# Pesticides in solid waste leachate in Norway

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**Abstract**

It is generally assumed that landfills contain pesticides, at least in areas with a large agricultural production, or near pesticide production sites or retailers. There are about 200 active municipal landfills, but in total more than 3000 sites have been registered in Norway. The total sale of pesticides amounted to 955 ton active ingrediences pr. year in 1998, of which 68 tons, or 7%, included compounds that are not related to agricultural activities. There are about 120 approved active ingredients in pesticides sold in Norway.

The pesticide concentration in the leachate will generally depend on adsorption and degradation inside the waste body and in the leachate, which again depends on the waste characteristics, the management of the landfill, climate, topography, and geology of the site. Also the content and type of colloidal matter and suspended particles in the leachate are important, and pesticides have been reported to be associated more with colloidal mobilized shortly after precipitation events. In the liquid phase, the content and type of organic matter may significantly influence the fate of pesticides.

There are relatively few reports on pesticide concentrations in leachate. Leachate samples from a waste disposal site in Switzerland showed concentrations up to 124 □g/l of mecoprop, and down gradient groundwater with surprisingly high concentrations up to 975 □g/l (Zipper et al., 1998).

In a testing program for leachate characteristics in Sweden, it was found that 5 out of 8 leachate samples contained residues of phenoxy acid herbicides, and only one sample out of 20 of leachate particles contained pesticide residues. Analyses of leachate samples from a landfill in Denmark showed few detections of pesticides.

Here we summarize findings of pesticide residues in leachate samples from 3 major active Norwegian landfills, before and after leachate treatment. The analyses represent grab samples taken both before and after leachate treatment.

Table @. Pesticides and metabolites included in the analyses.

| Pesticide | Type | $logk_{ow}$ | $pK_a$ | Sol. (mg/l) | pol. | Mol. | Location | Class |
|---|---|---|---|---|---|---|---|---|
| 2,4-D | H | 2.7 | 2.64 | 311 | - | 221 | be | aryloxyalcaonic acid |
| atrazin | H | 2.5 | 1.7 | 33 | - | 216 | fw | 1,3,5-triazin |
| bentazon | H | 5.84 | 3.3 | 570 | - | 240 | bes, h,ww,fw | - |
| cypermetrin-alfa | I | 7 | | 0.01 | | 416 | | pyretroid |
| cyprokonazole | F | 2.9 | | 93 | | | | azole |
| DDT | I | | | 0.001 | 0 | 354 | f | organoklorin |
| diazinon | I | 3.3 | | 60 | | 304 | | organic P |
| dikamba | H | 3.98 | 1.87 | 6.5 | - | 221 | | benso-syre |
| dikloroprop | H | 1.77 | 3 | 350 | - | 235 | bes, h, ww | aryloxyalkonic syre |
| dimetoat | I | 0.7 | | 23 | | 229 | fw | organic P |
| endosulfan | I | 4.7 | | 0.3 | | 407 | | organic Cl |
| esfenvalerat | I | 6.2 | | 0.002 | | 420 | | pyretroid |
| fenitrotion | I | 3.4 | | 21 | | 277 | | organic P |
| fenpropimorf | F | 2.6 | 6.98 | 4.3 | + | 304 | b, f | morfolin |
| fenvalerat | I | 5 | | <0.010 | | 420 | f | pyretroid |
| fluazinam | I | | | | | 465 | | 2,6dinitroanilin |
| fluroksypyr | H | -1.2 | 2.94 | 91 | - | 255 | | aryloxyalkonic syre |
| ioksynil | H | | 3.96 | 50 | - | 371 | | OH-benzonitril |
| iprodion | F | 3 | | 13 | | 330 | f | dicarboximid |
| klorfenvinphos | I | 3.85 | | 145 | | 360 | | org.fosfor |
| lindan | I | | | 7 | | 291 | f | org.klorin |
| linuron | H | 3 | | 81 | | 249 | ww | urea |
| mankozeb | F | 1.75 | <<0 | 8.4 | | 279 | h, ww, fw | acylalinin |
| MCPA | H | 2.75 | 3.07 | 734 | - | 201 | be, h, ww | aryloxyalkonic acid |
| mekoprop | H | 1.29 | 3.78 | 860 | - | 215 | bes, fw | aryloxyalkonic acid |
| metalaksyl | F | 1.75 | <<0 | 8.4 | | 279 | h, ww, fw | acylalinin |
| metamitron | H | 0.83 | | 1.7 | | 202 | ww | 1,2,4-triazinon |
| metribuzin | H | 1.58 | | 1 | | 214 | h, ww, fw | 1,2,4-triazinon |
| penkonazol | H | 3.72 | 1.51 | 73 | - | 284 | | azole |
| permetrin | I | 6.1 | | 0.2 | | 391 | | pyretroid |
| pirimikarb | I | 1.7 | pkb | 3000 | + | 238 | | carbamat |
| prokloaz | F | 4.38 | 3.8 | 34 | - | 377 | | azole |
| propaklor | H | 2 | | 613 | | 212 | ww | kloracetanilide |
| propikonazol | F | 3.72 | 1.09 | 100 | - | 342 | fw, f | azole |
| simazin | H | 2.1 | pkb | 6.2 | - | 202 | | 1,3,5-triazin |
| tebukonazol | F | 3.7 | | 32 | | 308 | | azole |
| terbutylazin | H | 3.04 | pkb | 8.5 | - | 230 | | 1,3,5-triazin |
| tiabendazol | F | | 4.73 | 30 (ph 5) | - | 201 | e, fw | benzimidazole |
| vinklozolin | F | 3 | | 3.4 | | 286 | | dicarbox-imid |

