Message from NSTF Executive Director

How, when and where to 'dump' plastics?

June is the month of the NSTF-South32 Awards gala dinner where the winners will finally be announced. NSTF is celebrating the International Year of the Periodic Table, and so we have been highlighting and discussing all things chemical and material(s). The winner of the Special Annual Theme Award – for Materials for Inclusive Economic Growth – will be announced along with the others, at the dinner. While we are awaiting the results anxiously, I thought we could consider the plastics materials crisis.

We are now all aware of how plastics are ubiquitous in the oceans and reach even the most remote areas of the planet. Huge dilemmas remain for humankind to solve – how to make any difference to the amount of current waste in the oceans, how to prevent more plastics finding their way into the oceans, how to increase the rates of recycling around the world, and how to reduce plastic manufacturing and use. Making progress on solving these problems is urgent, but the problems are wicked ones – complex and caused by multiple factors.

During the recent floods in Durban, plastic waste was a large part of the debris that had to be cleaned up on the beaches and in the harbour. When plastic waste is brought into one place like this, it is a shocking reminder of the impact that our addiction to plastic is having on coastal areas and beyond.

In October 2017 there was another big storm on the KZN coast. A ship containing large amounts of nurdles (tiny pellets used in the manufacture of plastic products, in this case polyethelene) had a small accident and kilograms of these nurdles spilled into the ocean. They washed ashore and the Durban beaches were littered with unwanted material – as so often happens. The incident was reported in the Saturday Independent. The shipping company took responsibility for the spillage and the clean-up operation. It was apparently legal and acceptable for a ship to carry such cargo. The South Durban Community Environmental Alliance called for the company to be prosecuted, because they said nurdles become toxic over time. The South African Association for Marine Biological Research led a citizens' clean-up operation. Jane Porter of the Association said the nurdles attract toxins which would end up in fish and other sea creatures. The nurdles were dispersed along the Transkei coast at that stage. The pollution control manager at Durban port and the Transport National Ports Authority (TNPA) acted fast and divers worked under difficult conditions to find and remove bags of the pellets underwater. The bags were successfully removed, but there was still a daily inflow of waste into the port.

Now an interesting research article has been published in the current edition of the *South African Journal of Science* (SAJS) entitled 'Nurdle drifters around South Africa as indicators of ocean structures and dispersion' (by Eckart H. Schumann, Department of Geosciences, Institute for Coastal and Marine Research, Nelson Mandela University, C. Fiona MacKay, 1. Oceanographic Research Institute, South African Association for Marine Biological Research, Durban, 2. School of Life Sciences, University of KwaZulu-Natal, and Nadine A. Strydom, Zoology Department, Nelson Mandela University). The abstract says that an analysis was done to model the dispersion of the nurdles from the accidental spill in Durban Harbour. The spill was regarded as a major pollution incident and the largest of such spillages reported worldwide. It explains that dispersion processes were modelled taking into account factors such as wind, ocean currents and waves. The pellets were dispersed over 2000 km of coastline during eight weeks. Nine months after extensive collection efforts, less than 20% had been removed. Modelling shows that ocean spillages will disperse much further than the areas where clean-up operations are conducted.

It is clear therefore, that once plastics are in the ocean, they are out of our control. Methods will have to be developed to recover plastic waste in massive amounts from the oceans - with minimal damage to marine life. Would robots be able to help us do this?

The issue of plastics recycling

How does one prevent used plastics from ending up in the oceans and being carried far afield by sea currents? Collection and recycling of plastics in coastal areas become urgent matters. The same applies to areas along rivers and streams. This is a massive task, but much easier than cleaning up the oceans.

South Africa is making a valiant effort to recycle. The South African Plastics Recycling Organisation (SAPRO) represents the plastics re-processors in South Africa. They claim on their website that “South Africa is amongst the top recycling countries in the world”. The organisation is funded by its member companies, and strives to build “a recycling industry that is respected and acknowledged by government, industry and the public”. Plastics have been recycled since the 1970s in South Africa. The 2009 Waste Act forces waste generators to engage in Extended Producer Responsibility (EPR) programmes. In 2010, 30% of all plastics packaging was recycled.

