Biodiesel Recipe

Oil wether it is from animal or vegetal source is composed of a triglyceride molecule which is made itself from 3 fatty acid chains of various length attached together with a glycerol molecule.

In theory, the conversion process takes away the glycerol by adding an alcohol group (OH) to each of the 3 fatty acid chains. This is called transesterification of oil.

In reality, more alcohol is needed to reach a near complete conversion of oil to biodiesel. The theoretical minimum as per the molecular ratio, requires 3 molecules of ethanol for each molecule of triglyceride (fat). Most biodiesel process use an excess of 6.

The conversion without catalyst has reached best results with an excess of 10 as was observed by Emerson's team in Brazil.[1]

Let's calculate first the theoretical minimum and convert that mass (g) in volume (mL).

Specific density of ethanol = 0.781 g/L at 27°C
Ethanol Molecular weight (mr) = 46.06 g/mol
Specific density of Waste Cooking Oil = 0.907 g/L at 27°C
Waste Cooking Oil Mr = 873 g/mol

(The value for WCO mr can vary according to the various oils composition)

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[1] https://www.sciencedirect.com/science/article/pii/S0196890416306872

The mr is the mass in gram of the number of molecules in 1mol. Therefore 46g = 1 mol of ethanol.

For every 1 mol of oil we need 3 mol of ethanol in theory.
3 x 46 = 138g of ethanol for 873g of oil

For the reality:
46 x 10 = 460g of ethanol for 1 mol of oil
This is what we call a molecular excess of 10.

This number has to be multiplied for each litre of oil to be converted.
460 x 2 = 920 g of ethanol for 2 litres of oil

Oil volume to mass is almost equal so don't worry about it, unless you want to see it for yourself, apply the same calculation as above with the appropriate numbers.
920/0.785 = 1,171 mL = 1,17 L of oil for 2L of Oil

Once the mass (g) required is calculated we can convert into volume (mL) by dividing it with the specific density of the compound, here ethanol, which is 0.785 g/L.

Once the ratio of alcohol to oil is known we can proceed to the biodiesel reactor and fill it up first with oil then ethanol using a funnel. Incline the reactor for an easier pour. Then close the valve and make sure the bottom valve is closed properly too.

Now the electronic heat controller can be turned on, also don't forget to switch the heater power supply which is a different switch. Connect the temperature sensor to the

controller. Make sure the knob is fully turned to the left. You should see on the bottom screen the amperage increasing in value, this is a sign that the current is going to the heaters. Soon you will start to see the rising temperature in red colour on the top screen. The green bottom value is the set temperature to reach and once it did you'll have to start a timer for 2 hours. Make sure while the temperature is rising that the pressure doesn't go above 40bars. If it does, then switch off the power of the heaters with the knob and release the excess pressure with the yellow valve on the top that is connected to the pressure relief valve. Don't release too much of the pressure as it is ethanol vapour, which is needed in this proportions to optimise the conversion process to biodiesel. How much pressure is released will depend upon how the systems reacts. However in this proportion we calculated above it there should be no need to open this valve. Just keep an eye on the pressure gauge till the set temperature is reached.

Once the 2 hour process is completed it is wise to let the machine cool down to at least 78°C which is the point at which ethanol liquifies back. Open the top valve from where we poured the oil slowly to release the left over pressure. Procure yourself with a container adapted to the volume it will received. Then open the bottom valve slowly.

There you go you just made your first batch of BIODIESEL !
Bravo!