Chapter One

Introduction

1.1 Introduction

Among their many applications, lasers are used in optical disk drives, laser printers, and barcode scanners; DNA sequencing instruments, fiber-optic and free-space optical communication; laser surgery and skin treatments; cutting and welding materials; military and law enforcement devices for marking targets and measuring range and speed; and laser lighting displays in entertainment. Vegetable oils and animal fats are the main materials that are saponified. These greasy materials, triesters called triglycerides, are mixtures derived from diverse fatty acids. Triglycerides can be converted to soap in either a one- or a two-step process. In the traditional one-step process, the triglyceride is treated with a strong base (e.g., lye), which accelerates cleavage of the ester bond and releases the fatty acid salt and glycerol. This process is the main industrial method for producing glycerol. If necessary, soaps may be precipitated by salting it out with saturated sodium chloride. The saponification value is the amount of base required to saponify a fat sample. For soap making, the triglycerides are highly purified, but saponification includes other base hydrolysis of unpurified triglycerides, for example, the conversion of the fat of a corpse into adipocere, often called "grave wax." This process is more common where the amount of fatty tissue is high, the agents of decomposition are absent or only minutely present.

1.2 Research Problem

Among more than 350 identified oil-bearing crops, only sunflower, safflower, soybean, cottonseed, rapeseed, and peanut oils are considered as potential alternative fuels for diesel engines (Demirbas A, 2006); this work concern on the effect of laser on sunflower oil properties.

1.3 Research Methodology

The method used to investigate the subjects that are focus on this research is experimentally in Vito irradiation of sunflower oil and experimentally operate the measurements.

1.4 Literature Review

Mojtaba Mansourpoor and Dr. Ahmad Shariati in 2012, Response surface methodology, based on a five level, three variables central composite design is used to analyze the interaction effect of the transesterification reaction variables such as temperature, catalyst concentration and molar ratio of methanol to oil on biodiesel yield. The linear terms of temperature and catalyst concentration followed by the linear term of oil to methanol ratio, the quadratic terms of catalyst concentration and oil to methanol ratio and the interaction between temperature and catalyst concentration and also the interaction between temperature and molar ratio of methanol to oil had significant effects on the biodiesel production (p ($p<0.05$). Maximum yield for the production of methyl esters from sunflower oil was predicted to be 98.181% under the condition of temperature of 48°C, the molar ratio of methanol to oil of 6.825:1, catalyst concentration of 0.679 wt%, stirring speed of 290 rpm and a reaction time of 2h.

Muhammet Arici , Ferya Arslan Colak in 2007, Black cumin samples obtained from the market have been irradiated under 2.5 kGy, 6 kGy, 8 kGy, and 10 kGy doses, respectively. Along with the increase in the dose of irradiation, both the free fatty acid and peroxide values of the samples increased, whereas oil contents, iodine numbers, refraction index and Rancimat values decreased. In the composition of fatty acids, while the percentages of unsaturated fatty acids decreased; trans fatty acid levels increased. Microbial count of the samples decreased as the dose of irradiation increased. It has been observed that total bacterial count as well as total count of yeast and mould reduced to the undetectable limit.

M. J. Y. LIN, et al, in 1974, determined certain functional properties including water absorption, fat absorption, emulsification, whip ability and foam stability on the sunflower flour, protein concentrates and isolate. The results were also compared to those obtained on soy products. Data on water and fat absorption studies suggest that soy products are more hydrophilic in nature while sunflower material exhibited greater lipophilic properties than the soy products. Emulsification tests showed that sunflower flour was superior to all other soy and sunflower products. In general, whipping properties of soy and sunflower isolates were similar, while less whippability was observed for the soy flour and protein concentrates. Whipped foams produced by soy and sunflower protein isolates and sunflower flour were more stable than soy flour, soy and sunflower protein concentrates.

Mohamed M Soumanou, Uwe T Bornscheuer in 2003 produced methyl esters from sunflower oil by lipase-catalyzed reactions. The effect of organic solvent on alcoholysis rate was investigated and highest conversion (80%) was found in *n*-hexane and petroleum ether. Among several microbial lipases tested for alcoholysis activity in a solvent-free system, the best conversion (>90%) was found with lipase from *Pseudomonas fluorescens* (Amano AK) at the highest molar equivalent of oil:methanol (1:4.5). To reduce inactivation of commercial immobilized lipases by methanol, a three-step protocol consisting of the stepwise addition of 1 M equivalent of methanol at 5 h intervals, was developed. Also with immobilized lipase from *Rhizomucor miehei* (Lipozyme RM IM) high conversion (>80%) was possible. Moreover, the transesterification could be conducted for at least 120 h during five batch runs without significant loss of activity.

M. López Granadosa, et al, in 2006 studied the activity of activated CaO as a catalyst in the production of biodiesel by transesterification of triglycerides with methanol. Three basic aspects were investigated: the role of H_2O and CO_2 in the deterioration of the catalytic performance by contact with room air, the stability of the catalyst by reutilization in successive runs and the heterogeneous character of the catalytic reaction. The characterization by X-ray diffraction (XRD), evolved gas analysis by mass spectrometry (EGA-MS) during heating the sample under programmed temperature, X-ray photoelectron (XPS) and Fourier transform-infrared (FT-IR) spectroscopies allowed to concluding that CaO is rapidly hydrated and carbonated by contact with room air. Few minutes are enough to chemisorb significant amount of H_2O and CO_2. It is demonstrated that the CO_2 is the main deactivating agent whereas the negative effect water is less important. As a matter of fact the surface of the activated catalyst is better described as an inner core of CaO particles covered by very few layers of $Ca(OH)_2$. The activation by outgassing at temperatures $\geq$973 K are required to revert the CO_2 poisoning. The catalyst can be reused for several runs without significant deactivation. The catalytic reaction is the result of the heterogeneous and homogeneous contributions. Part of the reaction takes place on basic sites at the surface of the catalyst, the rest is due to the dissolution of the activated CaO in methanol that creates homogeneous leached active species.

G Antolín, et al in 2002 studied the transformation process of sunflower oil in order to obtain biodiesel by means of transesterification. Taguchi's methodology was chosen for the optimisation of the most important variables (temperature conditions, reactants proportion and methods of purification), with the purpose of obtaining a high quality biodiesel that fulfils the European pre-legislation with the maximum process yield. Finally, sunflower methyl esters were characterised to test their properties as fuels in diesel engines, such as viscosity, flash point, cold filter plugging point and acid value. Results showed that biodiesel obtained under the optimum conditions is an excellent substitute for fossil fuels.

Susana M. Gallego, in 1996 studied the relationship between heavy metal ion toxicity and oxidative stress in plant cells. Leaf segments from 14 day old sunflower seedlings were incubated in solutions containing 0.5 mM Fe(II), Cu(II) or Cd(II) ions for 12 h in the light. Treatment with metal ions studied produced a decrease in chlorophyll and GSH contents as well as increases in lipid peroxidation and lipoxygenase activity. Free radical scavengers, such as sodium benzoate and mannitol, prevented the decrease in chlorophyll and GSH content and the lipid peroxidation and lipoxygenase increases. While Fe(II) and Cd(II) ions caused a decrease in superoxide dismutase activity, Cu(II) ions raised its level. However, all three metal ions caused decreases in other antioxidant enzymes (catalase, ascorbate peroxidase, glutathione reductase and dehydroascorbate reductase). Free radical scavengers protected these enzymes against inactivation. No effect of these scavengers was observed on superoxide dismutase activity. These results indicate that excess Fe(II), Cu(II) or Cd(II) ions produce oxidative damage in plant leaves.

A. A. Schneiter and J. F. Miller in 1981 developed and described stages of sunflower plant development in a manner which is simple but accurate.

