

PHOS-CHEK[®] INSUL-8[®] WATER-ENHANCING GEL

MAKING WATER A BETTER FIRE FIGHTER

FREQUENTLY ASKED QUESTIONS

IS ICL PERFORMANCE PRODUCTS COMMITTED TO SAFETY?

ICL Performance Products, LP is a strong advocate of the U. S. American Chemical Council's Responsible Care initiative. ICL strives to design, develop, manufacture and market our products in a manner that meets societal needs while posing no undue risk to human health or the environment during all stages of the product's life cycle. In addition, we continuously work with customers to ensure that these principles are followed during the product's use and ultimate disposal.

These principles are of particular importance when dealing with wildland fire retardants, foams and gels that, during their use, may come in contact with people, wildlife and the environment. ICL encourages the practice of good industrial hygiene during handling of the Phos-Chek concentrates and their solutions and good common-sense practices in their end-use in fire prevention, suppression, management and control. The Safety Data Sheet (SDS) should always be consulted as the primary source of health and safety information. This document provides additional guidance on the handling and use of Phos-Chek Insul-8 gel concentrate and its fire suppressing solutions.

HOW DO WATER ENHANCING GELS IMPROVE THE EFFICIENCY OF WATER?

Water is an excellent fire suppressant, however, it is very inefficient because it is difficult to place where it is most needed and impossible to keep there long enough to fully utilize its cooling capabilities. When applied aurally, water breaks up into fine droplets in the slipstream below the aircraft and during its descent to the fire. A large percentage of the water never reaches the burning fuel due to evaporation and wind drift.

Water enhancing gel concentrates, on the other hand, contain a Super Absorbent Polymer (SAP) that can absorb and retain extremely large amounts (as much as 500 times their own weight) of water. During preparation of the gel solution, the SAP absorbs water altering the physical characteristics of its captured water, transforming it from a very low viscosity liquid to a creamy fluid or even a stiff whipped cream or snow cone consistency that adheres to even vertical surfaces providing an insulative water barrier. The consistency of the "gelled" water depends on several factors, e.g., the capability of the concentrate, the ratio of gel

concentrate to water and the hardness of the water that is used. When applied aurally or from a fire hose, the droplet size remains larger than water applied under the same conditions reducing the amount of evaporation and wind drift on its journey and is retained rather than draining from the fuel.

DO WATER-ENHANCING GELS PERFORM LIKE FIRE RETARDANTS?

No. Water-enhancing gels depend entirely on their absorbed water to cool the fire. Once their absorbed water evaporates, the gel residue is no longer effective in suppression. In view of this, water-enhancing gels are most effective when used in direct attack (application) on the burning fuel or as a thermal barrier on structures. When applied indirectly (on threatened fuel), evaporation takes place as the fire and atmospheric temperatures heat the gel causing it to lose its contained water prior to arrival of the fire.

Wildland fire retardants, on the other hand, chemically react with the vegetative fuels after their contained water has evaporated, but prior to arrival of the fire, altering the fuel so that it will no longer support flaming or glowing combustion. For this reason, they are generally referred to as "long term" retardants.

CAN GELS BE "RE-HYDRATED" ONCE THEY LOSE THEIR WATER?

This often cited advantage of gels is unlikely to occur in a real life situation. As stated previously, water-enhancing gels are most effective when used in direct attack of the fire, i.e., directly on the flaming fuel. When applied in this manner, the fire and the burning cellulosic fuels will almost certainly impact the gels contained active SAP so that it can no longer absorb water.

If the gel solution is used in indirect attack, its contained water will be heated to relatively high temperatures that will likely cause it to lose its absorbed water before the fire reaches its location. Even elevated atmospheric temperatures (30 to 40°C/86 to 104°F) during storage negatively impacts the water absorbing ability of SAP containing concentrates. (See paragraph discussing concentrate storage.) Even if the original drop location can be located and water is applied immediately after the initial gel application loses its absorbed water, the addition of more water will likely only wet the surface of the gel residue with insignificant absorption and in some cases will simply wash much of the residual gel off of the surface of the fuel.

ICL HAS TWO GEL CONCENTRATES. HOW DO THEY DIFFER?

