SESSION 5

POSTER PRESENTATIONS

Session Organiser

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THE CHARACTERISTICS OF A TEST LIQUID FORMULATION FOR USE IN EVALUATING THE PERFORMANCE OF HANDLING AND METERING SYSTEMS

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ABSTRACT

Injection metering systems are an important option for the development of pesticide application equipment, with advantages relating to minimising the need for disposal of unused pesticide, improving the ease of cleaning and optimising the accuracy of chemical application. For all injection systems, characteristics such as the steady-state accuracy of delivered dose, dose stability and the time response for dose step changes are related to the ability of the system to operate with different chemical formulations. A system designed to inject liquids should be able to accommodate changes in viscosity and density. The aim of this study was to develop a methodology for testing chemical injection systems using liquids with different viscosities. The experimental arrangement simulating applications with injection metering systems used dye and salt solutions as tracers. Tests were conducted to analyse the influence of salt on the characteristics of the water and a viscous solution. Results showed that the salt interfered with the dye stability in the water solution. In tests with a viscous test liquid, the salt was introduced at different steps during the mixing process, providing four different liquids to be analysed in terms of viscosity, density and pH. Some differences in liquid characteristics were found which could influence the performance of the injection systems.

INTRODUCTION

One of the ways of minimising the need to dispose of unused pesticide during crop spraying is by using chemical injection systems. The use of such systems also provides advantages relating to the decontamination of the sprayer after work since the main tank and other components are only in contact with water. The ability to operate effectively with a wide range of chemical formulations is a key factor influencing the uptake of injection systems. Systems designed to inject liquids should be able to meter chemicals with different viscosities and densities. Since these properties can change the response of metering pumps and flow-meters, electronic control systems should provide correction methods or calibrations for chemicals with different liquid properties. Chi *et al.* (1989) reported that the equation for calibrating an injection system flow rate could be either a single linear or a quadratic relationship, depending on the liquid viscosity. Gebhardt *et al.* (1984) presented results showing that the response of a flow-meter can be directly linked to the chemical used and, for some flow-meters and chemicals, accuracy only can be achieved by controlling the temperature of the pesticide. Cochran *et al.*

(1987) found fluctuations up to 50% in viscosity over ambient temperature ranges when testing some chemical formulations.

An injection metering system evaluation must therefore use test liquids with a range of viscosities. Antuniassi *et al.* (1997) reported results where an injection system was unable to inject a viscous solution under specific conditions. In that work, the authors presented a methodology that used an experimental test rig designed to simulate applications by using injection systems to meter salt and dye solutions. Steady-state dose accuracy tests used colorimetry and electrical conductivity measurements to estimate dye and salt concentrations in the spray solution downstream of the injection point. The dynamic behaviour of the injection systems was evaluated by monitoring the electrical conductivity of the spray solution on-line using a conductivity sensor and a data acquisition system. British Standard BS:6356 (Anon., 1996) describes a viscous test liquid to be used for evaluating induction hoppers and closed transfer systems. However, a salt must be mixed with this liquid in order to allow conductivity to be used in dynamic testing. Since the addition of salt could change characteristics of the liquid, the aim of this study was to evaluate the influence of added salt, and provide information relating to changes in properties such as viscosity and density.

MATERIALS AND METHODS

Dye stability in the salt solution

Salt solutions with 23.4% of NaCl in tap water were mixed with 0.1, 0.05, 0.025 and 0.01% of *Green S* dye powder. A 0.1% dye solution without salt was prepared to be used as a reference. The solutions were stored in 100 ml measuring cylinders for 12 hours. After this storage period, samples were collected from both the top and the bottom of the cylinders using pipettes. The samples were diluted (0.6% in tap water), and the dye concentrations were measured by spectrophotometry, aiming to assess possible dye deposition at the bottom of the cylinders.

The influence of salt in the viscous test liquid

BS:6356 (Anon., 1996) specifies that the viscous test liquid is obtained by mixing polysaccharide (Xanthan), methyl cellulose and dye in tap water, following a defined mixing protocol. The polysaccharide is mixed with water, methyl cellulose and dye are then added, followed by a final mixing period. In the work reported here, four liquids were tested, differing in the way in which the salt was added in the mixing process (Table 1). All the solutions used 0.0075% of dye and 5.85% of NaCl, where appropriate.

Three factorial experiments were designed to evaluate the influence of the salt on the liquids, testing the four liquids under two different conditions, including three replications (Table 2). In these tests, the viscosity of three samples of liquid in each replication was measured with a Brookfield Viscometer (model LV, using spindle no.3). In order to evaluate the changes in viscosity with the rate of shear, all the measurements were made using three speeds in the viscometer (6, 12 and 30 rev/min). Other characteristics, including density and pH, of the liquids were also measured.

Table 1. Viscous liquids used for the tests.

Solution	Mixing process
NS	Standard solution without salt
SB	Salt added in the beginning of the process, before the polysaccharide
SM	Salt added in the middle of the process, after the dye and before the final mixing
SE	Salt added one minute before the end of the mixing process

Table 2. Viscosity tests.

Tests	Description
I	The shearing effect of pumping the solutions through a piston pump was evaluated, measuring the viscosity of samples pumped and not pumped, immediately after being pumped and 4 hours after being pumped.
II	The storage effect was evaluated, measuring the viscosity 1 and 24 hours after being prepared.
III	The temperature influence on the viscosity was evaluated, measuring the viscosity at 11 and 19°C, 5 hours after being prepared.

RESULTS AND DISCUSSION

The results from experiments evaluating the dye stability of the salt solutions (Table 3) showed that high concentrations of dye were not stable in high salt concentrations, with dye deposition occurring after 12 hours storage. Spectrophotometer readings were significantly higher with samples taken from the bottom of the measuring cylinder. Only when the dye concentration was reduced to 0.01% (a tenth of the standard concentration) was the deposition minimised.

