Water scarcity in the world and pakistan environmental sciences essay

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Water ac not only be considered as a resource, but it is considered as a life source. Life on earth either plants or animals are dependent on water for different purposes. We don’t only need water for drinking but it is also our requirement for growing our food, our corps, generating electricity and for running our industries. Only 3 percent of the water resources is not salty, two third of the water is locked up in glaciers and other ice caps. Only 0. 08 percent of the remaining water is only used by human being in the ever increasing demand for sanitation, drinking, manufacturing, industries, washing and agriculture. Our best concern in the future is the sustainability of the current and future water resources allocation. As water is becoming scarce, so the need and importance that how it should be managed, used and treated is growing vastly.

Pakistan profile

Water is a prime compound to sustain life on earth. Unfortunately, Pakistan is considered to be among one of those countries in the world which are facing water deficiency. Water shortage is one of the major problems that need a lot of attention to be dealt with. Water issues exist both in terms of quality and quantity. One cannot think to increase water resources as hydrologic cycles occur naturally and without any prospect of new reservoirs and dams in Pakistan. Water will remain a critical and limiting resource for sustained economic development of the country (Ahmad, 2004). Pakistan is already one of the most water-stressed countries in the world; a situation which is going to degrade into outright water scarcity (World Bank, 2005). The need of the day is to reduce the constantly growing stress on existing water resources for sustainable development. One possible solution to the problem is wastewater reclamation and reuse through treatment. Processes used to make water more acceptable for a desired end-use is termed as wastewater treatment. Groundwater recharging is one of the major benefits of waste water reclamation. The end product can be used for irrigation, industrial processes, and non potable purposes. Wastewater pollution is a major environmental and social concern in Punjab andPakistan. The impacts of discharging waste water without treatment into the environment have significant health and ecological impacts and externalities. The Environmental legislation and other related federal and provincial policies and legislation have set it mandatory to treat waste water before discharging it into the environment. Industries are also major polluters of environment. Except Faisalabad which only treats 20% of the wastewater, none of the cities treat their wastewater. The capacity of the Water And Sanitation Agency (WASA) and cities to design and operate waste water treatment plant is limited and needs specialized input to enhance their capacities.

Wastewater reuse after treatment is a sustainable option

A possible solution is to improve quality of wastewater so that it can be reused for non-potable purposes. Conventional wastewater treatment processes are not so in effect in removal of pathogens and their effluents causes risk to aquatic life and environment. Current technology may be able to satisfy discharge standards but not suitable for reuse. Major forces to undergo water recycling today are the increasing water demands due to population growth, change in human lifestyle, urbanization, and fading natural water resources. Moreover, well public alertness about environmental protection has resulted in growingly more inflexible wastewater quality discharge regulations. Disposal of treated wastewater below discharge standards from households or other units can result in adverse soil pollution and surface water contamination (Tanner, 2012)Especially in the textile industry a high quality of water effluent is demanded, since textile wastewater can be a major source of color and contaminants when discharged to the environment. The color from the textile wastewater is mainly due to the intense dyeing process, which involves a wide range of different types of dyes, of which only 50 % is biodegradable. Many of these dyes can cause environmental problems if released into the aquatic environment, thus causing highly environmental concerns. Because of this and local water scarcity which is a problem in many regions, reuse of the water effluent has become an important issue in the textile industry.

Different textile processes and the associated water consumption with them.

The textile industry consumes large amount of water in its different processing operations. In the mechanical processes of spinning and weaving, water consumed is very small as compared to textile wet processing operations, where water is used extensively. According to USEPA a unit producing 20, 000 Ib / day of fabric consume 36000 liters of water.

Ginning

The cotton seed grows in to a cotton gin. It separates seed and removes the trash (dirt, stems and leaves) from the fiber. So the process of separating the cotton fibers from the seed pods is termed as ginning. A machine which provides greater productivity then manual separation is termed as cotton gin.

Spinning-yarn manufacture

Spinning is the succeeding step to ginning. This process involves the making of yarn from the cotton fiber. The cotton yarns are made of different thickness in this stage.