Phos-Chek AquaGel-K® is an essentially 100% dry, granular, SAP. Chemically, the SAP in AquaGel-K is a potassium polyacrylate. This gel concentrate is extremely effective in absorbing water because it is 100% active. The characteristics of AquaGel-K will be addressed in a separate document.

Phos-Chek Insul-8® gel concentrate, on the other hand, is a creamy, yellowish liquid with a viscosity in the range of 1000 cPs and a weight (density) of about 0.98 kg/L, i.e., about the same as water. It was designed for municipal, industrial and wildland fire departments via application either aerially or from ground based engines. It easily mixes with water by proportioner, eductor or batch mixer. Insul-8 contains a polyacrylate type of SAP and a mixture of oils and other components that transform the polymer components to an easy to meter liquid with improved stability. The safety and performance of Insul-8 gel concentrate has been extensively tested and qualified for use by the U.S.D.A., Forest Service in accordance with their Specification 5100-306a dated June 1, 2007 as amended. Most U. S. Federal and State Agencies and several other countries use only fire chemicals that are qualified in accordance with the U. S. Forest Service requirements.

DOES WATER QUALITY IMPACT THE PERFORMANCE OF INSUL-8?

Unfortunately, yes! Like all SAP-type water enhancers, the ability of Insul-8 to absorb large quantities of water is negatively impacted by hardness ions in the utilized water. Since the quality of the available mix water cannot always be controlled, the ratio of concentrate to water will need to be adjusted to compensate for hardness ions in the chosen water. When time allows, some initial testing is helpful in providing guidance on the mix-ratio that will be required to provide the desired gel consistency. It is recommended that, when possible, the hardness of potential water sources be pre-determined. This can be simply accomplished in a matter of minutes using a water hardness test kit e.g., Hach 5B Hardness Test Kit, Catalog No.145300 or equivalent.

Soft water is generally considered to be water containing <60 mg/l of hardness ions. Hard water, on the other hand, is generally defined as water containing 120 to 180 mg/l of hardness ions. Most gel concentrates are qualified over a range of mix ratios, or concentrations. For example, ***Insul-8 concentrate is qualified for use at mix ratios ranging from 0.37 to 3.0% i.e., 0.37 liters (gallons) of concentrate per 100 liter (gallons) of water to 3.0 liter (gallons) of concentrate per 100 liters (gallons) of water.*** This wide range in qualified concentrations is necessary due to a number of other, often uncontrollable, factors, e.g., water quality, the desirable gel consistency and the tactics that the Fire Manager decides to employ. See the paragraph below on Gel Consistency Guidelines.

DOES EXPOSURE TO SUNLIGHT IMPACT THE PERFORMANCE OF INSUL-8?

Yes. The ability of Insul-8 concentrate to absorb large quantities of water is negatively impacted by exposure to the ultra-violet (UV) rays in natural sunlight. However, the container in which Insul-8 concentrate is received successfully shields the concentrate from UV radiation as long as it is stored therein. Consequently, Insul-8 concentrate stored in the original container is stable for at least one year when stored in mild temperatures. (See the discussion on concentrate storage.) Once Insul-8 solutions are prepared and applied, the gel is exposed to UV degradation; which is one of several factors that affect exposed gel stability.

HOW MUCH INSUL-8 CONCENTRATE IS REQUIRED TO PREPARE A GEL?

When preparing gel solutions with soft water, lower mix ratios are required to obtain the desired gel characteristics, e.g., 0.37 to 0.6%. Conversely, when the available water is considered very hard (>180 mg/l of hardness ions), higher (0.8 to 1.5%) mix ratios will be necessary to obtain the same gel characteristics. It should be recognized that the desired consistency of the gel will also vary dependent on the application and the objective. For example, the desired gel for direct attack of a fire might range from a low to an intermediate (~400 to ~800 cPs) viscosity level. Whereas, the desired gel consistency that will adhere to a vertical surface for structure protection might be similar to a whipped cream or hair gel consistency (>10K cPs viscosity). Following is some further guidance on mix-ratio.

When using distilled or deionized water (0 water hardness), viscosities in the range of 500 to 1000 cPs can generally be obtained with a 0.4% Insul-8 solution. In soft water, perhaps 0.5 to 0.6% will produce the same viscosity solution. Whereas, 0.7 to 0.8% solutions may be necessary in hard water and 0.8 to 1.0% might be required when using very hard water.