Plants were divided into either Vegetative (V) or Reproductive (R) stages of plant development. Vegetative development is divided into two phases, emergence and true leaf development. The latter stages are determined by the number of true leaves in excess of 4 cm in length. The number of vegetative stages is dependent upon the number of true leaves formed by the plant, making the method flexible but accurate. The reproductive development was divided into nine stages based on the development of the inflorescence from its initial appearance through anthesis to physiological maturity of the seed. This method of describing the stages of development in sunflower is rapid, accurate, greatly simplifies current methods, and can be used to determine plant development for either single or branched inflorescence sunflower.

1.5 The Objective of this Dissertation

This research aimed mainly to:

- Firstly, study the effect of laser on sunflower oil.
- Secondly, determine the change in oil physical and chemical properties.

1.6 Dissertation Layout

This thesis is consist of four chapters, chapter one Introduction and Literature Review ,and chapter two consist Basic Concepts of laser and Oil, and Light interaction with matter**,** chapter three consist Experimental Part (The materials and device and method), chapter four consist Results and Discussion and Conclusion, Recommendations and finally a list of References.

Chapter Two

Basic Concepts

2.1 Laser

The acronym LASER, constructed from light Amplification by Stimulated Emission of Radiation, has become so common and popular in everyday life that it is now referred to as laser. Fundamental theories of lasers, their historical development from milliwatts to petawatts in terms of power, operation principles, beam characteristics, and applications of laser have been the subject of several books Introduction of lasers, types of laser systems and their operating principles, methods of generating extreme ultraviolet/vacuum ultraviolet (EUV/VUV) laser lights, properties of laser radiation, and modification in basic structure of lasers are the main sections of this chapter.

Laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for "light amplification by stimulated emission of radiation".(Gould and Gordon 1959). (Laser, 2008)The first laser was built in 1960 by Theodore H. Maiman at Hughes Research Laboratories, based on theoretical work by Charles Hard Townes and Arthur Leonard Schawlow. A laser differs from other sources of light in that it emits light coherently. Spatial coherence allows a laser to be focused to a tight spot, enabling applications such as laser cutting and lithography. Spatial coherence also allows a laser beam to stay narrow over great distances (collimation), enabling applications such as laser pointers. Lasers can also have high temporal coherence, which allows them to emit light with a very narrow spectrum, i.e., they can emit a single color of light. Temporal coherence can be used to produce pulses of light as short as a femtosecond.

Modern telescopes use laser technologies to compensate for the blurring effect of the Earth’s atmosphere ("Four Lasers, 2016).

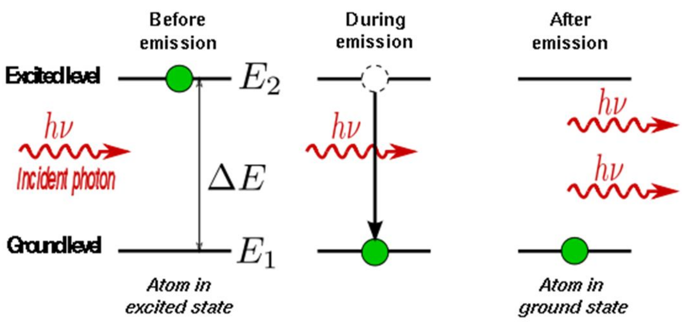
Lasers are distinguished from other light sources by their coherence. Spatial coherence is typically expressed through the output being a narrow beam, which is diffraction-limited. Laser beams can be focused to very tiny spots, achieving a very high irradiance, or they can have very low divergence in order to concentrate their power at a great distance.

Lasers are characterized according to their wavelength in a vacuum. Most "single wavelength" lasers actually produce radiation in several modes having slightly differing frequencies (wavelengths), often not in a single polarization.

Lasers are characterized according to their wavelength in a vacuum. Most "single wavelength" lasers actually produce radiation in several modes having slightly differing frequencies (wavelengths), often not in a single polarization. Although temporal coherence implies monochromaticity, there are lasers that emit a broad spectrum of light or emit different wavelengths of light simultaneously. There are some lasers that are not single spatial mode and consequently have light beams that diverge more than is required by the diffraction limit. However, all such devices are classified as "lasers" based on their method of producing light, i.e., stimulated emission. Lasers are employed in applications where light of the required spatial or temporal coherence could not be produced using simpler technologies

The most common type of laser uses feedback from an optical cavity a pair of mirrors on either end of the gain medium. Light bounces back and forth between the mirrors, passing through the gain medium and being amplified each time. Typically one of the two mirrors, the output coupler, is partially transparent. Depending on the design of the cavity (whether the mirrors are flat or curved), the light coming out of the laser may spread out or form a narrow beam. In analogy to electronic oscillators, this device is sometimes called a laser oscillator.

In the classical view, the energy of an electron orbiting an atomic nucleus is larger for orbits further from the nucleus of an atom. However, quantum mechanical effects force electrons to take on discrete positions in orbitals. Thus, electrons are found in specific energy levels of an atom, two of which are shown below:



$$E_2 - E_1 = \Delta E = h\nu$$

Figure 2.1 light matter interaction

When an electron absorbs energy either from light (photons) or heat (phonons), it receives that incident quantum of energy. But transitions are only allowed in between discrete energy levels such as the two shown above. This leads to emission lines and absorption lines.

When an electron is excited from a lower to a higher energy level, it will not stay that way forever. An electron in an excited state may decay to a lower energy state which is not occupied, according to a particular time constant characterizing that transition. When such an electron decays without external influence; it emits a photon that is called "spontaneous emission". The phase associated with the photon that is emitted is random. A material with many atoms in such an excited state may thus result in radiation which is very spectrally limited (centered around one wavelength of light), but the individual photons would have no common phase relationship and would emanate in random directions. This is the mechanism of fluorescence and thermal emission.

An external electromagnetic field at a frequency associated with a transition can affect the quantum mechanical state of the atom. As the electron in the atom makes a transition between two stationary states (neither of which shows a dipole field), it enters a transition state which does have a dipole field, and which acts like a small electric dipole, and this dipole oscillates at a characteristic frequency. In response to the external electric field at this frequency, the probability of the atom entering this transition state is greatly increased. Thus, the rate of transitions between two stationary states is enhanced beyond that due to spontaneous emission. Such a transition to the higher state is called absorption, and it destroys an incident photon (the photon's energy goes into powering the increased energy of the higher state). A transition from the higher to a lower energy state, however, produces an additional photon; this is the process of stimulated emission.

The gain medium is put into an excited state by an external source of energy. In most lasers this medium consists of a population of atoms which have been excited into such a state by means of an outside light source, or an electrical field which supplies energy for atoms to absorb and be transformed into their excited states.

The gain medium of a laser is normally a material of controlled purity, size, concentration, and shape, which amplifies the beam by the process of stimulated emission described above. This material can be of any state: gas, liquid, solid, or plasma. The gain medium absorbs pump energy, which raises some electrons into higher-energy ("excited") quantum states. Particles can interact with light by either absorbing or emitting photons. Emission can be spontaneous or stimulated. In the latter case, the photon is emitted in the same direction as the light that is passing by. When the number of particles in one excited state exceeds the number of particles in some lower-energy state, population inversion is achieved and the amount of stimulated emission due to light that passes through is larger than the amount of absorption. Hence, the light is amplified. By itself, this makes an optical amplifier. When an optical amplifier is placed inside a resonant optical cavity, one obtains a laser oscillator (Siegman, 1986)

In a few situations it is possible to obtain lasing with only a single pass of EM radiation through the gain medium, and this produces a laser beam without any need for a resonant or reflective cavity (see for example nitrogen laser). (Nitrogen Laser, 1974) Thus, reflection in a resonant cavity is usually required for a laser, but is not absolutely necessary.

The light generated by stimulated emission is very similar to the input signal in terms of wavelength, phase, and polarization. This gives laser light its characteristic coherence, and allows it to maintain the uniform polarization and often monochromaticity established by the optical cavity design.

