



# STITCHED WITH CHEMICALS

Understanding  
Nonylphenol Presence in  
Textile Products

A report by Toxics Link



## About Toxics Link

Toxics Link is an Indian environmental research and advocacy organization set up in 1996, engaged in disseminating information to help strengthen the campaign against toxics pollution, and to provide cleaner alternatives. We work with other groups around the country as well as internationally with an understanding that this will help bring the experience of the ground to the fore, and lead to a more meaningful articulation of issues. Toxics Link engages in the emerging issues of highly hazardous pesticides (HHPs), Persistent Organic Pollutants (POPs), hazardous heavy metal contamination, pharmaceutical pollutants etc. from the environment and public health point of view. We also work on ground in areas of municipal, hazardous and medical waste management and food safety among others. We have successfully implemented various best practices and have brought in policy changes in the aforementioned areas apart from creating awareness among several stakeholder groups. Our work on Endocrine Disrupting Chemicals (EDCs) management has spanned over a decade, entailing significant diverse body of work such as country-specific research data, policy engagement, involvement in setting standards, and capacity building of all stakeholders.

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# Executive Summary

This report discusses issues surrounding the presence of Nonylphenol Ethoxylates (NPEOs) in textile products available for sale in the Indian market, based on the study conducted by Toxics Link. NPEOs are primarily used as surfactants and detergents during the manufacturing of textile products, potentially resulting in their release from manufacturing facilities. The residues of NPEOs can also be retained in the finished textile products and subsequently released during washing, posing significant environmental and health risks. Once released, they break down to form nonylphenols (NPs), which are known to be toxic, act as hormone disruptors, and are persistent and bioaccumulative.

Toxics Link conducted a comprehensive assessment in 2018 to determine the presence of NPEOs in detergent samples from the Indian market and river water samples collected across India. The study revealed NPEO concentrations ranging from 0.82 wt% to as high as 11.92 wt% in detergents, while river water samples showed concentrations ranging from 9.2–41.3 mg/L. Notably, the highest concentration was found in Bandi River (41.3 mg/L) in Pali, Rajasthan, a major textile hub in India, indicating excessive use of NPEOs in textile industries. These findings suggest that drinking water may also be contaminated with NPEOs and their degradation products.

Toxics Link continued its efforts to address this concern and released a report in 2021 focusing on the presence of NPEOs in drinking water samples collected from various regions of the country. The concentrations of NPEOs in drinking water samples ranged from 29.1–80.5 µg/L. These results highlighted the widespread contamination of water sources with NPEOs, emphasizing the urgency to take action.

In contrast to the proactive measures undertaken by several countries, India currently faces significant gaps in addressing the issue of NPs and NPEOs. The European Union, Japan, China, the United States, and the Republic of Korea have recognized the dangers associated with these chemicals and implemented regulations to restrict their use in various products, including textiles. Furthermore, the United Nations Environment Programme has designated NP as a chemical of global concern.



Toxics Link's report aims to catalyze actions in India to phase out the use of NPEOs in textiles and consumer products. It emphasizes the persistent, bioaccumulative, and toxic nature of NPs, which can harm the environment and marine life, and potentially enter the food system. Additionally, direct exposure to consumers can occur through skin contact and ingestion, particularly among children.

Considering the harmful impacts of NPEOs and NPs, it is crucial for India to address this issue and align with global efforts to restrict the use of this chemical. Implementing regulations and promoting the adoption of alternative, safer substances in textile manufacturing and consumer products are essential steps towards protecting the environment and human health, and maintaining sustainable practices in the Indian market.









# 01

## Introduction



Nonylphenols (NPs) are a family of closely related phenolic compounds ( $C_{15}H_{24}O$ ), which are used as formulants in pesticides, lubricating oil additives, catalysts in curing of epoxy resins, at industrial laundries and in the production of nonylphenol ethoxylates (NPEOs). Since the 1960s, NPEOs have been in use as detergents, degreasers, wetting agents, dispersing agents, paints, and emulsifiers in several industrial sectors, such as steel manufacturing, pest control products, power generation, pulp and paper processing, institutional cleaning products, and textile processing (Lalonde and Garron, 2021) .

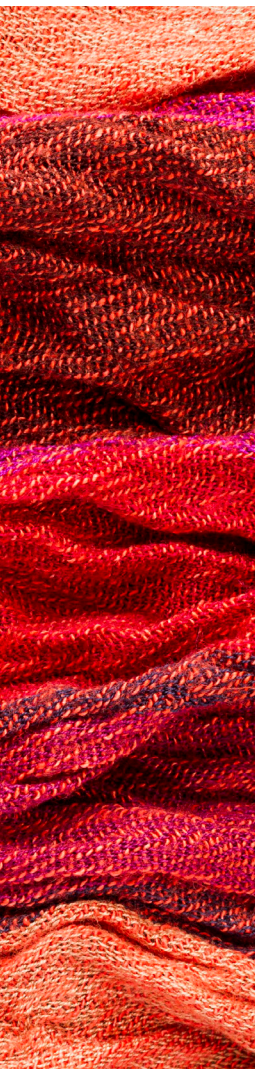
NPEOs can be released to the environment either directly into surface waters (rivers and lakes) or via wastewater treatment plants. Once released, they break down to form NPs, which are known to be toxic, act as hormone disruptors, and are persistent and bioaccumulative (Amalfitano et al., 2022). The use of NPEOs during the manufacture of products such as textiles can also leave residues of these chemicals within the final products.