Table 3.Spectrophotometry readings for samples taken from the top and bottom of a cylinder of stored test liquid.

Original liquids	Sampling position in the measuring cylinder, after 12 hour storage	
	Top	Bottom
0.1% dye without salt	0.610	0.610
0.1% dye + 23,4% salt	0.422	0.796
0.05% dye + 23,4% salt	0.230	0.408
0.025% dye + 23,4% salt	0.154	0.217
0.01% dye + 23,4% salt	0.070	0.074

The results for the viscous liquid tests showed that the addition of salt could change some characteristics of the standard liquid. Table 4 shows a very small increase in density, as well as a decrease in the pH of the viscous liquid when the salt was added during the mixing process. The difference between the higher and the lower value of density was less than 2.5%, but this difference could influence the results of a steady-state accuracy test with an injection metering system. The change in pH could influence the storage process, causing modifications to the liquid properties with time.

Table 4: Density and pH of the viscous liquid at 19°C, 5 hours after preparation.

Solutions	Density (kg/litre)	pH
NS	0.9803	7.61
SB	0.9967	7.14
SM	1.0047	7.16
SE	1.0036	7.17

Viscosity tests performed 24 hours after the end of the mixing process did not show any interaction between the addition of salt and the storage time (Table 5). However, longer storage periods should be further studied to analyse the effects of changes in pH. The viscosity tests showed that the addition of salt significantly reduced the viscosity of the standard liquid. The differences caused by the addition of salt were not large with the maximum difference between averages for the different solutions being less than 7.0% (Table 5).

Table 5: The effect of time on the viscosity at 19°C.

Solutions	Viscosity (Pa.s)
NS	11.67 a
SB	11.02 b
SM	11.17 b
SE	11.21 b
Time	
1 hour after being prepared	11.18 a
24 hours after being prepared	11.35 a
F pr.	
Solutions (S)	0.0008
Time (T)	0.0628
S x T	0.3824
C.V.	1.80

Notes: Viscosity at 6 rpm on the viscometer. Means with the same letter do not differ significantly (p = 0.05) Tukey's HSD test.

The BS:6356 standard viscous test liquid is non-Newtonian and so changes in viscosity with the rate of shear were expected. The addition of salt did not significantly influence this characteristic, (Figure 1). The use of non-Newtonian fluids for testing injection systems might reveal differences in performance for different metering pumps. For example, the pumping process could change the viscosity of the solution, and that change would influence results for performance tests. Table 6 presents results for the sensitivity of the liquids to the shearing caused by the pumping process through a piston pump. All the liquids were sensitive to being pumped, and the drop in viscosity persisted even four hours after the pumping process. Despite the significant difference between the solutions, there was no interaction between the addition of salt and the shearing caused by the pumping process.

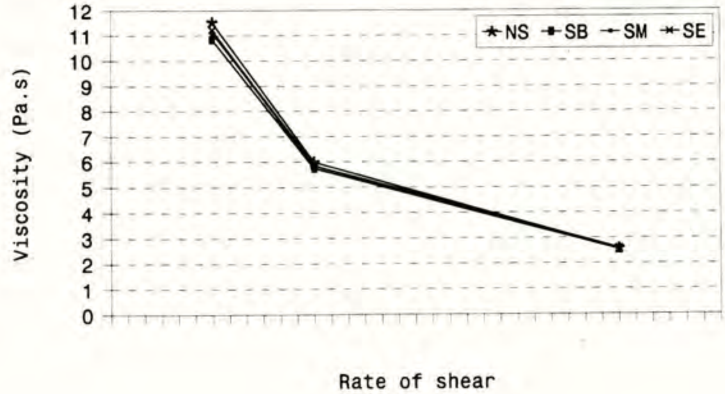
Another parameter that could influence the viscosity of the test liquid is temperature. The results in Table 7 show that the viscosity was significantly higher at low temperatures, when comparing solutions at 11 and 19°C. Although there were differences in the viscosity between liquids, there was no interaction between salt addition and changes in temperature.

Table 6: The effect of pumping process on the viscosity at 19°C.

Solutions	Viscosity (Pa.s)	
	Immediately after being pumped	4 hours after being pumped
NS	11.42 a	11.62 a
SB	10.64 c	11.02 b
SM	10.99 b	11.22 b
SE	11.02 b	11.10 b
Processing		
Not pumped	11.18 a	11.38 a
Pumped	10.85 b	11.11 b
F pr.		
Solutions (S)	0.0002	0.0003
Processing (P)	0.0011	0.0019
S x P	0.7761	0.8449
C.V.	1.75	1.53

Notes: the solution was pumped 1 hour after being prepared. Viscosity at 6 rpm on the viscometer. Means with the same letter do not differ significantly (p = 0.05) Tukey's HSD test.

Figure 1. Viscosity changes as a function of the rate of shear, obtained by increasing the speed of measurement in the viscometer (6, 12 and 30 rev/min).



CONCLUSIONS

The viscosity of the test liquid defined in BS:6356 was statistically reduced by the addition of salt. The largest difference between averages for different liquids due to the addition of salt was less than 7.0%. The salt does not affect the response of the liquids to changes related to rate of shear, temperature and time of storage. All the solutions, regardless of the addition of salt, were affected by the rate of shear and by temperature. The addition of salt also changed density and pH of the viscous liquids. Liquids with high salt and dye concentrations were not stable and gave deposits in the bottom of containers.

Table 7: The effect of temperature on the viscosity, 5 hours after the mixing process.

Solutions	Viscosity (Pa.s)
NS	11.79 a
SB	11.19 c
SM	11.50 b
SE	11.36 bc
Temperature	
19°C	11.38 b
11°C	11.54 a
F pr.	
Solutions (S)	0.0004
Temperature (T)	0.0342
S x T	0.8539
C.V.	1.48

Note: Viscosity at 6 rpm on the viscometer. Means with the same letter do not differ significantly ($p = 0.05$) Tukey's HSD test.

