To Study The Effect Of Air Pollution On MVV (Functional Capacity Of Respiratory System)

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Abstract:

In the environment all the livings are staying in their natural condition. Environment according to environmental protection agency - It is a complex of physical, chemical biotic factors that act upon an organism or an ecological community and ultimately determine its form of survival: OR The sum of all external conditions affecting the life, development & survival of an organism.

Keywords: Air Pollution, MVV, Environment, living organism, Human Health,

Introduction:

Air Pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment. Air may get polluted by natural causes such as volcanoes, which release ash, dust, sulphur and other gases or by forest fires that are occasionally naturally caused by lightning. However, like pollutants from human activity, naturally occurring pollutants tend to remain in the atmosphere for a short time and do not lead to permanent atmospheric change.

History of Air Pollution:

The Origin of air pollution on the earth can be traced from the times when man started using firewood as a means of cooking and heating as stated in the book of Environmental studies for undergraduate students by Erich Bharucha. Hippocrates has mentioned air pollution in 400 B.C. With the discovery and increasing use of coal, air pollution became more pronounced especially in urban areas. It was recognized as a problem 700 yrs ago in London in the form of smoke pollution, which prompted king Edward I to make the first antipollution law to restrict people from using coal for domestic opposing in the year 1273. In the year

1300 another Act banning the use of coal was passed. Defying the law led to imposition of capital punishment. In spite of this air pollution became a serious problem in London during the industrial revolution due to the use of coal in industries. The earliest recorded major disaster was the 'London Smog' that occurred in 1952 that resulted in more than 4000 deaths due to the accumulation of air pollutants over the city for five days.

In Europe around the middle of the 19th Century, a black form of peppered moth was noticed in industrial areas. Usually the normal Peppered moth is well camouflaged on a clean lichen covered tree. However the peppered pattern was easily spotted and picked up by birds on the smoke blackened bark of trees in the industrial area, while the black form remained well camouflaged. Thus while the peppered patterned moths were successful in surviving in clean non-industrial areas, the black colored moths were successful in industrial areas. With the spread of industrialization, it has been observed that the black forms are not only seeing in peppered moth, but also in many other moths. This is a classic case of pollution leading to adaptation.

Air pollution began to increase in the beginning of the twentieth century with the development of the transpiration systems and large-scale use of petrol and diesel. The severe air quality problems due to the formation of photochemical smog from the combustion residues of diesel and petrol engines were felt for the first time in Los Angeles. Pollution due to auto-exhaust remains a serious environmental issue in many developed & developing countries including India.

Kapha & pitta are also helpless without vāyu. Also in the atmosphere vāyu is important. Any motion is dependent on vāyu. Nature has given us a valuable gift like air. We cannot live without air. Only earth is having Biosphere out of all planets.

Water, food, air & shelter all are essential for a living organism. If these are available in sufficient quantity the organisms live stationary or their life cycle is going on. But due to some natural or man made causes these organisms suffer. OR their environment gets disturbed. What one states that environment gets polluted, due to these pollutants. Pollution is defined as, "Any alteration or addition to air, water, soil or food, which threatens the health, survival, capability or activity of not only humans but also any other living organism". In simple words, it is the unwanted concentration of substances, which are beyond the

environment's capacity to assimilate. Pollution is formed when wastes are released from the extraction, processing & utilization of resources. It can be in any form - solid, liquid, effluents or gaseous emissions.

Pollution occurs when the environment becomes over loaded beyond the capacity of these normal - processing systems, modern, High-tech civilization & industrialization have given birth to the wastes, which are not easily assimilated in the environment result into the pollution of natural resources. 'NIMBY' ***(Not In My Back Yard)*** THROW AWAY Principles are outcomes of the modern world's economy.

According to environmental status report 2004 Poona is one of most polluted city in Maharashtra. The sources of pollution are well known in the Pune city - such as human population & vehicular population, which are ever increasing. The City limits have increased multifold in last few decades concurrent growth in population having the current average population density about 10, 412 per sq.km. Vehicles - 12,00,000 vehicles are being used by 30,25,000 people i.e. 2.5 people per motorized vehicle.

