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Rotary Nozzle Development and Testing

Plate 3 tooth

Plate 4 Waterwheel Mk.6 with cylindrically channelled disc spraying water.
Fig. 5.20  (a) Variation of droplet size with flow rate on a single spinning disc (after N. Dombrowski and Lloyd 1974). (b) Single droplet, ligament and sheet formation from a spinning disc: (1) Herbi disc 2,000 rpm, 60 ml/min; (2) 2,500 rpm 100 ml/min; (3) 1,000 rpm 800 ml/min. (photos Micron Sprayers Ltd.)
Stacked discs have fine ‘v’ grooves which are prone to blockage

A row of teeth is only possible about every 5mm (with each cupped disc)

Rather than a groove leading to a tooth arrangement, the SP nozzle has individual pins every ~1mm .... so ~5x flowrate should be available
IN 2003, I PATENTED A NEW “SPINNING PINS” NOZZLE FOR AERIAL APPLICATION OF PESTICIDES, (WHICH I HOPE WILL HELP WORLD FOOD SECURITY).

so you see - I’m not actually all that green!

Craig, I. 2003. THE SPINNING PINS (SP) Nozzle; A New Controlled Droplet Applicator for Aircraft. IP Australia Application Number AU200163597B2 Patent Number 779967. Published 2003.02.27

Schematic diagram (based on stroboscopic light observation) of near-monosized droplet formation, via controlled fluid ligament breakup
Rotary atomiser design requirements for optimum pesticide application efficiency

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ARTICLE INFO

Pesticide application efficiency from aircraft could be increased substantially, and required downwind buffer distances to avoid drift damage reduced significantly, if sharp issuing points or pins were added to existing rotary cage atomizer designs. This would enable existing rotary cage units, already successfully deployed for Ultra Low Volume (ULV) applications of insecticides, to be also used for Large Droplet Placement (LDP) application of herbicides. Studies at Cranfield University using high speed photography and laser droplet sizing instrumentation demonstrated that the addition of fine pins to the final atomizing surface of the rotating cage would increase uniformity of droplet production, by promoting fluid atomization in the ligament mode. This would lead to a substantially increased percentage of droplets in the spray falling between 100 μm and 300 μm in size, suggested here as a biological/environmental droplet size optimum. Development of a 'spinning pins' rotary atomizer for aircraft would therefore be highly desirable for agricultural and other purposes. Investment in this technology has the potential to significantly reduce pollution of atmosphere, soil, fresh water and oceans with pesticides.

ABSTRACT

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About 3 million tonnes pesticides (ai) produced globally every year

~ application efficiency (AE) is thought to be substantially less than 1%

<table>
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<tr>
<th>AE</th>
<th>&lt;0.1%</th>
<th>1% ?</th>
<th>&lt;0.1%</th>
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<tbody>
<tr>
<td>(droplet #/cm²)</td>
<td>(1000s)</td>
<td>(100s)</td>
<td>(10s)</td>
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![Diagram showing droplet size distribution](image)

- **This fraction useful, but also causes spray drift damage**
- **This fraction constitutes the most useful size, biologically**
- **Most of the droplets here too large to be efficacious**
- **Much of the spray volume completely wasted here**
BCPC Droplet Size Distributions

Cumulative Volume Fraction

Droplet Diameter (µm)

- BCPC Fine
- BCPC Medium
- BCPC Coarse
- BCPC Very Coarse

Dr Steve Parkin

200µm
Droplet size distribution (triangles) from a spinning disc with sharp teeth, recorded using a PMS OAP-260 probe. For comparison, computer generated spectra with VMD 200µm have been added. The solid line represents a 200µm VMD spray with log span 0.1, typical for spinning discs. The dashed line represents a 200 µm VMD spray with log span 0.25, typical for hydraulic nozzles, and rotary cage atomisers such as the Micronair AU5000.

BCPC ‘medium’ spray (ie. VMD 200µm) ~ has 10% ‘driftables’ (ie. vol < 100µm)

the aim with sharp pins is reduce this to zero
Best Management Practice (BMP) for the Australian Cotton Industry

- getting pilots to understand the effect of the Australian summer Dusk Surface Temperature Inversion (DUSTI), so they that they avoid spraying at dusk!


downwind deposition can be up to 20 times greater in highly stable conditions