Introduction

We as Lidl are serious about our extended responsibility towards our customers, workers and the environment. Being the first food retailer to join the Greenpeace Detox Campaign end of 2014, we are striving to ban 11 prioritised group of chemicals defined by Greenpeace from the production of textiles and shoes. These chemicals are of concern to human health and the environment and we intent to eliminate these substances by 2020 from the production of textiles and shoes.

Abbreviations

Overview of the abbreviations used in the text:

AP	Alkylphenolethoxylate
APEO	Alkyphenolethoxylate
NP	Nonylphenol
NPEO	Nonylphenolethoxlyte
OP	Octylphenolethoxylate
OPEO	Octylphenolethoxylate
RL	Reporting Limit
ETP	Effluent Treatment Plant

What are APs & APEOs

Alkylphenols (APs) and Alkylphenolethoxylates (APEOs) belong to the chemical class of non-ionic surfactants having an emulsifying effect.

The APs/APEOs represent one class of chemicals of high concern to human health and the environment and thus we are set to ban their use from the production of textiles and shoes.

Alkylphenols (APs) are basic chemicals which are used as intermediates to produce chemicals of high value. Short chain Alkylphenols occur naturally in crude oil and crude oil containing rock layers. Nonylphenol and Octylphenol are commercially relevant and produced industrially by alkylation of phenol with nonene or octene respectively, with alkylation of the phenol possible in ortho, meta or para position. Technically nonene and octene do not consist of the C_9H_{18} / C_8H_{16} α-olefin solely, they rather are mixtures of highly branched olefins. Subsequently, the AP formed is also a mixture of different isomers.

APEOs are produced by reaction of AP with ethylene oxide under basic conditions. Generally branched isomers with different chain lengths are obtained. The ethoxylate chain length can range in between n = 1 to n = 100 units for commercially available products.

Alkyphenoles (AP) and Alkylphenole ethoxylate (APEO)	
Substance	CAS RN
Nonylphenol (NP) mixed isomers	104-40-5 11066-49-2 25154-52-3 84852-15-3 90481-04-2 1173019-62-9
Octylphenol (OP) mixed isomers	140-66-9 1806-26-4 27193-28-8
Octylphenol Ethoxylates (OPnEO), n ≈ 1-2	various
Octylphenol Ethoxylates (OPnEO), n ≈ 3-18	9002-93-1 9036-19-5 68987-90-6
Nonylphenol Ethoxylates (NPnEO); n ≈ 1-2	various
Nonylphenol Ethoxylates (NPnEO); n ≈ 3-18	9016-45-9 26027-38-3 37205-87-1 68412-54-4 127087-87-0

Table 1: Commercially relevant APs & APEOs

Properties and Usage of AP & APEOs:

APEOs are important surface-active agents, with good emulsification, dispersion and solubilizing properties. NPEO is used for industrial applications including paper production, textile production, pesticide formulations, paints and coatings, technical and household cleaners, production of plastics, resins and stabilizers and in personal care products. OP is primarily used in the production of phenolic resins.

Commercially most relevant are nonylphenol (NP) with a 9-carbon alkyl group, para-tert-octylphenol (ptOP) with a 8-carbon alkyl group and the corresponding nonylphenolethoxylates and octylphenolethoxylates see table 1. NP and ptOP are basically used to produce NPEO and OPEO, which are used in a vast variety of technical applications. NPEOs comprises roughly 80 percent and OPEOs about 20 percent of the APEOs on the market. About 90 percent of the APEOs used in the textile and leather industry are NPEOs.

The large production volumes and the widespread use of APEOs has led to a widespread release to environmental media. APs and APEOs have been detected in various aquatic environment: drinking waters, coastal and marine ecosystems, rivers, lakes, sediments, sludges and groundwaters. The occurrence of APEOs correlates strongly with the discharge of waste water relating to industrial/urban areas. [1]

What is the cause of concern with APs & APEOs

High molecular APEOs break down to low molecular APEOs and finally APs in nature. The different APEOs and APs vary in their toxicological effect. The most relevant toxicological effects are their endocrine disruptive behavior and their aquatic toxicity [2].

