Smog Checks

Contributed by Administrator
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More states are beginning to adopt stricter emissions standards, and our Saabs aren't getting any newer. That means that with each passing year it's becoming more difficult to get them through smog checks. The following is a "primer" designed to familiarize you with the four gasses involved with common smog checks, and hopefully point you in the right direction for repairs.

An Intro to Emissions The exhaust gases emitted by a 4 cycle spark ignition engine, operating at 100% efficiency and running on a mixture of air (oxygen) and any type of hydrocarbon fuel such as gasoline, would consist of water vapor and C02 (carbon dioxide). However, the typical automotive engine does not operate at 100% efficiency (it's closer to 30 or 40%), and the air/fuel mixture when burned produces exhaust gases which contain various pollutants. Among these are: CO (carbon monoxide), a colorless, odorless, highly poisonous gas; HCs (hydrocarbons) made up principally of minute particles of unburned gasoline; these particles react photochemically with sunlight to produce smog; and NOx (oxides of nitrogen) which combine with water in the atmosphere to help produce acid rain, a dilute nitric acid which is damaging to vegetation. NOx also aids in the production of ground-level ozone which is damaging to sensitive lung tissues, and threatening to the health of very young people and those with upper respiratory problems. Harmless gases are also emitted in the automotive exhaust stream. Most of the nitrogen content of the air which passes through the engine is unchanged. Any oxygen not used in the combustion process is also emitted unchanged, along with C02 and water which also are byproducts of the combustion process. An air/fuel ratio of 14.7:1 (known as the stoichiometric ratio) is considered to be the ideal to achieve from an emissions point of view. This ratio is the baseline value for measuring the oxygen content of the exhaust, and is often referred to as Lambda value = 1.   CO: Carbon Monoxide   CO is a result of incomplete combustion due to insufficient air in the air/fuel mixture. The level of CO emissions (usually measured as a pecentage of the total) is almost entirely dependent on the balance of the air/fuel ratio. The lowest emissions being consistent with excess air. In this condition, further weakening the air/fuel ratio has no effect on CO levels.   When the mixture is fuel-rich, the CO emissions will be high. Ignition timing has only a marginal effect on CO level - your best weapon is a properly working O2 sensor and an ignition system in good shape. HC: Hydrocarbons   HCs are measured in parts per million (ppm). Their presence in the exhaust stream is a result of unburned or partly burned fuel and engine oil which makes its way into the combustion chambers. Unburned fuel may originate from an ignition system in bad shape, clogged or obstructed fuel injectors which may not fully atomize their discharge, or from areas in the combustion chamber which are difficult for the spark-ignited flame front to reach. HC emissions are also caused by blow by, where unburned air/fuel mixture escapes past the piston rings into the crankcase. Current engine design restricts the amount of escape to the atmosphere by recirculating engine fumes back into the intake manifold. Unlike CO emissions, HC emissions may increase during both rich and lean air/fuel conditions. When the air/fuel mixture is rich in fuel, the combustion may be incomplete, therefore allowing the presence of unburned HCs in the exhaust stream. HC emissions increase in proportion to ignition advance, except at very lean air/fuel ratios. Factors such as poor mixture distribution, ignition misfires and low engine temperatures will all cause significant increases in HC and CO emissions.

Given a properly tuned and well-running engine, the catalytic converter is primarily responsible for controlling HC emissions.

(Evaporation from the gas tank also releases HCs into the atmosphere. Gas tank fumes are passed to a carbon canister which absorbs the fumes and then recycles them for combustion in the engine, when conditions permit. This process may be controlled by simple engine vacuum or may be controlled by the ECU (engine control unit), via an evaporative emission canister purge valve. Purge tests are now becoming part of the enhanced emission tests in some states, as are gas tank cap pressure tests.)   NOx: Oxides of Nitrogen   NOx emissions rise and fall in a reverse pattern compared with HC emissions. As the mixture becomes leaner, more HCs are burned, but the free oxygen present combines with nitrogen, especially at high engine temperatures and at high pressures in the combustion chamber. NOx emissions also increase in proportion to ignition advance, regardless of variations in the air/fuel ratio.   NOx emissions can be significantly reduced by incorporating EGR (exhaust gas recirculation) into the emissions control scheme. Since NOx formation is encouraged by high combustion chamber temperatures and pressures, EGR works to divert exhaust gases from the exhaust manifold into the intake duct, either through internal passages, or via external piping. This addition of exhaust gases cools the incoming charge, reducing the tendency of NOx to form. The process is controlled by either a vacuum-operated EGR valve, or by an electrically-operated EGR valve. Lacking EGR, the catalytic converter is solely responsible for controlling NOx emissions into the atmosphere. O2: Oxygen   Oxygen in the exhaust stream is the result of excessive air (leaning out) in the air/fuel ratio. As the air/fuel mixture becomes higher in air and lower in fuel, it may be referred to as going out of stoichiometric. Since the engine does not produce oxygen, the combustion process uses what oxygen there is in the air taken in with the gasoline. Therefore, any oxygen emitted with the exhaust gases will have passed straight through the engine. Any misfire will cause the 02 content to rise sharply, since the air is not used in the combustion process. Residual oxygen in the exhaust, ahead of the catalytic converter, is sensed by the 02 sensor, and the signal generated is used to adjust the air/fuel mixture back into the ideal stoichiometric ratio of 14.7:1.   Catalytic Converter   The catalytic converter is normally installed between the exhaust manifold and the first muffler. Some modern cars will incorporate a pre-catalyst into the exhaust manifold itself. It has a steel outer casing and an interior ceramic or metallic matrix. This matrix is coated (textured) with aluminum oxide to increase the surface area by several thousand times. The resultant surface area is in turn coated with a very small amount of rhodium and platinum.   The platinum coating accelerates the oxidation of HCs to CO_2 and H20 (water). The rhodium coating breaks down NO_x emissions to Nitrogen and Oxygen. The Oxygen combines with CO to produce CO_2. Neither coating is affected by this process, but each acts as an accelerating agent to provide a suitably quick reaction as exhaust gasses flow through the converter. The working life of a catalytic converter is normally greater than 50,000 miles, and there is no quantifiable upper limit on how long a catalytic converter will function correctly under ideal combustion conditions. Converter life can be drastically shortened if an engine is run with leaded fuel or contaminated by oil from a badly worn engine. Misfiring or over-rich mixtures can also lead to shortened catalytic converter life, as the high temperatures of the converter will tend to ignite unburned fuel in the exhaust stream. If these combustion temperatures exceed 2550 degrees F the ceramic core of the converter will melt.   The proper functioning of a catalytic converter can be checked using a surface temperature probe. The before-converter exhaust temperature should be about 122 degrees F cooler than the after-converter temperature (that is, the catalytic converter will heat the exhaust stream). If there is little or no temperature change between the two readings, it is a sign of a damaged or contaminated catalytic core. The normal working temperature of a catalytic converter is between 752 degrees F and 1442 degrees F.