The beam in the cavity and the output beam of the laser, when traveling in free space (or a homogeneous medium) rather than waveguides (as in an optical fiber laser), can be approximated as a Gaussian beam in most lasers; such beams exhibit the minimum divergence for a given diameter. However some high power lasers may be multimode, with the transverse modes often approximated using Hermite – Gaussian or Laguerre - Gaussian functions. It has been shown that unstable laser resonators (not used in most lasers) produce fractal shaped beams.(Karman etal , 1999) Near the beam "waist" (or focal region) it is highly collimated: the wave fronts are planar, normal to the direction of propagation, with no beam divergence at that point. However, due to diffraction, that can only remain true well within the Rayleigh range. The beam of a single transverse mode (Gaussian beam) laser eventually diverges at an angle which varies inversely with the beam diameter, as required by diffraction theory. Thus, the "pencil beam" directly generated by a common helium–neon laser would spread out to a size of perhaps 500 kilometers when shone on the Moon (from the distance of the earth). On the other hand, the light from a semiconductor laser typically exits the tiny crystal with a large divergence: up to 50°. However even such a divergent beam can be transformed into a similarly collimated beam by means of a lens system, as is always included, for instance, in a laser pointer whose light originates from a laser diode. That is possible due to the light being of a single spatial mode. This unique property of laser light, spatial coherence, cannot be replicated using standard light sources (except by discarding most of the light) as can be appreciated by comparing the beam from a flashlight (torch) or spotlight to that of almost any laser.

Some applications of lasers depend on a beam whose output power is constant over time. Such a laser is known as continuous wave(CW). Many types of lasers can be made to operate in continuous wave mode to satisfy such an application. Many of these lasers actually lase in several longitudinal modes at the same time, and beats between the slightly different optical frequencies of those oscillations will in fact produce amplitude variations on time scales shorter than the round-trip time (the reciprocal of the frequency spacing between modes), typically a few nanoseconds or less. In most cases these lasers are still termed "continuous wave" as their output power is steady when averaged over any longer time periods, with the very high frequency power variations having little or no impact in the intended application. (However the term is not applied to mode-locked lasers, where the intention is to create very short pulses at the rate of the round-trip time).

For continuous wave operation it is required for the population inversion of the gain medium to be continually replenished by a steady pump source. In some lasing media this is impossible. In some other lasers it would require pumping the laser at a very high continuous power level which would be impractical or destroy the laser by producing excessive heat. Such lasers cannot be run in CW mode.

Pulsed operation of lasers refers to any laser not classified as continuous wave, so that the optical power appears in pulses of some duration at some repetition rate. This encompasses a wide range of technologies addressing a number of different motivations. Some lasers are pulsed simply because they cannot be run in continuous mode.

In other cases the application requires the production of pulses having as large an energy as possible. Since the pulse energy is equal to the average power divided by the repetition rate, this goal can sometimes be satisfied by lowering the rate of pulses so that more energy can be built up in between pulses. In laser ablation, for example, a small volume of material at the surface of a work piece can be evaporated if it is heated in a very short time, while supplying the energy gradually would allow for the heat to be absorbed into the bulk of the piece, never attaining a sufficiently high temperature at a particular point.

The optical bandwidth of a pulse cannot be narrower than the reciprocal of the pulse width. In the case of extremely short pulses, that implies lasing over a considerable bandwidth, quite contrary to the very narrow bandwidths typical of CW lasers. The lasing medium in some dye lasers and vibronic solid-state lasers produces optical gain over a wide bandwidth, making a laser possible which can thus generate pulses of such mode-locked lasers are a most versatile tool for researching processes occurring on extremely short time scales (known as femtosecond physics, femtosecond chemistry and ultrafast science), for maximizing the effect of nonlinearity in optical materials (e.g. in second-harmonic generation, parametric down-conversion, optical parametric oscillators and the like) due to the large peak power, and in ablation applications, Again, because of the extremely short pulse duration, such a laser will produce pulses which achieve an extremely high peak power.

Another method of achieving pulsed laser operation is to pump the laser material with a source that is itself pulsed, either through electronic charging in the case of flash lamps, or another laser which is already pulsed. Pulsed pumping was historically used with dye lasers where the inverted population lifetime of a dye molecule was so short that a high energy, fast pump was needed. The way to overcome this problem was to charge up large capacitors which are then switched to discharge through flash lamps, producing an intense flash. Pulsed pumping is also required for three-level lasers in which the lower energy level rapidly becomes highly populated preventing further lasing until those atoms relax to the ground state. These lasers, such as the excimer laser and the copper vapor laser, can never be operated in CW mode.

2.1.1 Properties of Laser

The use of a laser for various applications depends upon the beam properties of laser, such as direction, divergence, and wavelength or frequency characteristics, which can be adjusted by the laser components. The features affecting the beam properties of laser include: size of the gain medium, location, separation and reflectivity of the mirrors of the optical cavity, and presence of losses in the beam path within the cavity. Some of these features determine the unique properties of the laser beam, referred to as lasermodes. The laser modes are wavelike properties relating to the oscillating character of the beam as the beam passes back and forth through the amplifier and grows at the expense of existing losses. The development of laser modes involves an attempt by competing light beams of similar wavelengths to fit an exact number of their waves into the optical cavity. For example, a laser mode of green light having a wavelength of exactly 5x 10-5 cm will fit exactly 1,000,000 full cycles of oscillations between laser cavity mirrors separated by a distance of exactly 50 cm. Most lasers have several modes operating simultaneously in the form of both longitudinal and transverse modes which give rise to a complex frequency and spatial structure within the beam which otherwise appears assemble pencil-like beam of light.

2.1.2 Laser Construction

A laser generally requires three components for its operation: (a) an active medium in the form of a laser rod, with energy levels that can be selectively populated; (b) a pumping process to produce population inversion between some of these energy levels; and (c) a resonant cavity containing the active medium which serves to store the emitted radiation and provides feedback to maintain the coherence of the radiation.

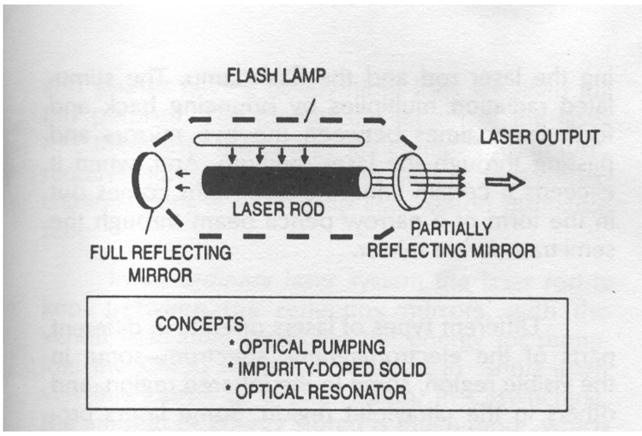


Figure 2.2 laser system

The main problem in designing a laser is to involve produce a sufficiently high population of atoms in the excited state. For this, many ingenious ways fully all have been evolved. The most common method of centre excitation is by sending an intense beam of light from a flash lamp or a continuous source of light through the material in the form of a cylindrical rod or a container tube with a suitable gas. Only those materials which can be pumped to achieve population inversion are used to give laser radiation. The existence of states, whose mean life times are relatively long so as to help pile up considerable energy in the excited levels, is necessary. Long life time of a level and the sharpness of the spectrum lines usually go together, and so, the materials that can be best used to give laser radiation are crystals with sharp lines, and gases at low pressure. An important aspect of the laser operation involves the design of a resonator cavity to maximize the process of stimulated emission. Two carefully aligned mirrors, one having more than 99 percent reflectivity and the other having less reflectivity, are placed at either end of the cavity containing the laser rod and the flash lamp. The stimulated radiation multiplies by bouncing back and forth many times between the two mirrors and passing through the laser medium. And, when it exceeds a certain limit, the laser light comes out citation in the form of a narrow pencil beam through the semi-transparent mirror. Different types of lasers operate in different xenon parts of the electromagnetic spectrum-some in the visible region, some in the infrared region, and others in the ultraviolet region. Some lasers produce continuous light beams while others give pulses of light (of less than millisecond duration). Basically, there are two types of lasers-the continuous wave (CW) laser and the pulsed beam allow laser. In the CW laser, the light is emitted as a, steady continuous beam, generally, with less intensity. Gas lasers belong to this category. On the other hand, the pulsed lasers produce powerful bursts of light of short duration. Crystals, glass and liquid types of lasers belong to this category. Normally the solid state lasers operate intermittently, mainly due to the large amount of heat developed in the crystal.