Sizing

Starch is added to the manufactured yarn for the strengthening of the warp to reduce the breakage of yarn.

Weaving

Weaving is the most important process in the making of cotton cloth. In this process, two yarns are placed to make warp and weft of a loom which successively turn them into a cloth. The length way threads are known as the warp, and the cross way threads are known as the weft.

Desizing

Depending on the size that has been used, the cloth may be steeped in a dilute acid and then rinsed, or enzymes may be used to break down the size.

Bleaching

Bleaching improves whiteness by removing natural coloration and remaining trace impurities from the cotton; the degree of bleaching necessary is determined by the required whiteness and absorbency. Cotton being a vegetable fiber will be bleached using an oxidizing agent, such as dilute sodium hypochlorite or dilute hydrogen peroxide. If the fabric is to be dyed a deep shade, then lower levels of bleaching are acceptable, for example. However, for white bed sheets and medical applications, the highest levels of whiteness and absorbency are essential.

Mercerizing

In this process the fabric is treated with caustic soda solution to cause swelling of the fibers. This results in improved lustre, strength and dye affinity. Cotton is mercerized under tension, and all alkali must be washed out before the tension is released or shrinkage will take place. Mercerizing can take place directly on grey cloth, or after bleaching.

Singeing

Singeing is designed to burn off the surface fibers from the fabric to produce smoothness. The fabric passes over brushes to raise the fibers, and then passes over a plate heated by gas flames. Sometimes different chemicals are also used.

Dyeing

This process involves the changing of fabric color by the treatment of dye. Finally, cotton is an absorbent fiber which responds readily to coloration processes. For improved fastness to washing, rubbing and light, other dyes such as vats and reactive are commonly used. These require more complex chemistry during processing and are thus more expensive to apply.

Washing

Chemical washing process is carried out on cotton fabric to remove natural wax and non-fibrous impurities from the fibers and any added soiling or dirt. Some of the dyes also need to be washed from the surface of the cloth.

Printing

Printing, on the other hand, is the application of color in the form of a paste or ink to the surface of a fabric, in a predetermined pattern. It may be considered as localized dyeing. Printing designs on to already dyed fabric is also possible.

Finished product

At this stage the cloth is prepared to be dispatched to the market.

Amount of wastewater generated from each wet process

Water requirements for cotton textile wet finishing operationsProcess

Requirements in litres/1000 kg of the product

Characteristics of waste water

Desizing2500-21000High COD, High Total Solids, pH NeutralBleaching2500-25000H_2O_2, High pHMercerizing17000-32000Alkaline, Low TDS, DetergentsSingeing500-8200Different chemicals, High COD, AlkalineDyeing10000-300000High COD, High TDS, Neutral to alkalineWashing20000-45000High phosphates

