Energy Conservation in Wireless Sensor Networks (WSNs) is prime concern in most of its applications. This become important as increase in the network lifetime depends mainly on minimizing the energy consumption in sensor nodes. Thus conserving and balancing the energy consumption is of utmost importance. WSNs have much attention in a large range of technical fields such as industrial, military, environmental monitoring etc. Sensors are powered by batteries. Changing batteries can be a tedious task especially if the nodes are deployed in remote and/or hostile environments. A reduced cost and easier installation and deployment of the wireless components are the main reasons for considering a wireless solution in industrial applications. This has resulted in an increased popularity among industry and especially companies interested in the area of industrial process automation. The process automation industry is adopting wireless technologies, but in such harsh environments technologies like Bluetooth and ZigBee are not reliable enough. For industrial revolutionary monitoring, WirelessHART (Wireless Highway Addressable Remote Transducer) is the next big technology advancements over ZigBee and Bluetooth specifications. Reliability can achieve in terms of terms of security, network lifetime and throughput.

The main objective of the thesis is to investigate the mechanisms to conserve and balance the energy consumption to extend the lifetime in WirelessHART enabled sensor network.

There are several ways to increase the network lifetime. They are: Clustering the nodes to reduce congestion, Medium Access Control (MAC) Protocols allow the nodes to enter in to sleep mode, In-network data aggregation which can minimize the energy consumption, efficient routing
tree construction along with data aggregation can further improve the network lifetime.

The energy stored by the sensor is the greatest impediment for increasing WSN lifetime, because power failure of a sensor not only affects the sensor itself, but also its ability to forward packets on behalf of other sensors. WSNs have many sensor devices that send their data to sink for processing. But this leads to heavy traffic in the network and as the nodes are limited with energy, this decreases the network lifetime. Since data transmission consumes more energy than sensing and processing activities, our major concern is how to efficiently transmit the data from all field devices along the shortest path towards a sink, helping to reduce the number of transmissions. Hence there is need to develop Energy-Efficient Packet Forwarding approach in WirelessHART to meet industrial requirements. Energy Efficient approach operates in two phases (i) efficient packet aggregating and (ii) packet forwarding. Packet aggregation technique is introduced to improve the lifetime. This technique decreases the data traffic and further saves energy by merging multiple packets into a single packet and then forwards it to sink. Packet forwarding approach uses graph routing, which can provide redundant paths to improve the reliability of the wireless communication. The network lifetime of the proposed system is monitored with varying node quantity, redundant paths and edge length.

In addition to that, topology of the sensor network plays vital in efficiency of WSNs. Large Networks will have large number of devices that need more hops to reach gateway. As the number of hops increases, so does latency. Cluster Tree topology is a hybrid one and that can provide improved performance than other topologies. Moreover, the selection of cluster head and cluster maintenance under the harsh environment is a tedious task. To improve the overall network scalability, an Energy Efficient Link aware
Cluster Tree based algorithm for data aggregation has been proposed to reduce the energy consumption in WSN. It consists of three phases: Cluster formation, Cluster tree hierarchy and optimal path selection. Using Cluster tree based structure stable link can be provided which reduces packet drop ratio and packet retransmissions over the network. The Performance of this algorithm is based on energy consumption, delay, throughput, packet delivery ratio, packet drop ratio. From simulation results, it is observed that the proposed algorithm can conserve residual energy, prolong the network lifetime and network reliability.

Clustering along with load balancing is an efficient way to expand the lifetime of a sensor network by limiting the energy utilization. Hence, Efficient Load Balancing algorithm in cluster tree based WirelessHART sensor network has proposed in order to avoid data packet loss in an efficient way by facilitating better Quality of Service with respect to network lifetime for Industrial based WSNs.

As per the analysis, it is evident that the proposed schemes are much more effective in terms of reducing the energy consumption in WSNs.