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New Developments in Rotary Atomiser Technology to Improve Drift Control - Results from Wind Tunnel Tests and Field Studies

John S Clayton

Timothy P Y Sander

Micron Sprayers Ltd, Bromyard, Herefordshire, England.

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Abstract. *This presentation will discuss several factors influencing drift from aircraft, notably drop size, uniformity and, most importantly, aircraft speed. Data will be presented on the impact of airspeed on drop size and problems of drop shatter with larger drops. Reducing airspeed greatly improves drift control with all nozzle types. The influence of tank mixes on surface tension and impact on drift will be discusses. A model has been developed to predict drop shatter against size, airspeed and physical characteristics from different tank mixes for rotary atomisers and their impact on drop size in the wind tunnel. The presentation will then describe the development of the AU5000 LD rotary atomiser, present wind tunnel data and spray patterns as well as this years results from field tests in cotton, bananas, cereals and potatoes from Australia, Africa and Central America.*

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Keywords. Rotary Atomisers, Drift Control, Aerial Application, Controlled Droplet Application (CDA)

Introduction

The Micronair AU5000LD has been developed in response to the needs of aerial operators to increase the range of droplet sizes they can select to allow for use of larger droplets typically up to 200um-250um VMD (volume median diameter) particularly with faster turbine aircraft where the label or regulatory authority requires minimal spray drift. For this purpose a new atomiser assembly has been developed to be inter-changeable with the standard Micronair AU5000 gauze assembly (Figure 1) The new atomiser assembly uses a stack of 65mm diameter serrated discs. The smaller diameter reduces tangential velocity on the spray liquid as the atomiser rotates creating larger droplets and the groove and teeth serrations channel the liquid and assist in more regular droplet formation. At low rotational speeds and low aircraft airspeeds droplet sizes as large as 400 – 500um can be produced for placement spray applications e.g. applying herbicides from helicopters.

Figure 1. Micronair AU5000LD with interchangeable atomiser assembly

Influence of Aircraft Airspeed and Tank Mix on Droplet Formation

Droplet formation from aircraft is not solely dependent on the atomiser as aircraft speed and the physical properties of the tank mix also influence the atomisation process. Irrespective of atomiser type aircraft speed is one of the most influential parameters in determining potential spray drift, particularly at aircraft speeds in excess of 110mph. At high aircraft airspeeds the production of small droplets increases due mainly to air shear but also droplet shatter, particularly with larger droplets over 250um in size. With conventional flat fan, hollow cone or deflector nozzles the spray is formed by the disintegration of a liquid sheet. As aircraft speed increases high air flows rupture the sheet prematurely and cause disintegration into smaller droplets. With rotary atomisers this effect is not so apparent as drops are formed as ligaments rather than a sheet and less influenced by airflow as ligaments are essentially porous. However there is a further influence of air speed during the atomisation process which is most pronounced on larger droplets over 250um in size. This is the process of droplet shatter that occurs after drops have first formed. When spray droplets are released into high airflows the droplet surface will deform causing the drop to ‘balloon’ and rupture into many smaller droplets (Figure 2, after Lane 1951). The point at which this occurs is strongly influenced by drop size, air velocity and dynamic surface tension of the

