# Development of a closed system for application of grain protectants

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*Abstract*

Roussel Uclaf Australia has developed a closed treatment system for the effective application of protectants to bulk grain. The system directly applies concentrates to a moving stream of grain. The patented system links a microprocessor with an applicator skid that rides on the grain.

Trials show that the system provides:

(i) Accuracy—application of the concentrate, by wiping direct to the grain, resulted in residues between 80–100% of target dose, whilst normal spray application produced residues between 49–62% of target dose. Single grain bioassays showed that even coverage was maintained, with 100% mortality occurring 6 months after treatment.

(ii) Safety—the applicator skid, by applying the protectants direct to the grain, overcomes atomisation, reducing the pesticide levels in silo air spaces by up to 97% of the level occurring with normal spray application. As the protectants are applied as concentrates without dilution, the level of operator exposure to the protectants is also reduced;

(iii) Flexibility—the system can be programmed for individual product, dosing or language information, and to suit multi-belt systems; and

(iv) Efficiency—the system can be linked to a central management point to allow ease of management and monitoring. The microprocessor has an internal diagnosis program which maintains a constant review of its operation with an error display to allow easy rectification.

## Introduction

The method of application of protectants to bulk grain will have a major effect on its storage. Incorrect application can have a variety of effects, including residues in excess of the MRL, or insect damage due to low treatment levels. Operator safety is also of concern, as spray application of protectants can expose operators to the chemicals at time of dilution, and to airborne particles produced during the application process. Roussel staff set out to produce a system that improved accuracy, while reducing the exposure of operators during handling and dosing of protectants.

## System Design

A schematic design of the system is shown in Figure 1. The system has a fluid pathway and an electronic pathway.

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### The fluid pathway

The protectant is pumped, as the non-diluted concentrate, through a filter and a flowmeter, to an applicator skid that rides on top of the grain on the conveyor belt. Where two protectants are being applied simultaneously, the fluid paths are separate until the two mix at the top of the applicator skid. The flowmeter provides a constant output of the flow of protectant into the electronic pathway, which then provides a response to the pump.

### The electronic pathway

The electronic pathway is focused on a microprocessor, which provides constant monitoring of relevant aspects of the applicator system.

The target dose for the individual protectants is set at the commencement of the treatment, and can be selected from a series of preset products and rates. The selections can be varied by a security accessible override, ensuring that operator error can be minimised.

The grain flow is monitored, and the flow of protectant is compared with both the desired application rate and the grain flow. The pump rate can then be varied to ensure the correct application is maintained. The use of protectant is monitored against the amount in the container at the start of the treatment, and warnings sound when replacement of the containers is required. A cumulative record of protectant usage is also maintained.

The electronic pathway includes an internal diagnosis program, which monitors the operation, and provides an error display to allow easy rectification. The system can also be configured to locate the microprocessor and keyboard in the central management areas, away from product areas. A number of applicator skids can be attached to an individual processor, but only one can be operated at any one time.

This configuration flexibility allows for grain to be efficiently processed into the store from a central control point.

## Application Accuracy

A trial was implemented in 1989–90 at Greenthorpe, NSW, where the applicator system was compared with a normal spray method. The volume of grain treated was measured, along with the amount of protectant applied, to calculate the percentage of target dose. These results are given in Table 1. The two protectants used were BRM (50 g/L bioresmethrin + 400 g/L piperonyl butoxide) and Reldan® (500 g/L chlorpyrifos-methyl). After 6 weeks, core samples from the top of the grain bulk were taken and analysed for protectant residues. These results are shown in Table 2.

Tables 1 and 2 show that the accuracy of application is enhanced by the use of the applicator, which provides a much higher level of the target dose at 6 weeks following treatment.

