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Operational Paper

Testing greenhouse shade nets in collection of fog for water supply

E. S. Shanyengana, R. D. Sanderson, M. K. Seely and R. S. Schemenauer

ABSTRACT

Fog is an important source of water for some inhabitants of arid regions where other sources of freshwater are scarce. Fog collection was carried out with polymeric greenhouse shade nets in order to investigate the feasibility of using similar shade cloths in fog water supply schemes in areas where the Raschel mesh that is used in standard fog collectors (SFC) is not available. The fog collectors were made from outdoor and indoor aluminet greenhouse shade nets of varying percent shade coefficient. The indoor weave is similar to that found in the Raschel mesh that is used in SFCs and proved to be more suitable for fog collection than the outdoor one. Fog collection with collectors made from the indoor weave mesh of varying percent shade coefficient indicates that the 40% shade coefficient is more appropriate for fog collection than the 60% and 90% mesh. The aluminet collectors appear to combine both fog and dew collection. The latter would make a 35% shade coefficient aluminet ('metal'-coated) collector more efficient than the plain polypropylene mesh that is used in fog collectors, particularly in low elevation areas where fog deposition is lower and therefore, the contribution of dew to the total collected volume is a significant one. The results of this study will enable prospective users of fog water to select the right weave and percent shade coefficient of a given mesh that is to be used for fog collection in areas where the Raschel mesh is not available.

Key words | drinking water, fog collection, greenhouse shade net, standard fog collector (SFC)

E. S Shanyengana (corresponding author)
R. D Sanderson
UNESCO Associated Centre for Macromolecules and Materials,
University of Stellenbosch,
South Africa
E-mail: *eshanyengana@hotmail.com*

M. K. Seely
Desert Research Foundation of Namibia (DRFN),
P.O. Box 20232,
Windhoek,
Namibia
Website: *http://www.drfn.org.na*

R. S. Schemenauer
Atmospheric Environment Canada,
Toronto,
Canada

INTRODUCTION

Fog is a key source of water for some people in arid regions (Schemenauer & Cereceda, 1994*a*). Fog water in these areas is of good drinking quality and is mainly collected with collectors that are made from a special weave and percent shade coefficient polypropylene mesh (see detailed description in Background section; Schemenauer & Cereceda, 1994*b*).

This particular fog collector material is not always available in some parts of the world and, as a result, it often limits implementation of fog collection in these areas (MacQuarrie *et al.*, 2001; Olivier, 2001). Other types of mesh, such as greenhouse shade nets, with weave and percent shade coefficient properties close to those found in the standard fog collector (SFC) Raschel mesh are often found in some of these areas.

This paper discusses results of fog collection with the aluminet shade net. Experiments were conducted with fog collectors made from the two weaves and various percent shade coefficients of the aluminet mesh that are available in Namibia and South Africa in order to determine the most appropriate one for use in fog collectors. All of the experiments were conducted alongside a Raschel mesh in order to determine the relationship of the aluminet collectors to this mesh.

BACKGROUND

Fog collection for drinking water purposes continues to receive increasing attention, particularly in arid regions where the availability of freshwater is limited (Shanyengana *et al.*, 2002). A well-known case of fog collection is a Chilean village, Chungungo, where fog water has been collected to meet the water demand of its 300 plus residents since 1992 (Schemenauer & Cereceda, 1994*a*). Fog collection has subsequently been implemented throughout the world with one of the most recent examples being in a small community, Lepelfontein, in South Africa (Rautenbach & Olivier, 2001).

Fog water collection schemes generally consist of a series of 48 m^2 collectors. The collector is made from a double layer of 35% shade coefficient polypropylene mesh that covers approximately 60% of the surface area of the collector (Schemenauer & Cereceda, 1994*b*). These collectors register an average fog collection of about 3 l/m^2/wet day at the above-mentioned Chilean site, 9 l/m^2/wet day in Peru, 30 l/m^2/wet day at sites in Oman, 3 l/m^2/wet day in Namibia, and about 7 l/m^2/wet day in South Africa (Schemenauer & Cereceda, 1994*a*; Henschel *et al.*, 1998; Rautenbach & Olivier, 2001).

