Environmental Risk Assessment of Bound Residues

Residues including extractable residue (ER) bound residues (BR) and non-extractable residues (NER), are an important factor in PBT assessment and risk assessment of chemicals (see Figure 1) However understanding the issues surrounding the phenomenon of bound residues continues to stimulate considerable debate. For example:

- Is it reasonable to assume that ‘bound’ chemical is not contributing meaningfully to chemical activity at present?
- Is it plausible that ‘bound’ chemical could be released under other biological conditions (e.g. the gut)?
- If changing environmental conditions can result in the release of bound chemical, is it likely to happen at a rate that would create risk?
- There are contrasting views about whether such residues are truly irreversibly bound, immobilised and non-biologically available or whether their long-term behaviour is impossible to predict. Precautionary risk assessments usually assume 100% bioavailability, i.e. all of the chemical present, is available for degradation or to have potential toxic effects on the biota. This precautionary approach generally overestimates the exposure concentration by the amount that is not available and therefore overestimates the level of risk to biota in the environment. It is also well documented that chemicals that are irreversibly bound to solids are less degradable and less toxic than the total residue would predict. Even though it is a position that has been recognised by ECPOA (2000), and referenced by REACH (2008) and OECD test guidance (2002), there is no agreed guideline on how to determine what is available or not, and how it should be considered in the risk assessment.

As a result, it continues to be debated from a scientific and regulatory point of view (Environmental Pollution, 133, Special Issue, 2005).

**Introduction**

**ECETOC Workshop October 2009**

A two-day workshop was held in Brussels, Belgium to review what is known about ‘bound residues’, to identify what issues may exist in respect to their understanding and interpretation in environmental risk assessments, and to identify areas of science that require further research.

The workshop objectives of reviewing extraction procedures, developing guidance on the use of NER in Environmental Risk Assessments (ERAs), identifying research gaps and drafting RfPs (Request for Proposals). The results are presented in this poster.

The following areas which need developing emerged from the discussions:

- RA 1. Extraction strategies that clearly identify available and non-available fractions.
- RA 2. An ecotoxicity testing strategy for NERs that addresses the potential effects of residues that may be released by soil/sediment ingesting organisms, in addition to the parent compound, and their transformation products that may also be present.
- RA 3. Increased understanding of binding mechanisms and predictive methods to quantify and characterise NER.
- RA 4. Develop knowledge base on how environmental changes (ploughing, seasonal variation and freeze-thaw cycles) may impact the behaviour of NER and BR.

The feedback from the symicate and plenary discussions, including the knowledge gaps and the proposed research projects have been used to develop a framework outlining a possible approach for advancing and improving the risk assessment of NER (Figure 3). It is anticipated that as the research (outlined above) is completed this framework would be re-evaluated to assess its potential usefulness in environmental risk and PBT assessments.

**Figure 1: Illustration of relationship between bound, extractable and non-extractable residues**

- Extraction?
- Physical-chemical properties
- Mode of attachment
- Rate of release and degradation rate
- Long-term PEC
- Potential NER
- Non-extractable residue
- BR
- Rate of release and degradation rate
- Long-term PEC
- Exposure
- Physical-chemical properties
- Mode of attachment
- Rate of release and degradation rate
- Long-term PEC
- Potential NER
- Non-extractable residue
- BR
- Rate of release and degradation rate
- Long-term PEC

**Figure 2: PEC testing flow chart for bound residues and NER**

The subsequent PEC testing flow chart was developed, keeping in mind the relevant exposure pattern.

**Figure 3: Risk assessment scheme to address non-extractable residues**

- Is there evidence of NER?
- Physical-chemical properties
- Mode of attachment
- Rate of release and degradation rate
- Long-term PEC
- Potential NER
- Non-extractable residue
- BR
- Rate of release and degradation rate
- Long-term PEC

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**Risk Assessment of Bound Residues**

The knowledge gaps and resulting RfPs are highlighted in a proposed environmental risk assessment scheme (Figure 3). The scheme is envisaged as a plausible framework, once the science has been developed, to adequately address all of the gaps.

**Future activities**

An ECETOC TF will be commissioned in 2010 to develop a standard framework for extraction methods Specific RfPs addressing some of the research needs outlined above will be posted on the CEPIC LRI website in June 2010.

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**References**


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