The classification of types of plastic for recycling

Plastics are of various types and this influences the effectiveness of recycling and reprocessing. The American Society for Testing and Materials’ (ASTM) Resin Identification Coding System was created in 1988 by the Society of the Plastics Industry (now the Plastics Industry Association) in the United States. Since 2008 the coding system has become an international system, administered by ASTM International. Variations of the code have been adapted for use in the United Kingdom and China, and is recommended by the British Plastics Federation and Plastics-Europe (formerly the Association of Plastics Manufacturers in Europe).

A proposed new ASTM international standard, WK20632, for marking plastic products is now being developed based on this resin identification code. The standard will expand on the original system by providing for additional codes for resin types not covered in codes 1-6, potentially adding to the list of materials currently available for recycling. By providing for the addition of new types of resin and allowing all stakeholders to participate in future revisions, the proposed standard will give the system a means to be adapted as knowledge, processes and technology for recycling and reuse development.

The current identification system is set out by Wikipedia:

Category (7): ‘other’ includes materials made with more than one resin from categories 1-6.

Table of resin codes

Re-cycling number	Image	Alter-nate image #1	Alter-nate image #2	Abbre-viation	Polymer name	Uses
1				PETE or PET	Polyethylene terephthalate	Polyester fibres (Polar Fleece),

Re-cycling number	Image	Alter-nate image #1	Alter-nate image #2	Abbre-viation	Polymer name	Uses
						thermos-formed sheet, strapping, soft drink bottles, tote bags, furniture, carpet, panelling and (occasionally) new containers.
2				HDPE or PE-HD	High-density polyethylene	Bottles, grocery bags, milk jugs, recycling bins, agricultural pipe, base cups, car stops, playground equipment, and plastic lumber.
3				PVC or V	Polyvinyl chloride	Pipe, window profile, siding, fencing, flooring, shower curtains, lawn chairs, non-food bottles, and children's toys.
4				LDPE or PE-LD	Low-density polyethylene, Linear low-density polyethylene	Plastic bags, six-pack rings, various containers, dispensing bottles, wash bottles, tubing, and various

Re-cycling number	Image	Alter-nate image #1	Alter-nate image #2	Abbre-viation	Polymer name	Uses
						moulded laboratory equipment
5				PP	Polypropylene	Auto parts, industrial fibres, food containers, and dishware
6				PS	Polystyrene	Desk accessories, cafeteria trays, plastic utensils, coffee cup lids, toys, video cassettes and cases, clamshell containers, packaging peanuts, and insulation board and other expanded polystyrene products (e.g., Styrofoam)*
7				OTHER or O	Other plastics, such as acrylic, nylon, polycarbonate, and polylactic acid (a bioplastic also known as PLA), and multilayer combinations of different plastics	Bottles, plastic lumber applications, headlight lenses, and safety shields /glasses

(I have deleted the last column of this table as it indicates collection and use in the US and elsewhere).

***Styrofoam** is the brand name of an expanded polystyrene product manufactured by The Dow Chemical Company.

Polystyrene

I have found the following on polystyrene in particular as an example, being one of the most widely manufactured and used plastics.

Polystyrene does not naturally biodegrade for hundreds of years and is even resistant to photo-oxidation, (degradation by oxygen or ozone, facilitated by sunlight). This applies to polymers in general. Photo-oxidation reduces the polymer's molecular weight and changes the properties of the material.

Recycling of expanded polystyrene (EPS)

In 1988, the first US ban of general polystyrene foam was enacted in Berkeley, California. As of 2006, about one hundred localities in the US had some sort of ban on polystyrene foam in restaurants. India and Taiwan also banned EPS for serving and carrying food before 2007. The government of Zimbabwe, through its Environmental Management Agency (EMA), banned polystyrene containers (popularly called 'kaylite' in the country), under Statutory Instrument 84 of 2012 (Plastic Packaging and Plastic Bottles) (Amendment) Regulations, 2012 (No 1.).