The potential of a site for a fog water supply scheme is determined with a SFC (Schemenauer & Cereceda, 1994*b*). The 1-m^2 collector is made from the same material that is utilized in the larger collectors, and is used to provide preliminary data on the quantity of fog water that can be collected by a fog water supply scheme. The use of a SFC also allows for comparison with other areas, throughout the world, where fog collection is being investigated.

METHODS

Fog collectors were made from Raschel mesh and from aluminet shade nets which are both available in similar sizes and are of comparable cost per square metre.

Aluminet shade net is made of high-density polyethylene (HDPE) strands (Polysack, 2001). The strands are coated with aluminium in order to increase their reflectivity and, thus, ability to keep greenhouses cool during the day. The mesh is available in two weaves, namely: aluminet O (outdoors) and I (indoors), and at percent shade coefficients of 30, 40, 50, 60, 70, 80 and 90% (Polysack, 2001). Samples of some of these nets are presented in Figure 1.

Fog collection was carried out with collectors made from outdoor and indoor aluminet mesh with 40% shade coefficient. The effect of varying the percent shade coefficient was investigated with double layers of the 40, 60 and 90% indoor mesh. The collector with the highest yield was then operated alongside a Raschel mesh for a period of about 4 months in order to determine its relation to the latter.

The use of a Raschel mesh alongside all the experiments enables comparison of the different collectors even when data were obtained during different fog events and varying climatic conditions. In the latter, a yield ratio (i.e. yield of aluminet collector to yield of Raschel mesh collector) is used. Most of the experiments were conducted through an entire fog event (one fog day), however sometimes they were only operated for as long as was required to obtain a measurable yield. This experiment design made it possible to collect more data points as was required to enable comparison of the collectors.

RESULTS AND DISCUSSION

The results of fog collection by the different weaves indicate that the indoor weave collects more fog water than the outdoor one (Figure 2). The indoor weave is in the shape of an isosceles triangle and resembles the weave found in the Raschel mesh, while the outdoor weave has a shape of an equilateral triangle (Figures 1 and 3).

The strands in a mesh with an isosceles triangle weave are more closely packed (i.e. the triangle is narrower) and near vertical. The indoor strand arrangement has a near vertical vector of the flow of collected droplets that enhances coalescence of the droplets and a more voluminous runoff on the strand in this weave than in the outdoor one.

Runoff on the strands of the outdoor weave has a more horizontally-oriented flow vector and therefore the runoff

