

# Application of Condenser for Methanol Recovery in Biodiesel Setup



Senthil Kumar S, Rajesh K, Vigneshvar S, Vignesh N P, Srinath Maruthi M, Sethu V

**Abstract:** *The waste cooking oil is transferred into biodiesel by using potassium hydroxide (KOH), alcohol (methanol) at a set temperature and time. The concentration of catalyst should be at correct level or else it will lead to negative effect on the overall output of the biodiesel produced. The biodiesel conversion is done to remove the free fatty acids present in the vegetable oil using transesterification process. It is known that the boiling point of methanol is 67 °C it gets evaporated if the reaction temperature exceeds beyond the boiling point. Due to evaporation the methanol required for the reaction to proceed forward may not be available. Thus in order to save the loss of methanol due to evaporation during high temperature operations, a condenser is required to condense the escaping methanol in the form of vapour. This condensed methanol is again sent back to the reaction vessel to carry the transesterification reaction. Petroleum diesel is widely used in the automobile sectors, industry purpose, domestic uses and in agriculture for generation of power (mechanical) energy for the purpose of meeting the energy demands. The fuels from alternate sources are renewable and do not cause severe effect on the environment. Biodiesel is one such source of fuel which can greatly support to reduce the dependency on conventional fuels. It will complete the process in 1 to 2 days to finish the vegetable oil into biodiesel fuel. Biodiesel is a renewable energy source to produce the natural oil and also fats. Hence producing biodiesel will be a better way to compensate the energy demands and the cost involved during production should also be considered. One of the cost-reducing methods is saving the raw materials from wastage.*

**Keywords:** Condenser, recovery, biodiesel, transesterification, renewable source

## I. INTRODUCTION

The usage of fuels for day-to-day activity has been increasing due to the rapid growth of human population and also to meet their requirements. Petroleum-based fuels are mostly utilized for power sectors and transportation sectors. Due to improved consumption of these fuels, there is a demand, cost increase and also depletion day by day. Therefore it is

very important to find an alternate solution for the non-renewable source which is being utilized at a larger rate. Also in the future, these fuels cannot stand to support the demand because at that time it might have exhausted at its maximum. Renewable fuels are one of the good solutions for replacing fossil fuels. One among them is biodiesel, which is derived from vegetable oils and fats of animals. Another important factor to be kept in mind is that the cost involved in producing this fuel. Raw material alone costs more for producing biodiesel. The raw materials used are vegetable oil, catalyst, alcohol. Most often methanol is used as alcohol and its cost is more. Hence in this paper, the importance of methanol recovery using a condenser is discussed as it plays a major role in supporting the reaction to move forward and also to save cost by recovering it.

## II. VALIDATING IMPORTANCE OF METHANOL RECOVERY

The use of alternate fuel reduces the carbon emission in the atmosphere. So the alternate fuel are also renewable fuels when compared to fossil fuels. **G. R. Kannan, S. Nagarajan and S. Velmathi** [1]. Fossil fuels are petroleum, which are extracted from the earth's surface and they are non-renewable. The alternate fuel are bio-diesel fuels, which are extracted from methanol and ethanol, which ignite the IC engine. Due to the usage of fossil fuels, carbon dioxide and carbon monoxide affect the atmosphere and make the layer thinner in ozone, which leads to an increase in temperature and unconditional changes in climate and season. **Nadir Yilmaz**\* [2]. The bio-diesel is one of the best alternatives for fossil fuels. This review paper discusses about some recent studies of bio-diesel fuel.

The raw materials for bio-diesel are divided into three categories. The feedstock is used for first-generation bio-diesel production and second-generation bio-diesel production. **Aditiya, H.B.; Mahlia, T.M.I.; Chong, W.T.; Nur** [3]. It eliminates the first-generation bio-diesel production, it is also known that due to the cost involved in second-generation feedstock, it cannot be a better source for biodiesel production to reduce demand on conventional fuels in the transportation market. Hence third-generation feedstocks can be used and are usually considered as algae bio-mass.

However, some authors consider it as the part of second-generation. The European Commission developed directives (EU)/2015/1513 focusing on reducing the usage of edible oil, which is a first-generation feedstock and to promote non-edible, which can be called as second-generation feedstock to serve as a source for the production of biodiesel.

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**Harish Venu, Venkataraman Madhavan** [4]. The alcohol is used for many purposes and present in human civilization from the beginning. Alcohols were started to use as the automotive fuel in the end of 19<sup>th</sup> century. There are two methods used for producing methanol first one is the reaction of methanol with the steam followed by alcohol fermentation of organic material in distillation.

