EFFECTS OF FLUSHABLE PRODUCTS ON WASTEWATER INFRASTRUCTURE AND NATURAL AQUATIC ENVIRONMENTS

Report to Fisheries and Oceans Canada

By

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Introduction

This report presents a perspective on why Fisheries and Oceans Canada should not consider INDA's (Association of the Nonwoven Fabrics Industry) flushability guidelines (4th Edition or GD4) as a potential platform to assess and standardize wet wipes as "flushable". INDA/EDANA's (European Disposables and Nonwovens Association) guidelines provide a platform that potentially suits interests of wipe manufacturers, but it fails to protect wastewater infrastructure, municipal funds, public health, and consumers' interests. The report is organized in 4 sections as 1- Summary Information on New Flushable Products, 2- Effects of "flushable" products on wastewater infrastructure and natural environment, 3- Worldwide Standardization Efforts, 4- Discussions and Conclusions.

1- Summary Information on New Flushable Products

Numerous sanitary products such as wet wipes, toilet-bowl cleaning brushes, medicated patient wipes, cleansing clothes, incontinence products, and colostomy bags are relatively new, diverse, and convenient products that are marketed worldwide as "flushable." Among them, wet wipes are commonly used for cleansing of adults, babies, and patients, for makeup removal, and for multipurpose cleaning.

Flushable, or non-flushable, wet wipes are manufactured as nonwoven sheets of natural and manmade fibers such as cellulose, cotton, rayon, lyocell, (regenerated cellulose), polyester, and high density polyethylene (HDPE) (Munoz et al. 2018). The fibers are mixed at various ratios through hydroentanglement, also known as spunlace process, (made by either carding, airlaying or wet-laying) or by a meltblown process during which polymer is heated to a high temperature then extruded through small nozzels while hot air is being blown. In the hydroentanglement process, high speed jets of water strike a web of fibers so that the fibers knot around one another.

The resulting product is a substrate that receives chemicals such as fillers, binders, resins, preservatives, and lotions (Russell, 2007; Das and Pourdeyhimi, 2014). The substrate usually has a high wet-strength, because synthetic fibers retain their form, shape, and strength in a moist state. High wet strength is a desired outcome for wipe manufactures, so the product will not fall apart during its life-cycle.

Eren & Karadagli (2018) recently investigated physical and mechanical characteristics of non-flushable wipes, flushable wipes, and toilet papers. They studied 18 non-flushable, 42 flushable, and 27 toilet paper samples that were collected from around the world. Physical properties included sheet mass, sheet volume, sheet thickness, and fiber density, while mechanical properties included dry strength and wet strength of each sample. Their results indicated that flushable wipes are similar to non-flushable wipes, rather than toilet papers, on the basis of their physical and mechanical attributes. They concluded that wipes are much "bigger" (surfaces areas), "heavier" (sheet masses), "thicker" (sheet thicknesses), and "denser" (density) than toilet papers. For mechanical characteristics, Eren & Karadagli (2018) measured the maximum force (F_{max}) required to break a sample. They quantified the F_{max} values for dry, and for wet states of wipes and of toilet papers. They identified loss of strength value for each sample by comparing its F_{max} value of a dry sample ($F_{max\text{-}dry}$) to its wet one ($F_{max\text{-}wet}$). Accordingly, flushable wipes lost their strength in wet conditions by an average of 29%, while toilet papers lost their strength in wet conditions by an average of 90%. Their results indicated that flushable wipes retain their shape and strength in wet conditions, because they contain synthetic fibers, e.g., polyester, HDPE, and regenerated cellulose, which maintain strength when wet. For comparison, toilet papers lose their strength by 90% in wet states, because they are made of cellulosic fibers that lose their rigidity and strength rapidly when wet.

2- Effects of "flushable" products on wastewater infrastructure and natural aquatic environment:

In sewer systems, flushable products are assumed to move along with wastewater to treatment plants. However, their transport depends on various factors such as pipe diameter and its slope, wastewater flow rate and velocity, as well as, frequency and amount of product discharge. If a significant amount of flushable wipes and toilet papers are discharged into a sewer system over a short period of time (a few hours), they will accumulate in drains and lead to potential sewer backups. Holidays, such as Christmas, are an example of times when the amount and frequency of product discharge at a single location may increase due to families and friends visiting each other.

When a product is flushed from a household toilet, it absorbs and blends with other wastes such as food waste, fat, oil and grease (FOG), shampoo, human hair, cosmetics, and other flushed products that flow with wastewater. When flow is intermittent and low as in building drains, household plumbing pipes, or private drain connections (PDC), flushable wipes (that are relatively large solids) settle in sewer pipes, accumulate over time, and cause sewer overflows. At treatment facilities, wipes clog and damage wastewater equipment such as screens, pumps, grinders, mixers, oil-water separators, and sensors that require complete replacement or extensive repairs.

As examples, in England and Wales, approximately 4,000 cases of pipe blockages and property flooding are reported each year (Jeyapalan 2017). In USA, 400,000 basement backups and 50,000 sewer overflows are documented per year (USEPA 2001). The City of Toronto, Ontario has approximately 7200 calls a year to their call center for reported blockages. Likewise, wastewater utilities from around the world have been reporting that wipes are responsible for most pipe blockages and pump clogs in sewer networks. These reports have been published as a series of articles in various languages, and in well-known newspapers such as New York Times (Caron, 2018), The Guardian (UK), and National Post (Canada). As a result, residents face property damages, financial costs, microbial and chemical threats, and health risks. Likewise, public funds are used unnecessarily for repair and replacement costs of wastewater equipment that is damaged by flushed wipes.