The wiping of a concentrated protectant directly onto the grain raised concerns regarding uniform application across the grain mass. The application distribution was demonstrated by

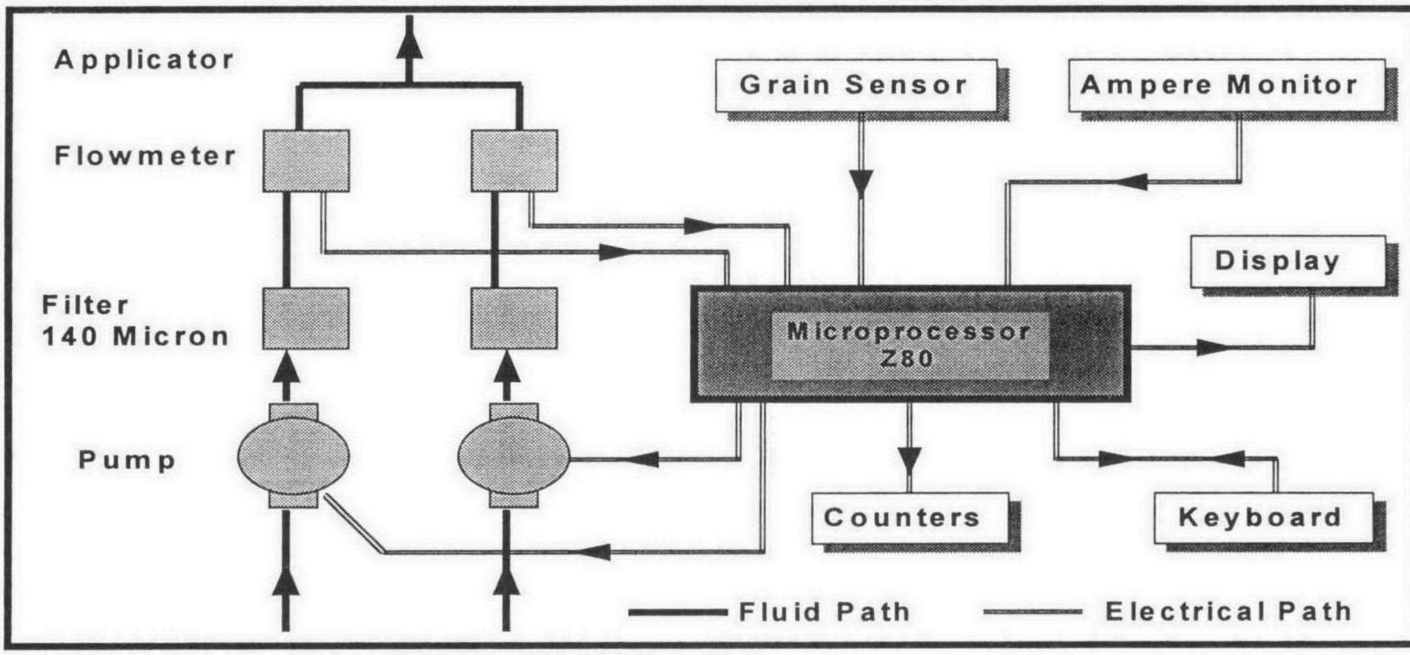


**Fig. 1.** Schematicof the system showing the electronic and fluid pathways. The interaction between the control unit and the pumps and flow meters is shown.

**Table 1.** Volumes of protectant applied and percentage of target dose for two different application methods.

| Application system | Grain treated (t) | Protectant applied (L) | | Percentage of target | |
|---|---|---|---|---|---|
| | | BRM | Reldan | BRM | Reldan |
| Applicator | 10120 | 219 | 178 | 108 | 110 |
| Spray | 1836 | 35 | 22 | 95 | 73 |

**Table 2.** Grain protectant residue analysis results for grain samples, taken 6 weeks after application, with two different methods of application, compared with the target dose.