Traffic growth chart shows,

Year	**2 Wheelers**	**3 & 4 Wheelers**	**Total**
2002 (Jan-Dec)	62,409	20,234	82,643
2003(Jan-Dec)	69,426	20,882	90,308
2004(Jan-Dec)	79,753	23,303	1,04,056

The growth rate of traffic is 25% *{environmental status report 2004}*

A Punekar emits particulate matter - 3.5439/day.

Effect on the human Health

According the surveys in the environmental status report 2004, the impact on kids was more as compared to the elder ones. About 800 persons & 20 doctors were interviewed from Pune & Pimpari Chinchwad area. It is estimated that a common man has to spend average Rs.200/- per month for the health recovery. *{environmental status report 2004}*

The major initial symptoms noted were eye irritation, skin irritation, cold, coughing, sneezing & gastric disorders etc., how the pollution affects a person living in a city like Poona.

In ancient time according to the scientist air is made up of maximum with Nitrogen - oxygen. After some time methane, Ammonia are developed due to the changes in atmosphere. Now a days Nitrogen, oxygen, carbon-di-oxide are the major components & Argon, Neon etc., are the minor component of clean air. But due to mixing of SO_2, CO, NO_x Chlorofluorocarbon, Ozone etc., the air gets polluted.

It is said in the text of Environmental studies for udergraduate students that pollution starts when man illuminated first the fire. And now there are May factors. All the scientist from the world who are doing research on environment have fear that the earth will disappear under the water as the temperature of the earth is increasing day by day. From 1980 this percentage of temperature increase is more due to increased concentration of carbon dioxide, carbon monoxide.

Objectives:

1. To Study the present status of air pollution literary and with the help of modern scientific instrument low volume sampler.
2. To study the functional capacity of respiratory system (MVV) with the help of spirometer.
3. To study the effect of air pollution on MVV (functional capacity of Respiratory system) .

From an ecological perspective pollutants can be classified as follows:-

Degradable or non- persistent polluants -

These can be rapidly broken down by natural process. e.g. domestic sewage, discarded vegetables etc.,

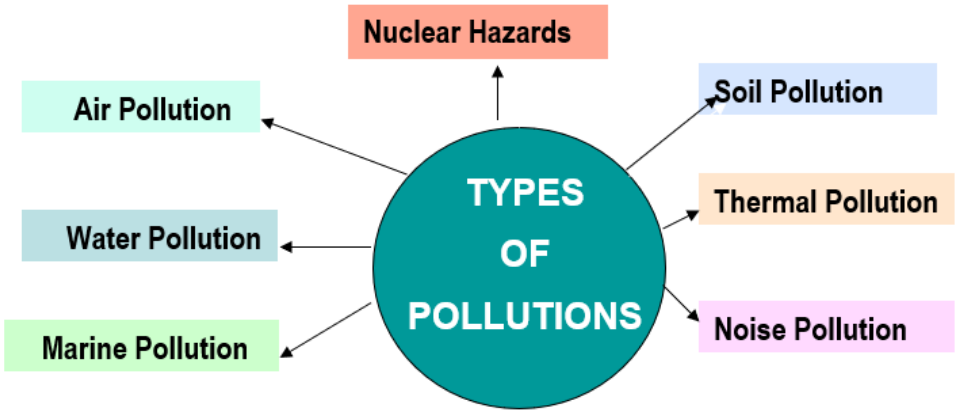
Slowly degradable or persistent pollutants -

Pollutants that remain in the environment for many years in an unchanged condition and take decades or longer to degrade e.g. DDT most plastics.

Non - degradable pollutants –

These cannot be degraded by natural processes. Once they are released into the environment they are difficult to eradicate and continue to accumulate e.g. toxic elements like lead or mercury.

Types of pollution



There are (1) Air Pollution (2) Water Pollution (3) Marine Pollution (4) Soil Pollution (5) Naise Pollution (6) Thermal Pollution (7) Nuclear Hazards

The atmosphere is normally composed of 79% nitrogen, 20% oxygen & 1% as a mixture of carbon dioxide, water vapor and trace amounts of several other gases such as neon, helium, methane, krypton, hydrogen, and xenon.

Atmospheric Gases & Composition of Clean Atmosphere.