For the impact of flushable wipes on natural environments, a growing concern to our ecosystem and health of mankind is microplastic pollution in aquatic environments such as rivers, lakes, estuaries, and oceans (Woodall et al. 2014; Rochman et al. 2017). Microplastics are defined as plastic particles less than 5 millimetres, which are discharged from many sources including wastewater treatment facilities into receiving waters. Munoz et al. (2018) identified various types of plastic fibres in "flushable" wet wipes meaning that they contribute to microplastic pollution in our natural environment. A spillway or harbour that outlets a combined sewer shows much evidence of a sewer overflow as wet wipes are present in trees, bushes, rocks, and shorlines. https://www.theguardian.com/environment/2018/may/02/wet-wipes-boom-is-changing-the-shape-of-british-riverbeds. Microplastics/microfibres are a source of contamination as they are carriers of chemical pollution (plasticisers and additives) also known as Persistent Organic Pollutants (POP) that are adsorbed onto their surfaces. Short chain chlorinated paraffins or SCCPs are being considered as an additional POP to the Stockholm Convention list (Sun et al., 2017). These chemically polluted microplastics are then ingested by all types of organisms such as crustaceans (e.g., shrimp & prawns), fish, birds, and ultimately, by humans via the food chain (Coppock et al. 2017). As a result, microplastics increase the risk of cancer or disrupt other systems like the endocrine system of many animals and humans, leading to problems with sexual development and reproduction (Lambert & Wagner 2017; McCormick et al. 2014; Munoz et al. 2018; Woodall et al. 2014).

3- Worldwide Standardization Efforts

Consumers assume that “flushable” products must have been tested rigorously for their compatibility with household plumbing and sewer systems. In contrast to this perception, consumers are unaware that there is no standard definition of what is flushable, and no standard method to assess flushability. Several organizations have developed test methods and technical specifications to define flushable products, e.g. moist wipes INDA and EDANA, 2018; International Water Services Flushability Group (IWSFG), 2018). As an example, IWSFG and INDA/EDANA proposed a Slosh Box Disintegration Test (SBDT) to evaluate disintegration of a wipe in water. A slosh box is a framed-glass-box that rocks from one side to the other, which is controlled by a cam and lever mechanism. Experimental conditions and pass/fail criteria of SBDT as defined by the two organizations are presented in Table 1.

Table 1. Comparison of experimental parameters, conditions, and pass/fail criterion of SBDT as proposed by IWSFG (2018) and by INDA/EDANA (2018).

Experimental Parameter	Requirement by IWSFG	Requirement by INDA/EDANA
Sample	A single sheet	A single sheet
Water volume (L)	4	2
Mixing speed of Slosh-box (rotations per minute)	18	26
Mixing time (hours)	0.5	1
Expected ratio of disintegration to pass (% of initial dry mass)	95% < 25 mm	60% < 12.5 mm

Table 1 shows that INDA/EDANA's procedure is relatively tolerant, i.e., 60% of a wipe should disintegrate after 1 hour of shaking at 26 rotations per minute (rpm). In contrast, IWSFG offers more stringent criteria, i.e., 95% disintegration after 30 minutes of shaking at 18 rpm. Similarly, INDA/EDANA uses relatively tolerant criteria for other test methods, while IWSFG requires stringent criteria to protect wastewater infrastructure, municipalities, and public health. In parallel, INDA/EDANA's guidelines are applicable only to wet wipes, while IWSFG's test protocols cover any product that will be labeled as "flushable", e.g., colostomy bags and toilet-bowl cleaning brushes.

In a recent scientific study, Wang et al. (2016) indicated that a wet wipe containing regenerated cellulosic fibers can be digested in a commercial composting facility due to its high temperatures, long retention time, and abundance of microorganisms (Wang et al, 2016). This finding highlights that the proper disposal method for wet wipes is through solid waste collection and treatment systems. Thus, wet wipes should be disposed of into solid waste bins, instead of flushing in toilets.

4- Discussions and Conclusion

In light of these arguments, Fisheries and Oceans Canada should not consider INDA/EDANA's guidelines to assess flushability of a product for the following reasons:

1- Flushable wipes are similar to non-flushable wipes on the basis of their physical and mechanical attributes. Wipes are bigger, heavier, thicker, denser, and much stronger than toilet paper.

2- As relatively large solids, wipes absorb and blend with other wastes such as FOG, toilet papers, and other flushed products, which lead to sewer overflows. Consequently, property damage, financial costs, and health threats are inevitable. Likewise, public funds are unnecessarily used for replacement and repair of wastewater equipment that is damaged by flushed wipes.

3- Fiber compositions of wipes include synthetic fibers that retain their shape and strength in wet conditions. This composition is different than toilet papers that are manufactured from natural cellulosic fibers, which lose their shape and strength rapidly in wet conditions.

4- Fiber composition of wipes include synthetic fibers (e.g., polyester, rayon, lyocell, regenerated cellulose) that will increase microplastic pollution in natural aquatic environments. Scientific studies indicated that microplastics have entered into our food chain and will contribute to various health problems including increased risk of cancer cases.

5- INDA's proposed test methods and their pass/fail criteria are more lenient, while IWSFG's proposed test methods and their pass/fail criteria are stringent to protect public health and wastewater infrastructure.

6- INDA's guidelines are applicable only to wet wipes, while IWSFG's test methods are applicable to any product that will be claimed as "flushable."

In conclusion, INDA/EDANA's guidelines provide a platform that potentially suits interests of wipe manufacturers, but it fails to protect wastewater infrastructure, municipal funds, public health, and consumers' interests. Government regulations are needed urgently to define technical characteristics of flushable products. In this direction, IWSFG's technical specifications and test methods clearly differentiate the products that are truly "flushable" from those that are not.

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