In Florida for instance they can take a toll on the tourism industry. Traffic patterns are altered due to the smoke-laden terrain. The mix of smoke with fog aggravates an already dangerous situation. And we all know about the health hazards from the smoke.

The firefighters have a tough job and all the best available technology is made available for their safety and job performance.

+ + COLD FIRE is now another viable tool in the fire technology package + +

THE CASE FOR THE AIRSHIP

One of the challenging problems in fighting forest fires is in the method of getting the suppression agent to the fire. For ground engine applications one confronts the difficult, or inaccessible, rugged terrains, such as steep slopes, dense foliage or swamp laden areas. For aerial applications a lot depends on the skill of the pilot for accuracy and timing of the drop. There is the troublesome aspect of the smoke and the very dangerous aspect of the heated air, lowering the air density, affecting aircraft aerodynamics.

Enter the airship. Not a new idea. Their big advantage is the ability to hover near the fire, first as a stationary observation platform. Coordination can be made with the fire commander

density and infrared sensors to locate hot spots are but a few ideas to help with the communication.

The airship would need to employ both the static and dynamic lift features for trim control, as the water/agent drop is a significant ballast release. A snorkel device could be used to load the on-board container (from a body of water). A special holding container would hold the suppression agent to be mixed with the water as is done with the aircraft "water scoopers," for example. A high pressure water jet could be used to not only deliver the mix several hundred feet but to break up the water droplet to a finer mist, an aspect that has been demonstrated to enhance the overall effectiveness of water. Clearly the operation would be managed by an on-board computer controlled system.

The large drawback is the upfront expense of the airship. It would make sense to design them for multiple uses. That is, a "fire status" mode and say, a "cargo" mode. The latter, for movement of large equipment, and the many other applications proposed in the literature. A flexible bladder, or detachable container, could be used for the fire status mode so that the static lift volume could be increased, perhaps using the ballonet concept.

The use of water with a modest yet adequate CF mix would be very effective for knockdown of the flame front. The non-corrosive, non-clogging features of CF, along with all its other attributes in combination with the airship delivery method would make a fine overall aerial technique for combating the

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During his college "summers" Addison Bain worked for the Flathead County Forest Service in Montana as a surveyor. With NASA he gained his expertise in rocket propellants and hazardous chemicals. He is a member of the NFPA and their Wildland Fire Management Section. He served as first chairman of the DOE Hydrogen Safety Panel, is internationally known for hydrogen related technologies and hydrogen safety and is author of, "The Freedom Element - Living with Hydrogen." Bain is a lifetime member of Strathmore's Who's Who as well as the America's Registry of Outstanding Professionals.

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