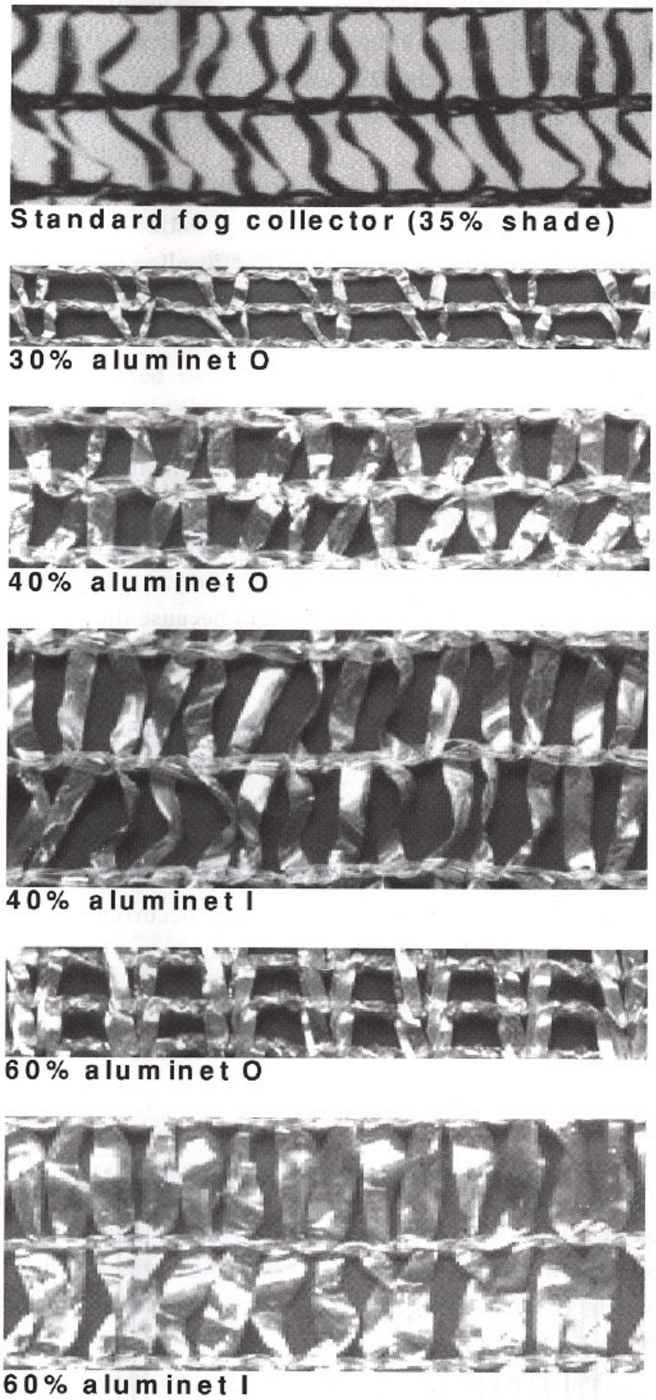

Figure 1 | Single layers of various meshes (c. 2.5×2 m), showing the weave and percent shade coefficient.

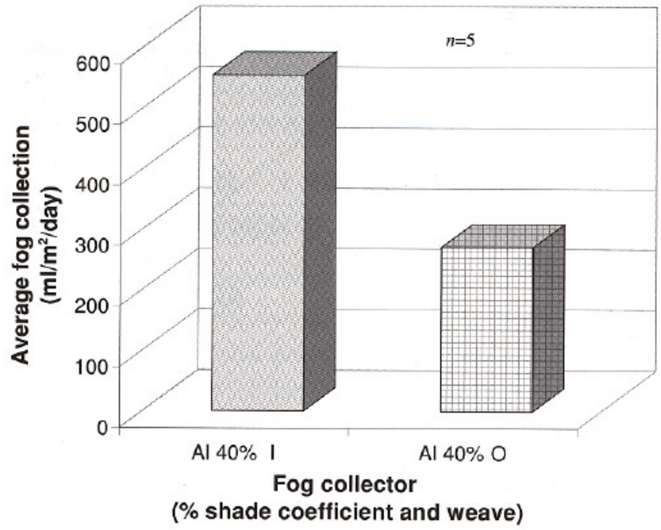

Figure 2 | Average fog collection in aluminet 40% collectors of indoor (I) and outdoor (O) weave.

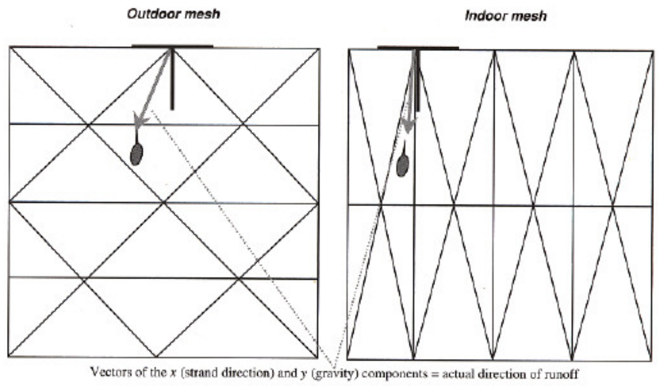

Figure 3 | A schematic view of the weave in the outdoor and indoor aluminet mesh of equal percent shade coefficient.

is slower and more droplet-wise than in the indoor weave. As a result, a collected droplet on a strand in the outdoor weave mesh is more susceptible to dropping off the strand or to being blown away in the wind that accompanies fog deposition. The latter accounts for the relation that is observed in Figure 2.