ACKNOWLEDGEMENTS

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PESTICIDE WASTE WATER MANAGEMENT IN CHAMPAGNE

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ABSTRACT

Cleaning pesticide application equipment can cause pollution in ground and surface water. An experiment has been performed in Champagne with the aim of pursuing a collective area for pesticide waste water collection and studying two treatment devices. The two tested systems, Sentinel and Epu-Mobil, ensured some good treatment performances.

However, the design of the collective area needs to be optimised. Control of water consumption and a separation of waste waters are required. Furthermore, as in any environmental approach, pollution reduction has to be considered upstream, by making wine-growers aware of the problem and adjusting pesticide application equipment in order to avoid excess waste.

INTRODUCTION

The environment protection is getting more and more important in every productive activity. In Champagne, after some years and as a consequence of a better knowledge of pest biology, the development of biological methods and cultivation practices to diminish of pest pressure (manure, trellis systems, etc.), an important reduction of chemical treatments and pesticides application has been noticed.

Thanks to the vigilance and encouragement of vine growers associations like Magister, the development of vineyard technologies respectful of the environment has been possible. However, beyond the vineyard's management, the use of agrochemical products can sometimes bring sporadic or permanent pollution problems because of cleaning and rinsing of application equipment.

In order to study pesticide waste water's management, a first study of pesticide waste disposal was done in 1993 following the Sentinel procedure, using a collective washing bay in a wine merchant's property. A second study was done in 1995 with a collective washing bay where two different waste water treatments were tested.

STUDY DESIGN

The washing bay

The washing bay was located over the platform of the marc stock at Vincelles' wine cooperative, where fifteen vine growers cooperated during the study. The area of vines involved was about 70 ha, which represents about 60% of the cooperative's total area.

Two services were available at the washing bay: it was possible to mix the liquid products on the site and to rinse the equipment after pesticide application

It has to be noted that during the study, the water used was free for the participants, who had a choice of two systems to rinse the pesticide containers :

- The « Lav box » : rotary pipes rinsing system. The container is turned over the four rotary pipes of the apparatus and a little push makes it start. The pesticide waste is diluted into water which is collected and sent back to the pesticide application tank.
- The « Phytonettoyeur » : is a rinse gun joined either to the water supply or to the pesticide application tank's pump. The empty container is turned over the tank, and is then perforated by the cutting point of the gun. When the trigger is pulled, water spurts out and rinses the container, going down into the tank.

Lastly, the users of the washing bay could get rid of the rinsed containers, the paper bags and the pesticides packing materials in a trash container lent by a supplying cooperative.

The treatment systems

Principle :
From the collected waste water, two purification systems were tested : Sentinel and Epu-mobil. Both are based on a « physical-chemical » treatment, using the coagulation-flocculation principle followed by a filtration with active charcoal. The flocculation principle is divided into two stages :

- coagulation : destabilization of suspended particles by eliminating the forces which prevent the negative charged particles from bringing together.
- flocculation : packing of uncharged particles to form an aggregate.

Both stages are triggered by the addition of a flocculating agent. Active charcoal is a solid with a large surface area which gives it an important adsorption capacity.

Process description

The main difference between the two systems tested is that Sentinel treats sequentially a low volume of effluents per day ($1m^3$/day) while Epu-Mobil allows continuos treatment ($4m^3$/hour) thanks to a stocking tank for the flocculation. Also, the Epu-Mobil system can be drawn by a car.

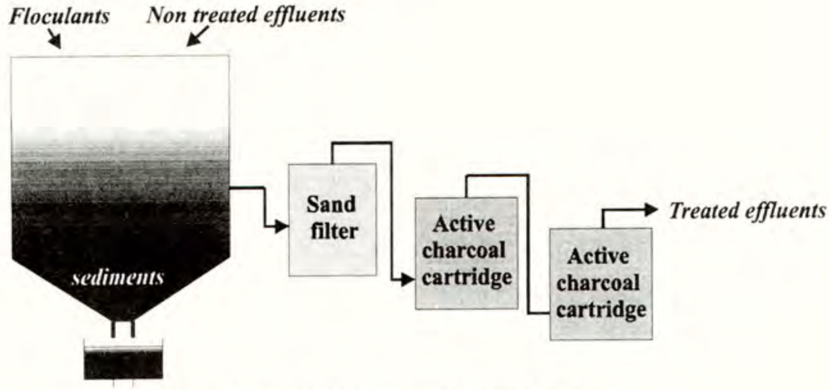

Figure 1 : Scheme of Sentinel system

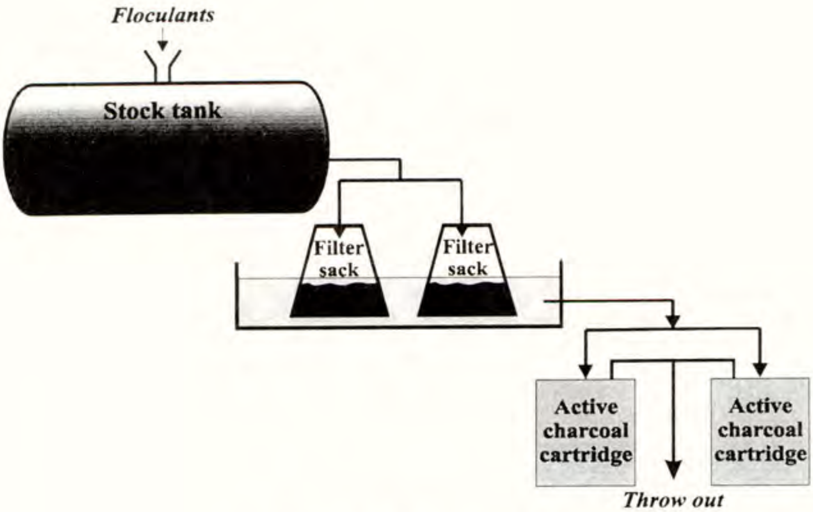

Figure 2 : Scheme of Epu-Mobil system

Regulations

In the past, the regulation (article 9, arrêté du 25 février 1975) said that « after any treatment the powder residues must be buried, the liquid patents, the spray mixture and the waste waters must be disposed of in 30 cm deep holes and then covered with earth. None of these operations can be done nearer than 50 m from any water source ».

