AIR POLLUTION

Introduction

The earth's atmosphere, at or near sea level, consists approximately of 78% nitrogen, 21% oxygen and 1% other gases. If it were possible to remain in this state, 100% clean air would result. However, many varied causes allow other gases and particulates to mix with the clean air, causing the air to become unclean or polluted.

Certain of these pollutants are visible while others are invisible, with each having the capability of causing distress to the eyes, ears, throat, skin and respiratory system. Should these pollutants be concentrated in a specific area and under the right conditions, death could result due to the displacement or chemical change of the oxygen content in the air. These pollutants can cause much damage to the environment and to the many man made objects that are exposed to the elements.

To better understand the causes of air pollution, the pollutants can be categorized into 3 separate types, natural, industrial and automotive.

Natural Pollutants

Natural pollution has been present on earth before man appeared, and is still a factor to be considered when discussing air pollution, although it causes only a small percentage of the present overall pollution problem existing in our country. It is the direct result of decaying organic matter, wind born smoke and particulates from such natural events as plains and forest fires (ignited by heat or lightning), volcanic ash, sand and dust which can spread over a large area of the countryside.

Such a phenomenon of natural pollution has been recent volcanic eruptions, with the resulting plume of smoke, steam and volcanic ash blotting out the sun's rays as it spreads and rises higher into the atmosphere, where the upper air currents catch and carry the smoke and ash, while condensing the steam back into water vapor. As the water vapor, smoke and ash traveled on their journey, the smoke dissipates into the atmosphere while the ash and moisture settle back to earth in a trail hundred of miles long. In many cases, lives are lost and millions of dollars of property damage result, and ironically, man can only stand by and watch it happen.

Industrial Pollutants

Industrial pollution is caused primarily by industrial processes, the burning of coal, oil and natural gas, which in turn produces smoke and fumes. Because the burning fuels contain much sulfur, the principal ingredients of smoke and fumes are sulfur dioxide (SO_2) and particulate matter. This type of pollutant occurs most severely during still, damp and cool weather, such as at night. Even in its less severe form, this pollutant is not confined to just cities. Because of air movements, the pollutants move for miles over the surrounding countryside,

leaving in its path a barren and unhealthy environment for all living things.

Working with Federal, State and Local mandated rules, regulations and by carefully monitoring the emissions, industries have greatly reduced the amount of pollutant emitted from their industrial sources, striving to obtain an acceptable level. Because of the mandated industrial emission clean up, many land areas and streams in and around the cities that were formerly barren of vegetation and life, have now begun to move back in the direction of nature's intended balance.

Automotive Pollutants

The third major source of air pollution is the automotive emissions. The emissions from the internal combustion engine were not an appreciable problem years ago because of the small number of registered vehicles and the nation's small highway system. However, during the early 1950's, the trend of the American people was to move from the cities to the surrounding suburbs. This caused an immediate problem in the transportation areas because the majority of the suburbs were not afforded mass transit conveniences. This lack of transportation created an attractive market for the automobile manufacturers, which resulted in a dramatic increase in the number of vehicles produced and sold, along with a marked increase in highway construction between cities and the suburbs. Multi-vehicle families emerged with much emphasis placed on the individual vehicle per family member. As the increase in vehicle ownership and usage occurred, so did the pollutant levels in and around the cities, as the suburbanites drove daily to their businesses and employment in the city and its fringe area, returning at the end of the day to their homes in the suburbs.

It was noted that a fog and smoke type haze was being formed and at times, remained in suspension over the cities and did not quickly dissipate. At first this "smog'', derived from the words "smoke'' and "fog'', was thought to result from industrial pollution but it was determined that the automobile emissions shared the blame. It was discovered that when normal automobile emissions were exposed to sunlight for a period of time, complex chemical reactions would take place.

It is now known that smog is a photo chemical layer and was developed when certain oxides of nitrogen (NOx) and unburned hydrocarbons (HC) from the automobile emissions are exposed to sunlight. Pollution was more severe when the smog would become stagnant over an area in which a warm layer of air would settle over the top of a cooler air mass at ground level, trapping and holding the automobile emissions, instead of the emissions being dispersed and diluted through normal air flows. This type of air stagnation was given the name "Temperature Inversion''.

Temperature Inversion

In normal weather situations, the surface air is warmed by the heat radiating from the earth's surface and the sun's rays and will rise upward, into the atmosphere, to be cooled through a convection type heat expands with the cooler upper air. As the warm air rises, the surface pollutants are carried upward and dissipated into the atmosphere.

When a temperature inversion occurs, we find the higher air is no longer cooler but warmer than the surface air, causing the cooler surface air to become trapped and unable to move. This warm air blanket can extend from above ground level to a few hundred or even a few thousand feet into the air. As the surface air is

trapped, so are the pollutants, causing a severe smog condition. Should this stagnant air mass extend to a few thousand feet high, enough air movement with the inversion takes place to allow the smog layer to rise above ground level but the pollutants still cannot dissipate. This inversion can remain for days over an area, with only the smog level rising or lowering from ground level to a few hundred feet high. Meanwhile, the pollutant levels increases, causing eye irritation, respirator problems, reduced visibility, plant damage and in some cases, cancer type diseases.

This inversion phenomenon was first noted in the Los Angeles, California area. The city lies in a basin type of terrain and during certain weather conditions, a cold air mass is held in the basin while a warmer air mass covers it like a lid.

Because this type of condition was first documented as prevalent in the Los Angeles area, this type of smog was named Los Angeles Smog, although it occurs in other areas where a large concentration of automobiles are used and the air remains stagnant for any length of time.

Internal Combustion Engine Pollutants

Consider the internal combustion engine as a machine in which raw materials must be placed so a finished product comes out. As in any machine operation, a certain amount of wasted material is formed. When we relate this to the internal combustion engine, we find that by putting in air and fuel, we obtain power from this mixture during the combustion process to drive the vehicle. The by-product or waste of this power is, in part, heat and exhaust gases with which we must concern ourselves.

Heat Transfer

The heat from the combustion process can rise to over 4000°F (2204°C). The dissipation of this heat is controlled by a ram air effect, the use of cooling fans to cause air flow and having a liquid coolant solution surrounding the combustion area and transferring the heat of combustion through the cylinder walls and into the coolant. The coolant is then directed to a thin-finned, multi-tubed radiator, from which the excess heat is transferred to the outside air by 1 or all of the 3 heat transfer methods, conduction, convection or radiation.

The cooling of the combustion area is an important part in the control of exhaust emissions. To understand the behavior of the combustion and transfer of its heat, consider the air/fuel charge. It is ignited and the flame front burns progressively across the combustion chamber until the burning charge reaches the cylinder walls. Some of the fuel in contact with the walls is not hot enough to burn, thereby snuffing out or quenching the combustion process. This leaves unburned fuel in the combustion chamber. This unburned fuel is then forced out of the cylinder along with the exhaust gases and into the exhaust system.

Many attempts have been made to minimize the amount of unburned fuel in the combustion chambers due to the snuffing out or quenching, by increasing the coolant temperature and lessening the contact area of the coolant around the combustion area. Design limitations within the combustion chambers prevent the complete burning of the air/fuel charge, so a certain amount of the unburned fuel is still expelled into the exhaust system, regardless of modifications to the engine.