human being [9, 10,11]. Heavy metals can be treated by various physical, chemical and biological methods. Adsorption was used successfully for removal of heavy metals like lead, cadmium, chromium, zinc, copper etc [12,13,14,15]. Biological processes like trickling filters and activated sludge process were also investigated [16,17,18,19]. Also use chemical treatment is also reported to be effective for heavy metal removal[20,21,22].Heavy metals are present in the wastewater from various industries like leather, electroplating, catalyst, fertilizer, pigment, minimizing and metallurgical industries. Arsenic one such heavy metal which needs to be removed from Water near smelting of ores such as those of gold, silver, copper and others. Arsenic present in water above regulatory limits can cause skin diseases, lung and kidney diseases. It can be removed from water by various methods like membrane techniques, chemical precipitation, coagulation and flocculation, ion-exchange or chelation and adsorption. The present review summarizes various techniques used by investigators for cost effective and efficient removal of arsenic from water.

II. RESEARCH ON ARSENIC REMOVAL

Herring carried out investigation on arsenic removal from drinking water during coagulation [23]. They used ferric chloride and alum during the investigation. They observed that arsenic removal was relatively insensitive to variation in pH for pH values below 8. It was not possible to remove arsenic from source water by using alum. Gomes et.al carried out investigation on arsenic removal by electro coagulation [24]. According to these studies; either Fe–Fe or combination of Fe and Al plates as sacrificial electrodes in EC process was very promising for arsenic removal. They also observed that the initial pH value of 6 was optimum for removal of arsenic. Hydroxide-type Adsorbents were used for arsenic removal by Fujita et.al. [25].They used three hydroxide-type adsorbents for removal of arsenic namely ferric hydroxide, ferric cupric hydroxide, and ferric lead hydroxide. The optimum pH value for Arsenic removal was 6.They also observed that ions change their form as the pH of the system varies and arsenic (III) was adsorbed onto the surface of the adsorbent (i.e. ferric hydroxide), while pH ranges between 4 and 9. Dhal et.al investigated bio sorption of arsenic on activated sludge [26].They used aerobic activated sludge for arsenic removal. According to their data, 90 minutes time of contact was found to be maximum to adsorb about 95% arsenic. Also 40 weight percent of adsorbent dose was sufficient to recover 96 percent of the arsenic. Mohan and Charles reviewed the arsenic removal from wastewater [27].They summarized sorption capacities of various adsorbents. According to their review, low-cost adsorbents like treated slag, carbons developed from agricultural waste (char carbons and coconut husk carbons), bio sorbents (immobilized biomass, orange juice residue), goethite and some commercial adsorbents, which include resins, gels, silica, treated silica were very efficient in removing the arsenic. According to them successful separation process should have Low-volume stream containing the concentrated contaminant(s) and high volume exit stream containing the decontaminated liquid, solid or gas. They made three important recommendations. They suggested that periodic monitoring should be stimulated, the wide use of deep aquifers low in arsenic should be encouraged and awareness and publicity of known effects of arsenic on the mental development of children. In their investigation, Li et.al. treated the wastewater from semiconductor industry for arsenic removal [28]. The processes of etching, cutting and washing in semiconductor industry give rise to arsenic emission. They proposed three step processes for arsenic removal. The first step was potassium permanganate treatment followed by second step of precipitation with ferric sulphate and slaked lime under pH adjustment. The third step was the adsorption of the bentonite. Their experimental results showed the removal efficiency was 99.99 percent. Chiban et.al. carried out review on arsenic removal by adsorption [29]. During their review, they found that the adsorption by using low cost adsorbents is gaining importance as simple and effective way for arsenic removal. Thermal and chemical modification of adsorbent can improve the adsorption properties of the material. An investigation was carried out on removal of various heavy metals including arsenic by Bakar et.al.[30]. They tested the potential of photo remediation for removal of the heavy metals. The

investigation indicated that the removal efficiency differed with type of aquatic plant. In the implementation of desalination technologies, the disposal of concentrates a major concern. Removal of arsenic and monovalent ions from brackish groundwater reverse osmosis (RO) concentrate was studied by Xu et.al. Their study indicated that the removal of arsenic was very effective by electro coagulation process [31]. They also observed that the chemical demand for ferric chloride is much lower than ferric sulphate as coagulant. Parks and Edwards used precipitation method for removal of heavy metals including arsenic by using sodium carbonate [32]. In their study, they developed linear and nonlinear regression to predict the effectiveness of soda ash softening for the removal of arsenic, barium, boron, chromium, strontium, and vanadium. They observed that the data on contaminant occurrence and contaminant removal followed linear and nonlinear results. Allende et.al carried out investigation on planted column reactors in order to study the effects of substrate media on the removal of arsenic, boron and iron from an acidic wastewater [33].They studied the effect of four types of wetland media, namely gravel, coco peat, zeolite and limestone. Electro coagulation method was investigated for removal of arsenic from industrial by Zodi.al. [34]. they were able to remove arsenic from wastewater using arsenic. Langmuir like sorption of arsenic on Fe hydroxide was observed.

III. CONCLUSION

Arsenic can cause serious health problem on inhalation and intake to human being. There is need for efficient and low cost method for arsenic removal. Arsenic can be removed from the water by various techniques like adsorption, electro coagulation, membrane separation, bio-sorption etc. One or more of these methods can be coupled to give more effective treatment. Adsorption seems to be most widely removal method for arsenic removal. Various low cost materials can be used for adsorption. Chemically or physically modified adsorbent prepared from low cost materials exhibit satisfactory adsorption properties for arsenic.

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