“Magnetic Cleansing” for the Provision of a ‘Quick Clean’ to Oiled Wildlife

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Abstract—This research is part of a broad program aimed at advancing the science and technology involved in the rescue and rehabilitation of oiled wildlife. One aspect of this research involves the use of oil-sequestering magnetic particles for the removal of contaminants from plumage – so-called “magnetic cleansing”. This treatment offers a number of advantages over conventional detergent-based methods including portability - which offers the possibility of providing a “quick clean” to the animal upon first encounter in the field. This could be particularly advantageous when the contaminant is toxic and/or corrosive and/or where there is a delay in transporting the victim to a treatment centre. The method could also be useful as part of a stabilization protocol when large numbers of affected animals are awaiting treatment. This presentation describes the design, development and testing of a prototype field kit for providing a “quick clean” to contaminated wildlife in the field.

Keywords—Magnetic Particles, Oiled Wildlife, Quick Clean, Wildlife Rehabilitation.

I. INTRODUCTION

FOR almost a decade, scientists at Victoria University and the Phillip Island Nature Park have been engaged in a collaborative program aimed at advancing the science and technology involved in the rescue and rehabilitation of oiled wildlife.

A promising development involves the use of oil-sequestering magnetic particles for the removal of contaminants from plumage [1], [2]. This is effectively a benign dry cleansing process - with minimal feather damage compared to detergent-based cleansing. Being inherently portable, the application of magnetic particle technology (MPT) to the removal of oil contamination from plumage (and fur) also offers a number of other advantages over conventional detergent-based methods, such as the possibility of providing a “quick clean” to the animal upon first encounter. This could be particularly advantageous when the contaminant is toxic and/or corrosive or where there is a delay in transporting the victim to a treatment centre. The method could also be useful as part of a stabilization protocol when large numbers of affected animals are awaiting treatment.

The “magnetic cleansing” technique requires the development and optimization, not only of the particles themselves, but also of the equipment and protocols that are appropriate for application in the field. With respect to the development of the oil-sequestering magnetic particles themselves, various approaches have been under investigation, ranging from the coating of iron particles with hydrophobic (or super-hydrophobic) surfaces, Fig. 1(a), to the identification and characterization of highly ab(d)sorbent grades of iron powder, Fig. 1(b).

Fig. 1 Electron micrographs of oil sequestering particles (a) polymer-coated and (b) finely divided iron powder

II. THE DEVELOPMENT OF MAGNETIC DEVICES

The development of appropriate equipment is also ongoing and includes the design and testing of a portable, hand-held, magnetic device (the “magnetic harvester”) that can safely and efficiently strip the oil-laden magnetic particles from the animal and which can allow the waste to be disposed off in a controlled way. The development of such devices within our research group is represented in Fig. 2.

The device shown in Fig. 2(a) is a standard “magnetic tester” the magnetic field of which may be turned on and off mechanically by operating the plunger. Although suitable for routine laboratory experiments, this device requires two hands to operate and is not considered practical for “field” work. Fig. 2(b) is a one-handed magnetic harvester with the mechanical on-off switch operated by compressed air. Although effective, this device is considered to be too cumbersome for field work. Fig. 2(c) depicts an electromagnetic device that has since proven to be unsuitable due an inability to achieve a magnetic field strength within the desired range of 5,000 – 10,000 Gauss. The device in Fig. 2(d), dubbed the “magnetic wand”, has been developed with a “quick clean” in mind. It is based on a carefully designed array of rare earth magnets within a stainless steel tube (100 mm), the tip (35 mm) of which has been made to be non-magnetic. This device generates a
strong, highly localized, magnetic field and the non-
magnetic tip allows oil-laden particles to be readily wiped
off into a waste container.

Fig. 2 (a) Magnetic “tester” (b) Compressed air device (c) Electromagnetic device (d) Magnetic “wand”

III. REMOVAL OF CONTAMINANTS FROM WHOLE BIRD MODELS

Concomitant with the development of the above technology, an experimental program has been conducted
into the removal of different coverage (% by mass) of various oil types from the plumage of Little Penguin
(Eudyptula minor) in order to investigate the feasibility of applying MPT to the cleansing of oiled wildlife in the field
[7]. As well as establishing important methodologies for conducting complex experiments of this kind, these
continuing investigations have attempted to estimate the logistical requirements for such potential operations - such
as the time taken, the mass of particles required per bird, the mass of waste per bird and the costs relating to materials,
waste disposal and personnel. Other factors such as the use of pre-treatment agents have also been addressed [8].

Fig. 3 depicts a typical set of data. These initial investigations were carried out using the laboratory
magnetic tester shown in Fig. 1(a) and indicate that a high percentage removal of contaminant can eventually be
achieved. However, at this stage, the most exciting finding is that a significant fraction of contaminant can be removed
after only one or two treatments (taking only 5 – 10
minutes). This observation gives rise to the possibility that
MPT could be applied to providing a “quick clean” upon
first encounter.

Fig. 3 A representation of the removal of Diesel oil (100% coverage – a worst case scenario) from a Little Penguin carcase.
Note that in this experiment, the “first generation” magnetic tester was used and that 37% removal may be achieved in 4.7 minutes
and 64% in 9.4 minutes

Accordingly, with the subsequent development of the
magnetic wand device, Fig. 2(d), a program has commenced
to develop a prototype set of equipment to enable a quick
wash to be trialled in the field. Such experiments are
depicted in Fig. 4.

Fig. 4 Simulating a “quick wash” for a Little Penguin carcase contaminated with (a) 20% coverage (by mass) of engine oil (b)
after application of magnetic particles (c) 82% removal is achieved
after one treatment. Two persons would be required for this
procedure to be carried out on live animals

Further analysis of the data obtained from such
experiments shows that the initial removal increases as the
percentage coverage decreases. Our more recent
experiments have also shown that use of the magnetic wand
device, rather than the magnetic tester, further enhances the
initial removal. Some representative data is presented in Fig.
5. Notably, for 20% coverage (by mass) of Diesel oil and
engine oil respectively, 85% and 93% removal of these
contaminants can be achieved after two treatments - taking
approximately 5 minutes in each case.
Work is continuing to further develop this method with respect to improving the magnetic particles and optimizing the equipment (such as the magnetic harvester). Studies are also continuing into the development and use of pre-treatment agents in conjunction with magnetic cleansing and to tailor the method for different scenarios.

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REFERENCES