2.1.3 Laser types

The wavelength, λ, of a laser is decided by the energy difference as the excited species is stimulated to a lower energy level [E = hc/λ, where h is Planck's constant (6.626 × 10−34 J s) and c is the velocity of light (3 × 108 m s−1)]. In general, the quantum states refer to molecular vibration levels for long-wavelength lasers, to electron orbit levels for visible laser radiation and to ionization effects with ultraviolet lasers.

For material processing, CO_2, Nd:YAG and fibre lasers are the most popular sys- tems. Excimer and diode lasers are also fast appearing on the scene. Performance char- acteristics of the commercially available lasers for material processing are provided in Tables 1.2–1.4. Figure 1.15 shows that a single laser can perform several processes if the power density and interaction time are manipulated. This is one of the main reasons why lasers are such popular candidates for flexible manufacturing systems.

2.1.4 Gas Lasers

A gas laser is a laser in which an electric current is discharged through a gas to produce coherent light. The gas laser was the first continuous-light laser and the first laser to operate on the principle of converting electrical energy to a laser light output, some of the common gas lasers are Carbon Dioxide Lasers, Carbon Monoxide Lasers and Excimer Lasers.

2.1.5 Solid-state Lasers

Solid-state lasers have the active medium held in an insulating dielectric crystal or amorphous glass. The lasing action comes from energy jumps between discrete electronic energy levels of the dopant such as rare earth ions or transition ions with unfilled outer shells or defect centres known as colour centres. The main industrial solid-state lasers include Nd^{3+}:YAG, Er^{3+}:YAG, Yb^{3+}:YAG, ruby ($Cr^{3+}:Al_2O_3$), titanium sapphire ($Ti^{3+}:Al_2O_3$) and alexandrite (Cr^{3+}:BeAl2 O4). The host material for the neodymium or other rare earth element may be YAG ($Y_3Al_5O_{12}$), yttrium lithium fluoride (YLF), yttrium aluminium perovskite (YAP; $YAlO_3$), yttrium vanadate (YVO_4) or phosphate or silica glass.

Solid-state lasers have the advantage of relatively long lifetimes for the excited states, which allows higher energy storage than for gas lasers and hence allows them to be Q-switched to give very high peak powers in short pulses (10^{15} -W peak power is the potential output of the Vulcan laser at Rutherford Appleton Laboratory, Didcot, UK).

2.1.5.1 Neodymium–doped Yttrium Aluminum Garnet Lasers

Pure $Y_3Al_5O_{12}$ is a colourless optically isotropic crystal with the cubic structure of garnet. If around 1 % of the yttrium rare earth is substituted by the alternative rare earth neodymium, the lattice will then contain Nd^{3+} ions. These ions can undergo the transitions. The Nd^{3+} ions absorb at specified absorption bands and decay to a metastable state from which lasing action can occur to a terminal state. This terminal state requires cooling to reach the ground state. The cooling is usually achieved with deionised water flowing around the YAG rod and the flash lamp. The rod and flash lamps are situated at different foci of a reflective elliptical cavity, which is either gold-plated or made of alumina. The quantum efficiency is 30–50 %. Using krypton flash-lamp pumping, the operating efficiency is low, approximately 2 % since the pumping is done with a broadband illumination of which only a proportion is able to excite the neodymium ions in the crystal. It thus lacks the natu- ral coupling between

N_2 and CO_2 lasers. This means that considerable energy has to be pumped into the crystal rod, giving a serious cooling problem. For this reason the YAG laser is currently limited to around 400 W per 100-mm length of rod before seri- ous beam distortion, due to thermal effects, occurs, or, worse still, the rod cracks. It is also the reason for the studies on different geometries, such as fibres, discs, slabs and tubes. The total power from the system may be increased by the use of a master oscillator–power amplifier arrangement or by optically coupling multiple beams through bundles of fibres as illustrated in Figure 1.26. A more efficient pumping system is to use diode lasers of the appropriate frequency to pump the neodymium with greater precision. The operating efficiency then rises to 8–10 %. The preferred pump- ing frequency for Nd:YAG is 0.809 μm. A further advantage of diode pumping is the lifetime of the diodes, which is some 10 times longer than that of lamps (currently 1,000 h for lamps but 10,000 h for diodes).

2.1.6 Laser applications

The laser was invented in 1960 and was soon dubbed "a solution looking for a problem". So new was the tool that our thinking had not caught up with the possibilities. Today the story is distinctly different. Table 1.8 lists most of the areas of application. They fall into three groups: optical uses, power uses, as in material processing, and ultrahigh power uses for atomic fusion. The range of applications is briefly discussed here only by way of background to material processing and to illustrate some of the possibilities with optical energy, many of which are not currently applied in material processing.

2.2 Sunflower Oil

Sunflowers are tall annuals. Modern cultivated varieties of sunflower reach a plant height of between 1.5 and 2.5 m at flowering and have strong taproots, from which deeply-penetrating lateral roots develop (Murphy, 1994). There is one apical inflorescence on a stem of 20-30 leaves. Leaves are large, dark green and roughly heart shaped, they have a wrinkled surface and prominent veins. The leaves are individually stalked and arranged round the stem in such a fashion that light interception is maximized. The flower head typically has a maximum diameter of 15-30 cm which consists of mostly yellow and sterile ligulae or ray flowers and the fertile disc or tube flowers. The flowers tend to be cross-pollinating and the best temperature range for the production of seed is 20-25°C (Lide, 1991).

Sunflower is adapted to a range of soil conditions, but grows best on well-drained, high water-holding capacity soils with a near neutral pH (6.5 - 7.5). Production on high-stress soils such as those affected by drought, salinity or wetness is not exceptional but compares favorably with other commonly grown commercial crops (Murphy, (1994)). High yields of sunflower may be produced from early plantings yet yields may be reduced by increased pest problems. Soil temperature should be a minimum of 7ºC for planting and around 10ºC for germination. Lower temperatures will increase the susceptibility of seedlings to diseases (Lide, 1991).

The crop is generally harvested in September-October after a growing season of around 120 days (depending on summer temperatures, relative moisture distribution and fertility levels). Sunflowers should be grown in a suitable rotation to reduce the risk of weed, pest and disease attack, volunteers establishing, soil moisture depletion or phytotoxicity of the sunflower residue to the sunflower crop (Askew, 1992).

Sunflower oil is the non-volatile oil expressed from sunflower seeds. The oil content of the seed ranges from 22% to 36% (average, 28%): the kernel contains 45–55% oil (Christov, 2012). Sunflower oil is commonly used in food as frying oil, and in cosmetic formulations as an emollient (FAO, 2015). To date, sunflower oil has only been used as edible oil due to its higher price and limited supply in comparison to other oils. But due to its naturally high proportion of linoleic acid and advances in oil processing technology, the oil has advantages as a drying oil over linseed oil as it does not yellow with time (The yellowing is due to the high linolenic acid content of the linseed oil). With the development of varieties high in oleic acid, and if a reduction in production costs can be achieved, sunflower oil could be used in the chemical industry (Alfred, 2002).

Seed and oil yield are reduced under conditions of stress. Oilseed producing varieties have a 1000 seed weight of 40 to 60g and non-oilseed varieties have a 1000 seed weight of sometimes over 100g. The crop originated in subtropical and temperate zones, but through selective breeding has been made highly adaptable, especially to warm temperate regions. The expressed oil is of light amber color with a mild and pleasant flavor (Christov, 2012).