APs themselves hardly break down in nature into smaller fragments. APs are toxic to aquatic life, have an impact on fertility of fish. There are hints that APs also have adverse effects on human fertility [3].

Thus the EU restricted the marketing of NPEOs and NPs in higher concentrations than 0.1 percent in product formulations (Directive 2003/53/EC). The EU is further enforcing the phase out of APEOs and prohibited the placing of textiles on the market with NPEO-levels equal to or exceeding 0.01% (w/w). This regulation will become effective February 3rd, 2021 [4].

Current status of AP/APEO-usage

In order to determine the current status of occurrence of AP & APEO usage within our supply chain we

(1) analysed existing test results of quality control with regards to the occurrence of AP/APEO-findings
(2) initiated a root cause analysis at factories having an issue with APEOs
(3) evaluated the data of the waste water testing conducted so far

(1) Analysis of test results of quality control

As all our products are checked for quality we decided to first investigate the test results of the quality control department. In 2015 in nearly 360 000 chemical lab tests were performed for quality assurance on textiles and 22912 for shoes. 21 180 (textile: 20347; shoes: 833) of these tests were conducted with regards on the occurrence of the APs and APEOs (see table for APs & APEOs and the limits).

Alkyphenole (AP) and Alkylphenol Ethoxylate (APEO) (inkl. aller Isomere)		
substance	CAS RN	Limit (mg/kg)
Nonylphenol (NP) mixed isomers	104-40-5 11066-49-2 25154-52-3 84852-15-3	Sum < 10
Octylphenol (OP) mixed isomers	140-66-9 1806-26-4 27193-28-8	
Octylphenol Ethoxylates (OPEO)	9002-93-1 9036-19-5 68987-90-6	Sum with NP, OP < 100
Nonylphenol Ethoxylates (NPEO)	9016-45-9 26027-38-3 37205-87-1 68412-54-4 127087-87-0	

Table 2:Excerpt from the actual Lidl-RSL with corresponding limits.

In 365 (textiles: 351, shoes: 14) cases the threshold value for APs/APEOs was violated, which corresponds to 1.7 % (textiles: 1.7%; shoes: 1.7%) in total.

(2) Audits on the status of APEO-usage

Audits on the status of APEO usage have been conducted. The goal was to identify the root cause for the APEO-finding and subsequently work methodically on a substitution of the APEO.

We have chosen products with a violation of the APEO-limit, identified the corresponding factories and commissioned a root cause analysis of three factories with regards to the usage and occurrence of APEOs.

Two factories had their own dyeing units on-site. One factory was a RMG producer only and the corresponding mill had to be identified.

As a service provider we have mandated ***Sustainable Textile Solutions*** to conduct the root-cause analysis. The audits were designed that way, that the chemical inventory was analysed, the chemical management and machinery checked, certificates looked for with the focus on identifying the APEOs.

In total 15 chemicals have been identified in these factories as possible sources for APEOs, amongst others soaping agents, scouring agents, detergents, levelling agents, wetting agents. For these chemicals the information at hand was not sufficient to exclude APEOs. Subsequently samples of these chemicals were analysed in accredited laboratories for APEOs. All tested samples were free of APEO.

(3) Analysis of the results of waste water testing

We analysed 94 waste water tests which have been conducted in factories producing for Lidl with regards to APs/APEOs. The samples for the waste water tests have been taken at factories located in Bangladesh and in China.

In 27 cases APs/APEOs have been detected in the effluent water stream (table 3, column after treatment) with maximum values of 10 µg/l for NP, 172 µg/l for NPnEO (n ≈ 1-2) and 24 µg/l for NPnEO (n ≈ 3-18). OPEOs haven't been detected in the effluent stream, but as the data clearly shows are in usage (table 3, columns 2 & 3).

Thus roughly 30 % of the factories which have been tested did show a AP/APEO release in the effluent water stream.

One of the waste water test results clearly showed a pollution of the incoming water with a measured concentration for NPnEO (n ≈ 3-18) of 25 µg/L.