**The presence of NPs in the environment is believed to be largely a result of the breakdown of NPEOs. Thus, the widespread use of NPEOs has raised concerns regarding the potential environmental and health implications associated with their use and release into the ecosystem.**



# 02

## Applications of nonylphenol ethoxylates in the textile industry



The properties of NPEOs differ depending on the varying length of the hydrophilic ethoxylates (EO). The NPEOs with chain lengths 7 to 15 are generally used in textile manufacturing but sometimes the shorter and longer chained ones are also used.<sup>1</sup> NPEOs are non-ionic (meaning they have no charge) surfactants or detergent-like substances. The chemical structure makes it fit for the EO molecules to show a tendency of attaching themselves to water, while NP is known to bind itself to dirt and oil. These qualities fit make NPEO fit for scouring, dye levelling and as a fibre lubricant in the textile industry.

Thus, NPEOs can be used at almost all stages in the textile manufacturing process for a wide range of textile products. Therefore, there is a possibility that NPs and NPEOs may be present in almost all types of textile products. It is to be noted that NPEOs are not used as pure chemicals and supplied in preparations such as detergents, wetting agents etc. in which they are used as surface active agents.<sup>2</sup> In addition to textile products, NPEOs are also used in the manufacture of leather and leather products as surfactants mainly in soaking, degreasing and fat-liquoring processes. Surfactants account for 1% of the total chemical consumption for a conventional tanning process (Karakas, 2014).

- 1 <https://www2.mst.dk/Udgiv/publications/2013/02/978-87-92903-94-5.pdf>
- 2 [https://emis.vito.be/sites/emis/files/attachments/BAT\\_for\\_the\\_textile\\_industry\\_full\\_version\\_0\\_0.pdf](https://emis.vito.be/sites/emis/files/attachments/BAT_for_the_textile_industry_full_version_0_0.pdf)

NPEOs are used in the textile manufacturing processes for the following functions:

- Washing and scouring of raw wool and cotton
- Fiber lubrication
- Dye levelling
- Surface active agent for cleaning and rinsing textiles
- Auxiliary agent in bleaching step
- Wetting agent for textiles
- Emulsifier for oils, fibers



# 03

## Textile Industry and Chemical Pollution

The textile industry is one of the largest industries in the world and employs more than 300 million people along the global value chain.<sup>3</sup> **The global textile market size was estimated at close to USD 1 trillion in 2022.**<sup>4</sup> The textile industry comprises all the processes from the processing of the raw materials, such as cotton or wool into a finished product, which includes developing, producing, manufacturing, and distributing textiles.

This industry is of prime importance for emerging economies and developing countries, such as India and Bangladesh, as these countries are seeing an explosion in the growth of their textile exports. However, the textile industry is one of the most polluting industries, and its impact on the environment is a cause of concern.

The textile industry is the second largest polluter of fresh water globally.<sup>5</sup> **The textile and apparel industry uses over 8000 chemicals starting right from production of fibres to dyeing, processing and finishing of textiles, such as biocides, flame retardants, azo-dyes, heavy metals, etc. The growth of the textile industry leads to an increase in the chemicals used in textile processing, and the market value of it is estimated to be 31.8 billion USD by the end of 2026.**<sup>6</sup> Several studies on the presence of chemicals in textile products (Ahlström et al., 2005; Herzke et al., 2012; Kajiwara et al., 2009) have been carried out over the past few years, including those on NPs and NPEOs<sup>7,8</sup>.

Many of these chemicals are toxic and can lead to adverse health effects. The Strategic Approach to International Chemicals Management (SAICM) has also accepted Chemicals in textiles as a cause of

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3 <https://fashionunited.com/global-fashion-industry-statistics>

4 <https://www.grandviewresearch.com/industry-analysis/textile-market#:~:text=The%20global%20textile%20market%20size%20was%20estimated%20at%20USD%20993.6,USD%201%20032.1%20billion%20in%202022>

5 <https://textilevaluechain.in/news-insights/water-pollution-due-to-textile-industry/>

6 <https://saicmknowledge.org/topic/chemicals-textiles>

7 [https://www.greenpeace.org/static/planet4-international-stateless/2012/03/806ceff8-dirty\\_laundry\\_product\\_testing\\_technical\\_report\\_01-2012.pdf](https://www.greenpeace.org/static/planet4-international-stateless/2012/03/806ceff8-dirty_laundry_product_testing_technical_report_01-2012.pdf)

8 <https://www2.mst.dk/Udgiv/publications/2013/02/978-87-92903-94-5.pdf>

concern. Many of these chemicals are highlighted in our previous report on **Chemicals in Textiles**<sup>9</sup>. Unsound practices and poor wastewater management in these industries not only impact the health of textile workers, but also the communities living near facilities, consumers of textile products, waste collectors and secondary processors, and the wider environment.

Studies conducted in textile manufacturing hubs such as Thailand, China, Mexico, and Indonesia have demonstrated the presence of NP/NPEOs in the effluents, indicating the release of these chemicals from manufacturing facilities.

In addition, the release of NPEOs from the washing of clothes and other fabric products contributes NP to surface waters, particularly via sewage treatment plants. Although the contribution of NPEOs from any given article of clothing will be relatively small, the sheer volume of clothing being sold and subsequently washed means that the total quantities being released may be substantial.

Textile workers are directly exposed to toxic chemicals via skin contact and breathing in contaminated air in the working environment. Moreover, the consumers using NPEO-containing textile products are in direct contact with these products.

Increased volumes of clothing are manufactured, sold, and discarded, which magnifies the human and environmental costs of our clothes at every stage of their life cycle. Even the apparently small amount of NPs can cumulatively amount to the widespread dispersal of damaging chemicals across the planet. The studies highlighting the presence of NPs and NPEOs in textile products are highlighted in **Annexure-I**.