This regulation is not adapted to environmental requirements, especially because of the risk of subterranean migration of pesticides which may contaminate the ground water. However, there is still no specific regulation concerning pesticide waste water.

Concerning the studies, it was necessary to make a request to settle a collective washing bay, as is usually done for cistern washing bays.

STUDY MEASUREMENTS

The study had three main objectives :

- Quantitative and qualitative characterization of pesticide waste water
- Technical and economical study of the treatment devices
- Determine user's motivation for the services available at the washing bay

Rinsing sheet

The organization of the washing bay was set up after two meetings with the vine growers. So, their remarks and opinions could be considered and the meter reading of water for rinsing and washing could be organized.

In order to know the effluents' nature, the vine growers were asked to fill in an anonymous rinsing sheet (rinsing date, commercial name of the products, etc.), so that the active compounds could be identified.

Analytical aspect

The following aspects were investigated :

- Parameters to follow organic pollution : COD (chemical oxygen demand), BOD (biological oxygen demand), pH, suspended particles
- Active substances : because of practical and economical reasons, an exhaustive analysis of all the active substances detailed on the rinsing sheets was not possible. A few active substances were then selected according to their amount and frequency of use, toxicity and solubility. The following molecules were measured : sulphur, cymoxanil, folpet, mancozeb, fosetyl, deltamethrin, fenpropathrin, bifenthrin, copper, and diuron.

RESULTS

Washing bay

From May to August, 80 m^3 of effluents were collected. Under the experiment's conditions, 635 liters of effluents were produced in average for each rinse. This significant amount can be explained by the self-service use of a fire hose-rinsing jet. Better water management is necessary, which could be achieved by using a water compressor (card or coin controlled).
The availability of containers was useful to the vine growers for preparing the spray mixture on site. Six cubic meters of cans and paper bags were collected. Some of the cans, despite special attention, because of the chemicals they contained, were difficult to rinse. So, these packing wastes could not be managed as domestic wastes and were sent to a treatment plant.
These observations underline the importance of packing evolution towards intelligent packing which would allow easy rinsing and ensure security.

Treatment performances

Table 1. Results before and after the Sentinel system.

Molecule	*Before treatment*	*After treatment*
pH	7,44	11,99
COD mg O_2/l	1100	610
BOD mg O_2/l	480	440
suspended particles	95 mg/l	<5 mg/l
sulfur	29000 µg/l	<1,00 µg/l
cymoxanil	340 µg/l	<0,10 µg/l
folpet	5 µg/l	<0,01 µg/l
diuron	260 µg/l	<0,10 µg/l
mancozeb	6940 µg/l	<450,00 µg/l
fosetyl	12000 µg/l	2000,00 µg/l
deltamethrin	3 µg/l	<0,01 µg/l
bifenthrin	40 µg/l	<0,01 µg/l
fenpropathrin	6 µg/l	<0,01 µg/l
copper	3310 µg/l	<50,00 µg/l

Table 2. Results before and after the Epu-Mobil system.

Molecule	*Before treatment*	*After treatment*
pH	6,21	7,28
COD mg O_2/l	1293	190
BOD mg O_2/l	90	54
suspended particles	1205 mg/l	10 mg/l
sulfur	30500 µg/l	680 µg/l
cymoxanil	14400 µg/l	<0,1 µg/l
folpet	0,65 µg/l	0,19 µg/l
diuron	326000 µg/l	0,26 µg/l
mancozeb	3289 µg/l	<450 µg/l
fosetyl	5000 µg/l	5000 µg/l
deltamethrin	17,8 µg/l	0,51 µg/l
bifenthrin	16,2 µg/l	0,1 µg/l
fenpropathrin	35,9 µg/l	0,26 µg/l
copper	550 µg/l	<50 µg/l

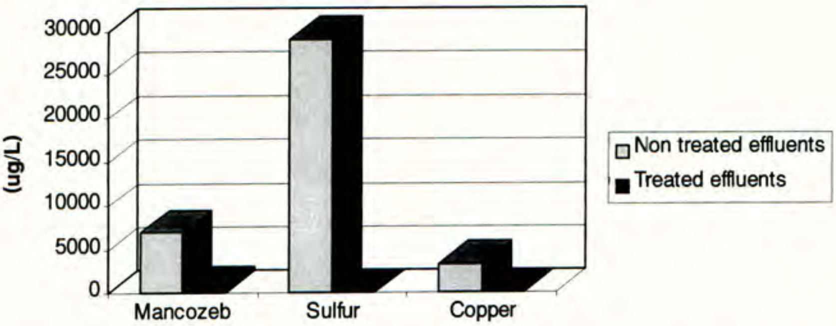

Figure 3 : Active substances concentration before and after the Sentinel's treatment

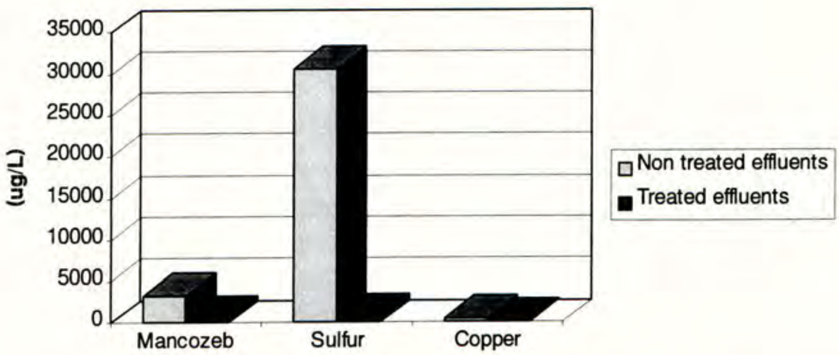

Figure 4 : Active substances concentration before and after the Epu-Mobil treatment

Overall, both systems show good performances. With the Sentinel system, most of the active substances measured after treatment were below the drinking water level (0,1 µg/liter per molecule). Concerning fosetyl, more investigations must be done in order to precise if the high level is linked either to a partial treatment efficiency or to analytical aspects. Some improvements, concerning the charcoal filtration and the separation of sediment, must be done on the Epu-Mobil system to ensure an optimal operation.

