

DIRECT INJECTION AS A RINSEWATER MINIMIZATION TECHNOLOGY

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Direct injection of pesticides into a spray system is a potential means of minimizing rinsewater. For the purpose of this paper, direct injection is defined as "Any scheme by which pesticide concentrates are metered, injected or introduced and mixed, by whatever means, into a sprayer pressure system directly from one or more shipping containers or other specialized containers and at a point in the system just before or near where the mixture would be discharged from the spray nozzles". A direct injection system (Figure 1) is essentially two systems -- a diluent system and a pesticide concentrate system, with the

tank (the one we now use to put spray mixtures into) used only for diluent. Ideally, nothing would be pre-mixed and whatever is introduced into the pressurized lines would be metered, measured, introduced, mixed and controlled by an on-board control unit. The control unit would monitor the ground speed, the flow from the diluent tank and from one or more concentrate tanks and would then actuate the appropriate control valves in response to the incoming signals or to any pre-set or prescribed values. The control unit could permit the introduction of pesticide concentrate either in response to ground travel or at a

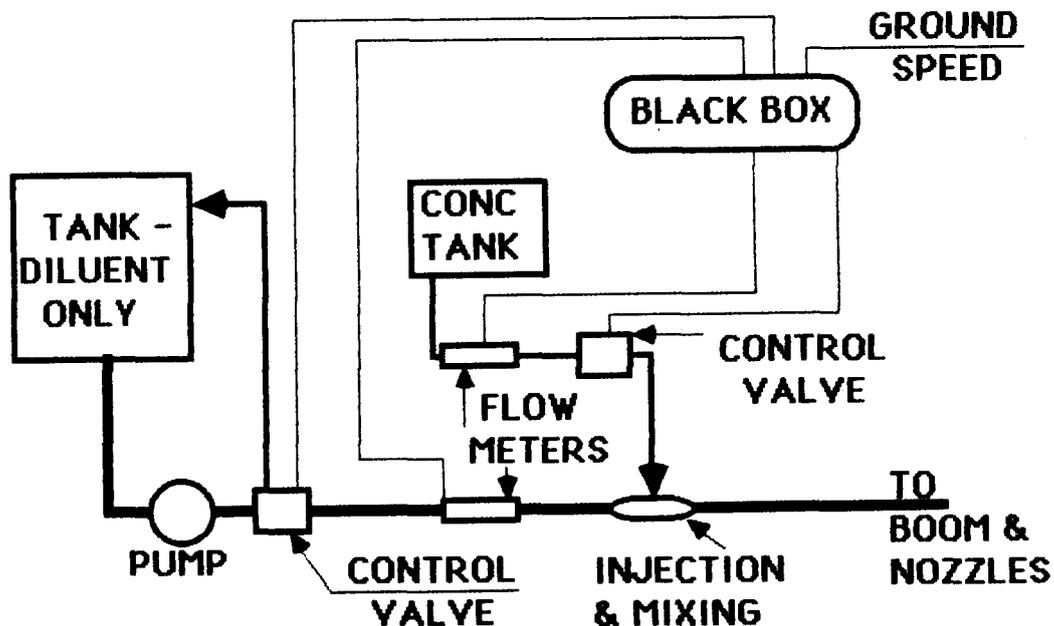


Figure 1. Schematic Diagram of Direct Injection System.

Universities and other research facilities have been employing evaporation, photodegradation and biodegradation in containment devices (often referred to as "pits") to treat pesticide wastewaters for over 15 years; however, this method is not widely utilized for several reasons. These include such unknowns as the potential for the treatment to further produce hazardous wastes, uncertainty of the science and the product results and lack of understanding of the treatment process on specific pesticides.

Leach fields are being used by many small fruit farms in New York. However, additional information is needed to fully assess the groundwater pollution potential posed by this system and it appears that the State of New York is re-evaluating the acceptability of this technology.

The remaining four technologies, found to be emerging technologies, will require three to five years of research and development before they can be expected to be available.

SUMMARY

There was a consensus of opinion that an immediate research effort was needed to:

1. Address those research needs identified for the currently available, proven technologies such that utilization of these methods can at least be maximized on an interim basis.
2. Conduct preliminary assessments of the effectiveness of the emerging technology opportunities and rank them for further development. Consider the combination of technologies as part of this effort.
3. In priority order, address the identified research needs for the emerging technology opportunities.

In addition, it was generally agreed that a combination of several technologies probably offers one of the best opportunities for overcoming some of the shortcomings of each individual method. Overriding issues that ultimately will determine the widescale acceptance of any disposal technology at the farm or commercial applicator level are effectiveness, cost, ease of operation, durability, safety, and mobility.

Reference:

Bridges, J. and Dempsey, C., "Proceedings: Research Workshop on the Treatment/Disposal of Pesticide Wastewater." U. S. Environmental Protection Agency, EPA 600/9-86-001, January 1986.

