

Volatile Organic Compound (VOC) Reduction within the Interior Cabin

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ABSTRACT

Due to the progression of environmental regulations, as they pertain to interior air quality, automakers and their respective supply-chain are considering current and future volatile organic compound (VOC) requirements of the vehicle cabin. Currently, initiative is being taken in order to attempt to reduce the VOC levels associated with these and other products sold around the world.

This paper will include an overview of existing regulations throughout the world and advancement in the reduction of VOC levels, including the methodology used to measure VOC content and specific technologies used to reduce VOC levels.

INTRODUCTION

Volatile Organic Compounds (VOCs) are compounds that have a high vapor pressure and therefore evaporate easily at room temperature. VOCs can be emitted from solids or liquids and are commonly found in paints, adhesives, solvents, cleaning products and waxes. Some of these compounds are considered hazardous, and there is a growing awareness of VOCs and their short term or long term effects on the human body.

In Japan, a condition called Sick House Syndrome (SHS) emerged as a result of more energy efficient, less air permeable buildings. SHS is caused by the exposure to excessive amounts of VOCs and causes irritation of the eyes, nose and throat and in some rare cases respiratory failure. For this reason, Japan has put in place regulations to control interior air quality and the VOCs in building materials. Because of SHS, the

awareness of interior air quality and VOCs grew not only in Japan but also in neighboring countries with similar living situations. This awareness soon led to additional activity being taken to control interior air quality not only in the home but also in a vehicle.

MAIN SECTION

OVERVIEW OF REGULATIONS

The interior air quality regulation is expanding from homes to vehicle interior cabins. As of 2007, the Japanese Automotive Manufacturing Association (JAMA) implemented a voluntary action program to regulate the amount of VOCs in the vehicle cabin¹. In Korea, legislation is currently in place to regulate cabin VOCs. Following suit, China has begun the process of implementing regulation. Through the State Environmental Protection Administration (SEPA), the execution of the regulation began in 2004 followed by the issuance of a vehicle test method in 2008 and an expected completion in 2009. Although an official regulation has not been issued, temporary targets have been put in place.

Table 1: Temporary VOC Targets for SEPA²

Compound	µg/m ³
Benzene	<110
Toluene	<1100
Xylene	<1500
Ethylbenzene	<1500
Styrene	<260
Formaldehyde	<100
Acetaldehyde	<50
Acrolein	<50

APPROACH

In preparation for the upcoming regulation in China, a voluntary effort was taken to reduce VOCs in order to ensure all vehicles exported to China meet this new regulation. In order to complete this task in the most efficient manner, a logical approach was needed.

The approach is as follows:

1. Determine vehicles and compounds of concern using the China (SEPA) vehicle test method
2. Use a developed part test method to determine which parts have the highest VOC content.
3. Work with the Tier 1 and material suppliers to reduce or eliminate VOCs.
4. Apply adsorptive material to further reduce VOC concentration

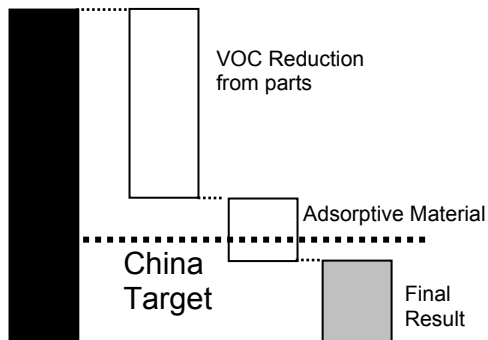


Figure 1: VOC Reduction Approach

VEHICLE MEASUREMENT

Vehicle test methods have been issued in China (SEPA)³ and in Japan (JAMA)¹. The two methods are summarized in Tables 2 and 3 below.

Table 2: Summary of (SEPA) Test Method

China		Background	Reference	Sample
Aldehyde	Time	30min	30min	30min
	Speed	100 - 500ml/min		
	Quantity	-	15L	15L
Other VOCs	Time	30min	30min	30min
	Speed	100 - 200ml/min		
	Quantity	-	6L	6L

Table 3: Summary of JAMA Test Method

JAMA		Background	Closed	Riding
Aldehyde	Time	30min	30min	15min
	Speed	400 - 1000ml/min		
	Quantity	-	>12L	>12L
Other VOCs	Time	30min	30min	15min
	Speed	100- 200ml/min		
	Quantity	-	>3L	>3L

In both methods, the vehicles go through a conditioning during which the vehicle is prepared for sampling. Then, at designated intervals of time, samples are taken at a particular location in the vehicle. Both methods collect samples while the windows and doors are closed. The JAMA method has an additional sample taken to simulate the condition while the vehicle is in motion. This sample is taken while the HVAC system is on the high setting with the circulation mode on. This takes into account any improvement from air filters. The vehicle measurement must be taken within 14-28 days and 28-35 days, respectively, for the JAMA and China methods.

PART MEASUREMENT

When the VOC investigation began in Japan, an official part test method did not exist, and currently, a test method on a part basis does not exist under China's regulation. For these reasons, a unique test method was developed for part VOC measurement. This method is very similar to the test method issued by JASO in 2007 (M902)⁴. The JASO test is a bag method where the part is sealed inside a sampling bag and then heated to a specified temperature. After a period of soak at this temperature, two samples are taken simultaneously. One sample is captured on an absorbent tube, the other on a DNPH (2,4-dinitrophenylhydrazine) cartridge. These samples are then analyzed using standard GC/MS (Gas Chromatography Mass Spectrometry) and HPLC (High Performance Liquid Chromatography) equipment. These values can then be used to calculate the VOC contribution to the vehicle as a whole.

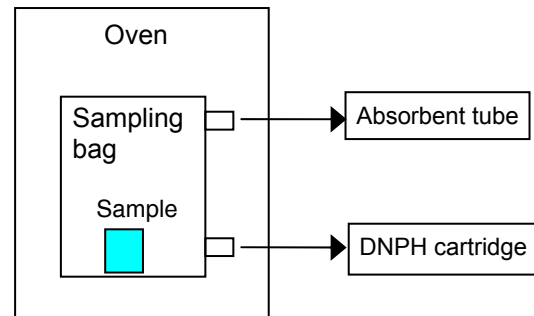


Figure 3: Part test Method

When completing part measurements, it is typical to be confronted with questionable situations. Typically, these deal with the size of part and how large parts should be handled. When faced with such a circumstance, there are a number of different approaches that can be used individually or combined. First, the part can be divided into smaller sub-assembly parts. Using the door lining as an example, the center pad, armrest, grip, etc. can be separated from the main body and tested individually. The individual parts may then be summed to get the total volatilization for the door lining.