Operation characteristics

The Sentinel system needs a lot of handling and care. But its conception optimizes the production of waste sediment. It can't be used on the scale of a collective washing bay because of its low volume batch principle. However, after some design changes, it could be more adapted to a research center.

Large volumes can be treated with the Epu-Mobil system because of its continuous operation principle after the flocculation stage. This conception, along with the system mobility, is well adapted to pesticide waste water treatment and could eventually be implemented as a provision of service.

Economical approach

As the studies carried out in Champagne are experimental, no precise technical-economical study could be done.

From our observations, an experiment made by the Faculté des Sciences de Gembloux in Belgium and Swiss experience, the running cost of the device can be estimated between 300 and 600 French francs per cubic meter (chemicals, energy, residues elimination, workforce).

Concerning investment, the cost is around 156000 FF for the sentinel device ($1m^3$) and 240000 FF for Epu Mobil (estimated cost from experimental material).

CONCLUSION

This study has shown that the pesticide waste water treatment can be done by a physical-chemical treatment. However, concerning the design and management of the washing bay, further studies have to be done. Thus all these aspects need better water management, a separation of the effluents according to pesticide waste water composition and a reduction for spray mixture's remainder after treatment.

This last point justifies both a need to make wine-growers aware of the issue and to improve wine pesticide application equipment.

A project is being done in Champagne in order to take into account every pesticide's application aspects related with the environment, as follows :

- Rising technologies of pesticides packing material
- Improvement of pesticides application
- Design of filling and washing bays for the application equipment
- Water management, recovery of tank deposits and waste water
- Studies of associated services to filling and washing bays
- Characterization of external-rinse-waste water
- improvement of a movable tank-rinse-waste water treatment that could be used to provide a service

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PACKAGING INNOVATION: THE DEVELOPMENT OF REFILLABLES AND ITS IMPACT ON THE AGROCHEMICAL SECTOR

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ABSTRACT

Small volume refillable pesticide packaging has now been in commercial use - in the field and by seed treaters - for over three years. This paper reviews the recent history of its development; the experience of farmers and seed treaters using the system; and the results in terms of time and cost saving, safety, and environmental impact.

INTRODUCTION

In the agrochemical sector, innovation in packaging technology is integral to the development of new products. It provides the infrastructure to ensure that new actives can be brought to market effectively.

The development and successful field use of refillable packaging technology represents a practical example of innovation, and of the commercial and environmental advantages which can arise from careful follow-through of an original concept.

BACKGROUND TO THE DEVELOPMENT OF THE REFILLABLE CONCEPT

Draft legislation on packaging waste disposal (EEC Draft Proposal 1991) motivated chemical manufacturers to become increasingly pro-active in their approach to formulations and packaging in order to minimise the volume of used packaging entering the waste stream. It was necessary that viable plans were in situ to ensure the workability of the legislation prior to its introduction.

The use of refillable containers in, for example, Canada had already proved their significant potential for reducing the total amount of used plastic packaging.

Another issue for chemical manufacturers was the requirement to further minimise the opportunity for operator contamination, especially that arising during transfer from container to sprayer. A key principle of the COSHH regulations, in this context, is that Personal Protective Equipment should be the last line of defence against contamination; elimination, substitution, engineering control, and operational solutions are all to be preferred.

A closed refillable container system obviates the need for certain operations which present the highest risk of contamination: removing the secondary seal (after cap removal), pouring the product, and rinsing the container.

As early as 1986, Ciba (now part of Novartis) recognising future legislative pressure and driven by an internal 'vision' of significant waste reduction had started to look at refillables. Initially, they considered 400 litre containers with pumps, which are used in the US, but these were unsuitable for the UK farmer, being too big and not sufficiently reliable.

Ciba moved on to other possible systems, and over the past eight years has developed, refined and brought to market a small volume refillable container system designed to meet legislative demands in terms of both environment and safety, and farmer demands in terms of speed and cost savings.

In 1992, two candidate containers were tested in farm trials. These were a 20 litre stainless steel keg; and the 10 litre 'Ciba-Link', a prototype pesticide container based on the closed transfer system used for filling racing cars.

This trial sequence also included a comparative operator exposure study using 2 x 1 litre conventional HDPE containers.

Results showed that a refillable system substantially reduced operator contamination during tank filling. The farm usage trials also showed a preference for Ciba-Link over the stainless steel keg.

The main advantages cited by farmers were: cleanliness; speed of filling; ease of measurement; ability to assess contents visually; cheapness; and the container's compact transfer valve.

Based on this trial work, further developments were made to the Ciba-Link prototype. A key one was to change the mode of operation to a twist (instead of a push) action. This made the output more controllable, the shut off more definite, and the measurement of small quantities easier.

The prototype container has now been developed into a commercial product known as the LinkPak, which has now been in use on farms and on seed treatment machines for some 4 years. This is a returnable refillable available in 5 and 10 litre sizes together with custom built 50 litre intermediate container. The drive for a clean and easy to use system with significantly reduced packaging waste has also been developed in the commercial use of 800 litre IBCs for use in seed treatment plants.