2.2.1 Composition of Sunflower Oil

Sunflower oil is mainly triglycerides (fats), typically derived from the fatty acids linoleic acid (which is doubly unsaturated) and oleic acid (BPC, 2005). Sunflower oil contains predominantly linoleic acid in triglyceride form (Alfred, 2002).

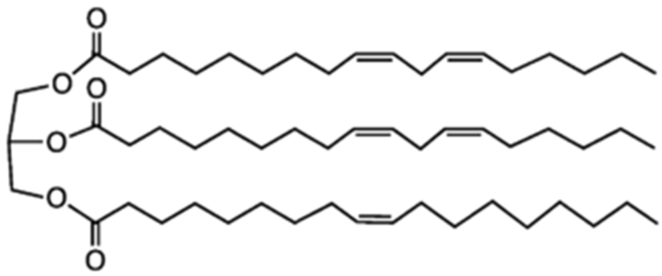


Figure (2.3): the chemical structure of sunflower oil

The British Pharmacopoeia list of sunflower oil is the following profile:

- Palmitic acid: 4 - 9%.
- Stearic acid: 1 - 7%.
- Oleic acid: 14 - 40%.
- Linoleic acid: 48 - 74%.
- Average protein content of the seed: 20-30%.

Sunflower oil also contains lecithin, tocopherols, carotenoids, waxes and high vitamin E content (British, 2005).

2.2.2 Types of Sunflower Oil

There are several types of sunflower oils:

- High linoleic: it typically has at least 69% linoleic acid
- High oleic: it has at least 82% oleic acid.
- Mid oleic.

Variation in unsaturated fatty acids profile is strongly influenced by both genetics and climate. High oleic sunflower oils are classified as having monounsaturated levels of 80% and above. Newer versions of sunflower oil have been developed as a hybrid containing linoleic acid (NSA, 2013). Sunflower oil's properties are typical of vegetable triglyceride oil. Sunflower oil is light in taste and appearance and it is a combination of mono-unsaturated and polyunsaturated fats with low saturated fat levels (NSAH)

2.2.3 Uses of Sunflower Oil

2.2.3.1 As Frying Oil

Sunflower oil behaves as a typical vegetable triglyceride. Linoleic sunflower oil is common cooking oil that has high levels of the essential fatty acids called polyunsaturated fat.

2.2.3.2 In Cosmetics

Sunflower oil has smoothing properties and is considered noncomedogenic. The high-oleic variety possesses shelf life sufficient for commercial cosmetic formulation (NHSRB, 1998).

Diet and cardiovascular benefits: Sunflower oil of any kind has been shown to have cardiovascular benefits as well. Diets combined with a low fat content and high levels of oleic acid have been suggested to lower cholesterol which, in turn, results in a smaller risk of heart disease. (Johnson,, 2014)

2.2.3.3 Sunflower Oil as Skin protection

Sunflower oil, like other oils, can retain moisture in the skin. It may also provide a protective barrier that resists infection in pre-term infants (Skoric et al., 2008).

2.2.3.4 Negative Health Effects

A high consumption of omega-6 polyunsaturated fatty acids, which are found in most types of vegetable oil including sunflower oil, may increase the likelihood that postmenopausal women will develop breast cancer. Similar effect was observed on prostate cancer. Other analysis suggested an inverse association between total polyunsaturated fatty acids and breast cancer risk uses as frying oil (NHSO, 1998)

The acid value or acid number of oil is defined as "number of milligrams of potassium hydroxide required to neutralize the free acids contained in 1 mg of the perfumery material (Weybridge and Surrey, 1970). The acid value corresponds to the amount of carboxylic acid groups in fatty acids. The older oil is the higher the acid value as triglycerides are converted into fatty acids and glycerol upon aging (ISO, 1983).

The maximum levels for acid value of edible fats and oils were established by the Ministry of Public Health at 0.6 mg KOH/1 g oil for refined fats and refined oils or mixed fats/oils, 1.0 mg KOH/1 g oil for mixed fats and mixed oils, and 4.0 mg KOH/1g oil for natural fats and natural oils or mixed fats/oils. The rapid screening on acid value of fats and oils should be applied to control the quality of cooking oils according to ISO 660.

2.2.4 Sunflower Oil Properties

2.2.4.1 Acid value

The acid value is measure of extent to which the glycerides in the oil have been decomposed by lipase action. The decomposition is accelerated by heat and light as rancidity is usually compared by free fatty acid formation. The determination is often used as general indication of the condition and edibility of oils (Weybrivge and surrey, 1970)

The acid value of oil often increases as the oil ages, especially if the oil is improperly stored. Processes such as oxidation of aldehydes and hydrolysis of esters increase the acid value. Oils which have been thoroughly dried and which are protected from air and light show little change in the amount of free acids (Kumar and Tripathi, 2011). The acid value of the vegetable oil should be less than one for a base catalyzed transesterification process, also reported that transesterification would not occur if the oils have FFA content more than 3% (Van Gerpan, 2006) (Dorodo, *et al.*, 2002) .

2.2.4.2 Saponification Value

Fires involving cooking fats and oils (classified as class K (US) or F (Australia/Europe/Asia)) burn hotter than flammable liquids, rendering a standard class B extinguisher ineffective. Flammable liquids have flash points under 37 degrees Celsius. Cooking oil is a combustible liquid, since it has a flash point over 37 degrees Celsius. Such fires should be extinguished with a wet chemical extinguisher. Extinguishers of this type are designed to extinguish cooking fats and oils through saponification. The extinguishing agent rapidly converts the burning substance to a non-combustible soap. This process is endothermic, meaning that it absorbs thermal energy from its surroundings, which decreases the temperature of the surroundings, further inhibiting the fire.

Saponification can occur in oil paintings over time, causing visible damage and deformation. The ground layer or paint layers of oil paintings commonly contain heavy metals in pigments such as lead white, red lead, or zinc white. If those heavy metals react with free fatty acids in the oil medium that binds the pigments together, soaps may form in a paint layer that can then migrate outward to the painting's surface. .(Silvia etal 2009) Saponification in oil paintings was described as early as 1912.(Schumann, Klaus; Siekmann,2000)It is believed to be widespread, having been observed in many works dating from the fifteenth through the twentieth century's, works of different geographic origin, and works painted on various supports, such as canvas, paper, wood, and copper. Chemical analysis may reveal saponification occurring in a painting's deeper layers before any signs are visible on the surface, even in paintings centuries old (*Siegman, ,1986).*

The saponified regions may deform the painting's surface through the formation of visible lumps or protrusions that can scatter LIGHT. These soap lumps may be prominent only on certain regions of the painting rather than throughout. In John Singer Sargent's famous *Portrait of Madame X*, for example, the lumps only appear on the blackest areas, which may be because of the artist's use of more medium in those areas to compensate for the tendency of black pigments to soak it up.(The process can also form chalky white deposits on a painting's surface, a deformation often described as "blooming" or "efflorescence," and may also contribute to the increased transparency of certain paint layers within an oil painting over time.

2.2.4.3 Refractive Index

Abbey refractometer was used in this determination. A drop of the sample was transferred into a glass slide of the refractometer. Water at 30 C^{o} was circulated round the glass slide to keep its temperature uniform. Through the eye piece of the refractometer, the dark portion was viewed and adjusted in line with the intersection of the cross. At no parallax error, the pointer on the scale pointed to the refractive index. This was repeated and the mean value noted and recorded as the refractive index. For the determination of the refractive index states the accepted standard temperatures for the expression of results $30C^0$. (Weybridge and Surrey, 1970).

2.2.4.4 Viscosity

The viscosity of the oil sample was measured. The viscometer was suspended in the constant temperature bath ($35C^0$) so that the capillary was standing vertical. The instrument exactly filled to the mark at the top of a bower reservoir with the oil by means of pipette inserted to side arm of the tube, the oil moved in to the top the upper reservoir, then liquid was allowed to a flow freely through the tube and the time required for meniscus to pass from the work above the supper reservoir to that at bottom of the upper reservoir was recorded, the flow time of distilled water measured by following the same steps above. The oil viscosity was calculated from the following equation (Weighbridge and Surrey, 1970):

$$\text{Relative viscosity} = \frac{T-T_0}{T_0}$$

Where:

T: flow time of the oil.

