Scientists Study MB Replacement

ProFume™ from Dow AgroSciences could be a new option—First in a two-part series

The phaseout of methyl bromide (MB) in the United States by 2005 has prompted researchers to explore alternative fumigants for managing insects in stored products. One of those alternatives is ProFume gas fumigant, which Dow AgroSciences (www.dowagrosciences.com) is developing for postharvest use. (ProFume™ is not currently available. U.S. Environmental Protection Agency (EPA) registration is pending.)

The active ingredient in ProFume is sulfuryl fluoride (SF). SF has been sold under the trade name Vikane™ and used for nearly 41 years to control structural pests such as termites and wood boring beetles.

Dow AgroSciences scientists have been evaluating SF for postharvest uses, especially as an MB alternative, since 1994.

This is the first of a two-part interview with Dow AgroSciences scientists Drs. Brian Schneider, Biology Team leader for postharvest fumigants, and Suresh Prabhakaran, field research scientist for the Midwestern U.S., who are involved in developing ProFume for postharvest uses. Watch for part two in the first quarter 2003 *Milling Journal*.

Q. *Explain your roles in developing ProFume for postharvest uses and the people in your company who are involved in this effort.*

A. Schneider: I lead the team of biologists conducting a wide range of biological and practical-use studies necessary to support registration and future uses of ProFume for postharvest fumigation. I also lead and facilitate incorporation of this information into the ProFume Fumiguide™, a computer-based program providing the power to do precision fumigations.

My role is to represent the biology function in the team of other Dow AgroSciences scientists and commercial personnel (market research, marketing, sales, communications) developing ProFume.

A. Prabhakaran: I have been involved in ProFume development since 1999. I am very closely involved in planning and executing several research fumigation trials for developing proper ProFume gas introduction techniques, improving gas retention inside the structures by enhanced sealing techniques, and developing proper aeration methods after fumigation.

On the IPM front, I am working on understanding stored product insect population dynamics in food processing plants. I am in the process of developing

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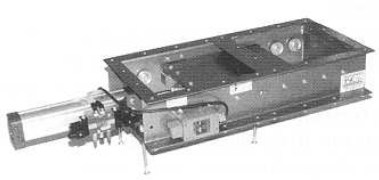

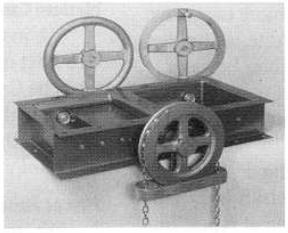

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and using a modeling approach that will help predict population fluctuations in food processing facilities.

There are several people involved in the development of ProFume at Dow AgroSciences. In the Research and Development Department, seven scientists are directly involved in ProFume projects with additional support from other scientists throughout the U.S, Europe and Asia. At least two full-time scientists from the Environmental Chemistry Department are involved in worker safety and environmental studies on ProFume.

In addition, there are several people from Technology Transfer, Regulatory Affairs, Risk Assessment and Manufacturing that are greatly involved in ProFume development. Our commercial team consists of a global ProFume leader, a ProFume marketing specialist, a customer technologist, and four sales associates.

Q. *On what postharvest commodities and at what sites can ProFume be used following registration?*

> "We began laboratory trials in 1994 with leading researchers around the world to define effective dosages for key stored product insect pests."
>
> *Brian Schneider, Dow AgroSciences*

A. Schneider: The initial Section 3 registration is planned to include flour mills, grain storage, and dried fruit and tree nut processing plants. This registration is expected to include the raw agricultural commodities and their processed fractions. Subsequent registrations are planned for processed food facilities and storage.

Q. *Discuss proposed registration timelines and indicate which sites have been approved by the EPA so far.*

A. Schneider: Registration by the U.S. EPA for cereal grains milling and storage, as well as dried fruits and tree nut processing and storage, is expected by the end of 2002.

A registration for the same use patterns is expected to be approved in several European countries in early 2004.

The U.S. registration to support the use of ProFume in food processing facilities is scheduled for 2004.