<sup>9</sup> <https://toxicslink.org/wp-content/uploads/2022/08/Toxics%20Chemical%20in%20Textile%20Report.pdf>





# 04

## Toxicity of Nonylphenols



Several studies have confirmed the endocrine disrupting compound (EDC) property of NP, with varying effects observed on the hormonal system of a number of organisms.<sup>10,11</sup> Adverse effects of NP on reproductive, immune, and central nervous systems have been discovered in fish, rats, birds, and humans with possible abnormalities in embryos and offspring (Ahmadpanah et al., 2019; Cao et al., 2020, 2019; Malmir et al., 2020; Saravanan et al., 2019).

A study by Lepretti et al. (2015) revealed negative impacts on human intestinal homeostasis and functionality. Recent studies on carcinogenesis have reflected the relation of NP exposure to the possibilities of breast cancer in women (Ko et al., 2019; Wen et al., 2020) and prostate cancer in men (Forte et al., 2019, 2016; Kim et al., 2016). Although NPEOs are less toxic than NP, they are also highly toxic and degrade to more environmentally persistent NPs.

NP is shown to be persistent at different levels in the environment (Ejlertsson et al., 1998; Manzano et al., 1999). NPs have a high affinity for solids such as sediments (Zhong et al., 2017), and sewage sludge (Lara-Moreno et al., 2022), as well as for lipids; hence, it can bioaccumulate in organisms (Ademollo et al., 2018; Keith et al., 2000). Previous studies have demonstrated the presence of NP at all trophic levels, such as plankton, benthic invertebrates, fish, birds, and mammals (Casatta et al., 2016; Diehl et al., 2012), via a complex food web<sup>12</sup>.

NPs have also been detected in foodstuffs (Lee et al., 2023) , drinking water (Xu et al., 2022), human adipose tissue (Sise and Uguz, 2017), urine (Ringbeck et al., 2021), maternal

10 <https://echa.europa.eu/documents/10162/43080e23-3646-4ddf-836b-a248bd4225c6>

11 [https://www.epa.gov/sites/default/files/2015-09/documents/rin2070-za09\\_np-pes\\_action\\_plan\\_final\\_2010-08-09.pdf](https://www.epa.gov/sites/default/files/2015-09/documents/rin2070-za09_np-pes_action_plan_final_2010-08-09.pdf)

12 <https://www.who.int/publications/i/item/9789241505031>

blood plasma and amniotic fluid (Shekhar et al., 2017), blood serum, and breast milk (Azzouz et al., 2016) alkylphenols, phenylphenols, bisphenol A and triclosan in human breast milk, blood and urine samples is proposed. Blood and milk require a pretreatment to remove proteins and other substances potentially interfering with the continuous solid-phase extraction (SPE). The presence of NP in pregnant women's uterine tissue and early embryos has also been observed (Chen et al., 2016), highlighting the transfer of NPs from mother to the developing embryo via placenta.

Non-occupational exposure to NPs and NPEOs can occur through a variety of exposure routes such as inhalation of air, ingestion of food and indoor dust and by drinking contaminated water. NPs present in plastic containers and wrappings can also migrate into foods and drinking water. Other routes of human exposure include contact with personal care products, textile products and detergents.

As a result, Europe severely restricted the use of NP and NPEOs. Moreover, NPEOs are being replaced by other surfactants, mainly alcohol ethoxylates, in most European, Canadian, and Japanese markets.





# 05

## Global Regulations on nonylphenols and their ethoxylates in textiles

On **December 30, 2022**, the **Chinese Ministry of Ecology and Environment** released a [list of new pollutants for priority management \(2023\)](#), which came into force on March 1, 2023.<sup>13</sup> This list includes NPs, which classifies it as an environmental endocrine disruptor of very high concern. For this pollutant, the proposed management measures are usage prohibitions to strengthen the source control.

In **2019**, **Taiwan** revised CNS 15290 **“Textile Safety Regulations (General Requirements)”** with which textiles and related goods must be in compliance in order to be placed on the market. According to CNS 15290, the sum of NPEOs and NPs should be less than 1,000 mg/kg (0.1%) in all the textiles.<sup>14</sup>

In **2018**, **US EPA** added NPEOs to the list of toxic chemicals, subject to reporting under **section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA)**<sup>15</sup>, and **section 6607 of the Pollution Prevention Act (PPA)**. Some of the US states have come up with regulations to monitor NPs in textile products.

For example, Oregon’s 73 high priority chemicals of concern for children’s health, as required by the [Toxic-Free Kids Act](#) passed in 2015 include specific alkylphenols (4-NP and its isomer mixtures; 4-tert-octylphenol).<sup>16</sup> According to this Act, the manufacturers must provide biennial notice to Oregon Health Authority of children’s products sold in Oregon that are covered by this Act and contain such chemicals in the final product at or above the practical quantification limit.