Gas	Concentration (PPM)
Argon	9340
Krypton	1.1
Xenon	0.09
Nitrogen Oxygen	780,840 209,460
Methane	1.65
Carbondioxide	332
Carbon Monoxide	0.05 - 0.2
Hydrogen	0.58
Nitric Oxide	0.33
Sulphur Dioxide	10-5-10-4

The general structure of the atmosphere has several important features that have relevance to environmental problems. The atmosphere is divided into several layers.

Methodology:

The present study was done in three parts.

1) Literary
2) With the help of modern Scientific instrument low volume sampler.
3) With the help of standard instrument spirometer.

1) In literature review all the information about air pollution modern point of view, air pollution, information about MVV (maximum ventilatory volumn), were studied.

Result and Discussion:

The respiratory system consists of the nose, pharynx (throat), larynx, trachea, bronchi and lungs, structurally, the respiratory system consists of two portions - i) The term upper respiratory system refers to the nose, pharynx and associated structures.

i. The lower respiratory system refers to the larynx, trachea, bronchi and lungs.
ii. The conducting portion - consists of a series of inter connecting cavities and tubes nose, pharynx, trachea, bronchi bronchioles and terminal bronchioles - that conduct air into the lungs.

The respiratory portion consists of those portions of the respiratory system where the exchange of gases occurs - respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli.

NOSE - The nose has an external and internal portion inside the skull. The external portion consists of a supporting framework of bone and hyaline cartilage covered with muscle and skin and lined by mucous membrance.

The interior structures of the nose are specialized for three functions -

1) Incoming air is warmed, moistened and filtered.
2) Olfactory stimuli are received
3) Large, hollow resonating chambers modify speech sounds.

When air enters the nostril, it passes first through vestibule, which is lined by skin containing coarse hairs that filter out large dust particles.

Mucous membrance lines the cavity and superior, middle & interior conchae. The mucous membrance contains capillaries and pseudostratified ciliated columnar epithelium with many goblet cells. As the air whirls around the conchae and meatuses, blood capillaries warm it. Mucus secreted by the goblet cells moistens the air and traps dust particles. Drainage from the nesolacrimal duct & secretions from paranasal sinuses also help moisten the air. The cilia move the

mucus - dust particles towards the pharynx so they can be eliminated from the respiratory tract by swallowing or expectoration (spitting)

Pharynx - or throat is a somewhat funnel shaped tube about 13 km long starts at internal nares to the larynx.

The pharynx functions as a passage way for air and food, provides a resonating chamber for speech sound.

Larynx - or a voice box, is a short passage way that connects the laryngo pharynx with the trachea. It lies in the midline of the neck anterior to the fourth through sixth cervical vertebrae.

When small particles, such as dust, smoke, food or liquids pass into the larynx, a cough reflex occurs to expel the material.

Trachea -

The trachea or windpipe is a tubular passage way for air about 12 cm (5 in) in lenth and 2 ½ cm in diameter.

The layers of the trachea from deep to superficial are (i) a mucosa (ii) submucosa (iii) hyaline cartilage (iv) adventitia, composed of areolar connective tissue. The mucosa of the trachea consists of an epithelial layer of pseudostratified ciliated columnar epithelium and an underlying layer of lamina propria that contains elastic and reticular fibers. The epithelium consists of ciliated columnar cells and goblet cells thatreach the luminal surface plus basal cells that do not reach the luminal surface. The epithelium provides the same protection against dust as the membrane lining the nasal cavity and larynx.

Bronchi -

At the superior border of the fifth thoracic vertebra, the trachea divides into a right primary bronchus, which goes into the right lung and a left primary bronchus, which goes into the left lung.

On entering the lungs, the primary bronchi divide to form smaller bronchi - the secondary bronchi, one for each lobe of the lung. (The right lung has three lobes and the left lung has two). The secondary bronchi continue to branch, forming still smaller bronchi, called tertiary (segmental) bronchi, that divide into bronchioles. Bronchioles, in turn branch repeatedly and the smallest bronchioles branch into even smaller tubes called terminal bronchioles.

Lungs -

The Lungs are paired cone - shaped organs lying in the thoracic cavity. Two layers of serous membrane, collectively called the pleural membrane, enclose and protect each lung. Layer lines the wall of the thoracic cavity and is called the parietal pleura. The deep layer, the visceral pleura cover the lungs themselves.