Proper tank sizing is not only important from the space and weight involved, but also the tank sizes need to be matched from a relative capacity standpoint so that both tanks will be empty at about the same time and one does not have to make two trips to fill one tank or the other. Provision must also be made for emptying and cleaning the concentrate tanks and system when it is necessary to use different materials, as well as disposing of the small amount of waste that may be generated in this process.

Since the metering device is the heart of a system, it must be selected to match the flow rates that it will be expected to handle and to provide the precision required. Means of adjusting the flow rate accurately and easily will need to be considered. If the pesticide concentrate metering rate is in response to ground travel, changes in ground travel speed will cause concentration transients that are a function of the system configuration and these will have to be carefully evaluated and minimized. The injection and mixing unit should be as close to the nozzles or discharge points as possible to minimize the amount of mixture in the supply lines and boom and minimize any undesirable concentration transient variations. However, this may result in relatively more of the concentrate material remaining in the concentrate supply lines. This may be satisfactory for single material systems, but must be considered if it is desired to have a system that will handle several different materials for long and reliable service.

The control system is where the newest technology will come into play, that is, microprocessor control technology. Microprocessors are currently used to monitor spray systems and perform specific application calculations. Thus, there is very little reason today that direct injection systems can not be monitored and controlled using such devices. In addition to monitoring and controlling, a microprocessor system could also be used to record pertinent operational information such as the type, amount and rate of pesticides used, weather data during application, dates and times of spray operations, field identification and location (including graphs showing salient features of the field and surrounding area) along with the application

history for the field, among other things. Periodically, then, the recorded data would be removed and transferred to a master computer for permanent storage and analysis and reference.

Some important decisions have to be made relative to the attachment, detachment and filling of the concentrate containers, as well as what to do with the small amount of liquid that may be trapped in the connecting supply lines. There may well need to be closer cooperation between the chemical manufacturers, the container suppliers and the equipment manufacturers to solve some of these problems.

Simple and accurate calibration procedures will be needed to assure that the pesticide and diluent are being applied at the correct rates. Monitoring systems and displays will be required to assure proper functioning of the system. With the development of more concentrated and more costly pesticides, small mistakes in the application can not be tolerated.

Potential users of direct injection technology include production agriculture (field crops and orchards), wide-area control, vector control, right-of-way, lawn and garden, pest control (residential and business), nurseries, greenhouses, animal pest control and forestry. Several of these application industries are already using equipment featuring concepts of direct injection and others are using undiluted materials directly without further dilution. Thus it should be obvious that one machine or one system will not be suitable for all application needs. Different chemicals and formulations with different physical properties and different application rates and different required methods of application, will require different systems.

The matter of retro-fitting needs to be mentioned since not all of the work going on will lead to entirely new pieces of equipment. There are a lot of sprayers currently being used that will not and can not be thrown away. Thus, there is a built-in market for retro-fit equipment. However, considerable ingenuity will be required in order to design workable retrofit systems for the host of different types of ground and aircraft sprayer systems now in use.

pre-determined constant flow rate. In any event, for such a system, when the flow of pesticide concentrate into the boom supply line would be stopped, shortly thereafter, only diluent would flow from the spray nozzles and there would be no left-over mixtures in a tank to dispose of at the end of a spraying operation.

Conceptually, this is a very simple idea and has several advantages to offer over conventional systems. The most obvious advantage would be to eliminate or significantly reduce the generation of un-used mixtures. Other significant benefits would be to reduce human exposure and the hazards associated with measuring, mixing and the transfer of mixed spray materials, as well as providing a quick, easy and thorough method of cleaning a sprayer immediately following each use -- something that is not now commonly and routinely done with existing equipment. This essentially automatic maintenance procedure would, by itself, almost certainly result in improved sprayer reliability. All of these contribute to direct economic benefits in terms of chemical saving and reduced application and waste disposal costs.

On the other hand, such systems would, of necessity, be more complicated, and consequently, if properly designed and thoroughly field tested, would be more expensive -- and likely by quite a bit. It is not clear that the market will stand an order of magnitude increase in the selling price -- even though the units demonstrate the desired and needed performance. More skill and training would be required to operate such equipment properly. Such systems may also tend to be product specific and some flexibility in use may be sacrificed, compared to the sprayers we now use that are supposed to handle all compounds that are put into them.

A few commercial direct injection systems similar to the one described already exist, though they may use different arrangements to accomplish the desired tasks. The basic notion of direct injection is not new, as work on such systems was done as long as 20 years ago by Nelson (1), Harrell (2) and Peck (3) and at a time when there was no great interest in or generally accepted need for such

devices. More recent work has been done by Vidrine (4), Kennedy (5), Larson (6), Reichard (7) and Ladd (8) some of whom used microprocessor technology in the control systems. Thus, there has been and is now a fair amount of research and development activity in this regard.