Washington’s [Children’s Safe Products Act \(CSPA\)](#) requires manufacturers to report each year if their children products contain [chemicals of high concern to children \(CHCC\)](#). Alkylphenols (NP, 4-NP, 4-NP

13 <https://www.reach24h.com/en/news/industry-news/chemical/china-issues-first-list-of-new-pollutants-for-priority-management-2023.html#:~:text=China's%20first%20official%20list%20of,force%20on%20March%201%2C%202023>

14 <https://www.cps.bureauveritas.com/sites/g/files/zyfpx236/files/media/document/Bulletin-21B-020.pdf>

15 <https://www.govinfo.gov/content/pkg/FR-2022-11-30/pdf/2022-25946.pdf>

16 <https://www.oregon.gov/oha/ph/healthyenvironments/healthynighborhoods/toxicsubstances/pages/childrens-chemicals-of-concern.aspx>

branched, 4-octylphenol and 4-tert-octylphenol) are part of the CHCC list. However, none of the alkylphenol is restricted at present.<sup>17</sup>

In **September 2016, South Korea** placed new restrictions on NP and NPEOs, which were implemented from **July 2018**. The restriction under South Korea's K-REACH applies to the import, sale, storage, transport or use of substances containing NP and NPEOs. K-REACH requires that the quantity of the NPs or mixtures of NPEOs shall not exceed 0.1% for products or components within.

In **2003**, the **European Union (EU)** published a regulation to restrict NPs and NPEOs as a new entry 46 to Annex XVII<sup>18</sup> to **Registration, Evaluation and Authorization of Chemical Substances (REACH)**.

The regulation said "NP and NPEOs shall not be placed on the market, or used, as substances or in mixtures in concentrations equal to or greater than 0.1 % by weight for the following purposes, including textiles and leather processing except: processing with no release into waste water, systems with special treatment where the process water is pretreated to remove the organic fraction completely prior to biological waste water treatment (degreasing of sheepskin)."

Further in **2016, the European Union (EU)** published a stricter regulation to restrict NPEOs in textile products as a new entry 46a to Annex XVII. This entry came into force on **3<sup>rd</sup> February 2021** and is applicable to textiles that can reasonably be expected to be washed in water during their life cycle.

*"NPEOs shall not be placed on the market after 3 February 2021, in textile articles that can reasonably be expected to be washed in water during their normal lifecycle, in concentrations equal to or greater than 0.01 % by weight of that textile article or of each part of the textile article."*

The **Canadian Environmental Protection Act of 1999's** Schedule 1 (the Toxic Substances List) contains a listing for nonylphenols (Environment Canada, 2013a). Since 2004, nonylphenol use has been gradually reduced in Canada, and the majority of nonylphenol users are now obligated to develop and carry out pollution prevention plans. One of the proposed risk management objectives was to achieve a 95% reduction of NPEOs in the formulation of processing aids used in textile wet processing and a 97% reduction in the annual use of NP and NPEOs by the textile sector.

The readers can refer to our previous reports on **nonylphenols in detergents**<sup>19</sup> and **nonylphenols in drinking water**<sup>20</sup> for a review of NP and NPEO regulations in water and other products.

At Chemical Review Committee (CRC)<sup>15</sup> of the **Rotterdam Convention (October 2019)**<sup>21</sup>, it was concluded that some notifications for NPs and NPEOs were found to meet the criteria set out in Annex II of the Convention but noted that the successful notifications come from only one PIC region. Notifications from two PIC regions are required before a chemical can be listed in the Convention.

17 <https://ecology.wa.gov/Regulations-Permits/Reporting-requirements/Childrens-Safe-Products-Act-Reporting/Chemicals-of-high-concern-to-children>

18 <https://echa.europa.eu/substances-restricted-under-reach>

19 <https://toxicslink.org/wp-content/uploads/2022/08/Nonylphenol-Dirty%20Trail%20Detergent%20to%20Water%20Bodies.pdf>

20 <https://toxicslink.org/wp-content/uploads/2022/08/Toxics%20Link%20-%20Nonylphenol%20Report.pdf>

21 <https://enb.iisd.org/events/15th-meeting-chemical-review-committee-crc-15-rotterdam-convention-prior-informed-consent-3>



# 06

## Status of Nonylphenol in India



**Indian Textile industry is expected to grow from USD 140 billion industry in 2018 to USD 223 billion industry by 2023.**

One of the oldest industries in India, the textile sector contributes approximately 2% to the country's GDP and 7% of industry output in value terms (2019-20). India is the sixth largest apparel and textile exporter of the world (Economic Survey 2020-21). The Textiles and Apparel industry in India plays a major role in generating jobs and 'Make in India' campaign, employing 45 million people directly and 60 million in allied sector (Economic Survey, 2019- 20). Indian Textile industry is expected to grow from USD 140 billion industry in 2018 to USD 223 billion industry by 2023.

**The Indian government has identified textiles as a high emission intensity sector and therefore, most of the efforts are directed towards reducing emission intensity and carbon dioxide such as, air quality improvement, energy efficiency, solid waste, wastewater treatment, and renewable energy, for mainstreaming sustainability and circularity in textile value chain. The Textile Ministry also launched Project SU.RE. – Sustainable Resolution in 2019, which is commitment by India's textile industry to establish sustainable pathway for the fashion industry. However, there is a very little focus on the toxic chemicals used in textiles. The adoption of safer chemicals in textiles is key to achieving a sustainability and circularity in the textile value chain.**

China and India are the biggest manufacturers of NPs.<sup>22</sup> As per the DGFT website (<https://www.dgft.gov.in/CP/>), India is importing and exporting NPs under the HS Code 29071300 (monophenols- octylphenol, nonylphenol and their isomers; salts thereof). In 2021-22, the top importers were Republic of Korea followed by Taiwan and Japan; whereas the top exporters were Malaysia, Singapore and United Arab Emirates. According to 2020-21 data, Maharashtra was the top exporting state of these chemicals in India.