The right lung has three lobes and the left lung has two.

There are ten tertitary bronchi in each lung. The segment of lung tissue that each supplies is called bronchopulmonary segment.

Each bronchopulmonary segment of the lungs has many small compartments called lobules.

Respiratory unit -

Respiratory unit is the terminal portion of respiratory tract. The exchange of gases occurs only in this part of the respiratory tract.

Structure of Respiratory unit -

The respiratory unit starts from the respiratory bronchioles. Each respiratory bronchiole divides into alveolar ducts. Each alveolar duct enters and enlarged structure called the alveolar sac. The space inside the alveolar sac is called antrum. The wall of the alveolar sac contains the alveoli. The epithelial lining of the alveolar consists of two types of cells called type I and type II alveolar cells. Type-I alveolar cells are squamous epithecial cells forming about 95% of the cells in alveolar epithelium. These cells form the site of gas exchange between the alveolus and blood. Type-II alveolar cells are cuboidal in nature and form about 5% of alveolar cells. Type-II alveolar cells secrete the alveolar fluid and surfactant.

Respiratory membrane -

The blood vessels in the lungs form a capillary network beyond the terminal bronchiole i.e. in the respiratory unit. The capillaries are formed by endothelial cells.

The alveolar membrane and capillary membrane together form respiratory membrane.

The exchange of gases (O2 and CO2) between the lungs and blood takes place by diffusion across alveolar and capillary walls.

Pulmonary circulation -

The right atrium receives deoxygenated blood from various parts of the body. From right atrium blood flows into the right ventricle, which pumps it into the pulmonary trunk.

The pulmonary trunk divides into a right and left pulmonary artery each of which carries blood to one lung. As blood flows through pulmonary capillaries, it loses CO2 and takes on O2. This blood called oxygenated blood, returns to the heart via the pulmonary veins that empty into the left atrium. The blood then passes into the left ventricle, which pumps the blood into the ascending aorta, Branches of the arch of the aorta and descending aorta (thoracic aorta and abdominal aorta) deliver blood to systemic arteries, which lead into systemic capillaries. In systemic capillaries blood loses O2 and gains CO2. This blood called deoxygenated blood returns to the right side of the heart through superior vena cava, inferior vena cava & coronary sinus.

Pulmonary Ventilation -

Pulmonary ventilation (breathing) in the process by which gases are exchanged between the atmosphere and lung alveoli. Air moves into the lungs when the pressure inside the lungs is less then the air pressure in the atmosphere. Air move out of the lungs when the pressure inside the lungs is greater than the pressure in the atmosphere.

Inspiration -

Breathing in is called inspiration (inhalation) Just before each inspiration, the air pressure inside the lungs equals the pressure of the atmosphere, which is about 760mm Hg, or 1 atmosphere (atm), at sea level for air to flow in to the lungs the pressure inside the alveoli must become lower than the pressure in the atmosphere. This condition is achieved by increasing the volume of the lungs. The first step in expanding the lungs involves contraction of the principal inspiratory muscles - the diaphragm and external intercostals. Air always flows from a region of higher pressure to a region of lower pressure and inspiration takes place. Air continues to flow into the lungs as long as the pressure difference exists.

Expiration -

Breathing out called expiration (exhalation) is also achieved by a pressure gradient, but in this case the gradient is reversed; the pressure in the lungs is greater than the pressure of the atmosphere. Normal expiration during quiet breathing, unlike

inspiration, is a passive process because no muscular contractions are involved. It results from elastic recoil of the chest wall and lungs. The lung volume decreases and the alveolar pressure increases to 762 mm Hg. Air then flows from the area of higher pressure in the alveoli to the area of lower pressure in the atmosphere.

During heavy breathing, however the elastic forces are not powerful enough to cause the necessary rapid expiration, so this is achieved by contraction of the abdominal muscles which forces the abdominal contents upward against the bottom of the diaphragm.

LUNG VOLUMES AND CAPACITIES

Tidal volume - (TV)

The volume of air breathed in and out of lungs in a single normal quiet respiration is called tidal volume. Tidal volume signifies the normal depth of breathing.

