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Regulated Flow of Insecticides *

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The spray programmes of malaria eradication projects are plagued with many uncontrolled variables in the amount of insecticide deposited on the sprayed surface. Speed of coverage, pressure, and nozzle delivery rate all vary from day to day, hour to hour, and minute to minute. All the variables have received attention, particularly nozzle erosion, which increases the delivery and results in the overtreatment of the surface by as much as 50 %. For this reason, it is considered good economy in many programmes to throw away and replace all the used nozzle tips each month. Recent developments described in this paper, however, indicate that it may be possible to use nozzle tips for several months, in some cases for an entire season, and at the same time to obtain regulated discharge from the nozzle despite changes of pressure in the tank.

ADJUSTMENT OF PRESSURE REGULATORS

Some malaria eradication programmes have their sprayers equipped with mechanical pressure regulators. These have not been very popular because of their extra cost, their mechanical complexity, and the difficulty of setting and maintaining their discharge pressure at the desired level. A simple method of overcoming the latter objection has been developed by one of the authors (J.E.T.) and it will be found useful in eradication programmes that have sprayers equipped with mechanical pressure regulators in good operational condition.

In this method, no attention is given to the pressure delivered by the regulator or to the erosion of the nozzle tip. Instead, the regulator is considered a flow-regulating device and adjustments are made to obtain the correct discharge with whatever nozzle tip may be used.

Once each week each sprayman, under observation by his supervisor, fills his sprayer with clean water and pumps up pressure. He puts the nozzle tip in a container and discharges water into the container for one minute, timed by a watch with a second-hand. The total flow for the minute is measured. The liquid may be discharged directly into a graduated vessel calibrated in millilitres or into a can, after which the water is poured into the graduated vessel for measurement. The latter method is most useful when only one such vessel is available to a crew. Used blood-product and photographic-chemical bottles, with a millilitre scale marked on their sides, can be used as volume measuring devices. They can sometimes be found discarded by a hospital and free for the asking. Most programme operations are designed on the basis of a discharge rate of 0.2 US gallons or 756 ml per minute. If the discharge from the sprayer in one minute is more or less than approximately 760 ml, the screw on the mechanical regulator is adjusted until further trials show a discharge close to that figure. The sprayer is then used with that setting until the following week, when the regulator is again adjusted to compensate for additional erosion of the nozzle tip.

RUBBER-DISC REGULATORS

A second, and operationally more simple, regulated flow system is now commercially available and can be used by malaria eradication programmes. Lonergan & Hall described in 1959 the flow regulation obtainable by means of an orifice in a disc of pliable material.[3] Laboratory-manufactured models of this device, with a rubber disc, were given field trials in Nicaragua in 1959. These led to commercial

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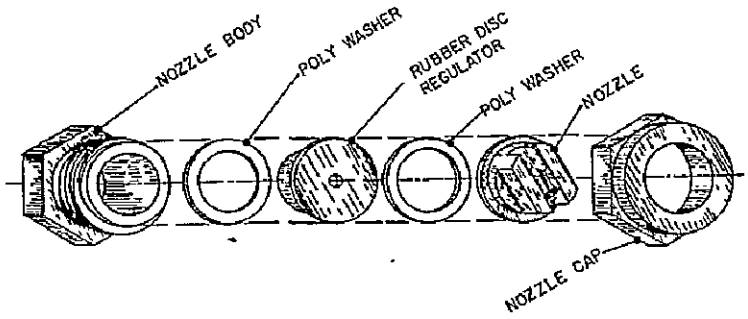
[3] Lonergan, R. P. & Hall, L. B. (1959) *Bull. Wld Hlth Org.*, 20, 955, 961.

FIG. 1

POLYETHYLENE WASHER, DISC, AND NOZZLE ASSEMBLY



production of models that were field tested in Guatemala in 1960.

Results of these field trials showed an erosion rate, for the nozzle tips used, of 6.5% per 1000 US gallons (3785 l) of insecticide as compared with rates as high as 50% for the No. 8002 [1] nozzle tips used without regulation. For the regulators tested, flow varied from 840 ml to 703 ml per minute. The maximum number of houses sprayed was 237 and the minimum 34 before the experimental discs had to be replaced owing to excessive change in delivery. After air-drying and return to the laboratory, all the discs had returned to within 3% of their original calibration.

The present International Cooperation Administration specification for the device is as follows:

"*Regulated delivery system*

"A regulated spray delivery system shall be supplied consisting of a stainless steel nozzle tip and a disc pressure regulator which shall be designed to be used together and to fit into the same nozzle body. The two components, when used together, shall provide delivery from the nozzle of 757 ml. ± 7 per cent per minute at all tank pressures between 65 and 20 p.s.i. Accuracy of delivery shall be maintained within the tolerance above, for not less than 30 days, under conditions of field use, or simulated use; e.g., eight hours per day in a nozzle housing during a total of three hours of which flow will take place at the rate of 27 seconds on and 3 seconds off, followed by 12 hours of air drying of the regulator out of the nozzle housing. Increase in delivery of the total system due to erosion of one or more of the components shall not exceed 7 per cent after the spraying of 1000 gallons of 75 per cent water wettable DDT made up as a 5 per cent suspension in water. One spare disc pressure regulator shall be furnished with each sprayer for a total of one nozzle tip and two disc pressure regulators."

[1] Nozzle tips 8002, 8004 and 8006 are manufactured by the Spraying Systems Company, Bellwood, Ill., USA. Use of trade names is for identification purposes only, and does not constitute endorsement by the Public Health Service.