Import/Export data	Quantity (kg)		
	2019-20	2020-21	2021-22
Import	7335287	3818500	4033184
Export	3465986	4033184	2924547

NPs have multiple uses in various products and processes; however, they are commonly used for the manufacture of NPEOs, which are widely used in surfactants. **A number of studies, as given below, have confirmed the presence of NPs in various environmental matrices in India.**

NP concentrations up to 2200 ng/L were observed in three rivers from southern India (Selvaraj et al., 2014). NP has been detected in the Indian marine environments ranging from 1.22 to 7.24 µg/L in water and 3.31 to 30.96 µg/kg in sediments (Raju et al., 2018). Recently, Saha et al. (2022) soil and their potential human health risks under Indian conditions. In the present work, the occurrence of eleven endocrine disrupting chemicals namely bisphenol-A, triclosan, triclocarbon, 4-nonylphenol, 4-tert octylphenol, methyl paraben, propyl paraben, butyl paraben, benzyl butyl phthalate, di (2-ethylhexyl demonstrated the presence of NP in river water samples (0.32–10.22 ng/g), agricultural soil samples (0.35–21.77 µg/L) and groundwater samples (0.63–2.1 µg/L). These studies indicate the usage of NPs in India. However, there is no specific study on monitoring the concentrations of NP and NPEOs in textile products sold in Indian markets.

Here, it is to be noted that the studies conducted by Greenpeace during 2011–2013 on imported products have found the presence of NPEOs in the textile items from all the textile manufacturing hubs of Asia including India. In a 2012 study<sup>23</sup>, Greenpeace analyzed NPEOs in Indian-manufactured imported child textile items (trouser), women items (blouse, top, dress and underwear) and man t-shirt and found concentrations ranging from 6.3–4000 mg/kg.

Though these compounds are well studied for their environmental and human health concerns and are under the lens of the regulatory agencies in several countries, these chemicals are hardly regulated in India. In 2009, India prohibited the use of NP in cosmetic products (Bureau of Indian Standards (BIS); **IS 4707-2 (2009)**), but there is no regulation or standard on its use in surfactants or other consumer products including textiles.<sup>24</sup>

22 <https://theconversation.com/how-the-man-made-chemical-nonylphenol-hampers-the-growth-of-fresh-produce-139136>

23 [https://archivo-es.greenpeace.org/espana/Global/espana/report/contaminacion/151012\\_Technical%20Note\\_Product%20Testing%20Report\\_%20With%20Exec%20summary.pdf](https://archivo-es.greenpeace.org/espana/Global/espana/report/contaminacion/151012_Technical%20Note_Product%20Testing%20Report_%20With%20Exec%20summary.pdf)

24 Bureau of Indian Standards (BIS). India Standard: Classification of Cosmetics Raw Materials and Adjuncts Part 2: List of Raw Materials Generally Not Recognized as Safe for Use in Cosmetics and Adjuncts (Third Revision). 2009. Accessed May 24, 2023. <https://law.resource.org/pub/in/bis/S11/is.4707.2.2009.pdf>



# 07

## Research Study



### RATIONALE OF THE STUDY

Considering the harmful impacts of NP and the global actions to phase out the use of this chemical in products, in 2018, Toxics Link conducted a detailed assessment on the presence of NPEOs in detergent samples collected from the Indian market and in river water samples collected from different parts of the country. That study reported the presence of NPEO in detergents from 0.82 wt% to as high as 11.92 wt%. Further, water samples collected from various rivers in that study also showed high NPEO concentrations, ranging from 9.2–41.3 mg/L. The highest concentration in that study was found in Bandi River (41.3 mg/L) in Pali, Rajasthan which is a known textile hub of the country indicating excessive use of NPEOs in textile industries.

As NPEOs were widely detected in detergents and surface waters, there was a high possibility that the drinking water is also contaminated with NP and its EOs. Therefore, in 2021, Toxics Link also came up with a report on the presence of NPEOs in drinking water samples (29.1–80.5 µg/L) collected from various geographical regions of the country.

In continuation with our efforts to catalyse actions to address this concern and for phasing out the use of this chemical in textile and other consumer products, Toxics Link has now come up with this report to highlight the issues pertaining to NPs in textile products available for sale in the Indian market.

NPEOs are used during the manufacturing of textile products, primarily as surfactants and detergents, which can result in release of NPEOs from textile manufacturing facilities. It is also most likely that some NPEO residues are retained in the finished textile products and released during normal washing. Once released to the environment, NPEOs can be converted into NPs, which are persistent, bioaccumulative and known toxic compounds impacting the environment and marine life. Further the chemical can enter the food system through the food chain. Moreover, the consumers can be directly exposed to these chemicals through skin contact and ingestion (for example, children sucking on clothes corners and mittens).

**This group of chemicals has been accepted as the chemical of high concern and efforts are being made in the European Union for restricting the use of this chemical in various products, including textiles. The Countries such as Japan, China, USA and Republic of Korea have also acknowledged the dangers of this chemical and come up with regulations to restrict its use in textile and other products. The United Nations Environment Programme has also designated NP as a chemical of global concern.**

In contrast to the efforts made by several countries and international organizations to restrict the use of the chemical of high concern, India currently faces significant gaps in addressing this issue.

## **METHODOLOGY**

Twenty three textile products belonging to a wide range of clothing brands were purchased for this study, out of which, three were bought online, while the remaining were purchased from the nearby market. The study covered a variety of items, including **vest, innerwear, t-shirt, jeans, sleepsuit, and towels designed for men, women and kids.**

Twelve out of 23 products were made up of cotton, one was 95% modal 5% elastane, and the fabrics of the remaining products were not mentioned on the product label. The place of manufacture of seven products was not mentioned on the product label or cover. One product was manufactured in Bangladesh and the remaining 15 items were manufactured in India.