ARE THERE GUIDELINE GEL CONSISTENCIES FOR GIVEN APPLICATIONS?

It is difficult to provide hard and fast rules for the most effective gel consistency for a given operation because there are many variables to consider. For example, low (~400 cPs) viscosity gel solutions may generally be applied for direct suppression. However, under windy conditions, ground fire beneath a canopy and the size and velocity of the fire plume, a medium (800 cPs) to high (1000 cPs) viscosity liquid might be required to penetrate the plume and reach the fire. These decisions must be made dependent on the circumstances faced by the Fire Manager. Generally, however, the required mix ratio for direct attack will be on the lower side of the qualification range. The mix ratio required to achieve this desired viscosity will, however, depend on the relative hardness of the available water.

Gels applied for structure (buildings, poles, trees, fences) protection are generally applied from ground engines. In this case, the gel consistency should be similar to a semi-solid free standing whipped cream. (Note that the consistency of semi-solid gel will vary considerably due to the impact of the utilized mixing method and the energy input from pumps, nozzles, etc. Consequently, some may describe the consistency as whipped cream, snow cone, hair gel, etc.) This consistency will be obtained with mix ratios on the higher end of the qualification range dependent primarily on water quality. Optimum adhesion is achieved when the gel is applied to the structure during several passes rather than trying to achieve the desired adhesive thickness in a single pass.

HOW RAPIDLY DO INSUL-8 GEL SOLUTIONS LOSE THEIR ABSORBED WATER?

The length of time that an Insul-8 gel blanket is effective depends on the mix ratio (volume of concentrate per volume of water), the application rate (liters of gel per unit area) and the environment in which the gel is applied. Higher mix ratios will increase the ability of the polymer to hold greater amounts of absorbed water and the tenacity with which it maintains

its absorbed water. Greater coverage levels will increase the insulative ability (depth and continuity) of the gel blanket. Environmentally, cloudy, lower temperature conditions will increase the gels stability and length of effectiveness. Under these conditions, the gel may be effective for 24 hours or more. In more normal wildland fire conditions: temperatures in the range of 30 to 40°C (86 to 104°F), low humidity, bright sunshine, moderate to high wind and an advancing wildfire, the gel may be effective for no more than 20 to 45 minutes.

IS INSUL-8 CONCENTRATE AND ITS SOLUTIONS SAFE?

Yes. Both Insul-8 concentrate and its water solutions (gels) have been fully tested and qualified by the U. S. Forest Service in accordance with the Specification referenced previously. That Specification requires full formulation disclosure under the terms of a Confidentiality Agreement as well as requirements on both the gel concentrate and its water solutions in such important areas as oral and dermal toxicity, eye and skin irritation, fish toxicity, biodegradation, flash and fire point and corrosion of aluminum, steel, magnesium and brass alloys found in aerial and ground application equipment. These tests are conducted by Agency scientists on the concentrate and on water solutions prepared at the maximum and minimum mix ratios for which the manufacturer is seeking qualification. In order to use a qualified product, it is necessary that a qualified concentrate be obtained and that the utilized mix ratio is within the range of concentrations tested during the qualification program. Otherwise, such important requirements as corrosion and toxicity may not be within safe ranges.

Insul-8 concentrate spills can result in a slipping hazard. It is recommended that spills be cleaned up immediately. See the paragraph on how best to clean up Insul-8 concentrate and solution spills.

The safety of Insul-8 solutions has been tested and qualified at concentrations ranging from 0.37 to 3.0%, i.e., 0.37 to 3.0 volumes of concentrate per 100 volumes of water. Generally, during wild land fire fighting, mix ratios will remain within the range of about 0.4 to 1.0%. Thus, Insul-8 solutions will generally consist of <1% concentrate and >99% water.

However, when Insul-8 is used in extremely hard or salt water and when used for structure protection, mix ratios as high as 3.0% may be required. Consequently, Insul-8 solutions were tested at its maximum 3.0% mix ratio during qualification. A 3.0% solution of Insul-8 was found to be

- non-toxic if swallowed, (oral LD₅₀ of >5050 mg/kg),
- non-toxic when in contact with the skin (dermal toxicity of >2020 mg/kg) and
- non-irritating to both the eyes and skin.