Temporary tolerances for walnuts and raisins were granted in early 2002 in conjunction with an Experimental Use Permit approved by the U.S. EPA.

Q. *What properties of ProFume make it suitable for postharvest applications?*

A. Prabhakaran: ProFume is a broad-spectrum fumigant effective on all stages of insects and rodent pests. It is fast acting, and exposure times can be as short as for methyl bromide. It is a non-flammable, colorless and odorless gas with a very low reactivity potential.

ProFume is non-corrosive in the gas phase and does not react with materials to form unpleasant odors. Other beneficial qualities include: low boiling point, high vapor pressure, and excellent penetration and rapid aeration.

It can also be utilized for resistance management strategies because of its new mode of action, which is different than the existing postharvest fumigants. Also, ProFume does not affect the ozone layer.

Q. *How does ProFume compare with MB and phosphine (PH_3)?*

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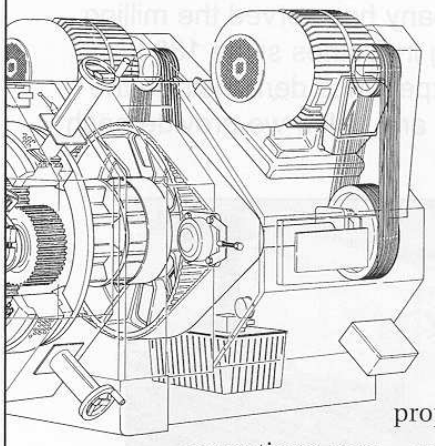

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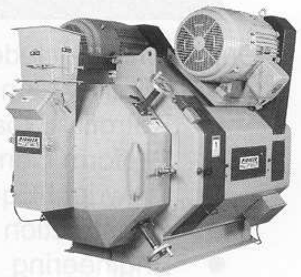

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A. Schneider: ProFume has characteristics similar to both MB and PH_3. ProFume and MB are not explosive, but PH_3 is explosive above a certain concentration. ProFume is not corrosive to metals like PH_3. ProFume and MB are heavier than air; whereas the molecular weight of PH_3 is essentially equivalent to air.

Similar to MB, ProFume is fast acting, and thus fumigation exposure period can be short or long to meet the downtime constraints of the miller. This is in contrast to the long minimum effective exposure time for PH_3.

PH_3 and ProFume are similar in that the egg stage is the least susceptible life stage, whereas the pupal stage is most tolerant to MB. Like PH_3, ProFume penetrates flour and other porous materials more rapidly, has lower sorption on food commodities, and also aerates more rapidly than MB.

Having a higher vapor pressure than MB, ProFume can be introduced into the high floors of mills without added pressurizing systems. Also, ProFume could be used in insect resistance management programs, because it has a mode of action different than both MB and PH_3.

Q. *What is involved in developing ProFume, or what data must be gathered, to realize that ProFume is a potential fumigant for postharvest applications?*

A. Schneider: The first step was to conduct market research to understand our potential customers' needs and expectations for insect control. We also needed to identify industry, government, and university cooperators for conducting biology research. Dialogue with the regulatory authorities was initiated to determine the biology and toxicology data requirements to receive our proposed registrations.

We began laboratory trials in 1994 with leading researchers around the world to define effective dosages for key stored product insect pests. Testing included all life stages across a range of temperatures and exposure periods. This was a monumental task, which continues as we develop dosages for pests of secondary importance.

> "ProFume is effective on all stages of insects and rodent pests. It is fast acting, and exposure times can be as short as for methyl bromide."
>
> *S. Prabhakaran, Dow AgroSciences*

Our next task was to incorporate these dosages into a computer-based program called the ProFume Fumiguide, which provides the fumigator with the ability to determine the necessary dosage for the target pest and life stage under the temperature, half-loss time, and exposure conditions specific to a fumigation. This program will also provide real time recommendations for reaching the necessary dosage as the fumigator inputs fumigant monitoring data.

Only a few toxicology studies were necessary, because sulfuryl fluoride was nearing the end of the re-registration process, initiated years ago to support Vikane registrations, for which the toxicology data package had been updated.

