



## WHAT IS SNOMAX® SNOW INDUCER ?

For over 15 years, Snomax Snow Inducer has been used at ski stations throughout the world. You have perhaps heard about or had some contact with Snomax. This paper will attempt to provide an explanation of what Snomax is, and how it helps ski stations conserve energy and water.

Snomax is a protein, specifically a source of ice-nucleating proteins. This protein initiates the freezing process by serving as an ice-nucleator and raises the freezing temperature of water by approximately 4-5° C.

0° C is the equilibrium temperature of water. This means that at and below 0° C, water will remain in a frozen state and that above 0° C, water will begin to melt. Water will not freeze unless it has a source of nucleators, something around which water molecules can align themselves to form the hexagon shape of an ice crystal. Pure, distilled, de-ionized water can be super-cooled down to -40° C. The freezing process is initiated by impurities or nucleators in the water. Nucleators can include dirt, dust, mineral, and organic matter to name a few. Each nucleator has a specific temperature at which the freezing process occurs. They are also randomly assigned by nature in the water, which simply means, they are not everywhere in the water. As a water droplet cools, energy(heat) is released into the atmosphere at the rate of one calorie per gram of water. As it freezes into an ice crystal, it releases additional energy at the rate of 80 calories per gram of water. This quick release of energy raises the droplet temperature to 0° C, where it will remain while freezing continues. Above ground ski station source water freezes, on average, at about -8° C, because it has some natural nucleators like sand, trace minerals and metals already in the water. The same water freezes at about -3° C with Snomax added.

Why ? Because Snomax works at the highest temperature of any nucleator that has been found on the planet.

How does Snomax help your snowmaking system? Snomax, if used properly, has multiple benefits. It increases snow volume production of any system. Results of over 125 snowmaking tests that we've conducted show, on average, Snomax increases production by over 20%, increases the quality of the snow and reduced energy input required to manufacture snow. This means that by using Snomax, a ski station can make more snow faster, thereby reducing energy expenditures. By converting more water to snow, snowmaking water is conserved. And because of its high nucleating temperature capabilities, an operator can make snow at higher temperatures which helps to get open earlier and to quickly recover from thaws and rain.

Snomax is exceptionally safe for the environment. It has been used for over 15 years worldwide without a single adverse result to the environment. It has been reviewed by multiple government agencies and most recently in Switzerland with no objection to use.



Snomax is used in every state in the U.S. that has snowmaking and is also used at ski stations in Canada, France, Italy, Switzerland, Norway, Sweden, Australia, New Zealand, Andorra, Japan, Argentina, Chile, Czech Republic and Scotland. Some of these countries are among the most environmentally conscious in the world.

Snomax is, without a doubt, the most thoroughly reviewed product in the ski industry. Hundreds of studies have been done on the product and all have come to the same conclusion, Snomax poses no threat whatsoever to humans, animals, or the environment.

Snomax has a worldwide quality reputation. It has served as an Official Snowmaking Supplier at all of the venues for the Winter Olympic Games ; Calgary, Albertville and Lillehammer and is being used in Salt Lake City, site of the 2002 Olympics, where York will also serve as the Official Sponsor. At Lillehammer, 98% of all the snow on the alpine and nordic venues was machine made and 100% of that snow was made with Snomax.

Snomax has also been used at numerous World Cup sites.

Snomax has been featured in National Geographic as well as industry journals.

In conclusion, Snomax is an exceptionally environmentally positive product, used in a range of environmentally sensitive applications. In snowmaking, Snomax allows the ski station to make more snow per cubic meter of water pumped per Kw at a higher temperature, thereby increasing efficiency.



## SCIENCE OF SNOWMAKING

Q. What is SNOMAX Snow Inducer ?

A. SNOMAX Snow Inducer is a source of ice nucleating proteins. SNOMAX nucleators are produced the same way as yogurt, cheese, beer, wine and bread.

Q. What is a nucleator ?

A. Any particle that starts the freezing process at a temperature above  $-40^{\circ}\text{C}$ , is a nucleator. Many substances, such as minerals, plant matter, microorganisms, and certain organic chemicals can function as nucleators at temperatures below  $-8/-10^{\circ}\text{C}$ . The nucleators in SNOMAX are active up to  $-3^{\circ}\text{C}$  and are considered to be the most efficient nucleators available for practical applications such as snowmaking, cloud seeding, thermal storage and ice engineering. This is due to its high nucleation temperature activity.

