Nitrogen and phosphorus are essential nutrients for plant growth but when released in excessive amount in the water bodies they become water pollutants as excessive nitrogen and phosphorus leads to uncontrolled eutrophication, major loss of oxygen and undesirable changes in aquatic population. The wastewater must be treated for excess nitrogen and phosphorus removal before discharge into water streams (Jafarzadeh et al., 2014) In addition, the increase in algae increases the need to increase chlorine doses of drinking water, which in turn, leads to higher levels of disinfection by-products (Fisher et al, 2004; Jack et al., 2002) that have been shown to increase the risk of cancer (Wang et al, 2007). Excessive amounts of nutrients can also stimulate the activity of harmful microbes, such as Pfisteria etc (Hasselgren et al., 2008).

Nitrogen is present in large concentrations in the effluent of various industries, landfill leachates, slaughter house wastewaters and sludge digester effluent. The Landfill leachate is characterized by a significant amount of ammonium, high organic matter content, which has a low biodegradable fraction, high salinity and alkalinity (Ganigué et al., 2008). Slaughterhouse wastewater contains diluted blood, protein, fat, and suspended solids, as a result the organic and nutrient concentration in the wastewater become high and the residues are partially solubilised, leading to a highly contaminating effect in riverbeds and other water bodies if the same is let off untreated. Sludge digestion and centrifugation processes are also one of the sources of highly concentrated ammonium streams. During this process a protein breakdown occurs and about 50% of the sludge bound nitrogen is released to wastewater stream in the form of ammonium. Recycling of such a stream to the head of a Wastewater treatment plant contributes to the average increase in the total nitrogen load by about 15–20%. Nitrogen is mostly present in wastewater as ammonium and is removed by physicochemical and biological processes. Biological treatment to remove nitrogen from wastewater is less expensive and more effective than physicochemical treatment.
and thus has been used more often to achieve nitrogen removal from domestic and industrial wastewaters (Khin T., & Annachhatre, A.P., 2004).

Environmental laws have become stringent for the discharge of nutrient containing wastewater. Lots of research work has been done on the new improved, innovative, sustainable and cost effective biological nutrient removal processes. In order to avoid eutrophication problem major emphasis has been giving on reducing the quantities of nutrient discharged as it stimulate the growth of algae and other photosynthetic aquatic plants.

Conventional biological nitrogen removal is achieved mostly by complete oxidation to nitrate and subsequent reduction of nitrate to nitrogen gas under anoxic conditions at the expense of a carbon source such as methanol. If the BOD/N ratio in wastewater is low, additional carbon source for denitrification is required, which increases the cost of operation. A new biological process for nitrogen removal, called anaerobic ammonium oxidation (ANAMMOX), which oxidizes ammonium to nitrogen gas with nitrite as an electron acceptor under strictly anoxic conditions, has been developed. Compared to conventional nitrification and heterotrophic denitrification this process requires less electrical energy for the aeration (Xiaoming Li et al., 2010).

Another new technology for nitrogen removal is completely Autotrophic Nitrogen Removal over Nitrite (CANON) process wherein removal of ammonium from wastewater occurs in a single oxygen limited treatment step. The CANON process relies on the stable interaction between only two bacterial populations Nitrosomonas-like aerobic and Planctomycete-like anaerobic ammonium oxidising bacteria (Gaber., 2010). The Canon process has been proved to be a cost-effective nitrogen removal technology because it is an autotrophic process that requires lesser oxygen, no need for a carbon source, and produce less amount of sludge, compared to conventional nitrification/denitrification processes. (Z. Zhang et al. 2010).

In the CANON (Completely Autotrophic Nitrogen removal Over Nitrite) system both types of bacteria can co-exist in one reactor (Sliekers et al., 2002, Young et al., 2006). Ammonia is partially oxidized under oxygen-limited conditions to nitrite and then
nitrite together with remaining ammonia is converted to dinitrogen gas by the Anammox bacteria.

The single reactor system for high ammonia removal over nitrite (SHARON) process is also new alternative for biological nitrification. This process is operated in single aerated reactor at relatively high temperature without biomass retention in the reactor. The process involves partial nitrification of ammonium to nitrite and this greatly reduces the cost of aeration. The sharon process can be carried out in a simple continuous stirred tank reactor and is ideally suitable for removing nitrogen from ammonium rich wastewaters.

The new innovative and most promising of all the recent technologies, is aerobic granular sludge technology which has the ability to improve the biological nutrient removal from wastewater by large extent. Compared to present wastewater treatment plants, similar efficiencies at lower costs can be achieved with the compact aerobic granular sludge technology. Aerobic granular technology possesses many advantages over activated sludge processes. Such as good biomass retention, the ability to withstand fluctuating loads and toxic conditions, and the availability of both aerobic and anoxic zones inside the granules that simultaneously allows different biological processes to take place within a single granule. (Jungles et al., 2013)

A number of reactors configurations have been used as biological treatment systems. In the last decade sequencing batch reactor (SBR) has gained importance over other reactors for the treatment of wastewaters. SBRs are especially preferred when nutrient removal is important because enrichment of nitrifying/denitrifying bacteria and phosphorus removal bacteria may take place in same reactor by simply changing the mixing and aeration conditions and time schedule. Moreover no separate units are required for equalization, biological treatment and settling as all these steps can be performed in a single reactor system. SBR can be operated in small space and is very cost effective reactor for biological nitrogen and phosphorus removal (Govindassamy Vijayan et al. 2016)
Objectives of the study

- To study the development of aerobic granules in column type sequencing batch reactors and to find the effect of height to diameter ratio (H/D) on granules formation in SBR.
- To enrich anammox microorganisms in SBR and to assess the performance of such microbial cultures for the removal of nitrogen from wastewaters.
- To study the performance of column type SBR for biological nitrogen and organics removal for three types of nitrogen rich wastewaters, namely, sludge digester effluents and landfill leachates using enriched anammox culture and slaughterhouse wastewater using aerobic granular sludge.