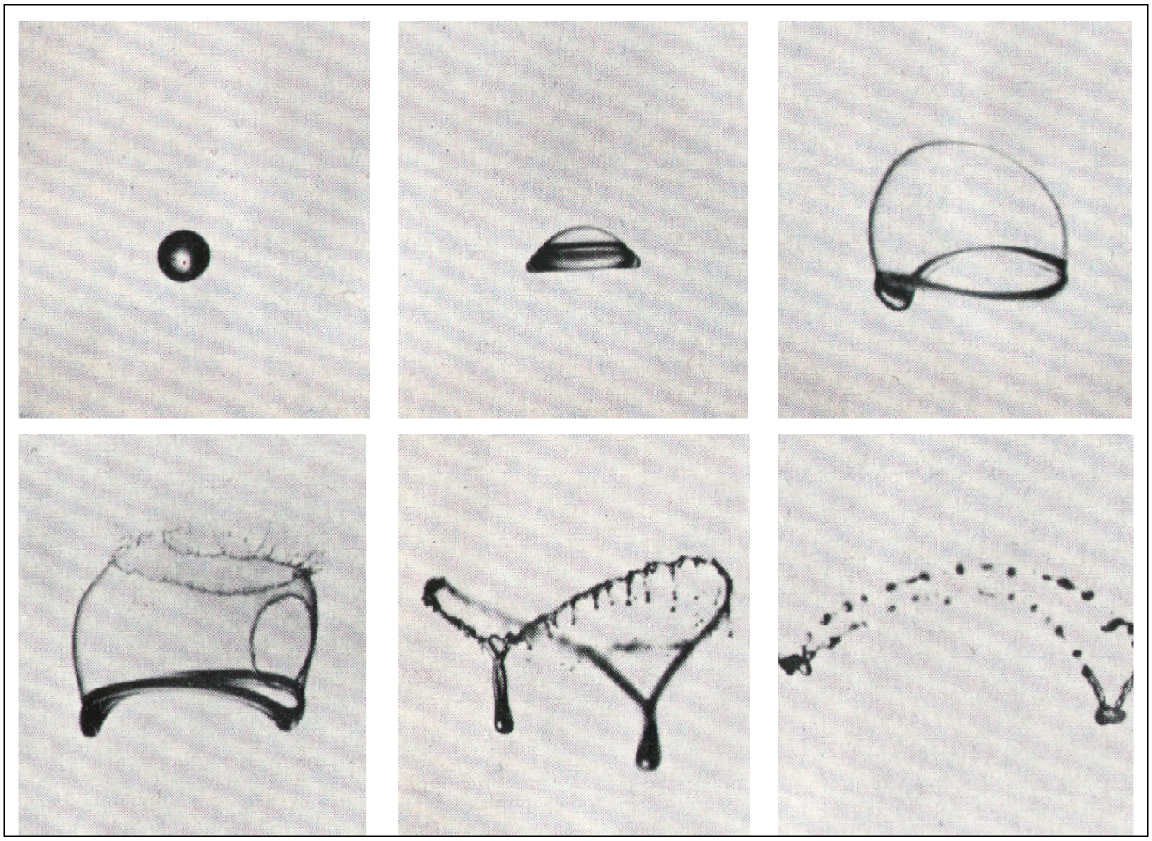


Figure 1. Shatter process of a single water droplet released into high velocity air stream

Studies by the Spray Drift task Force (SDTF, 1998) illustrated the effects of increasing airspeed and also reducing surface tension of the spray mix from drift studies with conventional flat fan nozzles showing that as airspeed increases from 100mph to 150mph spray drift can increase exponentially. The impact of dynamic surface tension also plays an important role as lower surface tension reduces droplet size (Hewitt, 1998). A model developed by Silsoe Research Institute in the UK predicts the influence of air speed and surface tension on droplet shatter (figure 3, after Parkin, 2001).

