

SETTING ALARM LIMITS FOR MIXTURES

INTRODUCTION

When using PIDs it is often necessary to set alarm limits for mixtures of compounds. To do this, it is necessary to know the threshold limit value (TLV) for the mixture. In a few cases of common complex mixtures such as gasoline, TLVs exist, but in many cases the mixture TLV must be calculated from the TLVs of the individual components. Once the TLV is known, it is best to calibrate with the compound mixture and set the alarm limits directly. However, when standards of gas mixtures are not available, it is possible to calculate mixture Correction Factors (CFs) from those of the individual components, and use this value to set the alarm limits. The necessary equations are given below:

$$TLV_{mix} = 1 / (X_1/TLV_1 + X_2/TLV_2 + X_3/TLV_3 + \dots X_i/TLV_i)$$

$$CF_{mix} = 1 / (X_1/CF_1 + X_2/CF_2 + X_3/CF_3 + \dots X_i/CF_i)$$

$$\text{Alarm Setting} = TLV_{mix}/CF_{mix}$$

where X_i , TLV_i , and CF_i are the mole fraction of total VOCs, TLVs, and CFs of the individual components, respectively. TLVs are available for many compounds in the ACGIH Handbook, and CFs are available for over 200 compounds in RAE Systems Technical Note TN-106.

Example 1: All Compounds Detected

Air contaminated with ppm level VOCs distributed as 5% benzene (CF = 0.53, TLV = 0.5 ppm) and 95% n-hexane (CF = 4.3, TLV = 50 ppm) has a Correction Factor of:

$$CF_{mix} = 1 / (0.05/0.53 + 0.95/4.3) = 3.2$$

A reading of 100 then corresponds to 320 ppm of the total mixture, comprising 16 ppm benzene and 304 ppm hexane. The TLV for this mixture is:

$$TLV_{mix} = 1 / (0.05/0.5 + 0.95/50) = 8.4 \text{ ppm}$$

This corresponds to 8.0 ppm hexane and 0.4 ppm benzene. The alarm setting for an instrument calibrated with isobutylene is:

$$TLV \text{ reading} = 8.4 / 3.2 = 2.6 \text{ ppm}$$

A common practice is to set the lower alarm limit to half the TLV reading, and the higher limit to the TLV. Thus, one would set the lower and higher alarms to 1.3 and 2.6 ppm, respectively.

Example 2: Not All Compounds Detected

Air-VOC mixture containing 30% phenol (CF = 1.0, TLV = 5 ppm) and 70% methylene chloride (CF = No Response, TLV = 25 ppm) has a Correction Factor, TLV, and alarm setting of:

$$CF_{mix} = 1 / (0.3/1.0 + 0.7/\infty) = 3.3$$

$$TLV_{mix} = 1 / (0.3/5 + 0.7/25) = 11.4 \text{ ppm}$$

$$TLV \text{ reading} = 11.4 / 3.3 = 3.4 \text{ ppm}$$

The suggested low and high alarm settings are 1.7 and 3.4 ppm. The TLV mixture corresponds to 30% of 11.4 = 3.4 ppm phenol and 70% of 11.4 = 8.0 ppm methylene chloride. In this case, the PID with a 10.6 eV lamp does not respond to the methylene chloride, and all the response is due to the phenol. The alarm setting of 3.4 ppm is lower than the TLV of the phenol alone (5 ppm), because the methylene chloride contributes to the toxicity of the mixture even though it is not measured.