T_0: flow time of distilled water.

2.3 Light Matter Interaction

When radiant flux (optical radiation) interacts with matter, it may be reflected, absorbed, or transmitted. Transmission is the process whereby radiant flux passes through a material or object without a change in wavelength of its monochromatic components. Therefore, photoluminescence – luminescence produced by the absorption of radiant flux. Diffusion is a change of the angular distribution of a beam of radiant flux by a transmitting material or a reflecting surface, such that flux incident in one direction is continuously distributed in many directions. The process does not conform on a macroscopic scale to the laws of

Fresnel reflection and refraction and does not change the wavelength of the monochromatic components of the flux. Regular transmission is transmission in accordance with the laws of geometrical optics, without diffusion, while diffuse transmission is transmission in which diffusion occurs, independently of the laws of refraction. Mixed transmission is a combination of regular and diffuse transmission. The transmittance t of an object is the ratio of the transmitted radiant flux θ_t to the incident radiant flux θ_i, under specified geometrical and spectral conditions, and is given by:

$$t = {}^{\theta_i}/_{\theta_t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (1 \quad (2.1)$$

Transmittance depends on wavelength, polarization, and on the angles of incidence and collection. The internal transmittance of an object is the ratio of the radiant flux reaching the exit surface to the radiant flux that penetrates the entry surface. The reflectance of an object is the ratio of the reflected radiant flux Θ_r to the incident radiant flux, under specified geometric and spectral conditions, and is given by The absorptance A of an object is the ratio of the absorbed radiant flux Θ_a to the incident radiant flux Θ_i, under specified geometric and spectral conditions, and is given by conservation of energy, the transmittance, reflectance, and absorptance sum to one. That is, Relating the measured transmittance of an object, which is an extrinsic property, to its intrinsic properties requires consideration of both the interaction of the radiant flux with the boundary of the object and with the material composing the interior.

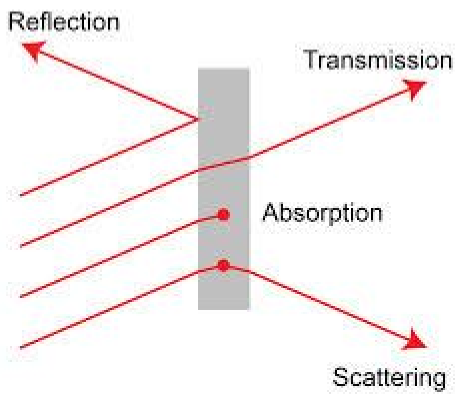


Figure 2.4 Describe how light interaction with matter

2.3.1 Absorption

If a light wave of a given frequency strikes a material with electrons having the same vibrational frequencies, then those electrons will absorb the energy of the light wave and transform it into vibrational motion. During its vibration, the electrons interact with neighboring atoms in such a manner as to convert its vibrational energy into thermal energy. Subsequently, the light wave with that given frequency is absorbed by the object .It is the transformation of radiant power to another type of energy, usually heat, by interaction with matter. In physics, absorption of electromagnetic radiation is the way in which the energy of a photon is taken up by matter, typically the electrons of an atom. Thus, the electromagnetic energy is transformed into internal energy of the absorber, for example thermal energy. The reduction in intensity of a light wave propagating through a medium by absorption of a part of its photons is often called attenuation. Usually, the absorption of waves does not depend on their intensity (linear absorption), although in certain conditions (usually, in optics), the medium changes its transparency dependently on the intensity of waves going through, and saturable absorption (or nonlinear absorption) occurs. The absorbance of an object quantifies how much of the incident light is absorbed by it. This may be related to other properties of the object through the Beer–Lambert law. The absorption coefficient determines how far into a material light of a particular wavelength can penetrate before it is absorbed. In a material with a low absorption coefficient, light is only poorly absorbed, and if the material is thin enough, it will appear transparent to that wavelength. The absorption coefficient depends on the material and also on the wavelength of light which is being absorbed. Semiconductor materials have a sharp edge in their absorption coefficient, since light which has energy below the band gap does not have sufficient energy to excite an electron into the conduction band from the valence band.

2.3.2 Reflection

Reflection is the process by which electromagnetic radiation is returned either at the boundary between two media (surface reflection) or at the interior of a medium (volume reflection) .it is the change in direction of a wave front at an interface between two different media so that the wave front returns into the medium from which it originated. Common examples include the reflection of light, sound and water waves. The law of reflection says that for specular reflection the angle at which the wave is incident on the surface equals the angle at which it is reflected. Mirrors exhibit specular reflection. Reflection of light is either specular (mirror-like) or diffuse depending on the nature of the interface. In specular reflection the phase of the reflected waves depends on the choice of the origin of coordinates. (Wikipedia, 2015). Diffuse reflection happen when light strikes the surface of a (non-metallic) material it bounces off in all directions due to multiple reflections by the microscopic irregularities inside the material and by its surface, if it is rough. Thus, an 'image' is not formed. This is called diffuse reflection. The exact form of the reflection depends on the structure of the material. Reflection and transmission of light waves occur because the frequencies of the light waves do not match the natural frequencies of vibration of the objects.

2.3.3 Transmission

It is the passage of electromagnetic radiation through a medium .The transmittance of a material is the proportion of the incident (approaching) light that moves all the way through to the other side.

For example, let's say you're shining a flashlight on a semi-transparent glass block. You start off with 100% of your incident light. The first thing that happens is that 30% of that light is reflected off the outer surface of the glass. That leaves you with 70% to continue through the glass block. Another 50% of the light is absorbed by the molecules inside the glass block itself. That leaves you with 20%

that immerges from the opposite side. So you could say that the glass block has a transmittance of 20%.

The transmittance of a material depends on its thickness, but it also depends on the type of 'light' (or electromagnetic waves) you are using. A material might have a different transmittance for visible light than it does for infrared, or x-rays. This is why hospital x-rays go through your skin until they reach the bones, even though visible light does not.

2.3.4 Light Scattering

Light scattering can be thought of as the deflection of a ray from a straight path, for example by irregularities in the propagation medium, particles, or in the interface between two media. Deviations from the law of reflection due to irregularities on a surface are also usually considered to be a form of scattering. Most objects that one sees are visible due to light scattering from their surfaces (Kerker,M.1969) (Mandelstam ,L.I.1928). Indeed, Scattering of light depends on the wavelength or frequency of the light being scattered. Since visible light has wavelength on the order of a nanometer, objects much smaller than this cannot be seen, even with the aid of a microscope. (Vande Hulst .H.C 1981) (Bohren, C.F and Huffman, D.R 1983).

2.3.5 Relation between These Three Processes

In general, reflection, transmission and absorption depend on the wavelength of the affected radiation. Thus, these three processes can either be quantified for monochromatic radiation. In addition, reflectance, transmittance and absorbance might also depend on polarization and geometric distribution of the incident radiation, which therefore also has to be specified. The reflectance(r) is defined by the ratio of reflected radiant power to incident radiant power. The transmittance (t) of a medium is defined by the ratio of transmitted radiant power to incident radiant power. The absorbance (a) of a medium is defined by the ratio of absorbed radiant power to incident radiant power, Figure (2.5).