| System | Active ingredient | Residue (mg/kg) | Application target dose (mg/kg) | Percentage residue[a] |
|---|---|---|---|---|
| Applicator | Bioresmethrin | 1.03 | 1.0 | 103% |
| | Piperonyl butoxide | 8.40 | 10.0 | 84% |
| | Chlorpyrifos methyl | 6.50 | 8.0 | 81% |
| Spray | Bioresmethrin | 0.62 | 1.0 | 62% |
| | Piperonyl butoxide | 4.90 | 10.0 | 49% |
| | Chlorpyrifos methyl | 4.00 | 8.0 | 50% |

[a]Percentage residue is calculated by dividing the residue detected by the target dose.

carrying out single grain bioassays. Grain samples, from the Holmwood trial site, were stored at ambient temperature in the laboratory, and at regular time intervals, single grains were removed, placed in vials and a single *Sitophilus oryzae* was introduced into each vial. Percentage mortality was then assessed. The results in Table 3 show that though the protectant is applied as a concentrate, the mixing that occurs in normal movement of grain in silos results in an even spread throughout the grain.

## Operator Safety

The applicator delivers non-diluted concentrate to the grain. This removes the need for operators to measure and dilute concentrate, as occurs with a normal spray method. The operators need handle the concentrate only when moving the suction tube from empty containers to full containers. This minimises the opportunities for accidental contamination of the operators, and the chances of incorrect measurement or dilution of product.

The applicator also reduces levels of airborne protectants. When a normal spray method is used, a spectrum of droplets is produced, and the smallest of them become airborne. This can lead to contamination of the air space in the silo area, with potential occupational health and safety concerns. As the applicator skid rides directly on the grain, and wipes the concentrate onto the grain, the small particles are virtually eliminated. Air sampling was carried out in conjunction with the Australian Wheat Board Technical Working Party Trials in 1986–87, at Bulk Grain Queensland's silos, Malu, Queensland. Airborne protectant was analysed by drawing air through a solvent filter, and then analysing for the amount of protectant collected. The results are given in Tables 4a and 4b.

**Table 3.** Percentage mortality of *Sitophilus oryzae* in single grain bioassays, for two application methods, at given periods of time.

| Application method | % Mortality at given time (months) | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 1.5 | 3 | 4.5 | 6 | 8 |
| Applicator | 100 | 100 | 100 | 100 | 100 | 100 |
| Spray | 100 | 100 | 100 | 100 | 100 | 93 |
| Untreated | 1 | 0 | 0 | 0 | 0 | 0 |

**Table 4a.** Detected airborne concentration of deltamethrin and piperonyl butoxide, following application to grain, by two treatment methods.

| Replicate | Application method | Residues detected (μm/m$^3$) Deltamethrin | Piperonyl butoxide |
|---|---|---|---|
| #1 | Spray | 2.2 | 24.6 |
| | Applicator | nd | 1.5 |
| #2 | Spray | 0.4 | 11.1 |
| | Applicator | nd | 2.9 |
| #3 | Spray | 2.2 | 39.1 |
| | Applicator | nd | 6.0 |

nd — not detected

While the above figures are comparative only, they demonstrate that the use of the applicator reduced airborne protectants to 3–5% of the levels occurring with the use of normal spray methods.

**Table 4b.** Detected airborne concentration of bioresmethrin, piperonyl butoxide and fenitrothion, following application to grain by two treatment methods.

| Application method | Residues detected (μm/m$^3$) Bioresmethrin | Fenitrothion | Piperonyl butoxide |
|---|---|---|---|
| Spray | 20.9 | 194.1 | 170.2 |
| Applicator | nd | 8.7 | 4.3 |

nd — not detected

## Conclusion

The closed treatment system for application of grain protectants, developed by Roussel Uclaf Australia is able to provide accurate, uniform dosing of protectants to the grain. It also provides a greater level of operator safety than normal spray application, by reducing the airborne concentration of protectants, and by removing the need for dilution of the protectant before application. The microprocessor linkage allows incorporation of the system into a total management scheme for large-scale grain handling.