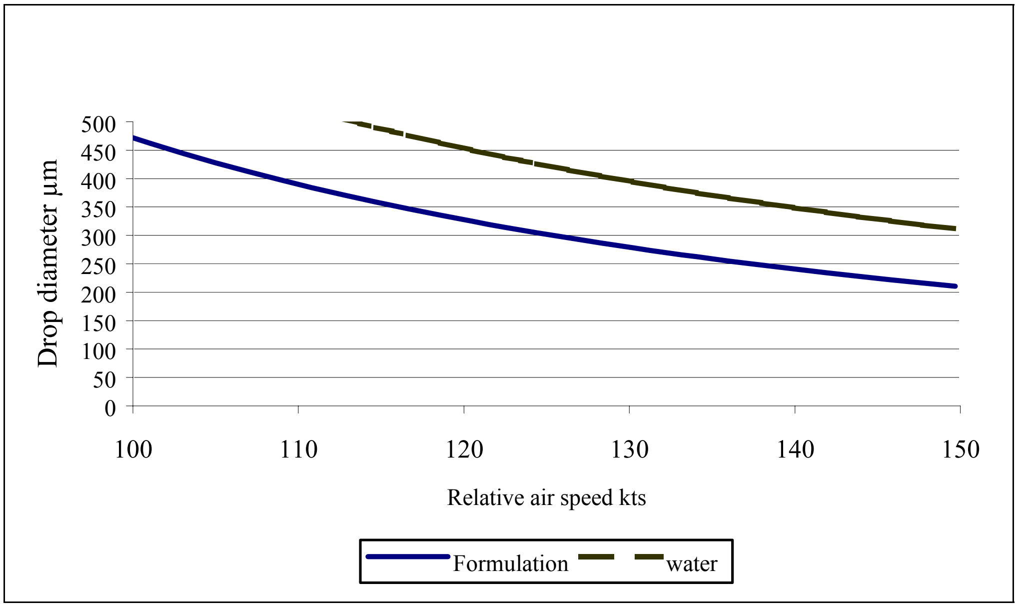
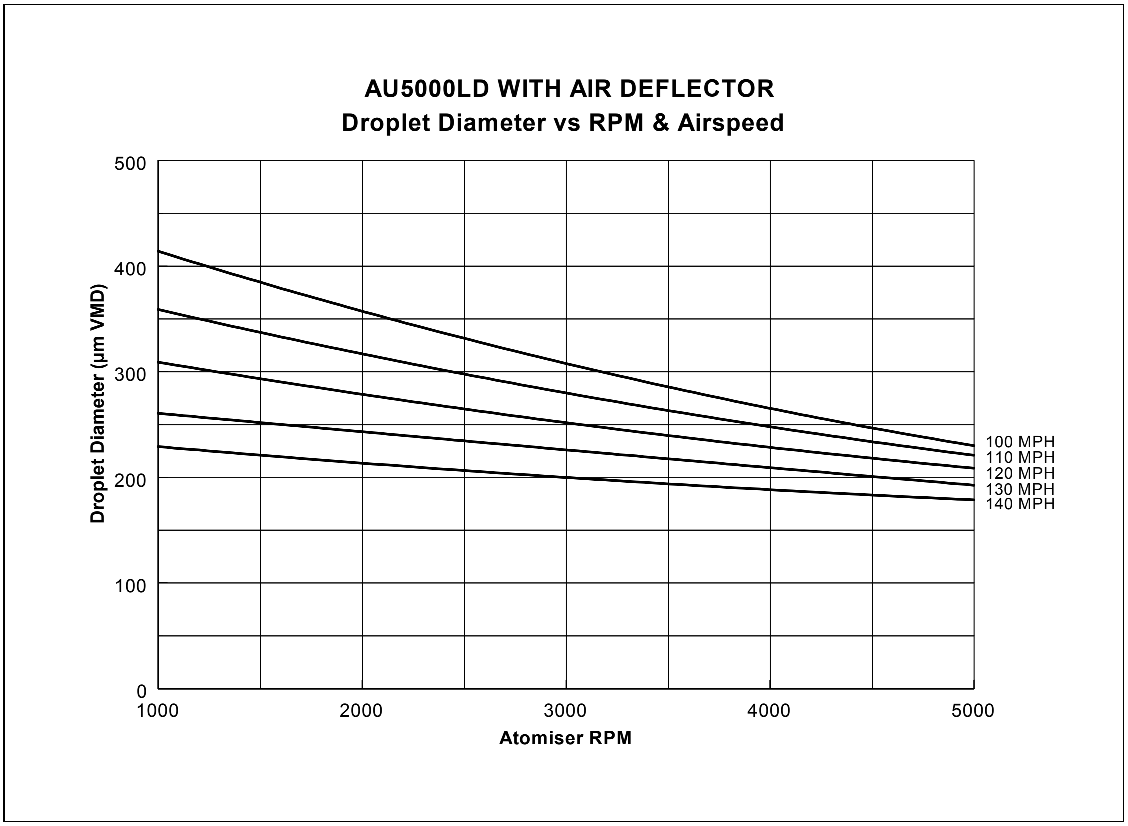


Figure 1. Maximum drop Size surviving in an airflow

The model demonstrates that particle size analysis from aircraft spray nozzles must always be made in a wind tunnel and using a spray mix with typical liquid properties of a tank mix. Testing with water only is inappropriate and misleading for measurements of spray atomisation, particularly from aircraft.

