August 2001

FOGGING OF REJEX-IT® TP-40. EFFECTIVENESS AS A FUNCTION OF DROPLET SIZE TO REPEL BIRDS

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ABSTRACT

Fogging of Rejex-it® TP-40 (Fog Force) offers a very efficient method for the management of nuisance birds in many diverse areas without any adverse effects to non-target animals. Despite its effectiveness, there are many factors that influence the effectiveness and desired results. The product alone does not guarantee the desired success. It is not always the quantity that determines fast reaction, but more the form for the specific application. Smaller droplets in the 10-micron range are theoretically 27 times more effective than 30 micron droplets and five micron droplets even 216 times more effective for the same quantity of product applied. It has been shown that droplets below 10 microns are inhaled by birds much more and therefore show an increase in effectiveness. Also, birds in flight with a breathing rate of 50-100 times higher than the resting rate show increased effectiveness. Large droplets not only are relatively ineffective, they also tend to drop to the ground prematurely and are lost. Smaller droplets stay in the air much longer and disappear by evaporation and do not drop to the ground. In large warehouses or hangars it is therefore advisable to bring the fogger to the height where the birds are, so that the fog stays in the upper regions without disturbing any operation on the ground floor.

Depending on the situation, it sometimes is still advantageous to use foggers, which do not produce the ideal droplet size, but have other advantages that are needed for success. In strong wind or with thermal currents sometimes larger droplets are needed to reach the nuisance birds. Also, many times automated ULV foggers (e.g., *Hurricane, BICO 2000*), that work without much noise are more effective than hand held thermal foggers.

Birds Strike Meeting 2001, Calgary, Canada, Aug. 27-30, 2001
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INTRODUCTION

Birds have always been objects of pleasure and frustration and people have tried to control the problems the birds create with limited results. Scarecrows, gun shots, recordings of dying birds, spikes and other pointy objects, plastic predators, and other devices are the daily toys that are widespread to give the impression to repel birds. They work pretty well - but only for a short while. And then, the birds learn what it really is. It is all a ploy that should scare them without any unpleasant experiences associated. And now, we even have loose dogs running around these places along with the birds. Fake snakes at least are good for nest building. In essence these are all cues that get the initial attention of the birds but lack the active punch to be effective for more than a few days. Unfortunately, the research and development into these scare tactics cost time and money and they delay the proper use of effective methods and tools. So, it is back to killing, which solves the problems if driven to the extermination of the target birds, despite the outcry of society.

Repellents, in contrast are a natural defense mechanism for many organisms, using irritants, toxins or bad taste without killing the target or other species. It is well known that birds do not eat Monarch butterflies *(Danus Plexippus)* as a learned response to their unpleasant taste due to the accumulation of a poisonous substance when the larvae feed on milkweed (*Ascleias syiaca*) plants (Brower 1964, Dolbeer 1986). The toxins make the birds momentarily violently ill until they regurgitate the remains of the caterpillar. Since the bird does not die, it can remember the impressive experience and avoid feeding on these caterpillars for the rest of his life.

The bird repellent properties of Methyl Anthranilate (MA) and other organic compounds have been known

for quite some time (Kare 1961) and have been described in the literature extensively (Curtis 1994, Dolbeer 1992,1993,1996, Vogt 1997,1999). The problem with MA from the beginning was to find an efficient and cost-effective delivery system that works fast and reliable. In the feeding application exposure to the repellent is limited to the mouth cavity, the gizzard and the digestive tract and is subject to dilution by the food the bird is eating. Therefore, it usually requires relative high concentrations that are not always practical. Application of Rejex-it® TP-40 (TP-40) in the form of the aerosol is much more direct as it exposes the more sensitive mucous membranes of the bird and offers a very efficient method for the management of bird problems. It does not depend on the voluntary feeding of the bird and, if done properly, is effective no matter what the activity is. The effectiveness depends on the efficient exposure of the target birds to the TP-40 aerosol. Therefore, it is important to generate a fog with the most effective properties, such as droplet size, droplet concentration and its ability to travel the required distance and reach the target birds.

FUNCTION

Methyl Anthranilate (MA), the active ingredient in Rejex-it® Bird Repellents, acts as a sensory repellent by irritating the bird's taste buds, skin, and trigeminal chemoreceptors in the beaks, gizzards, eyes, and mucous membranes. Irritation occurs as a result of exposure to or ingestion of the formulation similar to how people react to chili pepper extract.

