AIR CHANGE INDEX

Modified July 14, 2003

A risk-based approach to assess exposure to solvent vapours released from indoor decorative paints

ACI DEFINITION

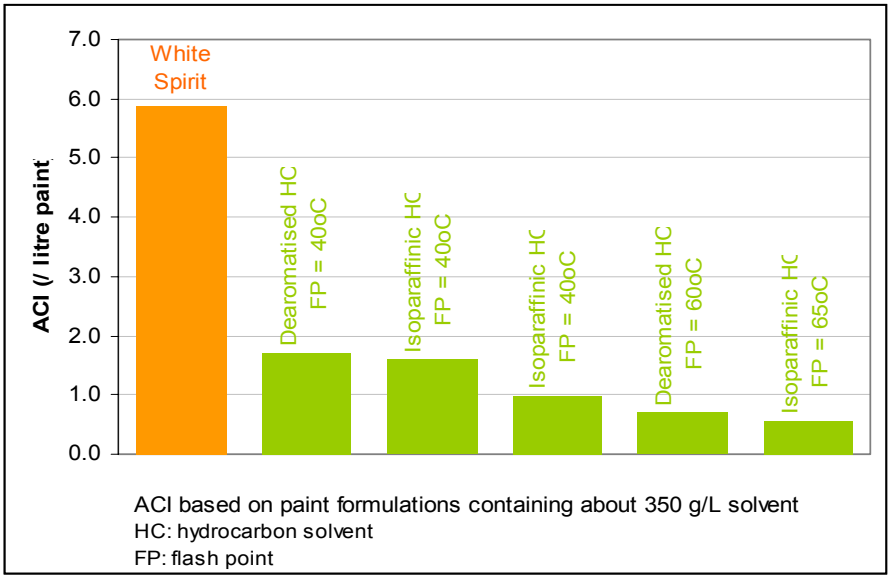
The Air Change Index (ACI) model was developed to rapidly assess the potential for solvent vapours released from solvent-borne decorative paints to exceed the OEL (Occupational Exposure Limit) during the indoor painting of trims (window frames, doors and skirting boards).

The Air Change Index gives a prediction of the number of air changes needed to ensure that the peak solvent vapour concentration remains below the OEL of the solvent when applying one litre of paint under standard conditions.

Standard conditions are defined as an ambient temperature of 20°C, a room volume of 100 m^3, and a paint coverage of 10 m^2/L. However, the ACI can be calculated for any set of conditions, with the appropriate changes in the formula:

$$\textbf{ACI} \text{ (per litre paint)} = \frac{\textbf{Solvent content in paint} \text{ (mg/L)} \times \textbf{f} \text{ (volatility factor)}}{\textbf{Solvent OEL} \text{ (mg/m}^3\text{)} \times \textbf{Room Volume} \text{ (m}^3\text{)}}$$

Figure 1: ACI (per litre paint) for solvent-borne paints formulated with different types of hydrocarbon solvents. *(OELs developed by the Hydrocarbon Solvent Producers Association were used in the calculations)*



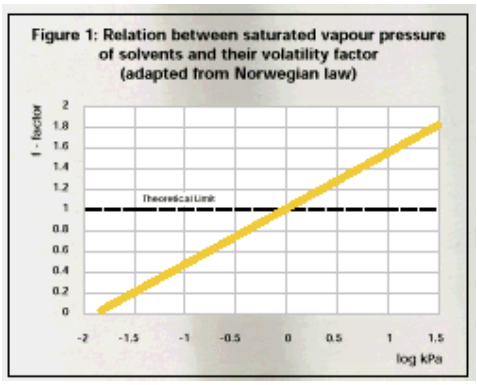
ACI INTERPRETATION

An ACI lower than 1 means that the volume of air in the room is enough to keep the solvent vapours below the OEL, thus corresponding to zero air renewal. Above 1, the ACI value gives an indication of the number of air renewals required to work safely with one litre of paint without exceeding the OEL.
In other terms, a high ACI means more precautions should be taken to handle the paint safely than a product with a low ACI.
However, it is always good practice to ensure adequate ventilation when painting indoors, even when using paints with very low air change indices.