Fog collection in collectors made with the indoor weave mesh of varying percent shade coefficient was highest in the 40% collector and decreased with increasing percent shade coefficient (Figure 4). This pattern can be attributed to an increase in the shielding-effect of the mesh

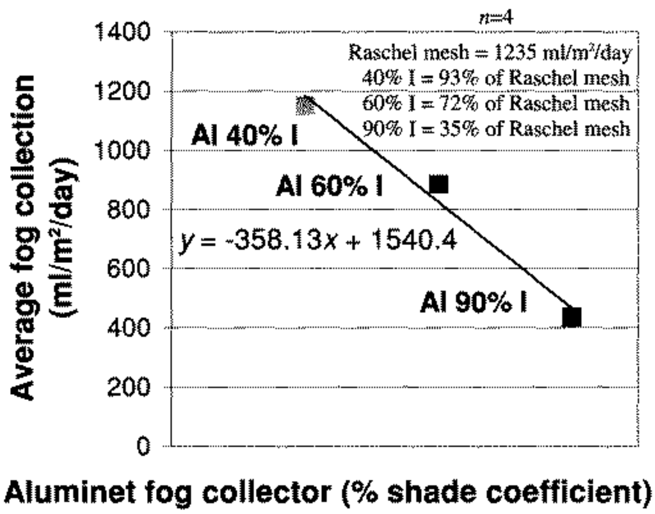

Figure 4 | Average fog collection in indoor aluminet collectors of varying percent shade coefficient.

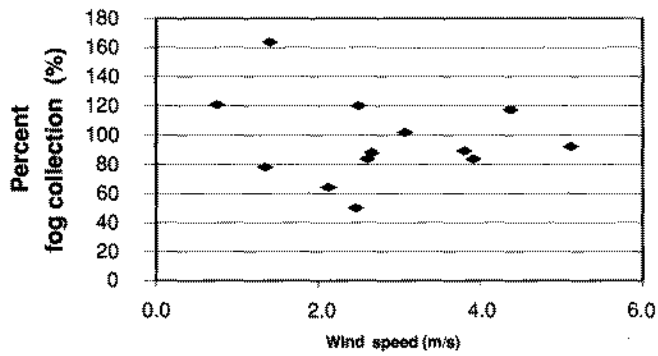

Figure 6 | Fog collection in the indoor aluminet 40% collector expressed as a percent of fog collection in a Raschel mesh of equal surface during different speeds of fog deposition.

that results from the increase in percent shade coefficient of the collector. The degree to which incoming fog is diverted depends on the shielding effect of the mesh, that is, the higher the percent shade coefficient the higher the diversion and, as a result, the collector yields a smaller volume. This indicates that it is necessary that some through-flow be permitted, so that the collector does not act as a shield, which would then force most of the incoming fog to divert and flow sideways. It should, however, be noted that earlier work on the Raschel mesh indicates that 35% is the optimal shade coefficient for fog collection, and also that the linearity of the relationship presented in the graph only serves to show the relationship between these three points and would not suffice to accurately predict fog collection at a higher or much lower percent shade coefficient because that would require more than three data points to be statistically acceptable.

The 40% indoor collector had the best results among the aluminet collectors, and yielded on average 96% (range = 50–164%) of the fog collection of a Raschel mesh (Figure 5). Cases where fog collection in the aluminet collector approached the 96% average, or where it was higher than that in the Raschel mesh, occurred mainly during periods when fog deposition took place at low wind speed (Figure 6).