Textile Wastewater Characteristics

Textile wastewater: characteristics and effects on the environment

Textile industry is characterized as large quantity of water consumption and a variety of chemical used. Water is used in wet process and lies in a range of 80-150 m3 per 1000 kg of the product. Wet process generates wastewater. In Pakistan textile industry discharge highly polluted waste water into the fresh water bodies adversely affecting the aquatic life and human health. Different process involved in textile industry produce different impacts on environment. This impacts start with the use of pesticides during the cultivation of natural fibers. However world's wide environmental problems of textile industry are those which are linked with the water pollution caused by discharge of untreated effluent these chemicals can harm consumers if they retained in the fiber. The impact of environmental regulations on the textile sector of Pakistan can be classified according to various parameters of waste water. The waste water generated by textile industry is high in BOD, COD, pH, temperature, color, turbidity and toxic chemicals, direct discharge of this wastewater in rivers or lakes can affect flora and fauna. Effluents of textile industry are generally hot, alkaline, and strong smelling, and coloured by chemicals used in dying process. Some of the chemicals, including dyes and pigments, are toxic or can lower the dissolved oxygen content of receiving waters, threaten aquatic life and damage general water quality downstream. Effects on organisms in the environment can be either short term (acute) or long term (chronic). Many add-ons in dyeing namely carriers, dye-fixing agents, cationic retarders and heavy metal salts- are difficult to biodegrade and therefore have a negative impact on the environment. In textile waste water the toxic effect of heavy metals on animal and aquatic life is dependent on their physico-chemical form. In dye house effluent, heavy metals occur as a consequence of the heavy metals salts used in dyeing, the use of metal-complex dyes, or from the presence of impurities in dyestuffs. It has been observed that dyeing losses contribute to only 10- 30% of BOD of the total, with respect to COD, the contribution of dyes themselves is around 2-5%, while that of dye bath chemicals is as high as 25-35%. upto 50% of dyes may be lost directly into the waterways when using reactive dyes. Acetic acid used in disperse dyes on polyester exerts a high BOD and can account for 50- 90% of dye house BOD. The presence of dyes in waterways is easily detectable even when released in small concentrations. Dyes may also be problematic if they are broken down anaerobically in the sediment, as toxic amines are often produced due to incomplete degradation by bacteria . the breakdown products of dyes are toxic and mutagenic to life. Dye used varies from day to day and sometimes even several times a day preliminary because of the batch wise nature of the dyeing process due to which a large pH swing is especially troublesome because the pH tolerance of conventional biological treatment is very limited the dye waste effluent is varied in color from purple, dark red, brown, grey, dark blue or black. There are almost more than 2000 different chemicals are used in textile industry from dyes to transfer agent. Being a chemically intensive industry textile industry is no 1 polluter of clean water after agriculture. It takes about 500 gallons of water to produce enough fabric to cover one sofa. Half a billion people already live in regions prone to chronic drought, and by 2025, that number is likely to increase by five-fold, to between one third and one half of the entire world population. Global consumption of fresh water is doubling every year. The basic chemicals discharges in mill drainage are dyes, dextrin, gums, alcohol, fatty acids, soaps, detergents, sodium hydroxide, carbonates, sulfides, sulfites, carboxymethyl cellulose, gelatin, peroxides, resins chlorine, formaldehyde, acetic acid, starch along with heavy metal such as lead and mercury. There are no of problems which can be caused by dyes. Depending on exposure time and dye concentration, dyes can have acute and or chronic effects on exposed organisms. The presence of very small quantities of dyes in water less than 1 ppm is highly visible due to their brilliance. The primary concern about effluent color is not only its toxicity but also its undesirable aesthetic impact on receiving waters. The color of reactive dyes is due to the presence of N= N azo bond and chromophoric group these dyes in both ordinary and hydrolyzed form are not easily biodegradable and thus even after treatment color may be present in the effluent The greatest environmental concern with dyes is their absorption and reflection of sunlight entering the water. Light absorption diminishes photosynthetic activity of algae and seriously influence on the food chain. Dyes can remain in the environment for an extended period of time, because of high thermal and photo stability. Many dyes and their breakdown products are carcinogenic, mutagenic and toxic to life. There is ample evidence of their harmful effects. Triple primary cancers involving kidney, urinary bladder and liver of dye workers have been reported in a past several years. A lot of investigations of respiratory diseases in workers dealing with reactive dyes have been made. Certain reactive dyes have caused respiratory sensitization of workers occupationally exposed to them Most of the dyes, used in the textile industry are known only by their trade name, while their chemical nature and biological hazards are not known. Textiles industry also have a huge impact on the environment from growing natural fibers to the finishing and dyeing process, to the substantial amounts of water and energy used to clean the textiles once in hand of the final user. For examples: Cotton is a water intensive crop and is often grown in water-scarce areas. Cotton requires a lot of toxic pesticides to grow and accounts for 16% of the global pesticide use, even though it's only 2. 5% of all crops. These pesticides runoff and pollute local ground water. The discharge of organic pollutant either BOD or COD to the receiving stream can lead to the depletion of dissolved oxygen and thus creates anaerobic condition. Under anaerobic condition foul smelling compound such as hydrogen sulfides may be produced. This will consequently upset the biological activity in stream. A study appearing in the October 2006 issue of the " Journal of Environmental Biology" investigated the effects of textile dye waste water on the health of the freshwater fish. The researchers measured the toxic effects of untreated waste water on the shape and size of the fishes' red blood cells, or RBCs, and compared them to the same parameters in fish that inhabited areas with treated waste water. The study found that there were significant differences in both the shape and size of RBCs caused by the untreated effluent and recommended that these parameters be included in future monitoring of toxic effects on all fish species. Untreated textile dye waste water is detrimental to the reproductive capabilities of most animals that come into contact with it. An article published in the March 2005 issue of " Reproductive Toxicology" investigated the effects of untreated waste water on the body weight and the weight of reproductive organs of animals. The researchers orally administered both treated and untreated waste water to two groups of animals. They found that the group ingesting the untreated waste water had significantly reduced body weights and their reproductive organs were up to 44% smaller. Additionally, they found very unhealthy reductions in total protein concentrations of up to 70% and cholesterol was depleted by up to 9%.