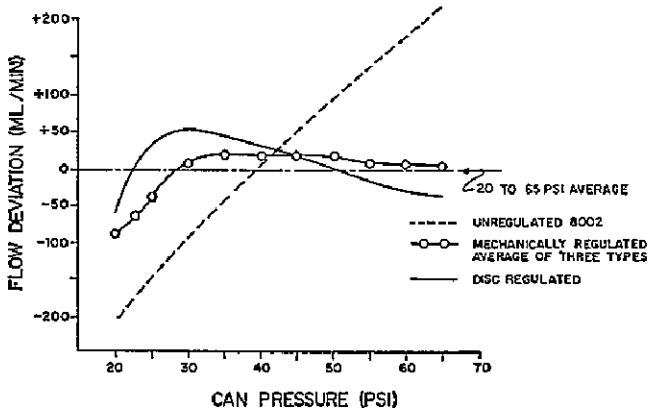
The device, as it is being manufactured at present, is shown in Fig. 1 with the associated parts. The rubber disc regulator is contained in a small brass housing which fits back-to-back with an 8004 nozzle tip. The entire assembly fits into the nozzle housing and adds only 5 g to the weight at the end of the wand. The regulator works with an 8004 tip to deliver 757 ml ± 7% at all tank pressures from 20 to 65 p.s.i. (1.41-4.57 atm.). The device will not regulate delivery with an 8002 nozzle tip. The 8004 nozzle tip, however, can erode to an increased capacity of 50% (i.e., 8006), but actual delivery with a disc regulator will remain within the tolerance given above. Previously, the nozzle orifice performed the dual function of restricting flow and shaping the spray. In the present system, the nozzle orifice primarily shapes the spray and the disc regulates the volume of flow.

Fig. 2 shows the delivery at various tank pressures with unregulated, mechanically regulated, and disc-regulated flow. Unregulated flow results in the output of too much insecticide at high tank pressures and not enough at low pressures. Mechanical regulators do not give absolutely level regulation and are difficult to maintain. The disc regulators, while not the complete answer to all problems, give reasonably good regulation of insecticide delivery, require minimum maintenance, and greatly reduce the problem of orifice erosion.

Laboratory and field data show evidence that nozzle erosion with this system is reduced to at least one-sixth that of erosion of the 8002 tip with unregulated pressure. The nozzle tip erodes at a reduced rate and the orifice in the disc erodes very slightly. If there is any change in the rate of delivery through the regulator, it will probably be due to a slight softening and a "set" in the rubber in the closed configuration of the orifice.

FIG. 2

SPRAYER DISCHARGE RATES WITH UNREGULATED, MECHANICALLY REGULATED, AND DISC-REGULATED FLOW



The change in the delivery from the regulator can be kept to a minimum by removing the disc from the nozzle housing each night and allowing it to air-dry. At least once each week the delivery should be calibrated by the method previously described for use with mechanical pressure regulators. If delivery per minute is less than 700 ml or more than 800 ml (roughly 757 $\pm$ 7%), the disc regulator should be replaced and the used regulator should be allowed to dry further. If necessary, each crew can be equipped with two or three regulators for each nozzle tip. If the regulators are rotated in such a manner that each regulator will be used for one week followed by one or two weeks of "rest", their calibration will remain essentially unchanged over extended periods of use. Drying over a fire or in an oven should not be attempted, for such high temperatures may destroy the disc entirely.

The pressure regulator disc system, working at a low nozzle pressure as it does, is economical in its power requirement. One pumping of the tank to about 65 p.s.i. will discharge the entire filling of insecticide without a second repumping. Each crewman can quickly learn for himself the number of strokes of his pump required to reach this point and pressure gauges become unnecessary.

Although this system regulates the application of insecticide effectively, spraying crews will find it a change and will have to adapt to it. It does not "feel right" to them, it does not make enough noise, and the distance from the nozzle to the wall must be increased from 18 inches (45 cm) to 21 inches (53 cm). Larger droplets are produced by the low-pressure spray. This may result in a more noticeable deposit on the walls, objectionable to some householders. Since spraymen commonly base the accuracy of their operations upon habit, drastic changes in mid-cycle can cause difficulties. It is therefore recommended that the new system be inaugurated at the beginning of a spray cycle, when all spraymen can be retrained. With proper training of spraymen and proper use of regulated flow of the insecticide, considerable economies can be achieved in terms of insecticide and nozzle tips, while a more even spray is applied.

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RÉSUMÉ

L'usure des buses des pulvérisateurs à main provoque une augmentation du débit auquel il est possible de remédier en réglant l'alimentation en insecticide. Deux procédés différents sont décrits par les auteurs. Le premier consiste à utiliser le système régulateur de pression existant sur certains pulvérisateurs, non comme contrôle de la pression mais comme appareil de réglage du débit. En effet il peut être ajusté, sans tenir compte de la pression; de manière à obtenir un débit correct avec des buses qui, dans d'autres conditions, projetteraient des quantités exagérées d'insecticide. Le débit ainsi réglé peut être vérifié par des moyens fort simples.

L'autre procédé décrit est aussi facile à utiliser. Il s'agit d'un disque de caoutchouc régulateur de débit actuellement disponible sur le marché. L'appareil est constitué d'une garniture en cuivre contenant le disque de caoutchouc régulateur; on l'introduit dans le corps de la buse juste derrière la pointe. Des essais sur le terrain ont montré que ce disque permet un contrôle satisfaisant du débit tout en diminuant de 5/6es l'usure des buses. Avec quelques précautions simples la durée d'utilisation de ces régulateurs est prolongée et une régularité satisfaisante de leur débit assurée.

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