After purchasing the items, they were sealed in zip lock covers, labelled and sent to Eurofins Spectro Analytical Labs Private Limited, New Delhi for analysis.



Sr. No	Samples	Material	Manufactured	Nonylphenol Ethoxylate (NPEO) (%)	Nonylphenol Ethoxylate (NPEO) (mg/kg)	Cost per piece
<b>ADULT TEXTILE PRODUCTS (MEN)</b>						
1	MENS VEST	Premium Cotton	India	0.04	400	100
2	MENS VEST (Duplicate)	Premium Cotton	India	0.0178	178	100
3	MENS INNERWEAR	100% Premium Combed Cotton	India	ND	ND	120
4	MENS INNERWEAR	100% Cotton	India	0.0211	211	160
5	MENS VEST	100% Egyptian Cotton	India	0.0178	178	209
6	MENS VEST	100% Super Combed Cotton	India	ND	ND	349
<b>ADULT TEXTILE PRODUCTS (WOMEN)</b>						
7	WOMENS INNERWEAR	100% Combed Cotton	India	0.0072	72	121
8	CAMISOLE	100% Combed Cotton	India	ND	ND	299
9	CAMISOLE	Modal Lace Camisole (95% Modal 5% Elastane)	India	ND	ND	545
10	T-SHIRT (WOMEN)	Unknown	Bangladesh	ND	ND	274
11	WOMEN JEANS (BELLBOTTOM)	Unknown	Unknown	ND	ND	875
<b>BABY AND CHILDREN PRODUCTS</b>						
12	KIDS SLEEPSUITS (0–3 months)	100% Soft Cotton	Unknown	ND	ND	175
13	KIDS SLEEPSUITS (0–3 months) (Duplicate)	100% Soft Cotton	Unknown	ND	ND	175
14	BABY UNDERWEAR (CARTOON)	Unknown	India	0.0145	145	102

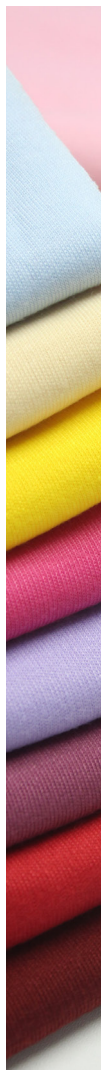
Sr. No	Samples	Material	Manufactured	Nonylphenol Ethoxylate (NPEO) (%)	Nonylphenol Ethoxylate (NPEO) (mg/kg)	Cost per piece
15	BABY UNDERWEAR (Character)	Combed Cotton	India	0.0018	18	150
16	KIDS JEANS	Unknown	Unknown	0.0516	516	625
17	KIDS-T-SHIRT	Unknown	Unknown	ND	ND	329
18	BOYS KIDS T-SHIRT	Rich Cotton	India	Multicolor Print on fabric: 1.1093 Fabric: 0.0067 Total: 1.116	Multicolor Print on fabric: 11093 Fabric: 67 Total: 11160	260
19	BOYS JEANS	Unknown	Unknown	0.0101	101	387
20	BOYS VEST	Unknown	India	ND	ND	378
21	Mitton booty set	100% Cotton	India	ND	ND	210
<b>OTHER PRODUCTS</b>						
22	TOWEL (ASSORT)	Unknown	Unknown	ND		406
23	TOWEL	100% Cotton	India	0.1		200

ND: not detected.

## ANALYTICAL METHOD

The samples were extracted and analyzed for NPEO using **ISO 18254-1** method<sup>25</sup> using LC-MS. Briefly, approximately 1 g of the cut textile (5 mm × 5 mm) was extracted with methanol in an ultrasonic bath at 70 °C for (60 ± 5) min. After cooling the extract to room temperature, about 1 ml of the extraction solution was filtered into an HPLC vial using a disposable syringe equipped with a membrane filter. The detection and quantification of defined NPEOs (2 to 16 ethoxylates) were conducted using LC/MS with gradient elution and ESI mass spectrometer.

<sup>25</sup> <https://www.iso.org/standard/70906.html>





# 08

## Results and Discussions



Some studies have highlighted the presence of NPEOs in textile products in other countries, including imported textile products from India. However, to the best of our knowledge, this is the first study analysing the presence of NPEOs in textile products for sale in the Indian market. The major findings from this study are as follows:

- Out of **23 textile products**, NPEOs were detected in **11 products** (about 44%)
- NPEO concentrations ranged from **18–11160 mg/kg** in these 11 products
- NPEOs in 9 out of 11 products were above the present **EU limit (<100 mg/kg)**. The remaining 2 products having NPEOs below the EU limit were women innerwear and baby underwear
- 8 out of 11 products were manufactured from **cotton**, while the raw materials for the three other items were not mentioned on the product
- 9 out of 11 products were manufactured in India, while the place of manufacturing of the remaining 2 items (children jeans) was not known
- The boys kids T-shirt with multicolour print on the fabric had the highest NPEO concentration (**11160 mg/kg**)
- All the six men textile items purchased were innerwear products (4 out of these 6 items had NPEOs (178–400 mg/kg)
- 50% (5 out of 10) baby and children products had NPEOs (18–11160 mg/kg)

In this study, **8 out of 11 products** having NPEOs were made up of **cotton** (raw material of two products was not mentioned). This was also observed in previous research reports, where NPEOs were detected in several cotton products, including those imported from India<sup>26,27,28</sup>. One of the possible reasons for the detection of NPEOs in cotton products may be due to the use of these non-ionic surfactants in washing and scouring of cotton.