**André R.T.S. Araujo, M. Lúcia M.F.S. Saraiva** [5]. An elaborated study on the production of biodiesel and effective recovery of methanol. This improves the overall production and yield of the biodiesel produced.

(1) The reaction of the ethane with steam.  
(2) alcoholic fermentation and distillation from renewable bio organic material the methodologies used for this process is Pre treatment and hydrolysis.

The detailed literature on the study of biodiesel production are given,

(1) An integrated energy pinch of condenser and reboiler in bio ethanol in distillation train.  
(2) Gravity fermentation technique is used very often in this process  
(3) Evaporation membrane employed in hybrid process is the recent development  
(4) with the help of membrane technology it is possible to achieve >99.5% pure ethanol by the substitution of dewatering process.

(5) Micro filtration of fermenter with the condenser is an additional development to improve the operation.

The various sources of methanol are Hydrogen, Coke oven gas, natural gas, coal and biomass by using bio energy hydrogenation is the important pathway to create methanol fuel from bio energy

**G. R. Kannan, S. Nagarajan and S. Velmathi**[1]. By using hydrogen obtained from steam electrolysis, the energy of the bioenergy resources is maximized. A variety of bio mass feed stocks may be used in the process **B. Ghobadiana,\* , H. Rahimia**[7], hydrogen and water is shown

**BIO MASS + HYDROGEN + WATER = METHONAL**

**B. Ghobadiana,\* , H. Rahimia**[7], Another way for obtaining methanol is carbon di oxide hydrogenation using carbon di oxide captured and carbon tress recycling. The pathway associated with the chemical reaction is given as

**CARBON DIOXIDES+ HYDROGEN =METHONAL+ WATER**

For obtaining methanol CO electrolysis is another pathway  
**WATER+CARBON DI OXIDE=HYDROGEN+ CARBON MONOXIDE+ OXYGEN = METHONAL +OXYGEN**

**Hiroaki Imahara, Eiji Minami, Shusaku Hari, Shiro Saka**[8]. Bio diesel way synthesized in super critical ethanol and methanol . the kinetics of these reaction is determined . the determination of activation energies of the reaction from the temperature dependence of the coefficient . bio diesel . bio diesel is also synthesis in super critical carbon di oxides catalyst.

**B. Ghobadiana, H. Rahimia** [9] The temperature alcohol to oil molar ratio and the required enzyme concentration was also determined when the reaction was conducted in super critical methanol and ethanol however low conversion were

obtained when the reaction was catalyzed by an enzyme in super critical carbon monoxide

**Kowalewicz, A.; Wojtyniak, M. Alternative fuels**[10] Some properties of the alcohol blends such as its viscosity, high latent heat of vaporization, corrosive nature has serious effect on the fuel supply and injection systems. Due to the facts of lower cetane number and corrosive nature of the fuel, it requires fuel system modification for prolonged usage of the system.

The environmental concern, health and energy concern are facing a serious challenge due to the use of fossil fuel which can be solved by the use of biodiesel. But the use of vegetable oil is not possible and it requires transesterification to produce biodiesel. Producing biodiesel in large quantities involves relatively high cost than producing petroleum diesel because of high feedstock cost and cost of other raw materials. **Ameya Vilas Malvadea, Sanjay T Satpute**\*[11]

**Nadir Yilmaz**\*[12]. In this point there is a need of developing a low cost and environmental friendly technologies for biodiesel production. Also it must be able to produce in large scale in order to meet the demand arising from automobile and industry sectors. It is essential to compare the production of biodiesel from oils and fats from conventional and advanced technological methods for better results.

### III. RESULTS AND DISCUSSIONS

During transesterification process methanol is added to replace free fatty acids by OH group. Transesterification process is a reversible reaction process. Therefore excess methanol is added to vegetable oil to produce biodiesel. If the temperature during the reaction goes beyond 67°C, the methanol starts to evaporate (boiling point of methanol is 67°C). In order to make the reaction to proceed forward, amount of methanol in the reaction should be maintained. Hence a condenser is employed to recover the escaping methanol. The condenser functions as a heat exchanger for condensing methanol evaporated during transesterification reaction. Methanol evaporates during the reaction process when the temperature increases above 67°C. The evaporated methanol from the transesterification reactor enters into the tube which is placed inside the shell. It releases heat into the outside water passing through shell side. Once the latent heat from the vapour methanol is removed, methanol condenses into liquid and is sent back to the reactor again

### IV. CONCLUSION

It is concluded that incorporating a condenser in the biodiesel setup will help the Transesterification reaction to proceed forward to achieve high yield of biodiesel as the end result.

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