Rotary atomiser design

In an attempt to reduce the impact of droplet shatter with the new Micronair AU5000LD atomiser assembly an air deflector has been incorporated to shield droplet from the airflow. This previously existed on the standard AU5000 gauze assembly but to create larger droplets particularly for turbine aircraft this has been extended using a series of slots in the air deflector to reduce drag and create a velocity gradient to accelerate droplets into. Particle size measurements in a wind tunnel with water and an anionic surfactant (Agral 90^{TM}) spray mix at 10l/minute flow gave volume median diameters (VMD) of 320 um at 100mph reducing to 220um at 140mph with an atomiser rotational speed of 2000rpm. As rotational speed of the atomiser increases to 5000rpm then the air speed of the aircraft has less effect as drops are smaller and therefore less prone to shatter.



Discussion and Conclusions

The Micronair AU500LD has largely been developed in response to the needs of aerial operators in Australia applying endosulphan to cotton crops. Contamination of grazing lands and the potential bio-accumulation of endosulphan in beef cattle forced the industry to adopt higher volume applications (typically 30l/ha using larger drop sizes around 250um VMD to reduce drift (the so called LDP – large droplet placement technique). The technique has reduced drift in comparison to ULV applications using droplet sizes around 80 - 100um VMD but insect pest control has not been always as efficacious as ULV application with smaller droplets. With larger spray droplets there is also a risk of striping as nozzle configurations may have to be spaced differently and invariably effective swath width is reduced. With many products requiring the use of spray buffer zones to reduce the impact of aerial spray applications the ability to spray with narrower buffer zones using larger droplets is advantageous but a balance has to be struck to maintain adequate biological efficacy.

In forestry applications using either *bacillus thuringiensis* (Bt), insect growth regulators (IGR's) or contact acting insecticides smaller droplets formulated in an oil carrier and applied at rates as low as 1 litre /ha in drop size ranges of 15 – 55um have been shown to be the most efficacious as only a few droplets larger than 60um are to be found on the foliage of pine trees where the products need to be applied. (Picot and Kristmanson 1997, Himel and Moore, 1969, Joyce and Beaumont, 1978). Such application techniques satisfy the customer's need for efficient pest control, the needs of the operator for high work rates favouring use of very low spray volumes and wide swath widths. Drift management as viewed by regulators has often, unfortunately, simply been an issue of increasing drop size that can be contrary to effective efficacy. Often a balance has to be struck depending on the potential environmental impact of spray drift into non target areas and in some instances it may be desirable to use larger droplet size ranges but at lowest possible spray volumes. Frankenhuyzen *et al* (1996) found that increasing drop size from 80 to 160um VMD applying Bt with Micronair AU4000 atomisers although reducing numbers of drops deposited did not significantly reduce dose deposited and efficacy was not impaired. Similarly this year in New Zealand applications of Bt in residential areas to control lepidopterous pests in narrow stands of trees required the use of helicopters to apply spray in larger drops around 100-150um to reduce off target drift into residential areas. The Micronair AU5000LD therefore extends the options available to aerial operators in their selection of droplet size. The Micronair AU5000LD is currently on trial in cotton and rice on both helicopters and fixed wing aircraft in Australia, in cereal and cotton crops in east Africa and bananas in northern Australia and the Philippines. Initial results have been encouraging demonstrating reduced drift with larger droplets. Some minor problems have been found with viscous products such as wettable powders, trace elements and some flowable fungicide formulations used in bananas which can sediment out in the atomiser discs and feed holes. Modifications to the atomiser are being investigated to reduce these problems.

Due to the faster flying speeds of turbine aircraft compared with piston engine aircraft the production of smaller droplets and hence drift will increase with airspeed irrespective of atomiser type.

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