This study reported NPEOs only in the domestic (Indian) brands, and no NPEOs were reported in the products of international brands. This demonstrates that the domestic brands have not taken any efforts to minimize or phase out the use of NPEOs. The major reason for this is the lack of restrictions on the use of NPEOs in India. On the other hand, the Indian manufacturers producing textile products for international brands seem to be aware of the ramification of the use of NPEOs in the products. This also reflects that, although the Indian manufacturers have the capacity to manufacture textile products by restricting the use of NPEOs, are not shifting to sustainable alternatives due to the lack of regulations in India. The study also tried to analyse the cost of the samples with respect to the presence of NPEOs, however no such correlation could be established.

The presence of NPEO residues in textile products has raised concerns about the use of NPEOs as a surfactant in textile manufacturing processes in India. It is also pertinent to mention that the test results are not conclusive proof to estimate the NPEO usage during its manufacturing as residue levels in the final products will depend on a number of factors, including the number and efficacy of wash cycles the products are subjected to during the finishing stage. If NPEOs are more efficiently washed out from materials during manufacture and finishing, it will inevitably result in lower levels of NPEO residues in the final product. But at the same time, the washing process would lead to an increase in the quantities of NPEOs released via wastewater.

**One of the possible reasons for the detection of NPEOs in cotton products may be due to the use of these non-ionic surfactants in washing and scouring of cotton.**

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26 <https://www.greenpeace.org/international/publication/6889/toxic-threads-the-big-fashion-stitch-up/>

27 <https://www.greenpeace.to/greenpeace/wp-content/uploads/2014/02/Technical-Report-01-2014.pdf>

28 [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1026176/Nonylphenol\\_ethoxylates\\_in\\_imported\\_textiles\\_-\\_withdrawn.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1026176/Nonylphenol_ethoxylates_in_imported_textiles_-_withdrawn.pdf)

# Conclusions and Recommendations

The absence of restrictions in India poses significant concerns as it can lead to the continued use of these chemicals in textile manufacturing, potentially exposing workers, consumers, and the environment to their harmful effects, considering the endocrine disrupting property of NPs. The lack of regulations also undermines efforts to ensure the safety and well-being of individuals and to meet international standards for chemical management.

Furthermore, the absence of stringent measures in India creates a potential discrepancy in trade practices. With other countries implementing regulations and restrictions, Indian textile products containing toxic chemicals may face barriers or trade limitations in the global market. This could hinder the competitiveness of the Indian textile industry and affect its reputation in terms of sustainability and responsible manufacturing practices. It is essential for India to recognize the concerns associated with some chemicals and prioritize their regulations and restrictions in various sectors, especially textiles. By aligning with international efforts and adopting strict measures, India can safeguard its population, promote sustainable manufacturing practices, and ensure compliance with global standards for chemical management.

Incidentally the textile Committee (TC) of Government of India has entered into a Cooperation Agreement with United Nations Environment Programme on “**Mainstreaming Sustainability & Circularity in the Textiles Sector**” to minimize the negative environmental impacts of the Indian textile industry by promoting sustainable practices and mainstreaming knowledge of best practices in circular production in the textile and apparel sector. This project must address the concerns of the toxic chemicals like Nonylphenol in the textiles sector by phasing out the use of such toxic chemicals and replacing them with sustainable alternatives.

Therefore efforts should be made;

- To phase out NPEOs, used as surfactants, with suitable alternatives available in the market
- Critical Standards for NPs and NPEOs in textile products consistent with the global standards
- More research studies to elucidate the impact of NPEOs on the ecosystem
- To prepare a comprehensive plan to restrict or phase out toxic chemicals such as NPEOs wherever as possible



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## ANNEXURE-I: NONYLPHENOLS AND NONYLPHENOL ETHOXYLATES DETECTED IN TEXTILE PRODUCTS ACROSS DIFFERENT STUDIES

Study	Country	Findings
<b>Greenpeace 2012<sup>29</sup></b>	18 countries—including 10 within the EU and representing 13 different countries of manufacturing	<ul style="list-style-type: none"> <li>• 52 of the 78 articles showed the presence of Nonylphenol ethoxylates (NPEOs) at concentrations above 1 mg/kg</li> <li>• NPEO levels in plain fabric samples ranged from &gt;1 to 1100 mg/kg</li> <li>• NPEO levels in samples bearing a plastisol print ranged from 5 to 27000 mg/kg</li> </ul>
<b>Greenpeace 2012<sup>30</sup></b>	27 countries/ regions around the world	<ul style="list-style-type: none"> <li>• NPEOs were detected in fabric of 61% of the 82 articles investigated, with concentrations ranging from 1.2 to 17000 mg/kg</li> </ul>
<b>Greenpeace 2013<sup>31</sup></b>	25 countries across the world	<ul style="list-style-type: none"> <li>• NPEOs detected in fabrics from 12 of 27 articles, with concentrations ranging from 1.7 to 760 mg/kg</li> </ul>
<b>Danish Ministry of the Environment 2013<sup>32</sup></b>	15 textile samples were analysed for content of NP and NPE (before washing)	<ul style="list-style-type: none"> <li>• Total NPs (including NPEOs) ranged from 1.2 to 112.6 mg/kg</li> </ul>

## ANNEXURE-II: INITIATIVES FOR SUSTAINABLE TEXTILE PRODUCTION

Several initiatives and certification systems have been undertaken globally to reduce the use of chemicals (including alkylphenols such as NPs). Some of these initiatives are highlighted below:

### Oeko-Tex

Oeko-Tex (<https://www.oeko-tex.com/en/>) is a registered [trade mark](#), representing the product labels and company certifications issued and other services provided by the International Association for Research and Testing in the Field of Textile and Leather Ecology (Oeko-Tex in short) with headquarters in [Zürich](#) (Switzerland) and founded in 1992.