Location: b...bølstad landfill, e...Esval landfill, s...Spillhaug landfill, f...forest production landfill, fw...farmland well, ww...water work

**Results and discussion**

Leachate samples with positive detection of pesticides have concentrations between 0.03 – 30.01 µg/l (Table @). Some substances have detection in all samples, such as the phenoxy acids mecoprop and dichloroprop, and bentazone

Table @. Pesticides (µg/l) found in MSW leachate samples in Norway

| Compound | B Oct. 97 | B Oct. 98 | B Sep. 99 | E Oct. 97 | E May 99 | E Oct. 99 | S Oct. 97 | S Oct. 98 | Type |
|---|---|---|---|---|---|---|---|---|---|
| fenpropimorph | | 0.04 | | | | | | | F |
| tiabendazole | | | | 0.4 | | | | | F |
| mecoprop | 1,00 | 0,58 | 1,40 | 1,00 | 8,70 | 9,70 | 0,17 | 0,03 | H |
| MCPA | | | 1,50 | | 0,35 | 0,84 | | | H |
| dichloroprop | 0,40 | 0,10 | 0,22 | 0,04 | 9,10 | 13,00 | 1,10 | 0,04 | H |
| 2,4-D | | 0,05 | 0,08 | 1,80 | 0,04 | 0,57 | | | H |
| bentzone | 0,50 | 0,41 | 0,87 | 0,56 | 5,60 | 5,90 | 1,00 | 0,18 | H |
| klopyralid | | | | | 0,39 | | | | H |
| **Sum pesticides** | **1,90** | **1,18** | **4,07** | **3,80** | **24,20** | **30,01** | **2,27** | **0,25** | |

B=Bølstad, E=Esval, S=Spillhaug Landfills

Table @. Pesticides (maximum concentrations) found in leachate or leachate-polluted groundwater at waste sites in the forest trees nurseries (µg/l)

| Pesticide | Max. C |
|---|---|
| fenvalerate | 0,20 |
| fenpropimorf | 0,15 |
| iprodion | 0,13 |
| lindan | 3,31 |
| propikonazole | 0,25 |
| tolylfluanid | 1,80 |
| DDT | 5,00 |