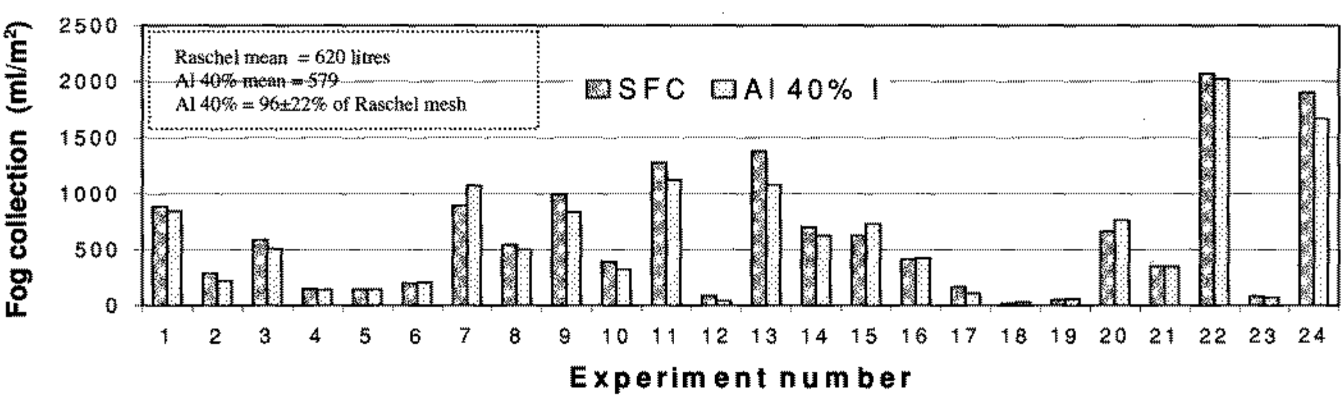

Figure 5 | Fog collection (daily and hourly) in the Raschel mesh and aluminet 40% I collectors.

The increased yield in the aluminet collector could be attributed to the collection of dew that would be higher on the relatively cooler aluminium coated fibres than on the polypropylene ones of the Raschel mesh. The data set is, however, too small to substantiate this opinion and therefore, more experiments would be necessary to confirm this relationship.

The contribution of dew to the total yield is minimal and thus rather insignificant during high wind speeds when fog collection is high, however, it becomes significant during periods when fog collection is low, as happens during low wind speeds. This factor makes aluminium/metal-coated netting attractive for construction of fog collection systems in low elevation areas where fog deposition generally occurs at low wind speed.

Use of a 35% percent shade coefficient aluminet mesh, i.e. one similar to the well-tested Raschel mesh (e.g. Schemenauer & Cereceda, 1994*b*) could possibly yield better results than the 40% one that is used in this study.

This study only serves to point out the feasibility of using other material for fog collectors and also to aid prospective users of fog water with the selection of netting. The actual implementation of fog collection with aluminet nets or other material should always include analysis of the quality of the collected water to ensure that the collector does not impart any chemicals that would pose a threat to the health of the users. It is therefore important that long-term water quality monitoring programmes are instituted for fog water supply schemes in order to identify any contaminants from the collector material and/or atmospheric deposition.

CONCLUSIONS AND RECOMMENDATIONS

This study shows that other greenhouse shade nets can be used for fog collection, particularly in areas where the polypropylene mesh that is used in SFCs is not available. Meshes with an isosceles triangle-like weave and a percent shade coefficient of about 35–40% are more suitable for fog collectors than ones with a more equilateral triangle-shaped weave or with a higher percent shade coefficient.

The results of this study will enable prospective users of fog water to select the right weave and percent shade coefficient of a given mesh that is to be used for fog collectors in areas where the Raschel mesh is not available.

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