There are some important considerations and realities that must be dealt with in the design of a direct injection system. First, the nature of the pesticide must be considered, i.e., the formulation, whether a liquid concentrate, a flowable, a wettable powder or something else. At the present time, the known systems are being designed to handle only liquid formulations. The physical properties of viscosity and density must be known and especially how the viscosity may change with a change in temperature, if the metering is to be done accurately over the range of temperatures normally encountered in field operations. The concentration or strength of the product must also be known, as a value for this parameter will be needed to determine the metering rate of the pesticide concentrate into the system.

Early on in a design, the decision will need to be made whether the equipment will be product specific or will be designed to handle one or more pesticide formulations having different physical properties.

Although the same basic concept may be applicable to either ground-based equipment or equipment for aircraft, there are several aspects of aircraft systems that require special consideration. For example, larger flow and pumping rates are required as well as special fast acting control valves, because of the greater speed of travel. Weight, space and drag limitations, provision for shock and vibration mounting of components, among others, are factors that must be considered for aircraft systems.

Direct injection systems designed for use by private applicators, that is, farmers, may not satisfy the needs of commercial applicators, who may need to apply more than one compound at a time and who require equipment, because of a large amount of use, that features a high level of durability and reliability.

The development of direct injection equipment is complicated by one other factor. The equipment industry serving the pesticide manufacturing industry is composed of a number of relatively small companies, small compared to the major pesticide manufacturers. Most of these companies manufacture a limited variety of rather specific equipment for a limited market -- and certainly a depressed market at this time. Few, if any, of these equipment companies have large amounts of money to invest in research and development for new and innovative products and thus will likely not venture very far away, very quickly, from traditional designs now in the market place. Along with some new products from these companies, it is likely to expect a number of new small companies to appear with new designs and products that address this new need. Because there is a demonstrated need for a new generation of products and because there is a new technology, that is, the microprocessor technology, available to control and monitor these more complicated systems, an increasing number of new and innovative designs are almost certain to be developed and marketed. Further, the designs of the equipment now in common use have essentially "matured" -- that is, there is not much more that can be done with them, as such, to improve their performance, especially given a new set of constraints placed on the process of application. Hopefully, the new designs and equipment that do appear in the market place will be carefully and thoughtfully designed and thoroughly field tested.

Pesticides are becoming increasingly sophisticated -- and will likely be more concentrated and accordingly, more expensive. Thus, the pesticide application equipment of the future, direct injection or whatever, will also have to be more sophisticated to accurately meter and precisely apply these materials at the prescribed rates in a safe and efficacious manner.

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WASTE WATER RECYCLING

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ABSTRACT

The Louisiana Department of Agriculture began enforcement of pesticide waste disposal regulations on January 1, 1985. These regulations pertain to all commercial pesticide applicators. Basically, these regulations require that applicators have facilities to clean the equipment spray tank, spray system, mixing tanks and pesticide containers without contaminating the soil, ground water or other bodies of water.

After evaluation of various pesticide waste disposal techniques, 60% of Louisiana's 190 commercial aerial applicators elected to use waste water recycling to dispose of aircraft spray system wash water.

Waste water recycling involves collecting the aircraft wash water and storing the water in tanks for use as a dilution agent on future application jobs. Three to five tanks are normally used to store various pesticides thus preventing label violations and the possibility of crop damage. Thirty percent of the applicators rinsed the aircraft over the field being treated. Ten percent modified the aircraft or used other waste disposal techniques.

At the completion of the 1985 season, several aerial applicators were interviewed to determine the cost of constructing and operating the waste water recycling systems as well as suggested operating procedures and problems encountered during 1985.

Most aerial applicators used a 50' X 50' or 50' X 60' cement wash area and three to five 250 to 500 gallon waste water storage tanks. Most waste water recycling systems cost \$8,000 to \$12,000 to build with a range of \$3,000 to \$15,000. Very few problems were reported and there were no reported incidences of crop damage.

INTRODUCTION

During 1981 and 1982, discussions were held between Louisiana aerial applicators, members of the Louisiana Cooperative Extension Service (LCES) and the Louisiana Department of Agriculture. These discussions covered techniques required to comply with proposed Louisiana Department of Agriculture pesticide waste disposal regulations (1), (2), (3).

It was generally agreed that pesticide containers could be converted from

pesticide waste to solid waste via the well established triple rinsing process (4). Most of the pesticides commonly used in Louisiana require dilution with water prior to application. The water used to wash the containers could be easily used for dilution (4). Mixing and loading equipment could be easily washed and the wash water used for dilution. The triple rinsed containers could be sold for scrap or sent to an approved solid waste land fill for disposal. Based on EPA regu-