Inspiratory reserve - Volume (IRV)- An additional amount of air that can be inspired forcefully after the end of normal inspiration beyond tidal volume is called inspiratory reserve volume.

Expiratory reserve volume (ERV)- The additional amount of air that can be expired out forcefully, after normal expiration is called expiratory reserve volume.

Vital capacity (VC)

It is the maximum amount of air that can be expelled out forcefully after a maximal (deep) inspiration. Vital capacity include IRV, TV and ERV.

VC = IRV + TV + ERV

Total lung capacity (TLC)

Total lung capacity is the amount of air present in the lungs after a maximal (deep) inspiration.

The method by which the lung volumes and capacities are measured is called spirometry and the instrument is known as spirometer.

Out of all the pulmonary function tests as far as the study is conserned: MVV (maximum ventilatory Volume), which is the standard test for assessment of functional capacity of respiratory system was chosen.

MVV (MAXIMUM VENTILATORY VOLUME)

In clinical practice, the word respiration (Ventilation) means one inspiration plus one expiration. The healthy adult averages 12 respirations a minute and moves about 6 liters of air into and out of the lungs while at rest.(-*Human Physiology by*

C.Chaterjee) A lower than normal volume of air exchange is usually a sign of pulmonary malfunction. The apparatus commonly used to measure the volume of air exchanged during breathing and rate of ventilation is a spiro-meter. The records is called spirogram.

What is MVV?

Maximum ventilatory volume previously known as maximum Breathing Capacity It measures the maximum volume of gas that can be breathed per minute by maximum voluntary effort by API Book of Medicine.

The subject asked to breathe forcefully and rapidly with a respirometer for 15 seconds. The amount of air inspired and expired is measured from the spirogram. From this the MVV is calculated for one minute by Sembulingam.

The subject breaths violently and maximally for 15 seconds into a spirometer (mechanical, water sealed variety or electronically operated where available) from this the MVV in liters / min is obtained, Normal values. in strongly built healthy adult young males are often over 100 liters. -By S.Chaudhari

The maximal voluntary ventilation (MVV) or as it was formerly called, the maximal breathing capacity, is the largest volume of gas can be moved in to and out of the lungs in one minute by voluntary effort.

-By Willium Ganong.

Maximal voluntary ventilation - subject can breathe with maximal voluntary effort (actual measurement for twelve seconds) by C.C. Chatterjee.

Measurement

The subject is asked to breath forcefully and rapidly with a spirometer for 15 seconds. The amount of air inspired and expired is measured from the spirogram. Form this the MVV (MBC) is calculated for one minute.

For example the MVV in 12 seconds = n liters.

so, MVV / Min= n/12 x 60 liters

Normal values-

MVV more than 100 lit / min in normal healthy man - by sujeet chaudhari.

MVV on an average 140 lit/min by C.C. Chaterjee

Females 80 - 100 lit / min
Males 150 - 175 lit/min } by Sembulingam

One an average it is between 125 to 175 lit/min by Willium Ganong.

Adult Male - 150 lit / min
Adult femal - 125 lit / min } by API Book of Medicine.

Normal subjects can attain a maximal ventilation volume of 100 lit/min or more in the age group 16-34yrs. By Samson Wrights in the book Applied Physiology.

The ability to reach a high MVV dependes upon the muscular forces available, on the compliance of the throracic walls and lungs and on the airway resistances set up.

MVV is reduced in respiratory diseases. In efficiency in ventilator (below) action like emphysema, asthma, hypnosis etc., gives low values.

Conclusion:

There is relation between the MVV and pollution levels. In Pimpari Chinchwad area the NOx levels are more as compaired to normal levels of the sensitive area. The MVV in this area is less than the normal. The NOx levels increases as per area Swargate, Nal stop, Pimpari Chinchwad as shown in the graph. The levels of the NOx in the sensitive area is 15µg/m3 according to the standards of the ambient air quality. The MVV is found to be more affected in the Pimpari Chinchwad area which is less than 100 lit/ min in 75% of the sample size. There is definite effect of air pollution on MVV. In industrial area like Pimpari Chinchwad the functional capacity of the respiratory system is reduced.

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