Food residue studies were necessary. These were initially begun with dried fruits and tree nuts because that group of growers and pro-

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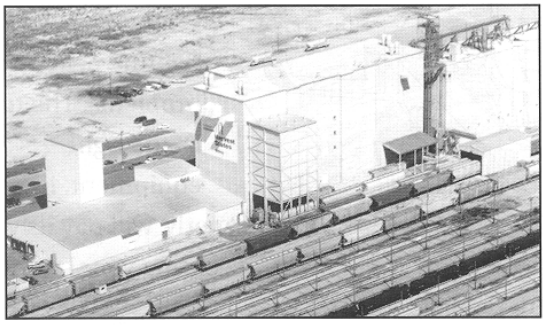

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cessors committed very early to developing methyl bromide alternatives. They also were willing to work closely with Dow AgroSciences to develop ProFume.

Next, we completed the cereal grain residue studies, and now the processed food residue studies are ongoing.

Quality tests were conducted in cooperation with knowledgeable researchers and industry experts in both the cereal grain and dried fruit and tree nut industry. Many hours were spent designing these studies.

> "Similar to MB, ProFume is fast acting, and thus fumigation exposure period can be short or long to meet the downtime constraints of the miller."
>
> *Brian Schneider, Dow AgroSciences*

Field trials began in 1997 to develop fumigation techniques, including efficient sealing, application, and aeration procedures.

Since then, we have completed over 25 field trials in mills and processing plants in the United States, Germany, England, and Switzerland. From this work and guidance from fumigators, a *ProFume Fumigation Manual* was written.

All of the data and conclusions from the myriad of studies were then compiled for submission to the EPA and some state regulatory agencies. Along with the data went a proposed label, incorporating suggestions and ideas from the many industry, university, and government cooperators who worked on this project.

Finally, stewardship and training programs were designed and developed through close interaction.

Q. *You mentioned half-loss time (HLT) several times. Can you describe HLT as it relates to the dosages necessary for effective fumigation with ProFume and what factors affect HLT?*

A. Prabhakaran: Well, all fumigants leak out of structures. The question is, how fast? Wind speed, building construction materials, and the thoroughness of sealing by the fumigator, all influence gas leakage rates, which are measured as half-loss time (HLT).

HLT is the time it takes for half of the fumigant to leak out. When HLT is less than 10 hours, the benefit of improved sealing on gas savings is dramatic.

The average HLT on our fumigations has been about 10 hours, and we will be working with fumigators and millers to bring that average up to our goal of 15 hours. Investment in sealing is often supported by reduced fumigant costs.

Q. *What are the minimum environmental requirements for ProFume use?*

A. Schneider: The label limits application to above 40F at the site of the pest. Having a boiling point of -67F, it will not change state into a liquid at that temperature, but insect metabolism is extremely slow at or below that temperature.

ProFume can be used at any relative humidity. Care must be taken however, not to introduce ProFume beyond the heat exchanging capacity of the introduction fan(s), especially at humidities above 90%.

We could not find such humid conditions, and we tried, during all of our mill and processing plant field trials. We had to artificially create humidities above 90% to challenge our delivery systems.

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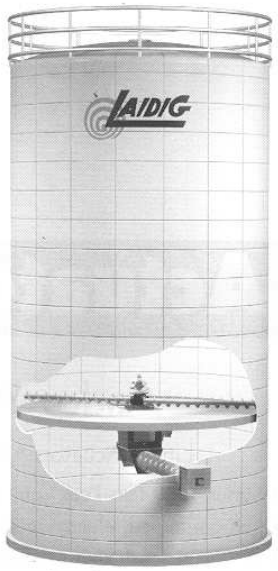

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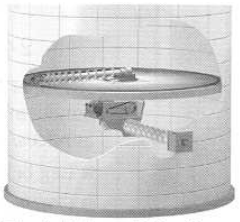

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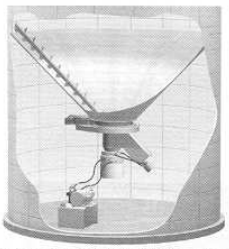

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