LCA STUDY OF TV SETS WITH V0 AND HB ENCLOSURE MATERIAL

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Introduction

For the past 5-10 years there has been an ongoing discussion of possible environmental effects associated with flame retardants. In most cases the focus has been on specific brominated flame retardants but at times the whole group has been considered environmentally questionable by association. Within this context the opinion that "it is better to let things burn more often than to use flame retardants" has been voiced. Upon closer inspection it quickly becomes apparent that there is no work published that would support (or refute) this opinion.

In response to this lack of information a new life-cycle assessment model, the so called "Fire-LCA" model, has been developed. This model aims at weighing the environmental benefit of a high level of fire safety, in terms of a reduction in the size and number of fires, against the environmental cost of the production and use of the flame retardant by which this fire safety is achieved. The model itself has been described in detail elsewhere[1,2]. Thus, this paper concentrates on the first full application of the LCA model to compare a product with a high level of fire safety to one with a lower level of fire safety. The product chosen for this first application is a TV set.

TV Fire Statistics and Fire-LCA model

Most developed countries keep detailed statistics over the frequency and source of fires. Variations in statistics between different countries and different sources within any given country provide information concerning the size and type of fire.

Based on the results of a previous investigation[3] one can define the number of TV fires in Europe and the US. The results of the full statistical division are summarised in Table 1. These statistics cover all TV fires where the enclosure material has been breached. Additional information from Insurance statistics indicates that a further 160 TV fires occur per million TVs each year where the enclosure material is not breached. This number is assumed to be independent of the presence or absence of flame retardants in the enclosure material.

Table 1: FiRe-LCA input for European TV (HB enclosure) and US TV (V0 enclosure) denoting all fires where the enclosure is breached.

European TV	US TV
58 minor	5 minor
88 TV only	
8 full room	
11 full house	

A schematic flow chart describing the Fire-LCA model is also shown elsewhere[4]. In essence the Fire-LCA model represents a modification of a conventional LCA in that it includes emissions from fires.

Results and Discussion

A large number of results are available due to the large number of input parameters present in the model and complex flows through the entire life cycle. Full results are found in reference 4 and only those details relevant for this conference are presented here. Results are presented for a present day scenario and a future scenario. In the present day scenario 1% of TV sets go to incineration, 2% go to disassembly (for recycling) and the rest go to landfill (with the exception of those involved in fires). In the future scenario 1% go to incineration, 89% to disassembly and the rest to landfill. The future scenario has been modelled based on possible future waste treatment system, designed for the year 2010. It should be noted that the TV enclosures from disassembly are directed to incineration. It is assumed that all incineration is run with energy recovery.

A significant decrease is seen in the PAH emissions for the flame retarded (FR) TV relative to the non-flame retarded (NFR) TV (see Figure 1), for both the present day and future scenarios. This is a direct effect of the fact that the NFR TV is involved in a greater number of fires.

Similarly, a significant decrease is seen in the TCDD-equivalents for the FR TV relative to the NFR TV (see Figure 2), for both the present day and future scenarios. The TCDD-equivalents are based on EADON factors as the majority of other input information from other sources throughout the life-cycle cite EADON values. In the full report of this study more recent factors are also considered.

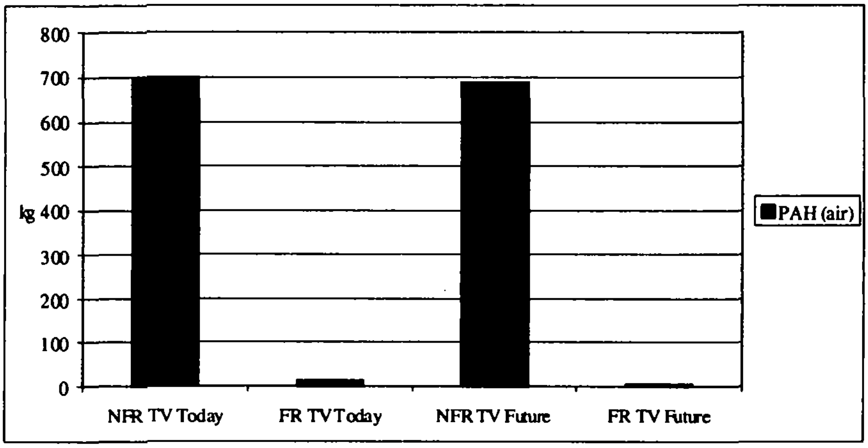

Figure 1: The emission of PAH to the air for 10^6 TV set over their 10 year life cycle.