WHAT IS MEANT BY THE TOXICITY TERMS LD₅₀ and LC₅₀?

The LD₅₀ (Lethal Dose) is the dosage of a product that is fatal to 50% of the animal population being tested. The test animal may be a rat, rabbit or other species that is being used. When

the LD₅₀ is expressed as a greater than (>) symbol, it means that less than 50% of the population died when subjected to the indicated dosage for the prescribed length of time. The LC₅₀ (Lethal Concentration) is a similar term used when describing the toxicity of aquatic life such as fish and invertebrates. It represents the *concentration* that is toxic to 50% of the test population. It needs to be remembered, that when comparing toxicity results, higher LD₅₀ and LC₅₀ values indicate lower toxicity.

IS THE INSUL-8 MSDS (SDS) COMPLETE AND UP-TO-DATE?

Yes, the Insul-8 MSDS is now being re-issued as the Safety Data Sheet (SDS). Previous versions of the MSDS and label for Phos-Chek Insul-8 warned only that exposure to the concentrate may cause slight irritation to the eyes and skin.

Newer versions of that document, now called a SDS, are being prepared under the United Nations Globally Harmonized System of Classification and Labeling of Chemicals, commonly referred to as the GHS. The GHS brings a new look to the way potential hazards are portrayed in the SDS and on the label – a system of standard statements and pictograms that allow for easy recognition of potential hazards and preventative measures of a product that provide an improved means of comparing products. The SDS for Phos-Chek Insul-8 has been converted to this new GHS format.

The formulation for Phos-Chek Insul-8 has not changed, but the new SDS does reflect some changes in the way potential hazards are described. It is important to recognize that, in most instances, the SDS addresses the composition, properties and safety of the concentrate only, i.e., the product that is procured in its original container rather than the solutions prepared for application during fire fighting operations.

Irritation to Eyes and Skin: The slight irritation to eyes and skin as described in the previous MSDS, as evidenced by U. S. Forest Service data, is not severe enough to require classification under the GHS.

Specific Target Organ Toxicity following Single Exposure (STOT SE 3) – This classification requires the Exclamation Mark pictogram



and the statement “May cause drowsiness or dizziness.” This statement is meant to convey that the product may cause some relatively minor respiratory irritation or dizziness after breathing fumes. This is a common feature of many mineral oils such as one of the ingredients in Phos-Chek Insul-8. Since the concentrate would normally be used outdoors or in other well-ventilated areas, respiratory irritation or dizziness would not be expected.

IS INSUL-8 CONCENTRATE TOXICITY INFORMATION AVAILABLE?

Yes. The toxicity information on Insul-8 is provided in the new SDS, within this document and is directly available on the U. S. Forest Service web site www.fs.fed.us/rm/fire/wfcs/

Phos-Chek Insul-8 concentrate is a blend of functional ingredients specifically formulated to maximize performance while maintaining safety in handling and to the environment. The formulation has undergone rigorous toxicity testing during qualification as referenced previously. It is generally recognized by risk assessment scientists that any LD₅₀ value above 2000 mg/kg indicates that the material is not toxic.

- Insul-8 concentrate was found to be non-toxic if swallowed (Oral LD₅₀ > 5050 mg/kg).
- It was found to be non-toxic, as well, when in contact with the skin (Dermal LD₅₀ > 2020 mg/kg).
- Insul-8 concentrate was found to be only mildly irritating to the eyes, and non-irritating when diluted with water at the maximum qualified (3.0%) mix-ratio.

ARE INSUL-8 SOLUTIONS HARMFUL TO FISH?

It needs to be remembered that, when comparing toxicity results, higher LC₅₀ values indicate lower toxicity. Phos-Chek Insul-8 is less toxic to fish than most other qualified gel concentrates. Insul-8 gel concentrate has been tested and meets U. S. Forest Service requirements in this regard. The 96-hour LC₅₀ for Insul-8 using 60-day post hatch rainbow trout is 1051 mg/L in soft water and 1776 mg/L in hard water. *Risk assessment scientists generally recognize that an aquatic LC₅₀ value greater than 100 mg/L is not toxic.*

Since some potential risk to aquatic species remains, ICL endorses the U. S. Forest Service policy of limiting use within 100 meters (300 feet) of a waterway, particularly when aurally applied.