EXPERIENCE OF COMMERCIAL USAGE

Field crop protection

Over the last 3 or 4 years, advances in sprayer design, including the modification of chassis and boom suspension, have led to much increased spraying speeds. Also, products are now being registered for lower application rates. Both these developments have led to a need to add chemical to the sprayer tank more frequently, and therefore to cut filling time, if the spray operation is to maintain efficiency.

The LinkPak system has proved able to meet this need, as well as the environmental and safety demands which originally stimulated its development.

The system has now been in commercial use on farms over the past 4 years. Packs are delivered and collected from farms by distributors. There is no requirement to rinse, as each container is labelled and reserved for a specific product.

Farmers find LinkPak offers significant time savings in all stages of sprayer filling. Work done by Chris Ascroft on Wilbraham Farms in 1997 gave the following average figures.

Container	Opening	Pouring	Rinsing	Total for 10 lts
10 lt LinkPak	2 secs	25 secs	5 secs (connections only)	32 secs
5 lt HDPE	6	16	10	1 min 4 secs
1 lt PET	6	15	5	1 min 20 secs

In addition, there is no time requirement to open seals or dispose of packaging.

Seed treatment

Prior to introducing its new product 'Beret' for seed treatment, Ciba's research in this market had revealed that both static and mobile seed treaters were experiencing difficulties in chemical handling, although the issues were different for the two groups.

In response to this, the refillable system under development was adapted for seed treatment as well as field usage.

Static seed treaters run a continuous operation, and the use of chemical supplied in traditional containers creates a packaging waste disposal problem. Further, there is an opportunity for operator contamination as the dip pipe is frequently moved between supply containers.

A refillable system has now been developed for this market as a 800 litre returnable intermediate bulk container (IBC) which is unloaded from the top using a micromatic valve. An integral industrial balance indicates liquid volume using a digital readout system, which also allows continuous calibration of the process. The containers do not require washing out and are returned to Novartis for refilling after use.

These IBCs have been in commercial use since 1994 and, uniquely, because of their robust stainless steel construction and top unloading have been approved for use outside bunded areas, by the National Rivers Authority.

Mobile seed treaters are in a different position insofar as they must have delivery of chemicals in small packs, to facilitate continual moving of their operation from one farm to the next. Consequently, there is a higher risk of operator exposure and, due to farm conditions, more likelihood of dirt and dust contaminating the chemical.

For this market, Novartis has developed a refillable supply system based on a 50 litre intermediate container which fits directly onto the seed treatment machine, using a dry break coupling with the LinkPak adaptor on top of the intermediate container. This allows for a pump to measure and pull off the required amount of chemical and recharging from standard 5 or 10 litre LinkPaks. The main advantages of this system are that it is clean, safe and fast, and eliminates disposal and rinsing requirements.

By 1996, 72% of all the Novartis seed treatment 'Beret Gold' was being sold in one or other of these two refillable systems. From sales figures, it has been calculated that in this one year, the use of refillables reduced the weight of packaging which would have entered the waste stream by using single trip packaging, by 12 tonnes.

THE FUTURE FOR REFILLABLES

The advantages of refillable chemical supply have now been proved in practice. The process is currently at a stage where LinkPak is the industry standard for smaller volumes, and the Cyanamid system (Ecomatic) for volumes over 20 litres. Novartis also has a 100/200 litre container (the 'Big Set') under development, for chemical delivery, which the farmer can use to transfer product into measuring containers, as well as direct into the sprayer.

Further developments will take place as the market for returnable/refillable containers evolves. For example, although it reduces the problems of container disposal, it potentially increases the problems of empty container storage and security. As usage of refillables becomes more common, this will be addressed by increased frequency of collection by distributors.

Experience also suggests that colour coding of containers for broad categories of produce would be useful, and Novartis is considering this but is aware that this is no substitute for thoroughly reading the label.

The next phase of development is the commitment by major agrochemical companies to supplying product through a refillable system; six now have selected products in LinkPak which is available to all manufacturers for field sprayed products.

Widespread acceptance and use of returnable refillable system will offer real safety, environmental and cost benefits. Therefore, manufacturer and distributor commitment, together with a good range of product choice, are now essential to the agrochemical industry.

DEVELOPING THE ECOMATIC SYSTEM

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SUMMARY

Cyanamid Agriculture has developed a closed-transfer keg system that cuts out the need for on-farm packaging disposal entirely and reduces the risk of environmental or operator contamination. Perhaps most importantly for the farmer, it is five times faster than dealing with conventional packaging in the manner specified by BAA guidelines.

Chemical is supplied in a 25-litre keg and extracted using a specially-designed unit. The kegs are returnable and have a life-span of five years.

The system was successfully test-marketed in autumn 1996 and a total of 500 units are now estimated to be on-farm.

MATERIALS AND METHODS

<u>The Tracer System</u>

The closed-transfer keg system includes an electronic tracking device, which means that the container is fully traceable.

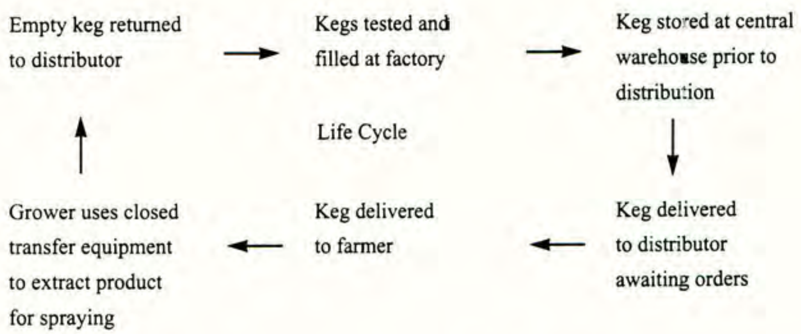
A low-frequency transponder ensures that the container is only refilled (with specified product) and re-circulated when damage free and within its legal five-year lifespan.