Sustainable Textile Production (STeP) is the new Oeko-Tex certification system for brands, retail companies and manufacturers from the textile chain. Certification is possible for production facilities of

29 [https://www.greenpeace.org/static/planet4-international-stateless/2012/03/806ceff8-dirty\\_laundry\\_product\\_testing\\_technical\\_report\\_01-2012.pdf](https://www.greenpeace.org/static/planet4-international-stateless/2012/03/806ceff8-dirty_laundry_product_testing_technical_report_01-2012.pdf)

30 [https://archivo-es.greenpeace.org/espana/Global/espana/report/contaminacion/151012\\_Technical%20Note\\_Product%20Testing%20Report\\_%20With%20Exec%20summary.pdf](https://archivo-es.greenpeace.org/espana/Global/espana/report/contaminacion/151012_Technical%20Note_Product%20Testing%20Report_%20With%20Exec%20summary.pdf)

31 <https://www.greenpeace.org/static/planet4-thailand-stateless-release/2019/09/192afd2f-a-little-story-about-the-monsters-in-your-closet-technical-report.pdf>

32 <https://www2.mst.dk/Udgiv/publications/2013/02/978-87-92903-94-5.pdf>

all processing stages. The production sites certified in accordance with STeP must comply with a certain wastewater criteria, which also includes limits for alkylphenols and alkylphenol ethoxylates.

Parameter	Limit value (µg/L)
Nonylphenol	5
Octylphenol	5
Nonylphenol Ethoxylate	5
Octylphenol Ethoxylate	5

Oeko-Tex certification system also requires the textile products to follow specific limits for alkylphenols (surfactants/wetting agent residues).

Alkylphenols (mg/kg)	Baby	Direct contact with skin	With no direct contact with skin	Decoration material
Sum of BP, NP, OP, HpP, PeP	10	10	10	10
Sum of BP, NP, OP, HpP, PeP, NPEO, OPEO	100	100	100	100

\*BP: 4-tert-butylphenol, NP: nonylphenol, OP: octylphenol; HpP: heptylphenol; PeP: pentylphenol, NPEO: nonylphenol ethoxylates, OPEO: octylphenol ethoxylates

## EU Ecolabel

The **EU Ecolabel** is the official European Union voluntary label for environmental excellence. It was established in 1992 and is recognised across Europe and globally. The criteria for EU Ecolabel for Textiles ([https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1403869165475&uri=OJ:JOL\\_2014\\_174\\_R\\_0015](https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1403869165475&uri=OJ:JOL_2014_174_R_0015)) limits the use of substances harmful for the environment during manufacturing. It states that the following alkylphenol substances shall not be used in any preparations or formulations used for textiles and are subject to limit value of 25 mg/kg (sum total) for the presence of substances on the final product:

Nonylphenol, mixed isomers

- 4-Nonylphenol
- 4-Nonylphenol, branched
- Octylphenol
- 4-Octylphenol
- 4-tert-Octylphenol



Alkylphenolethoxylates (APEOs) and their derivatives:

Polyoxyethylated octyl phenol

Polyoxyethylated nonyl phenol

Polyoxyethylated p-nonyl phenol

## **Zero Discharge of Hazardous Chemicals**

Zero Discharge of Hazardous Chemicals (ZDHC) Programme (<https://apparelcoalition.org/collaboration-impact-zdhc/>) is a collaboration of leading brands, value chain affiliates, and associate contributors committed to advancing towards zero discharge of hazardous chemicals in the textile, leather, and footwear value chain, thereby reducing harm to the environment and human well-being. The ZDHC Manufacturing Restricted Substances List (ZDHC MRSL) (<https://mrsl.roadmaptozero.com/>) is a list of chemical substances banned from intentional use in the processing of textile materials, leather, rubber, foam, adhesives and trims used in textiles, apparel, and footwear industry. Intentional use means the substance used deliberately in a chemical product to achieve a desired look or functionality. The ZDHC MRSL includes Alkylphenol (AP) and Alkylphenol Ethoxylates (APEOs) and all their isomers.

## **Global Organic Textile Standard**





The Global Organic Textile Standard (GOTS) (<https://global-standard.org/>) is the global leading textile processing standard for organic fibres, including ecological and social criteria, backed up by independent certification of the entire textile supply chain. GOTS certified final products may include fibre products, yarns, fabrics, clothes, home textiles, mattresses, personal hygiene products, as well as food contact textiles and more. GOTS ensures that all prohibited substances (including NPEs) are excluded from the GOTS certified supply chain through a combination of complementary control measures.

Organization for Economic Cooperation and Development (OECD) has come up with OECD Due Diligence Guidance for Responsible Supply Chains in the Garment and Footwear Sector ([https://www.oecd-ilibrary.org/governance/oecd-due-diligence-guidance-for-responsible-supply-chains-in-the-garment-and-footwear-sector\\_9789264290587-en](https://www.oecd-ilibrary.org/governance/oecd-due-diligence-guidance-for-responsible-supply-chains-in-the-garment-and-footwear-sector_9789264290587-en)). This Guidance Document was adopted in 2017. One of the modules of the Guidance focuses on hazardous chemicals.





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-  <https://www.youtube.com/user/toxicslink2012>
-  [www.toxicslink.org](http://www.toxicslink.org)