

PREFACE

In this 21st century with the growing population and the nature of luxury of human lifestyle increases the energy needs such as energy demand and energy supply. The Majority of the world energy needs are supplied by the non-renewable resources (also called finite resource) which include fossil fuels (coal, petroleum and natural gas), earth minerals, ores, renewable resources such as solar energy, wind energy, hydropower, geothermal and biomass. Industrialized driven advancement, world energy supply and consumption have profound implications for socioeconomic development as well as environmentally friendly nature. According to Key World Energy Trends, 2016 (International Energy Agency) world total energy supply, by fuel in the year 2014 was 13,700 MTOE through the various sources such as oil 31 %, coal 29 %, biofuels 10 %, nuclear 4.8 %, hydro 2 %, nuclear 5 %, and natural gas 21 %. Thus we see that oil, coal, and natural gas were the most widely used energy sources and almost about 81 % of world energy demand is supplied by these three energy sources (oil, coal, and natural gas), with rest of 19 % shared by various renewable energy resources such as bio-fuels, bio mass, hydropower, solar, wind, tidal, wave, geothermal, etc. Now world needs an innovative environmental friendly energy resources due to various problems such as environmental pollution and depleting of non-renewable energy sources. The main challenge from fossil fuels is their cheapness and easy access which makes them still most used and reliable source of energy even for many developed nations, but with the major environmental problems caused by it as well as their depleting, the world is witnessing a shift from these fossil fuels to renewable sources of energy.

There is dozen loopholes while enjoying the perks of cheap fossil fuels. Environmental pollution is one of the major disadvantage of fossil fuels and increase in CO level as well as SO_x emissions, particulate matter and un-burnt hydrocarbons which cumulatively are responsible for global warming, acid rains, depletion of ozone layer, melting of ice caps, smog atmosphere, etc. Also, they have detrimental effects on aquatic life due to oil spillage incidents which are common. The mining of fossil fuels is also too harmful to environment as it destroys flora and fauna of the region. Thus all stages of fossil fuels have a severe impact on the environment from recovery, transportation, preparation/refining, storage and end use.

Biodiesel is one of the biofuels which has a potential to replace the petroleum diesel since it is non-toxic, biodegradable, renewable, non-explosive, non-flammable, environmentally friendly and low emission profiles in comparison to petroleum diesel. Biodiesel has similar properties with petroleum diesel, and it can be used in a pure or blended form with small or no modification of diesel engine. Also, biodiesel betters anti-wear properties and fuel lubricity while blending with petroleum diesel. Biodiesel is long chain alkyl esters extracted from plant oils or animal fats. In general biodiesel synthesis from plant oils or animal fats using a suitable catalyst through a transesterification. Biodiesel can be synthesized using various type of catalysts. The most widely in use are namely enzymatic, homogeneous acid/base and heterogeneous acid/base catalysts. Enzymes are most expensive, and their reactions are too slow. Homogeneous catalytic reactions are fast, but the separation of homogeneous catalysts, as well as their reusability, is difficult in transesterification reactions. Heterogeneous catalysts are easily separable and reused in transesterification reactions.

The main objective of this thesis is the synthesis of biodiesel using modern technical methods. Esterification followed by transesterification steps were adopted for the synthesis of biodiesel. Characterization of biodiesel and effect of biodiesel parameters on biodiesel yield were studied with and without co-solvent.

The present study divided into eight chapters. Introduction and literature survey are first and second chapters respectively. The third chapter illustrates the materials and methods which are involved in all experimentations. Extraction of feedstocks, preparation of catalysts and their characterizations were described in the fourth chapter. Chapter fifth to eight demonstrates the synthesis as well as characterization of biodiesel and effect of biodiesel parameters on biodiesel yield, were examined with and without co-solvent covers. Prepared catalysts were reused with and without calcination. Summary of each chapter is described at the end followed by the references.