There is presently no accepted international method of defining TBDD-equivalents. For the sake of simplicity we have assumed that the same factors can be used to define the toxicity of the various members of the PBDD-equivalents as those used for the chlorinated variety. As in the case of TCDD-equivalents, a significant decrease is seen in the TBDD-equivalents for the FR TV relative to the NFR TV (see Figure 2), for the present day scenario. This is changed to an increase in the future scenario.

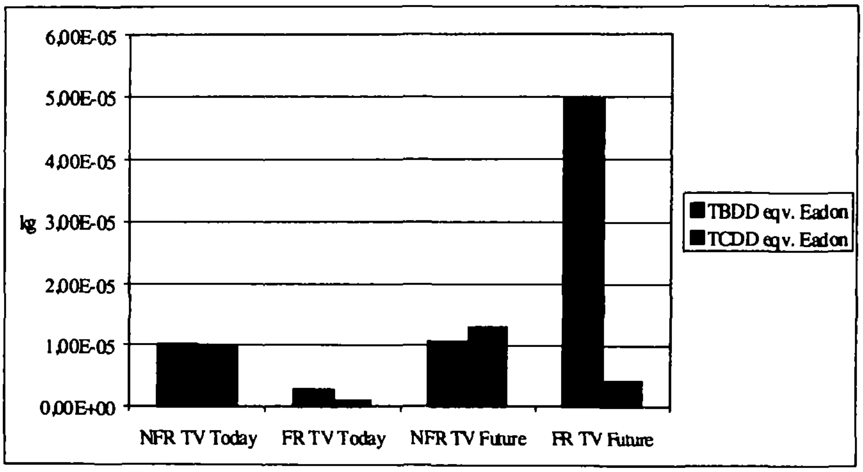

Figure 2: The emission of TCDD and TBDD equivalents to the air for 10^6 TV set over their 10 year life cycle.

Again the result for the present day scenario is a direct effect of the fact that the NFR TV is involved in a greater number of fires than the FR TV. The fact that the TBDD-equivalent emissions increase for the FR TV in the future scenario is a direct result of the allocation of a small amount of TBDD-equivalent emissions to all FR TV enclosures sent to incineration and energy recovery. The TBDD-equivalents are allocated according to bromine content and in our model it is assumed that the dioxin emission limit proposed in the waste directive, i.e., 0.1 ng TCDD eq./Nm^3, is met. Thus, the maximum emissions can be estimated to this value for a normal chlorine content in the waste. Assuming an average halogen content of 5000 mg/kg waste and a flue gas flow of 5 Nm^3/kg waste at 11% O_2, the dioxin emission is estimated to be 0.50 ng TXDD equiv./kg waste or 0.10 ng TXDD-equivalent per g halogen input. The amount of TBDD-equivalent produced is then calculated in direct relation to the amount of bromine input to the energy recovery facility in the form of TV enclosures.

One should note that the production of PAH is many times higher than the production of all types of dibenzodioxins and furans. In light of the large amount of PAH produced throughout the TV life-cycles relative to dibenzodioxins and furans it is reasonable to conclude that PAH emissions represent a much greater risk to health and the environment that TCDD-equivalent and TBDD-equivalent emissions. This fact has recently been discussed in more detail elsewhere[5].

Conclusions

Preliminary results from a comparison between the LCA of a TV with V0 enclosure material to that with HB enclosure material indicate that the original postulate that "it would be better to allow things to burn more often rather than use flame retardants" can be questioned. In the case of a number of key emission species there is a markedly higher total emission over the whole life cycle from the NFR TV than from the FR TV in the present day scenario, although the picture becomes more complicated in the future scenario.

The emissions with the most marked difference between in FR and NFR TV sets reflect those species that can be minimised from all controlled combustion sources. These include PAH and TXDD-equivalents. The emission of PAH dominates over the emission of TXDD-equivalents. Thus, the PAH emissions represent a far greater cancer potential that the TXDD-equivalent emissions.

Finally, in a risk analysis it is important to consider all potential risks. In this context it should be emphasised that according to European statistics at least 16 people die each year and 197 are injured as a direct result of TV fires. This number is a conservative estimate from a study conducted by the UK Department of Trade and Industry[6]. A true estimate may be up to 10 times this number. In the US, however, there is no record of people dying as a result of a TV fire. Thus, the risk to human lives of a fire should not be neglected in an overall assessment of the risk of flame retardants.

References

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