Q. How does a nucleator work ?

A. First let us review some of the characteristics of water and ice.

1. The equilibrium point of water is  $0^{\circ}\text{C}$ . This is the temperature at which water will continue to stay in its frozen form and above which it will begin to melt.
2. Water can be cooled well below  $0^{\circ}\text{C}$  and still remain liquid- the phenomenon of supercooling.
3. To start the freezing process, an ice nucleus must be formed- ice nucleation.
4. For nucleation to occur, free energy must be removed from the liquid water.
5. Pure, distilled, de-ionized water has a self nucleation temperature of  $-40^{\circ}\text{C}$ .
6. Impurities in water reduce the free energy level, lower the requirements for supercooling, and facilitate nucleation.

For water to freeze molecules need to be aligned in a stable hexagonal (six-sided) pattern. To arrange the molecules in this pattern requires the release of free energy. Free energy can be transferred out of the liquid through heat exchange processes such as convection and evaporation. The process is easier when molecules can attach to the surface of particles such as SNOMAX Snow Inducer.

As soon as the critical number of molecules are aligned, an ice nucleus will form. This is nucleation and it is necessary to freeze any volume of water. Once formed, the crystal serves as the pattern for further crystallization.

Q. What determines the temperature at which a nucleator will work ?

A. Two things determine the temperature at which a nucleator works : 1) its size which must allow the critical number of water molecules to attach to it and 2) the precision with which it arranges the molecules to mimic the structure of the ice crystal.

SNOMAX nucleators are very efficient in these functions.

Q. What does a nucleator do in snowmaking ?

A. The key to efficient snowmaking is to freeze as many droplets as possible before they hit the ground. The use of a high temperature nucleator in each droplet of water greatly increases the ability to freeze droplets at any ambient temperature that is suitable for snowmaking.

Q. Doesn't all water contain nucleators ? Why add more ?

A. Most water sources contain some particles that function as nucleator at temperatures below  $-8/-10^{\circ}\text{C}$ . Some sources may even contain a few protein nucleators like SNOMAX, but SNOMAX provides as many as 1 million times the number of nucleators of any sample we have ever tested.



The key to snowmaking productivity is to have at least one high temperature nucleator in each droplet of water. The faster a droplet starts to freeze after leaving the snow gun, the longer it has for further crystallization before hitting the ground. Increased crystallization means more high quality snow with lower water content. This means shorter curing times and better grooming qualities. For ski stations using municipally treated water or below ground well water, the water is usually very clean and does not contain many nucleators.

Q. Should You stop using SNOMAX when the air (ambient) temperature is below  $-10^{\circ}\text{C}$  ?

A. SNOMAX Snow Inducer should be used whenever you make snow. Because SNOMAX treated droplets require less cooling, they start to freeze almost immediately after leaving the gun. This means that the cooling capacity around the plume is available to freeze more droplets. Droplets retain more of their original volume and freeze more completely. Less water loss to evaporation or leaching out. This increases your snow production even at these colder temperatures. Also, at colder temperatures, the water droplets are more susceptible to thermal updrafts. The longer the droplets are airborne, the greater the chance for evaporation or to land in unwanted areas. Snomax allows for a larger droplet to be produced.

Q. Will SNOMAX cause my water lines to freeze ?

A. SNOMAX will not cause freezing problems. Many freeze-ups occur when the system is being operated at low flows. There are ample nucleators in all water sources to start the freezing process in a stream of water that is cooled below  $0^{\circ}\text{C}$ . The use of SNOMAX will help you maintain flow for any set of snowmaking conditions, thereby decreasing the chance of a freeze up.

Q. Can I make snow at higher temperatures with SNOMAX ?

A. SNOMAX will allow you to make more snow or drier snow whenever you use it. SNOMAX reduces the supercooling requirement of water and starts the freezing of droplets at higher temperatures. That means more of the cooling potential in the air around the plume, regardless of the ambient temperature, can be used for crystallization instead of supercooling water. SNOMAX enhances the performance of all snowmaking systems. So if you want to make more or drier snow at warmer temperatures – SNOMAX will work for you.

#### BENEFITS of SNOMAX

Q. What will SNOMAX do for you ?

A. SNOMAX allows you to :

- produce the same amount of snow at less cost through improved energy and labor efficiency or
- produce more snow during a given period of time
- make more snow at marginal snowmaking temperatures
- control the quality of snow that you produce
- shorten the « curing » time for snow

#### REGULATORY STATUS

Q. How do you know that SNOMAX is safe to use ?

A. Now on 5 continents, Snomax has been used for over 15 years without a single negative incident or adverse environmental impact.

Q. Is there potential for risk to humans, animals, or plants from the use of SNOMAX ?

A. No. The product has been tested to be non-pathogenic, and non-toxic. It is also produced in a form to assure absolute human safety when used according to package instructions.