DO INSUL-8 SOLUTIONS HARM THE ENVIRONMENT?

The ability of Insul-8 concentrate to biodegrade when placed in the environment was tested in accordance with Test Method OECD 301B during U. S. Forest Service qualification. Like all other SAP type gel concentrates, Insul-8 was found to be *non-biodegradable*. However, it is important for the user to *recognize that Insul-8 does biodegrade when placed in the environment*; it just does not biodegrade quickly enough to meet the definition of biodegradable as defined in the utilized test method.

According to the test method definition, “a concentrate which is $\geq 60\%$ biodegraded within 28 days is considered to be *readily biodegradable*. And, a concentrate which is not $\geq 60\%$ biodegraded within 28 days, but which is $\geq 60\%$ biodegraded in 42 days is considered to be *biodegradable*.” If neither occurs, the concentrate is considered *not biodegradable*.

Testing of Insul-8 concentrate revealed that 56.6% of the concentrate biodegraded after 42 days of exposure. Thus, Insul-8 concentrate does biodegrade when exposed in the environment but at a rate slightly lower than the desired rate. It is important to recognize that Insul-8 concentrate, and residue after water from its solutions evaporates, will not be bio-accumulative. However, care should be taken while using any fire chemical to avoid spills and runoff, particularly when handling the concentrates. Selection of the most biodegradable concentrate that provides the desired characteristics at the lowest concentration (qualified mix ratio) would, of course, minimize environmental disturbance.

Insul-8 gel solutions are slippery and consequently can be hazardous to fire personnel walking through an area where the solution has been applied. They should be made aware of this potential hazard.

IS INSUL-8 CONCENTRATE FLAMMABLE?

The U. S. Forest Service tested the flammability of Insul-8 concentrate during qualification of the product. Their requirement for flash point is greater than 140°F (60°C). The flash point of Insul-8 was found to be >177°F (>80°C). They also tested the fire point for information only. It was found to be >199°F (93°C). Water solutions of Insul-8 concentrate are, of course, non-flammable.

IS INSUL-8 CORROSIVE?

Insul-8 concentrate and its solutions were tested by the U. S. Forest Service during qualification and found to meet their corrosion requirements when used at the mix ratios for which it is qualified. Consequently, Insul-8 is qualified for application from fixed and rotary wing aircraft with internal tanks as well as from helicopter buckets and ground engines. Consult the U. S. Forest Service's Water Enhancer Qualified Products List (QPL) and other locations within the web site referenced earlier if desired or as listed for each type of delivery platform.

HOW SHOULD INSUL-8 CONCENTRATE BE STORED?

The ability of all SAP containing concentrates to absorb large volumes of water is directly impacted by the storage condition history of the concentrate. Storage temperature, length of storage and exposure of the concentrate to natural sunlight slowly reduces the water absorbing capability of the water enhancer concentrate. It is recommended that Insul-8 concentrate be stored in its closed delivery container in order to minimize exposure to natural sunlight. When stored out of doors, storage in the shade or under a covering to reduce concentrate temperature would prove beneficial in maintaining storage stability. This is particularly important when storing the concentrate for long periods of time.

When stored in the closed container in which it is received, and stored at temperatures in the range of 10 to 32°C (50 to 90°F) the viscosity of Insul-8 concentrate remains relatively stable for at least one year. Thereafter, slightly higher mix-ratios of concentrate to water may be

necessary to obtain the desired solution consistency. Storage temperatures below 10°C have not been studied but cooler temperatures would be expected to increase concentrate stability. Concentrate storage at 49°C (120°F) results in some thickening of the concentrate and negatively impacts the consistency of gel solutions prepared therefrom.

Although Insul-8 concentrate has been carefully formulated to maintain a stable consistency, when stored for long periods of time in a static environment, some separation and settling may be experienced. Testing has been conducted to determine if periodic shaking or recirculation of stored inventories should be recommended. These tests indicated that, when using Insul-8 concentrate that had set undisturbed for more than a month, shaking, stirring or recirculation just prior to use will result in a more uniform gel solution.