Effluent Characteristics of Textile Wastewater

ParametersValuespH7. 0-9. 0Biochemical Oxygen Demand (mg/L)80-6, 000Chemical Oxygen Demand (mg/L)150-12, 000Total suspended solids (mg/L)15-8, 000Total dissolved solids (mg/L)2, 900-3, 100Chloride (mg/L)70-80Total Kjeldahl Nitrogen (mg/L)70-80Color (Pt.-Co)50-2500

Composition of Synthetic Textile Wastewater

The following composition is based on the analysis of the textile wastewater samples collected from two different textile industries Azgard9 mill and Cresent textile mill. ChemicalAmount (mg/L)Glucose1000NH4Cl760KH2PO4220NaHCO3800CaCl210Mg2SO410FeCl33. 3MgCl22Copper sulphate1. 5Chromium chloride2Disperse dye100Vat dye100Reactive dye100Pigment dye100The dyes i. e. disperse, vat, reactive and pigment dye were given by the cresent textile mill. Following is a brief description of the above mentioned dyes.

Dye Class

Description

Main application

Disperse dye

Moderate priceComplete color rangeNormally dispersed in water for applicationGood fastnessMostly used forPolyester, Acetate, Nylon, Acrylic.

Vat dye

Difficult to applyExpensiveIncomplete color rangeGood fastnessTending to decrease in popularity due to increasing use of reactive dyesMostly used forHigh quality cotton goods, e. g. towel; Specially used in the dyeing of denim fabric.

Reactive dye

Easy application; Moderate price; Complete color range; Good fastness as direct reaction with fibers occurs. Mostly used forAll cellulosic goodsSelective dyes can also be applied on wool, silk & rayonIncreasingly used in printing due to good fastness.

Pigment dye

Basically it is not a dye rather they are ground based pigments, easy to apply with good shade; Full color range; Can be applied on all textile fibers & their blends. Mostly used forUsed for coloring paint, Ink, Plastic, Fabric, Cosmetics, Food and other materials.

Treatment techniques for the Textile Wastewater

Conventional Wastewater Treatment

Activated sludge treatment is most widely applied for wastewater treatment. In activated sludge process soluble and insoluble organic contents are removed from wastewater by conversion into a flocculent microbial suspension that settles under gravity (Ramothokang, 2003). Three major steps involved in conventional activated sludge treatment are primary, secondary and tertiary treatment. In primary treatment the sewage is simply retained in a basin that results in settling of heavy solids leaving only light solids and oil to come on surface. The settled material is left behind in the basin while rest of the wastewater moves for secondary clarification. Dissolved and suspended biological matter is removed in secondary treatment and is sent for tertiary treatment. In tertiary treatment sewage is further treated by physical or chemical disinfection. The water can then be discharged into the stream, used for ground water recharge or irrigation (Bhatti et al., 2009).