Stimulation of the trigeminal chemoreceptors leads to a wide variety of protective, but not adverse, physiological reflexes. These reflexes are an important part of the common chemical sense to prevent exposure to irritants (Parker 1912). As a result, birds modify their behavior by avoiding places where they have been exposed to this stimulus. Significantly, they cannot habituate to these reflexes. Indeed, they remember and avoid the geographic location where this experience took place if no other audible or visual reference is present. However, because the impact on the olfactory nerves (odor) is minimal, subsequent visits by other, more welcomed birds are possible, despite some lingering odor.

As each droplet in the fogging application hits the mucous membranes it creates a response. While the fogging of TP-40 effects birds no matter what their activity is, it is still dependent on the droplet size and breathing rate of the birds. Therefore, the applications are far more effective on birds in flight as their breathing rate can be up to 50-100 times the resting rate.

DROPLET SIZE

Average Droplet Size microns	Comparable Size	Time to fall 1 meter seconds	Drift while falling one meter in wind of 4.8 km/hr meters
< 0.001	Molecular	-	-
0.001 – 0.1	Smoke	-	-
0.1 – 1	Haze	-	-
2 – 5	Dry fog	8,500 – 1,360	12,444 – 2,000
10 – 40	Wet fog	340 – 21	500 – 31
50 – 100	Misty rain	14 – 4	19 – 5.3
200 – 400	Light rain	1.4 – 0.63	2 – 1
500 - 1,000	Normal rain	0.53 - 0.37	0.66 - 0.33
2,000 - 5,000	Heavy rain	0.3 - 0.28	0.33 - 0.5

Table 1. Comparison of droplet size and time it takes to fall one meter and the distance they travel in this time in wind of 4.8 km/h (3 miles/hr).

Fog, the dispersion of a liquid in air, describes a wide range of droplet sizes. To repel birds with TP-40

(Fog-Force) we are generally interested in a fog with a droplet size in the range of 1-30 microns which covers the range from haze to wet fog (Table 1, Figure 1). Wet fog and mist with droplets upward from 30 microns, as produced by most sprayers, are not as effective and tend to form a wet film on any substrate in their path. Depending on the droplet size and their weight they tend to stay in the air for some time and travel a certain distance accordingly (Figure 2). Droplets of 40 microns fall one meter in just 21 seconds and in this time travel just 31 meters in wind of 4.8 km/h (3 miles/hr). For droplets of 10 microns it takes 340 seconds to drop one meter and they can drift 500 meters under the same conditions, while 5-micron droplets reach 2,000 meters and more. As the droplet size decreases, the inertia of the droplet decreases and they can penetrate dense foliage without coating the foliage. Thus, smaller droplets not only stay longer in the air, but they also are inhaled deeper by the birds and thus increased effectiveness is achieved.

Drop size in microns	Drops/ml	Relative Impact
30 microns	70 million	1
15 microns	560 million	8
10 microns	1890 million	27
5 microns	15 billion	216

Table 2. Droplet size of Rejex-it® TP-40 (Fog Force) and relative impact on birds for equal amounts of product.

As the droplets decrease in size, less material is needed to create the same number of droplets. Typically, one ml of product will yield 70 million droplets of 30 microns (Table 2). The same amount however, will give 1,890 million droplets of 10 microns and 15 billion droplets of five micron size. Under the assumption that each droplet, independent of its size, hitting the mucous membrane of a bird, will generate one impulse, than more droplets will be more effective. As one droplet of 30 microns has the same volume of product as 27 droplets of 10 microns or 216 droplets of five microns, we can assume that the same amount of product in the form of 10 micron droplets can be 27 times, and in the form of five micron droplets 216 times more effective as in the form of 30 micron droplets (Table 2). Therefore, with the decrease in the droplet size, the amount of product required for an effective response decreases accordingly. Naturally, there is a limit how small the droplets can be without losing their effectiveness. If the droplet size is too small, they tend to evaporate more rapidly and disappear too fast without reaching their target. Best overall results are achieved with droplets in the in the 5-10 micron range. For windy conditions and to reach over longer distances larger droplets have an advantage. Also, where thermal currents are present larger droplets are needed to keep the product closer to the ground, as long as they are kept in the air without hitting the ground and become ineffective. Once they hit the ground or any other substrate, the droplets will only slowly disappear by evaporation, resulting in lingering odors. For indoor applications smaller droplets are preferred to get them with updraft toward the ceiling. For outdoor applications many times larger droplets might give better performance as they stay closer to the ground.