Because of the low density of polystyrene foam it is hard to collect scrap in a profitable way. However, if it goes through a compaction process, the density can change from 30 kg per square metre to 330 kg per square metre. This then does make recycling worthwhile, as plastic pellets can be made from it. Compactors and logistical systems are needed to follow this route, and the costs are often prohibitive for recycling businesses. Expanded polystyrene scrap is used for insulation sheets and other construction applications. Manufacturers of these (in the US) often cannot obtain enough of this scrap because of the difficulties in the collection of it. Since 2016 about 100 tons of expanded polystyrene have been recycled every month in the UK.

Can polystyrene be destroyed in any way?

Incineration of polystyrene at temperatures up to 1000 degrees C can generate mainly water and carbon dioxide, and the final volume of solid waste can be about 1% of the original, if this is done in modern facilities (according to the American Chemistry Council). Because of the amount of heat generated, this process can also be used as a power source.

Microbes have been shown to degrade polystyrene, already in the 1970s. These are methanogenic microbes, such as those which occur in the digestive tracts of ruminants and humans, and are responsible for belching and flatulence. Some of these play a crucial role in anaerobic wastewater treatments. Other types are extremophiles, surviving in the harshest of environments. The rate of degradation of polystyrene by using microbes was found to be much faster than other methods previously identified. One of the differences is that the degradation of styrene was the aim, as opposed to the break-up of the polymer, polystyrene.

There is also the hope given by mealworms, the larvae of the beetle *Tenebrio molitor*, as discovered in 2015. They can digest and live a healthy life on a diet of EPS. About 100 mealworms can eat 24 to 39 mg daily. The droppings were found to be safe in soil used for growing crops. Superworms, *Zophobas morio*, have also been found to eat EPS. Other types of insect larvae can digest various plastics.

A bacterium called *Pseudomonas putida* can convert styrene oil into a biodegradable form. "This may someday be of use in the effective disposing of polystyrene foam."

So what about plastic bags?

The phasing out of lightweight plastic bags has been done or proposed in many countries since 2002. South Africa also enacted legislation to do this at about that time, and putting a value on heavier weight bags. The banning of plastic bags in the US has been actively opposed by the American Chemistry Council (ACC). In 2016, California voters approved a state wide ban on carry-out plastic bags. A few other countries have banned plastic bags completely.

Personally, I am concerned about the effects of an outright ban on bags in South Africa. Poor people rely heavily on cheap plastic bags, to carry various things, including personal belongings, to do their shopping while using public transport or walking, and even for covering gaps in makeshift housing. It will be extremely difficult for the government to enforce a ban on using plastic bags. Even the selling or distributing of plastic bags will be hard to control. For all of us, there are various uses of plastic bags, including for collecting rubbish of various kinds. Even the collection of goods for recycling relies on plastic bags. For a mother of a baby who uses cotton nappies (because disposable ones are environmentally unfriendly), plastic bags are essential to carry or keep soiled nappies in until they can be washed. She is not always close to a plastic bucket with a lid. Banning bags just seems extremely impractical. We should rather prioritise effective means of disposal so that bags can be kept off the streets and out of the water.

There are many questions that remain. What about the electronics industries and all the industries that are related to the 4th industrial revolution? As the manufacture of electronics proliferates, so will that of plastics. My impression is that there is very slow progress on the recycling of plastics that are made to stay intact for prolonged use, such as the casings of computers and cell phones. Are these matters being researched?

There is no easy way out of the plastics quagmire. Priorities have to be identified and addressed. The problems have to be addressed in various ways and by every sector of society. For governments it requires political will to implement what is feasible at this point in time. For consumers it means looking for alternatives to plastic or especially, plastic bags.

The opinions expressed above are those of the Executive Director, Jansie Niehaus, and do not necessarily reflect the views of the Executive Committee or members of the NSTF.

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