Key features of the ACI model are:

- *A volatility factor f for the solvent used directly related to its vapour pressure (Figure 2).*
- *A safety margin, inherent to the volatility factor: the volatility factor for very volatile solvents can be higher than the theoretical limit of 1.*
- *An additional safety margin in the formula that implies complete evaporation of the solvent, independently of the kinetics of solvent diffusion in the paint film.*
- *The composition of the paints, i.e., the amount of solvent used.*
- *A standard room volume, so that the ACI (per litre paint) can be correlated to a ventilation rate.*

Figure 2:



COMPARING PAINTS

The ACI is particularly useful for comparing similar paints formulated with different hydrocarbon solvents. Figure 1 illustrates the ACI calculated for formulations containing different hydrocarbon solvents.

Paints formulated with de-aromatised and isoparaffinic solvents have an ACI far below the ACI of paints formulated with traditional White Spirit.

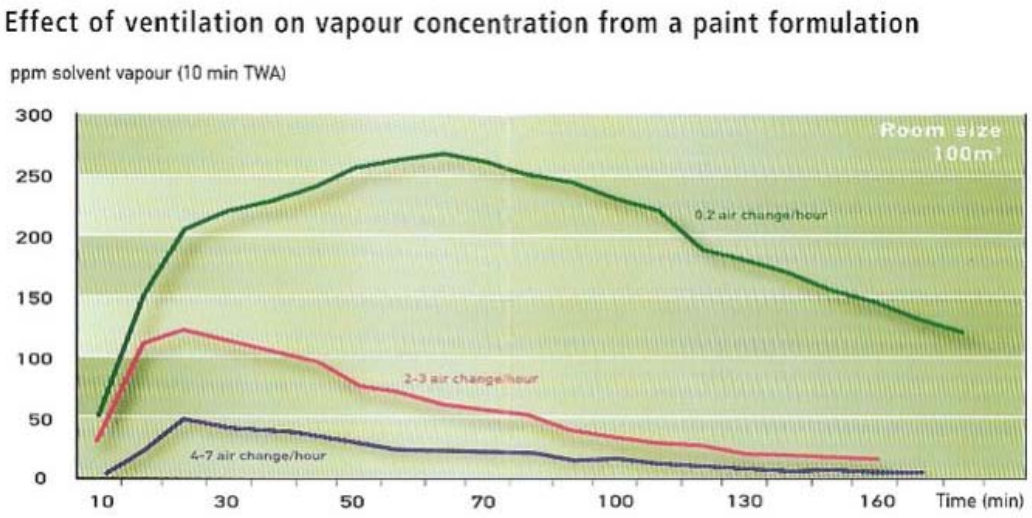
CORRELATION WITH EXPERIMENTAL DATA

Independent research has validated the ACI approach to predict the potential risk of exposure.

- Building Research Establishment (BRE): The results of the BRE experimental measurements of solvent vapours (*BRE Information Paper, IP 8/95, May 95. More information is available on request*) were in line with the estimates of the ACI model. Both show that with proper solvent selection and simple precautions the potential risk of painters' exposure to solvent vapours can be adequately controlled (Figure 3)

- The Dutch research institute TNO: TNO studied solvent vapour releases from a broad range of solvent-based paints and established that there was a correlation between the ACI of paints and the likelihood to exceed the OEL (TNO report V3287-11, 2000). The TNO study concluded, based on experimental data, that coatings that have lower ACI could be applied safely*. In addition, their study showed that for most paints except a couple with a very high content of a volatile solvent, the average solvent concentration in the room stayed below the OEL.

Figure 3: Importance of ventilation demonstrated by experimental results obtained at the BRE (Building Research Establishment). The graph shows solvent vapour concentrations released from paint based on White Spirit (45 vol% content) under different ventilation rates.



CONCLUSIONS:

- **The Air Change Index is a risk-based tool to assess the potential risk of solvent exposure of solvent users and assists in taking precautionary measures.**
- **Solvent-borne decorative paints can be used safely indoors when simple precautions such as ventilation and careful solvent selection are implemented.**
- **The Air Change Index model has been validated by independent experimental studies.**

* TNO in fact validated the Occupational Air Requirement (OAR) approach, which is similar to the ACI. The OAR calculates the volume of air required to work safely while the ACI calculates the number of air changes instead (ACI = OAR / room volume)