IS INSUL-8 GEL EFFECTIVE IN PREVENTING IGNITION OF FOREST FUELS?

The U. S. Forest Service utilizes a test designed to measure the length of time that a water enhancing gel can delay ignition of a vertically oriented plywood panel. This test, referred to as the Lateral Ignition and Flame Spread Test (LIFT), measures the length of time before ignition occurs when a water enhancer solution, foam or gel is applied and then tested on a panel prepared from T1-11 plywood. The agent-coated panel is placed in a vertical orientation and a high temperature heat source impinges directly on the insulative, gel-protected surface. Insul-8 solutions were found to be particularly effective in delaying ignition via this test because of the product's tenacious adhesion to even vertical surfaces including glass. Its adhesion to glass is of importance because of its ability to protect windows from breaking and allowing ignition of the interior of structures.

When applied with a fire hose, 7.5-cm (3-inch) thick insulative coatings will adhere to unpainted vertical wood siding. Most agents tend to slide off of the panel due to their weight and, particularly when heated, rather than remaining in place as a protective coating. While this test is most applicable to structure protection situations, it is indicative of the performance of the gel in the protection of ladder fuels, power poles and other wooden structures such as bridges. (Phos-Chek AquaGel-K and Insul-8 are the most effective of the qualified gels when tested according to the LIFT protocols.)

WHAT IS THE BEST METHOD OF CLEANING UP INSUL-8 SPILLS?

Care should be taken to prevent concentrate spills but when they occur, a slippery situation is present which makes it imperative that remedial action be taken at the earliest possible time. Physical means of recovery should be used before using other methods. Physically scooping the concentrate into pails, or other containers, should be effective in recovery of many spills. Only when as much of the concentrate is physically recovered as possible, should other means be considered. If the spill is relatively small (a few liters or gallons), the application of a solid absorbent such as "kitty litter" or vermiculite should be considered. The contaminated absorbent can then be scooped or swept up and discarded. If further cleaning is necessary, thoroughly washing the area with water from a fire hose can be considered. However, the use of extremely hard water such as salt-water or sea water is

most effective for cleanup without development of a difficult to recover gel solution, i.e., a solution containing enough water-soluble ions to keep the concentrate from absorbing the cleanup water and forming a gel. If located at a retardant tanker base, the use of long-term retardant wash-down water might be considered. Removal from a structure would be accomplished in the same manner. The use of colored retardant solutions, however, should be avoided for cleanup of structures.

It is important to cleanup concentrate spills and water gel residues from concrete or bitumen covered areas prior to evaporation of its contained water. Otherwise, the gel solution can seep through cracks and swell the subsoil causing uplift of the pad. It is recommended to clean painted surfaces, glass or chrome on fire engines and other suppression vehicles as soon as is practical.

IS INSUL-8 GEL QUALIFIED FOR USE IN FIXED-TANK HELICOPTERS?

Yes. Insul-8 is qualified for use in fixed or internal tanked helicopters. The recommended mix ratio for this method of application is 0.37%.

IS INSUL-8 QUALIFIED FOR USE IN SEATS?

Yes, Insul-8 gel concentrate is qualified for application from single engine aircraft (SEATS) at mix ratios ranging from 0.37 to 1.0%.

IS INSUL-8 QUALIFIED FOR USE IN GROUND ENGINES & BUCKETS?

Yes, Insul-8 gel concentrate is qualified for application from helicopter buckets and ground engines at mix ratios ranging from 0.37 to 3.0%.

SHOULD COLORING THE GEL SOLUTION BE CONSIDERED?

The only reason to color a gel is to identify the location, length and width of the line or aerial drop. As discussed earlier, water enhancing gels are most effective when used in direct attack, i.e., when applied directly on the flames. The location of the application can, in this case, be best determined by visually observing the impact on fire intensity, flame height, etc.

The U. S. Forest Service has qualified some gels containing a colorant for experimental purposes. ICL has experimented with a number of different color packages and can offer them to determine the desirability of a colored Insul-8 solution. Please contact your local representative if you have an interest in coloration.