On multiple applications, frequently, birds tend to recognize the noise, color, or shapes of the fogger, the applicator, or the white fog generated and leave the area prematurely without getting exposed to the fog. In this case the strategies have to change until the birds leave. Smaller droplets and decreased amounts of product allow for the formation of a fog cloud that is practically invisible. With no visible cloud the birds have no visible cue or reference except the area where they had the experience and thus they will avoid the site much earlier. As the clouds become invisible, the exposure to the birds increases as they fly around in an exited state to find the exit of the cloud. As with the Monarch butterfly, where the birds learn to avoid anything associate with the same shape and color, they learn with the Rejex-it® fog to recognize the area where they had the bad experience and avoid it in the future.

At an application rate of 0.1 ml/l (0.1 oz/10,000 cu ft) already 7 million droplets/l or 7,000 droplets of 30 microns are generated per cm^3 of air. This amount increases to 1.5 million for droplets of five-micron size for the same rate of application. Obviously, the amount of product could be reduced to about 0.1 ml per 10-liter volume (0.1 oz/100,000 cu ft) with the same or better result. Best overall applications are achieved with droplets of 5-10 microns. At 5 microns they stay in the air for 4 hours in an indoor environment.

CONCLUSION

Clearly, the conclusion is "*Less is Better*." It is not the amount of product applied but the form and method that will determine effective control of the bird problems Birds learn very fast. They are very good in processing optical information; otherwise they would not be able to fly through dense woods or see prey over large distances. So, if they cannot see the source that causes the unpleasant experience, or they cannot see the end of the fog cloud, the only correlation is the location. Therefore, the generation of an invisible fog at unexpected intervals to make the area totally unacceptable to the birds until they leave forever, or the use of visible cues in the area that is being fogged to give the birds the impression that the visible cue is the source of their misery. While thermal foggers generally tend to produce smaller droplets, they are noisy and cannot be automated as easily as the mechanical foggers, which produce larger droplets with little or any noise. The most important fact remains the training and knowledge of the applicator to make the right decisions to recognize the nature of the problems and then chose the right method of application.

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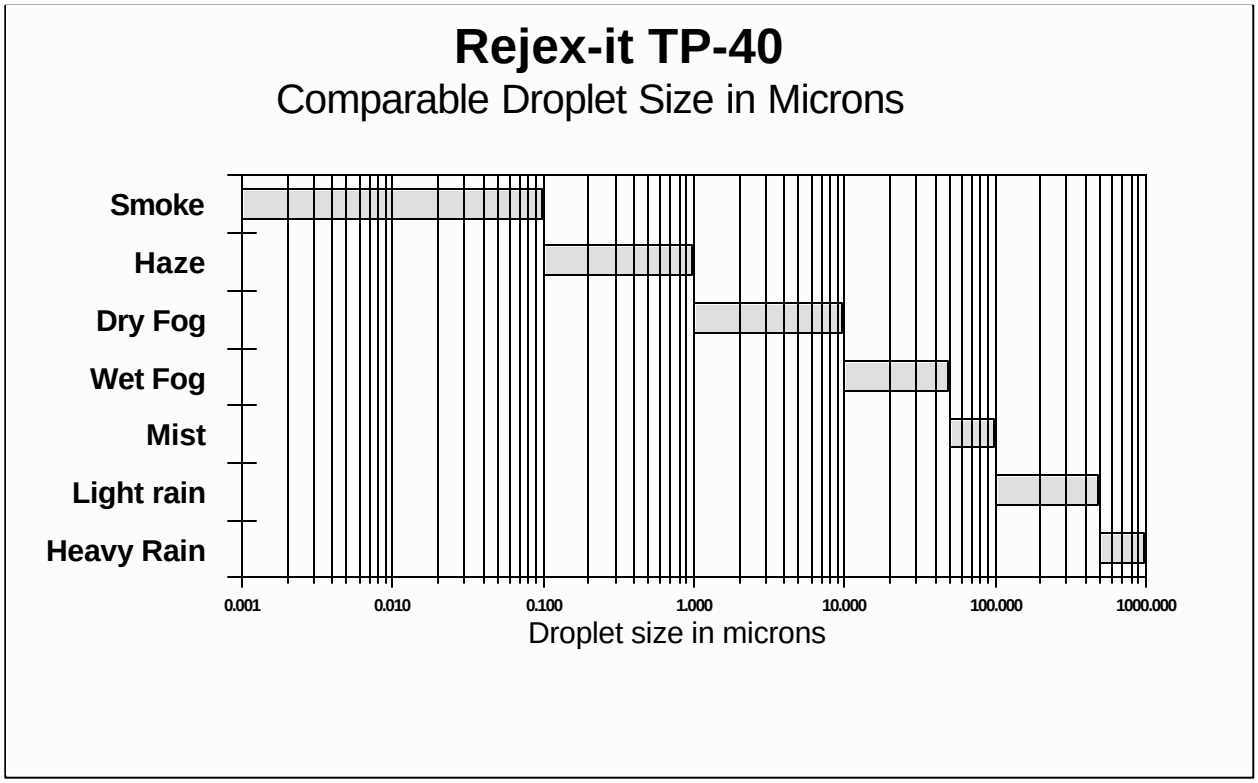