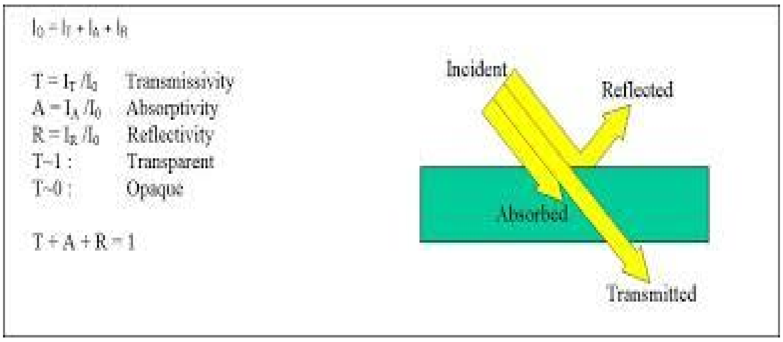


Figure (2.5) Describe the Relation between Reflectance, Transmission and Absorption

By Kirchhoff's radiation law, the flux emitted by a hot object must be equal to the amount absorbed by it; therefore, the emittance of an object must be equal to

$$a + r + t = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \quad (2.2)$$

As all light that is neither reflected nor transmitted must be absorbed the difference (1-r-t) is equal to the absorption (a). In a rough approximation we could now calculate the absorption coefficient (α) according to the equation:

$$R + T = e^{-\alpha d} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.3)$$

Where d is the thickness of the sample. (Grolik Benno, Kopp Joachim 2003)

Reflectance, transmittance and absorbance are dimensionless.

The optical properties of materials are not a constant since they are dependent on many parameters such as:

- Thickness of the sample
- Surface conditions
- Angle of incidence
- Temperature (Gigahertz-opitks,2015).

Chapter Three
Experimental Part

3.1 Materials

3.1.1 Sunflower Oil

Sunflower oil sample was obtained from commercial oil; it was 5 ml, shown in figure 3.1.

Figure 3.1 Sunflower oil

3.1.2 Nd:YAG laser:

Nd:YAG lasers are optically pumped using a flashtube or laser diodes. These are one of the most common types of laser, and are used for many different applications.

Nd:YAG laser typically emit light with a wavelength of 1064 nm, and maximum output power 100 Watt, adjusted 1 Watt in step.

Figure 3.2Nd:YAG laser

3.1.3 Microscope

Sun flower refractive index was determined using traveling microscope exhibit in figure 3.2, with 0.01 mm accuracy.

Figure 3.3 Travelling Microscope

3.1.4 Viscometer

In order to check the oil viscosity; calibration procedure used by the graduated cylinder.

Figure 3.4 Viscometer

3.2 Method

Sunflower oil sample was divided into four equal sizes, then it was irradiated with different power of laser by Nd: YAG laser 1064 nm (0, 10, 30 and 60) W for time five minutes for all samples. Then some physical and chemical oil properties were determined.

3.2.1 Determination of Refractive Index

To determine the refractive index of sunflower oil; a travelling microscope fixed on a stand in such a way that it may be made to travel in vertical as well as horizontal direction without disturbing its adjusted focus. The readings were recorded by means of main scale and vernier scale of high accuracy (0.001 cm) attached to the instrument.

3.2.2 Viscosity

In order to check the oil viscosity calibration; a graduated cylinder filled with the oil, a steel ball dropped into the oil, to record how long it takes the steel ball to reach the bottom a stopwatch was used.

3.2.3 Chemical Properties

3.2.3.1 The pH Value

The pH value determination of sunflower oil was carried out using pH meter.

Figure 3.5 pH meter

3.2.3.2 Saponifaction value

1.00g of oil sample was weighted into 200ml flask, 25 ml of the ethanolic solution of potassium hydroxide added and boiled under a reflux condenser or half hour and rotated the contents frequently. While the solution is still hot, the excess of alkali was titrated with (0.5m) hydrochloric acid with using 1ml of phenolphthalein solution as indicator. Operation was repeated without the substance being examined.

Chapter Four

Results and Discussion

4.1 Introduction

In this chapter the results of the study are presented and discussed with reference to the aim of the study.

4.2 Results and Discussion

4.2.1 Refractive Index of Oil

Table 4.1 shows the changing in the refractive index value of the oil samples due to irradiation by continuous Nd: YAG laser 1064 nm wavelength and different output powers, it shows that the refractive index increased from 1.4 for the control sample to 1.636 with laser dose 10 W for five minutes, but this value decrease to 1.571 when the laser dose raised to 30 W and 60 W for the same time, this explain the effect of the laser exposure on the optical density of the oil.

Table 4.1 Changing in Refractive Index

Sample	control	10 W	30 W	60 W
RI	1.4	1.636	1.571	1.571
Pv	< 0.05			

4.2.2 Viscosity

Table 4.2 shows the changing in the viscosity value of the oil samples due to irradiation by continuous Nd: YAG laser 1064 nm wavelength and different output powers, it shows that the viscosity decreased from 0.4 for the control sample to 0.1864577 with laser dose 10 W for five minutes, then this value increased to 0.225621 when the laser dose raised to 30 W and increased to 0.248596 when the laser dose raised to 60 W for the same time, this explain the effect of the laser exposure on the viscosity of the oil.

Table 4.2 Changing in Viscosity

Sample	control	10 W	30 W	60 W
Viscosity	0.4	0.1864577	0.225621	0.248596
Pv	< 0.05			

4.2.3 The pH results

Table 4.3 shows the changing in the pH value of the oil samples due to irradiation by continuous Nd: YAG laser 1064 nm wavelength and different output powers, it shows that the pH value increased from 6.69 for the control sample to 6.96 with laser dose 10 W for five minutes, then this value decreased to 6.76 when the laser dose raised to 30 W then it decreased to 6.66 when the laser dose raised to 60 W for the same time, this explain the effect of the laser exposure on the pH value of the oil.

Table 4.3 Changing in pH value of sunflower oil

Sample	control	10 W	30 W	60 W
pH	6.69	6.96	6.76	6.66
Pv	< 0.05			

4.2.4 Saponifaction value

The saponifaction values of the sunflower oil samples and its calibration calculations is presented here

Table 4.3 Calibrations Results

No	Power	Primary Reading	Final Reading	Consumer size
1	0.00	0.00	12.90	12.90
2	10	0.00	11.20	11.20
3	30	0.00	11.30	11.30
4	60	0.00	18.20	18.20

Saponification value was calculated from the expression

Total number of moles = $\frac{250.5 \times 0.5}{1000}$ = 0.0125 mole

$KCL + H_2O \longrightarrow KOH + HCL$

1- Base number of moles = $\frac{12.90 \times 0.5}{1000}$ = 0.00645

The number of moles of excess acid = 0.0125 – 0.00645 =0.00605m

Number of moles = $\frac{\text{weight (g)}}{\text{Molecular Weight}}$ = 0.00605

Weight = 0.00605x 56.1 = 0.339405 g

Saponification value = 339.405

2-Base number of moles $\frac{11.20 \times 0.5}{1000}$ = 0.0056

The number of moles of excess acid = 0.0125 – 0.0056 = 0.0069m

Number of moles = $\frac{\text{weight (g)}}{\text{Molecular Weight}}$ = 0.0069

Weight = 0.0069x 56.1 = 0.38709 g

Saponification value 387.09

3-Base number of moles $\frac{11.30 \times 0.5}{1000} = 0.00565$

The number of moles of excess acid = 0.0125 – 0.00565 = 0.00685m

Number of moles = $\frac{\text{weight (g)}}{\text{Molecular Weight}}$ = 0.00685

Weight = 0.00685x56.1 = 0.384285 g

Saponifaction value = 384.285

4-Base number of moles= $\frac{18.20 \times 0.5}{1000}$ = 0.0091m

The number of moles of excess acid = 0.0125 – 0.0091= 0.0034m

Number of moles = $\frac{\text{weight (g)}}{\text{Molecular Weight}}$ = 0.0034

Weight 0.0034x 56.1 = 0.19074 g

saponification value 190.74

Pv < 0.05

Table 4.4 Changing in saponifaction value

Sample	Control	10 W	30 W	60 W
Saponification	339.405	387.09	384.285	190.74
Pv	< 0.05			

Table 4.4 shows the changing in the saponifaction value of the oil samples due to irradiation by continuous Nd: YAG laser 1064 nm wavelength and different output powers, it shows that the saponifaction value increased from 339.405 for

the control sample to 387.09 with laser dose 10 W for five minutes, then this value decreased to 384.285 when the laser dose raised to 30 W then it dropped to 190.74 when the laser dose raised to 60 W for the same time, this explain the effect of the laser exposure on the saponifaction value of the oil.