The transponders are tough enough to even withstand being driven over by a tractor and are designed to have a long-life, with no batteries or maintenance required.

<u>The Keg</u>

Technology from the brewing industry was harnessed to developed a drum-shaped keg for ease of handling.

Internal fins agitate chemical prior to use, to give optimum extraction without the need for shaking.



<u>The Tamper-proof Valve</u>

Each keg is fitted with a drum valve, providing the only opening to the container and featuring a tamper-evident seal.

This dry-break valve is one-way, meaning there is no risk of contamination of the drum and its remaining contents.

<u>The Transfer Unit</u>

The transfer unit has a stainless steel extractor valve in its base, and connects to the drum by a bayonet fitting. It fits to most commonly-used sprayers.

Chemical is drawn from the container by suction and can be drawn directly into the sprayer tank or via a measuring bowl, calibrated to allow part kegs to be used., After measuring and emptying into the sprayer, the in-built-in flushing facility enables easy cleaning.

Once the drum is empty or sufficient chemical has been extracted, the extraction unit is easily disconnected and special couplings prevent spillage or dripping from the valves.

RESULTS

Time Saving

A test was carried out to assess the time taken to unpack, open, dispense and rinse out 4 X 5 litres of Stomp 400 SC, as a comparison to the time taken to dispense 20 litres of product using the closed-transfer extraction unit with an Ecomatic® 25-litre keg.

The following table shows the time taken to complete each step (NB additional time would have been required to dispose of the empty packs, but this could not be simulated in the laboratory).

	Cumulative Time	
Process	Seconds	Minutes
Open box, remove packs	17	0.3
Shake pack 1, remove cap, remove seal and dispense	53	0.9
Repeat with packs 2, 3 and 4	157	2.6
Triple rinse pack 1	269	4.5
Repeat with packs 2, 3 and 4	618	10.3
Total Time	618	10.3

In trials with the keg system, 50 litres of chemical have been measured into a large sprayer in less than four minutes. This represents approximately 15% of the time required for equivalent conventional packaging.

Response to the system

Cyanamid has carried out in-depth research amongst nearly 200 Ecomatic users to-date. These key facts demonstrate the value of the system:

- 75% of farmers surveyed felt the 25-litre keg was the most appropriate size for on-farm use
- Operator safety was considered the most valuable feature, followed by fewer chemical containers, returnable packaging and labour savings
- In relation to packaging disposal, 80% of farmers stated a preference for packaging that could be returned and refilled, compared with 16% for packaging to be destroyed on farm and 2% to be destroyed off farm by a third party
- The most frequent problem area was not being able to see the chemical through the opaque container, causing problems in calibration. To solve this problem, systems fitted in 1998 will incorporate a see-through measuring bowl
- Overall satisfaction was good, and where problems were experienced, the underlying feel was that this was related to lack of practice with the system - which is to be expected when a new approach is being pioneered

SUMMARY OF FINDINGS

	The Problem	The Solution	The Benefits
Time	Ever-increasing pressure on farmers' time. In addition, poor weather at spraying can mean narrow windows of opportunity for some products	The closed-transfer keg system reduces the time required to dispense chemical and deal with packaging by up to 85%	• More hectares can be sprayed in a day • More efficient use of expensive sprayers • Less impact of bad weather on spray programme
Packaging Disposal	Container and packaging disposal presents on-farm problems and manufacturers are now required to recycle 50% of waste by 2001	Returnable kegs with predicted five-year life-span - chemical costs same per litre as in conventional packs	• No packaging disposal required on-farm - saving time and hassle, and offering environmental benefits • Returnable keg works towards EU objectives for packaging recovery
Environmental Contamination	Ever-increasing pressure on growers and the industry to minimise environmental impact of pesticides and their packaging	Completely closed transfer system	• No risk of environmental contamination with chemical • No direct packaging or outers to be burned or buried
Operator Contamination	Operator safety must always be of paramount importance when dealing with chemicals under COSHH regulations	Completely closed transfer system - and the extraction unit is capable of measuring at more than twice the speed of an experienced operator using traditional methods	• No accidental operator contact • No accidental spillages - maximising usage of chemical purchased • Increased quality of work place
Accuracy	Environmental-sensitivity requires chemical to be accurately measured	The transfer system offers accurate measurement of part containers - works with all liquid formulations	• Maximum efficiency of chemical usage • Minimises environmental risk from over-application

A SURVEY OF SPRAY OPERATORS AGROCHEMICAL CONTAINER RINSING SKILLS CONDUCTED IN JUNE 1997

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ABSTRACT

Operators were invited to test their skills at decontaminating disposable 5 litre capacity, agrochemical containers that had been preconditioned with a viscous test material. An induction bowl fitted with a container rinsing nozzle was used by all for a time of 20 seconds each. Some 69% of the 103 participants could clean the containers to less than 0.5 mls of residue; the upper limit defined by BS 6356. A second less skilled group [21%] had residues between 0.5 and 2.0 mls; whilst a further 6% had < 4mls. It was concluded that both the equipment used today and the operators skills were capable of meeting the Standards needs.

INTRODUCTION

Many sectors of the agrochemical industry - from pesticide producer to machinery manufacturer and operator - are being prompted to consider the ways and means by which waste can be minimised. All forms of such losses are included - from packaging to both undiluted and diluted pesticides. The industry has responded with better packaging designs, Small Volume Returnables, Closed Transfer Systems, use of container rinsing equipment and improving operator awareness. Agreed National and International Standards have been developed to help ensure the generation of meaningful data when describing performance levels. Great improvements have, therefore, been made that needed to be assessed before further - and perhaps unnecessary - goals are set. Hence, a survey was conducted to establish whether modern agrochemical packs can be rinsed to meet the relevant Standards and to gauge if operators do have the skills and will seek the improvements demanded.