Figure 1. Comparable droplet sizes for Rejex-it® TP-40 versus water.

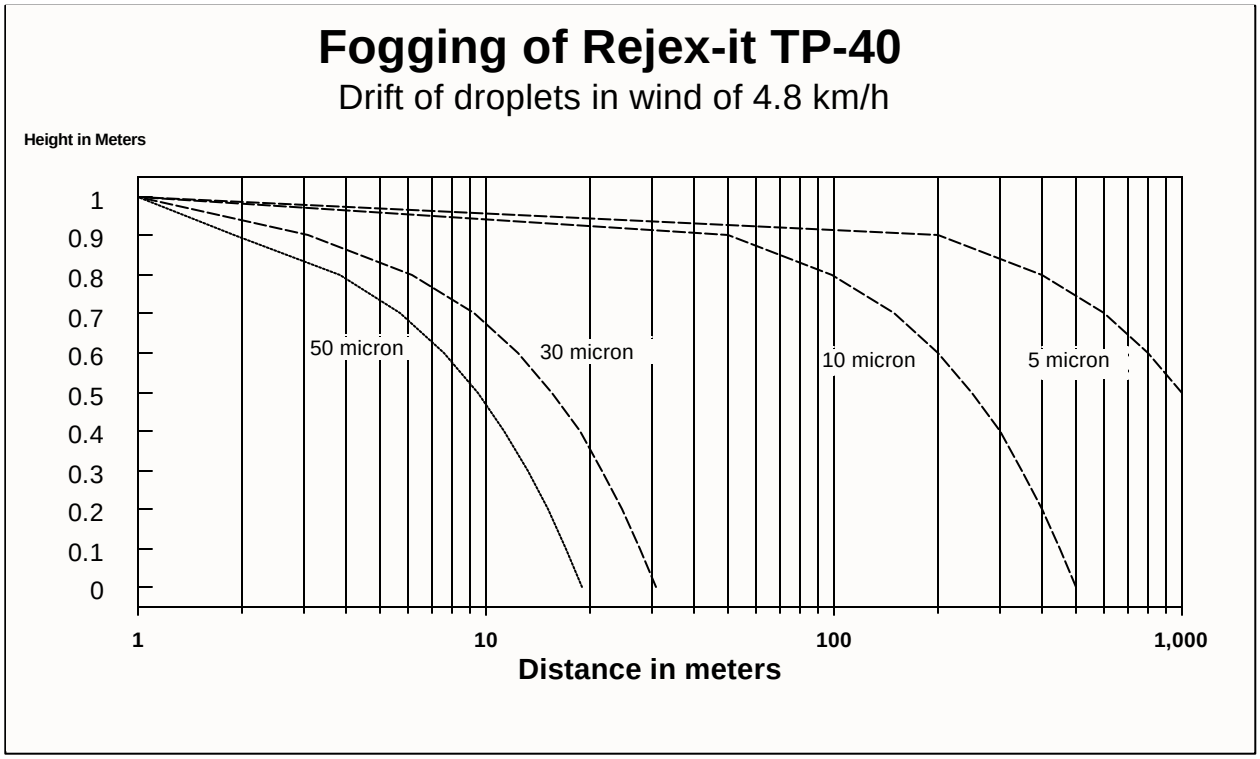

Figure 2. Drift of Rejex-it® TP-40 (Fog Force) droplets of 5 to 50 microns in wind of 4.8 km/h (3 miles/ hr).

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