4.2.5 Statistical Analysis

All experiments were carried out at least in duplicate on three different occasions. Data points with bars represent means ± standard error. Analysis of significant difference was compared by one-way ANOVA using IBM SPSS Statistics. The probability level interpreted as statistically significant was $P < 0.05$.

4.3 Conclusions

Irradiation of the oil samples by continuous Nd: YAG laser 1064 nm wavelength and different output powers results in significant changes of increase and decrease in some physical properties; particular refractive index and viscosity, it also results in significant changes of increase and decrease in some chemical properties; particular pH value and saponifaction value

REFERENCES

Alfred Thomas (2002). "Fats and Fatty Oils". Ullmann's Encyclopedia of Industrial Chemistry. Weinheim: Wiley-VCH. doi:10.1002/14356007.a10_173.

Alfred, T. (2012). "Fats and Fatty Oils". Ullmann's Encyclopedia of Industrial Chemistry. Weinheim: Wiley-VCH. doi:10.1002/14356007.a10 -173.

Archived from the original (Power point presentation) on June 14, 2007. Retrieved January 1, 2007.

Beal G. D. (1926). "Trimyristin". Organic Syntheses. 6: 100. doi:10.15227/orgsyn.006.0100.

Boroson, Don M. (2005), Optical Communications: A Compendium of Signal Formats, Receiver Architectures, Analysis Mathematics, and Performance Characteristics, retrieved 8 Jan 2013

BPC. (2005). British Pharmacopoeia Commission. "Ph. Eur. monograph 1371". Norwich, England: The Stationery Office.

Christov, M., (2012). Contribution of interspecific hybridization to sunflower breeding. 35(57): 37

Chu, Steven; Townes, Charles (2003). "Arthur Schawlow". In Edward P. Lazear (ed.),.Biographical Memoirs. vol. 83. National Academy of Sciences. p. 202. ISBN 0-309-08699-X.

Costela A, Garcia-Moreno I, Gomez C (2016). "Medical Applications of Organic Dye Lasers". In Duarte FJ. Tunable Laser Applications (3rd ed.). Boca Raton: CRC Press. pp. 293–313. ISBN 9781482261066.

Demirbas A, Kara H (2006) New Options for conversion of Vegetable Oils to Alternative Fuels. Energy Sources, Part A: Recovery, Utilization and Environmental Effects 28: 619-626.

Dorodo W et al. (2002). An alkali-catalyzed transesterification process for high free fatty acid waste oils. Trans ASAE ;45(3):525–9.

Dorodo W et al. (2002). An alkali-catalyzed transesterification process for high free fatty acid waste oils. Trans ASAE ;45(3):525–9.

Duarte FJ (2016). "Broadly Tunable External-Cavity Semiconductor Lasers". In Duarte FJ. Tunable Laser Applications (3rd ed.). Boca Raton: CRC Press. pp. 203–241.ISBN 9781482261066.

FAO. 2015. FAOSTAT Database. http://faostat3.fao.org/download/ FB/CC/E Food and Agriculture Organization

G. D. 1926 Saponification to the sodium salt of myristic acid takes place with NaOH in water. The acid itself can be obtained by adding dilute hydrochloric acid.(GD, 1926)

Gigahertz Optics. (2015) *Reflection, Transmission, and Absorption*. [Online] available from: http://light-measurement.com/reflection-absorption/.[Accessed on 2015-08-11]

Gould, R. Gordon (1959). "The LASER, Light Amplification by Stimulated Emission of Radiation". In Franken, P.A.; Sands R.H. (Eds.). The Ann Arbor Conference on Optical Pumping, the University of Michigan, 15 June through 18 June 1959. p. 128.OCLC 02460155.

ISO (1983), International standards organization, 660. Application Bulletin: Ffood stuffs and fat industry; Animal and vegetable fats and oils,: analysis of edible oils and fats, determination of acid value and acidity,NO.1413/ 3e.

Johnson, J.J., Meyer, R.F., Krall J.M., Shroyer, J.P., Schlegel, A.J. Falk, J.S. and Lee, C.D. (2014). Agronomic Practices. In: High Plains Sunflower Production Handbook. Kansas State University, Manhattan, KS.

Kumar, R. and Tripathi, Y.C. (2011). Getting fragrance from plants, Training Manual on Extraction Technology of Natural Dyes, aroma therapy and cultivation value addition of medicinal plants. Organized by Extension division in collaboration with chemistry and non wood forest product division 2-4 November, 2011, Forest research institute, P.O. New Forest, Dehradun: pp: 8-18.

Loevschall, Henrik (1994). "Effect of low level diode laser irradiation of human oral mucosa fibroblasts in vitro". Lasers in Surgery and Medicine. 14 (4): 347–354.doi:10.1002/lsm.1900140407.

New Healthful Sunflower Oil Resists Breakdown / June 11, 1998 / News from the USDA Agricultural Research Service.

Nourredini, H., Teoh, B.C and Clements, L.D. (1992). Viscosities of vegetable oils and fatty acids. J. Am. Chem. Soc. 69:1184-1188.

Nourredini, H., Teoh, B.C., and Clements, L.D. (1992). Viscosities of vegetable oils and fatty acids. J. Am. Chem. Soc. 69:1184-88.

NRA (2008), National Renderers Association. Pocket information manual: abuyer’s guide to rendered product p Published by National Renderers Association. Inc. pp:18-28. RNA website: www.renderers/org

Polanyi, T.G. (1970). "A CO_2 Laser for Surgical Research". Med. & Biol. Engng. 8: 541–548. doi:10.1007/bf02478228.

Popov S (2016). "Fiber Laser Overview and Medical Applications". In Duarte FJ. Tunable Laser Applications (3rd ed.). Boca Raton: CRC Press. pp. 263–292. ISBN 9781482261066.

Schumann, Klaus; Siekmann, Kurt (2000). "Soaps". Ullmann's Encyclopedia of Industrial Chemistry. Weinheim: Wiley-VCH. doi:10.1002/14356007.a24_247. ISBN 3-527-30673-0.

Siegman, Anthony E. (1986). Lasers. University Science Books. p. 4. ISBN 0-935702-11-3.

Silvia A. Centeno; Dorothy Mahon (Summer 2009). Macro Leona, ed. "The Chemistry of Aging in Oil Paintings: Metal Soaps and Visual Changes". The Metropolitan Museum of Art Bulletin. Metropolitan Museum of Art. 67 (1): 12–19. JSTOR 40588562. See pages: 12–19.

Skoric, D. Jocic, S., Sakac, Z. and Lecic, N. (2008). Genetic possibilities for altering sunflower oil quality to obtain novel oils". Can J Physiol Pharmacol;86(4): 215–21.

Soft-Tissue Laser Surgery - CO_2 Surgical Laser - LightScalpel". LightScalpel. Retrieved 2016-04-04.

Stewen, M. Larionov, and A. Giesen, "Yb:YAG thin disk laser with 1 kW output power", in OSA Trends in Optics and Photonics, Advanced Solid-State Lasers, H. Injeyan, U. Keller, and C. Marshall, ed. (Optical Society of America, Washington, D.C.., 2000) pp. 35–41

Symon, Keith (1971). Mechanics (Third ed.). Addison-Wesley. ISBN 0-201-07392-7.igh resistance to flow while a low viscosity indicates a low resistance toflow

Tcheknavorian A -Asenbauer Managing Director Industrial Sectors and Environment Division United Nations Industrial Development Organization Vienna International Centre Austria EDITORK. TULEY DE SILVA NOVEMBER 1995 Amanual on the essential oil industry

Weybridge and surry (1970) the chemical analysis of food , national college of food technology