Wastewater treatment (adapted from Henze et al., 2008)

Biological Wastewater Treatment

Treatment system in which natural role of bacteria is utilized for bioconversion; the biological flocs and biofilms are used for degrading or adsorbing dissolved colloidal, settleable and particulate matter (Henze et al., 2008). Biological treatment processes include both aerobic and anaerobic systems. Aerobic biological wastewater treatment systems make use of mixed microbial consortia to transform organic and inorganic pollutants to harmless byproducts that can be released easily into the environment (Dias et al., 2003). Aerobic technologies are mostly implied for treatment of municipal and industrial wastewaters. But use of anaerobic systems has now increased because of its low construction, operation and maintenance cost. However the biomass production is low and the effluent requires post treatment because of high COD along with nutrients and pathogens (Gašpariková et al., 2005).

Membrane bioreactor introduction and its efficiency in wastewater treatment

Membrane Bioreactors

Membrane bioreactors (MBR) are commonly understood as the combination of membrane filtration and biological treatment using activated sludge (AS) where the membrane primarily serves to replace the clarifier in the wastewater treatment system (Gunderet al., 1998). An MBR can replace two physical processes in to one by filtering the biomass by using the membrane while in conventional activated sludge process the wastewater undergoes two stages of treatment: aerobic degradation followed by secondary sedimentation to remove biomass. (Judd, 2006)Textile wastewater repossession is assumed to be a capable process to prevail over the increasing pressure on water resources. Though, textile wastewater because of contaminants may also carry potential health dangers, source of pathogenic disease and toxic effects and color. Thus, textile wastewater repossession need a highly competent treatment processes to achieve a quality water, together with economic feasibility. In a variety of wastewater treatment processes, use of membrane has increased to meet environmental regulations. Environmental awareness, laws and improved strength, efficiency and variety of treatment technologies have made the reuse of water more feasible (Hoinkis et al., 2012). Membrane process appears to be well suited to fulfill the water quality requirements for reuse purposes such as irrigation. (Jamal and Visvanathan, 2008).

Membrane Operational Modes

Membrane can be operated either under dead-end filtration or cross-flow filtration mode depending upon the nature of use. Dead-end filtration is also known as direct filtration in which the flow of direction is perpendicular to the membrane. The particles retained by the membrane result in cake formation on the membrane surface. The cake my damage and clog the pores of the membrane. Figure illustrates dead-end filtration. FeedPermeateIn cross-flow filtration, the flow is tangential across the surface of the membrane. A portion of feed passes through the membrane which is called permeate and the rest is rejected. Cross flow filtration opposes cake formation as it scours the membrane surface along with the flow, until adhesive forces binding the cake to the membrane are balanced. Upon this equilibrium a steady state is achieved resulting in higher permeate flow. Figure shows mechanism of cross flow filtrationFeedPermeate

Advantages and Disadvantages

MBR is effective technology used for textile waste water treatment to achieve higher effluent quality that is difficult to achieve with the conventional activated sludge process. The advantages of MBR are: Effluent is of high quality. MBR can be operated to ensure simultaneous nitrification and denitrification and phosphorus removal by precipitation (Melin et al., 2006). Use of membrane eliminates need for secondary and tertiary treatment (Bhatti et al, 2009) resulting in smaller footprint. Operational conditions are more controlled as an independent sludge retention time (SRT) and hydraulic retention time (HRT) can be maintained. High sludge concentration allows better treatment of wastewater. Despite of several advantages of MBR, the process has certain limitationsMBR is expensive to install and operate. Frequent monitoring and maintenance of membrane is required. Certain limitations are caused by temperature, pressure and pH to meet membrane tolerances and the sensitivity of membranes to some chemicals. Oxygen transfer may be less efficient because of high MLSS concentration and also if there is surplus sludge its treatability is doubtful (Melin et al., 2006). Membrane fouling reduces membrane filtration capacity by reducing filtration flux (Dias et al., 2003). Microbes responsible for treatment of wastewater is also responsible for biofouling of the membrane (Wagner and Loy, 2002)