Substance	CAS RN	Method	RL	Inlet	Before Treatment	After Treatment
Octylphenol	various 140-66-9, 27193-28-8, 1806-26-4	With Reference to DIN EN ISO 18857 and followed by LC/MS analysis	1 µg/L			
Nonylphenol	various 25154-52-3, 104-40-5, 90481-04-2, 84852-15-3, 1173019-62-9	With Reference to DIN EN ISO 18857 and followed by LC/MS analysis	1 µg/L		6	10
NPEO, n ≈ 1 - 2	various	With Reference to DIN EN ISO 18857 and followed by LC/MS analysis	1 µg/L		41	172
NPEO, n ≈ 3 - 18	various 9016-45-9, 26027-38-3 68412-54-4, 127087-87-0, 37205-87-1	With Reference to DIN EN ISO 18857 and followed by LC/MS analysis	1 µg/L	25	338	24
OPEO, n ≈ 1 - 2	various	With Reference to DIN EN ISO 18857 and followed by LC/MS analysis	1 µg/L		20	
OPEO, n ≈ 3 - 18	various 9002-93-1, 9036-19-5, 68987-90-6	With Reference to DIN EN ISO 18857 and followed by LC/MS analysis	1 µg/L		5	

Table 3: Evaluation of waste water testing. For a waste water test three samples are taken: a) inlet - this is the fresh water the factory is sourcing, b) Before treatment – influent water to the ETP after it has been used in the production and c) after treatment - effluent water from the ETP after treatment. All data reported represent the maximum concentrations observed. If a measured concentration is higher than RL (Reporting Limit) then the value is reported.

Summary and discussion

Occurrence of APs & APEOs within our final products is very low (1.7 %) as the data of the quality control of the final product clearly shows. This in general indicates that our suppliers/producers are sensitive to not use APs & APEOs for a Lidl production and that it is possible to avoid APs & APEOs.

The results from the waste water testing shows that APs & APEOs are still being used at factories within our supply chain. Nearly 30 % of the factories tested so far do release APs & APEOs with their effluent water stream. There seems to be a discrepancy to the data from the quality control of the final product as this indicates a much lower use of APEOs. A possible explanation for this result may be, that the factories are not fully aware of which chemical products in use contains APEOs.

Another factor to be considered is that APEOs could be contained in auxiliaries and detergents used in the production of textiles with only a temporary contact to the textile fabric. Thus APs and APEOs could have been used but might not show up in the final test for quality control of the textile product.

The audits with regards to the source of APs & APEOs in the selected factories did not identify the root source of the APs & APEOs. Though articles produced in these factories have been tested positive on APs and APEOs, this demonstrates, that there exist multiple pathways for the entry of APs/APEO.

Conclusion

In General, a control of single article production and the chemical used for it is too short sighted, as it does not take into account of what is happening in the rest of the site. A sound and proper approach is to (a) consider the whole site of operation (b) all chemicals handled therein and (c) the chemical/material suppliers. Awareness across the supply chain has to be raised via trainings and workshops, a proper chemical management will be installed which will take sourcing of chemicals into account.

Follow-up

1) Review of the test data with the suppliers.
2) Initiation of a chemical management system at the factories to comply with increased environmental requirements with regards to APEOs.
3) Capacity building by workshops and trainings for factories.

Lidl strives for bringing about this change to its supply chain and has departed on its way to a better tomorrow.

[1] Tlou B. Chokwe, Jonathan O. Okonkwo, Linda L. Sibali, Esper J. Ncube, Microchemical Journal, Volume 123, pp 230-236, 2015

[2] Huang S.-L., Ngoc Tuan N., Lee K., Current Drug Metabolism, 17, 3, pp 293-302(10), 2009

[3] Jardak K., Drogui P., Daghrir R., Environmental Science and Pollution Research, 4, 23, pp 3195-3216, 2016

[4] see Annex XVII to Regulation EC 1907/2006; https://echa.europa.eu/de/addressing-chemicals-of-concern/restrictions/substances-restricted-under-reach/-/dislist/details/0b0236e180a8d772