Some ecological aspects of PVC for irrigation tubes

by Jürg Vogt

1. Introduction

Especially in Europe there has been an intensive discussion about the ecological risks related with the use of PVC. This discussion mainly took place in Germany, Austria, Switzerland and the northern countries. At a certain time, the german government even decided to forbid to use PVC for many applications. Due to the pressure of a very strong lobby organization and due to the fact, that during the discussion some arguments have been exaggerated, this decision was undo again some years later.
Todays situation is, that in spite in Europe the end of PVC was predicted, still huge amounts are used. However, the consumption is constant, whereas other plastics are strongly growing. It is somehow accepted, that PVC is not a very fine solution, but at least it is one - and mostly is is the cheapest one. For packaging PVC has been almost completely replaced by other plastics (PE, PP).

2. Basics about PVC

- PVC is polymerized from Vinylchloride. It contains 57% chlorine, 38% carbon and 5% hydrogen.
- Pure PVC is a hard plastic. It is used in this form for articles like profiles (e.g. window frames), tubes or vinyl music discs.
- As soon as a flexible material is required, plastizicers are added to modify PVC. The higher the amount of plastizicers, the softer the material becomes. The amount of plastizicer can be up to 50%! A plastizicer is (mostly) a liquid, oily chemical substance that is somehow soaked in the PVC. Depending on the quality of the plastizicer, it can be lost during the time by evaporation, extraction by water, powderous materials or chemicals and it can also be extracted by microorganisms. If a part made of soft-PVC becomes hard and brittle after some time, loss of plastizicer will be the reason for this kind of ageing.
- PVC itself is chemically not very stable. That means, if PVC would be processed in pure form, it would degrade immediately. To prevent from this, quite big amounts of stabilizers are used. Such stabilizers contain heavy metals like cadmium, lead, tinn and zinc. In Europe, cadmium stabilizers are mostly replaced by less harmful types. However, lead stabilizers are still widely used. The stabilizers with the best ecological profile are less efficient and more expensive than lead stabilizers.
- If PVC is burned, big amounts of chloric acid are set free. Under special conditions even the formation of dioxides is possible (but not very likely).

3. Main ecological problems with PVC

3.1 Plastizicers

Due to the loss of plastizicers after some time, big amounts of these chemicals have already been spread out over almost the whole world. Some plastiziers are more harmful than others and it is almost an endless discussion about the risk resulting from these substances. In any case, if soft-PVC is in contact with food or potable water, special, much more expensive plastiziers have to be used.

3.2 Heavy metals

As long as cadmium and lead free stabilizers are used, the related ecological problem is not so big. However, it has to be assumed, that soft-PVC that originates from India or Nepal will still contain the less costly, more efficient cadmium or lead types.

3.3 Disposal

If PVC is burnded, chloric acid and heavy metal containing chemicals will be set free. In Switzerland for instance, this is not a very big problem anymore, since in all waste combustion plants large cleaning equipment is installed to wash the exhaust[1]. In cases however, PVC is burned in free nature, it is obvious that the resulting products are highly polluting.
Of course the best solution would be to recycle the material after use. However, this will be hardly possible with dripping pipes since they are dirty and the material has an unknown amount of plastizicer after use. Further more it is a big logistical problem to collect the articles with reasonable costs.

4. Comparison with Polyethylene

All Polyethylenes such as LDPE, LLDPE, HDPE are only built of carbon and hydrogen. Their chemical structure can be easily compared with other carbon hydrogens such as propane gaz, fuel (octene) or very clean mineral oils. When Polyethylene is burned, only water and carbondioxide are set free. Burning causes a big amount of heating energy.
In Polyethylenes, no plastizicers are used. Nevertheless it is possible to make harder or softer grades by modifying the chemical structure[2] (still only using carbon and hydrogen, in some cases also oxigen).
Polyethylens do not require stabilizers like PVC. In general, the amount of stabilizers is very low (less than 1%) and most stabilizers are again built only of carbon, hydrogen and oxigen. Even if Polyethylene is burned under very primitive conditions, the effect will be the same as if fuel or oil was burned.

5. Conclusion

From my point of view, Polyethylene is clearly the better solution for dripping pipes than PVC. The use of PVC is not a catastrophy, but as long as there are better alternatives available, one should prefer those.
Besides the aspect of waste disposal, it has also to be born in mind, that with Polyethylene a longer service life can be expected than with PVC since the problems with loss of plastizicers do not exist and since Polyethylene is by no means attacked by microorganisms.

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[1] Even with this system, big amounts of waste products coming from the filters are produced. These products have to be disposed as hazardous waste.

[2] In my material analysis, I will also include mechanical tests to determine if and how the PVC grade used in Nepal could be replaced by a softer Polyethylene grade. There is a thumb rule, that the softer a Polyethylene grade is, the more expensive it will be (this is only true in case a pure LDPE is not soft enough). Further more softer grades have a lower melting point which can also cause problems under certain conditions.
Before making predictions how difficult the replacement could be, let's wait for the results of the analysis.