THE SURVEY

The Sprays and Sprayers event on June 24/25 1997 at the Novartis site near Whittlesford in England attracts large numbers of farmers, spray operators and others within the trade. It was considered that this venue would therefore be appropriate to conduct a survey of such peoples skill at rinsing containers. A tent was provided close to a main route through the exhibits and within which was housed the necessary equipment, instruments and work area. Hardi Ltd supplied a 25 litre induction bowl –

complete with container rinsing nozzle - mounted on a small frame and piped to deliver mains water only to the nozzle. Although three sizes of disposable packs are in normal use, for the purpose of this survey which demands comparative data, only the middle 5 litre size was used. These containers were pre-conditioned with a viscous Test Product that mimics very well the more tenacious pesticide formulations - its composition and production being described in the Standard.

Participants were given 20 seconds use of the rinsing nozzle - an exposure time earlier studies have indicated to be both effective and acceptable to the operator. After each test, residues were visually examined, removed in a known volume of clean water and samples determined on a Cecil spectrometer. The relevant British Standard demands that residues are < 0.5 mls for this container size after rinsing.

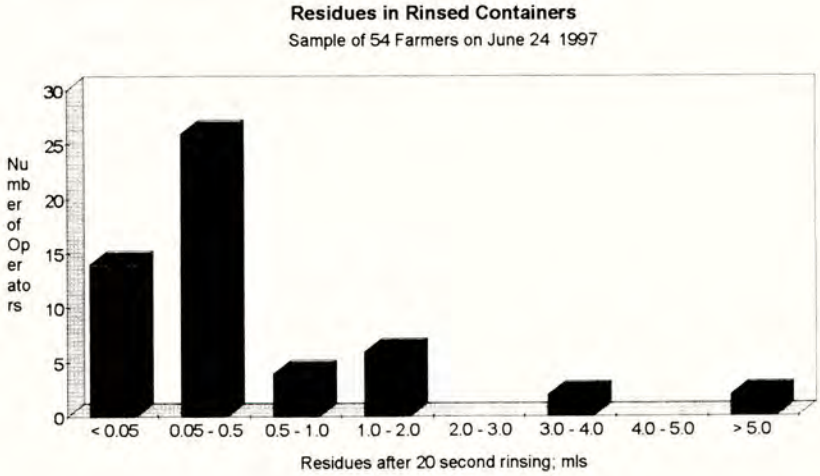
RESULTS

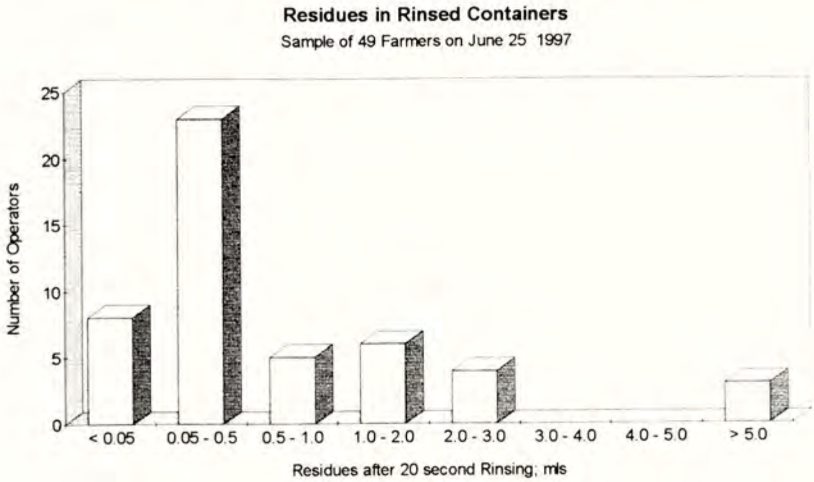
The interest and response from all sectors of the industry was overwhelming. In the two days, 103 participants tried their skills. Although, most were from England, many others came from Scotland, Ireland and Scandinavia. Operators with all types of sprayer size and levels of experience were included within this sample. The number of participants and the values generated between the two days did not show much change [Chart 1 and 2] and we feel inclined to be confident of the credibility of the data.

Despite the rigors of the test, some 69% rinsed the containers to a level that met the Standards needs [Chart 3]. Indeed 21% of the most skilled operators rinsed to a level that retained less than 0.05 mls. We believe that these operators were dedicated to sprayer use either on large farms or as contractors. A second [21%] less skilled group, had residues between 0.5 and 2 mls and these, we believe, were Farm Managers and others who were familiar with the techniques but not well or recently practiced. A further 6% had residues < 4 mls - a group likely to comprise advisors and others who have not previously used such systems. The final 5% held the container fixed in one position over the nozzle, to thereby leave the highest residues, typically of about 25 mls.

A prize, as an inducement to take part in this survey, was offered each day and would be donated to that person who was most effective at rinsing containers. It should be stressed that we assumed a clear winner would be easily identified; the conditions adopted for the survey were those, we believed, would push skill levels to the limit. In reality, the best, eleven operators achieved residues at the limits of detection for the instrument and were, later reassessed under even more demanding conditions. In this final "play-off", a 10 litre container was used and the exposure time over the nozzle was reduced to 10 - rather than 20 - seconds. Almost beyond belief, 36% of them met the relevant Standard - < 1.0 mls - with one, a New Zealander achieving a 0.01% residue level. The second best participant was a Pershore student and, tying in third place, two Scottish farmers.

Charts 1 and 2: Survey data from the two days





CONCLUSIONS

The skill levels of the better operators - who are likely to be using the bulk of the all products applied - exceeds that we had anticipated. Indeed, almost 70% met the Standards needs without much apparent effort. A further 20% knew the technique and, with a second effort, would have joined this leading group.
We have, therefore, concluded that:

containers can be rinsed with existing equipment and

the operators present skill levels will readily meet the Standards requirements.

ACKNOWLEDGEMENTS

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Chart 3: The combined data for both survey days.