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Establishment of Innovative Approaches of Nanofluids

Ranajit Nath[1], Ratna Roy[2], Ambika Mandal[1], Rajesh Ghosh[2], Writormi Chatterjee[2], Rupam Pramanik[3]

[1]Department of Pharmaceutics, NSHM Knowledge Campus, Kolkata- Group of Institutions, Kolkata, West Bengal, India

[2]Department of Pharmacology, NSHM Knowledge Campus, Kolkata- Group of Institutions, Kolkata, West Bengal, India

[3]Department of Pharmacology, Guru Nanak Institute of Pharmaceutical Science and Technology, 157/F, Nilgunj road, Kolkata, West Bengal, India

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ABSTRACT

The main objective of therapy for many medications is to obtain a therapeutically effective and non-toxic steady-state blood or tissue level for a sustained length of time. Conventional drug delivery system not only achieves but also maintains the drug concentration within the therapeutically effective range only when taken several times a day depending upon the dosage regimen. This result shows significant fluctuation in drug levels. An approach to overcome such fluctuations conventional led to the development of several novel drug delivery systems (NDDS) that could revolutionize formulation methods and provide a number of therapeutic benefits. The chapter is divided into two sections: the first deals with nanofluids, and the second discusses their use in medicine. Nanotechnology is a novel technique that comprises materials and equipment capable of regulating a substance's physical as well as chemical characteristics at subatomic scales. This invention has the potential to remove some of the obvious boundaries between biology, physics, and chemistry, as well as influence our current perceptions and understanding. As a result of the widespread application of nanotechnology throughout time, a slew of new challenges and bearings may develop in education, research, and diagnostics. Nanofluids are known as emulsions or suspensions of nanoparticles (NPs) in fluids. At low nanoparticle concentrations, they demonstrate a significant improvement in their characteristics.

Keywords : Nanofluids, mechanism of action, challenges, preclinical study, application

I. INTRODUCTION

Conventional drug delivery system is responsible for achieving the drug concentration within the

therapeutically effective range only when taken several times a day depending upon the dosage regimen. This result shows significant fluctuation in drug level. An approach overcome such fluctuations conventional led to the development of several novel drug delivery systems (NDDS) that could revolutionize methods of formulation and provide a number of therapeutic benefits(1). The major goals of these novel drug delivery systems are as follows:

1) Single dose which releases the active ingredient over an extended period of time.

2) Delivery of the active entity directly to the site of action thus minimizing or eliminating the side effects(2).

The prefix "nano" comes from the Greek word "dwarf." In science, a nanometer (nm) is one billionth (10 to the minus 9) of a meter, or 0.000000001 meters (3). Nanomedicine is a branch of research that uses nanotechnology in conjunction with drugs or diagnostic compounds to increase the capacity to target specific cells or tissues. These materials are made at the nanoscale and are completely safe to introduce into the body. Nanotechnology's applications in medicine include imaging, diagnostics, and drug delivery, all of which will aid medical practitioners in treating a variety of illnesses. Nanotechnology is shown to bridge the barrier of biological and physical sciences by applying nanostructures and nanophases at various fields of science(4).

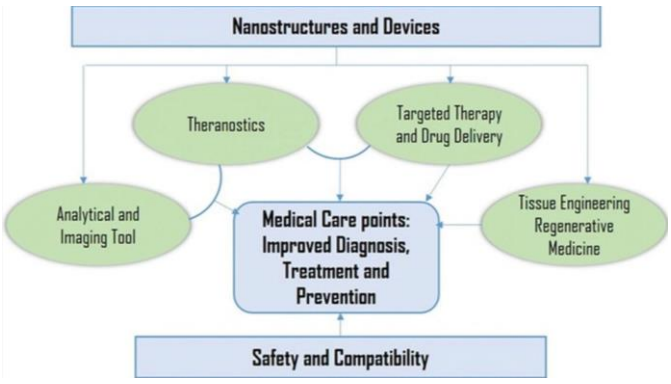

Fig. I : Nanomedicine's use and aims in several fields of biomedical research

Nanotechnology for drug delivery has a lots of benefits:

1. Improve the capacity to deliver poorly water soluble drugs.
2. To minimize drug accumulation in healthy tissue, provide site-specific targeting.
3. Assist to maintain the drug in the body for long enough to be effective.
4. Extending the bioactivity of a drug by protecting it from the biological environment
5. Enable for drugs to pass through epithelial and endothelial barriers.
6. Incorporate therapeutic and diagnostic modalities into a single agent(5).

Nanofluids are a novel class of fluids developed by distributing nanometer-sized materials in base fluids (nanoparticles, nanofibers, nanotubes, nanowires, nanorods, nanosheets, or droplets). Nanofluids are colloidal suspensions of nanomaterials on a nanoscale. They are two-phase systems, having one phase (solid phase) within the other (liquid phase). Nanofluids have been shown to have improved thermo-physical characteristics such as thermal conductivity, thermal diffusivity, viscosity, and convective heat transfer coefficients when compared to base fluids like oil or water in earlier studies(6).

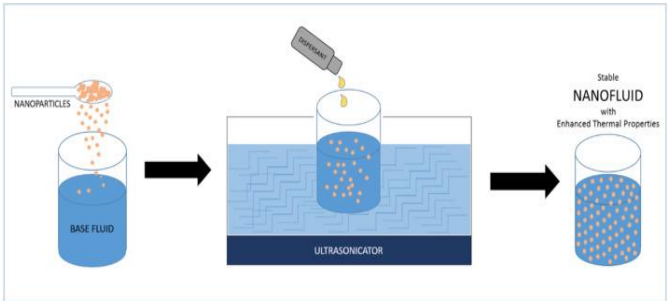

Fig. I I: Nanofluid with enhanced thermal properties by adding prepared nanoparticles to the base fluid and placing in a dispersing device (ultrasonicator) or adding dispersant leads to the formation of stable nanofluids.

Nanofluids may be utilized in a wide range of technical applications, from the automobile sector to the medical field to power plant cooling systems and computers, thanks to their improved characteristics as thermal transfer fluids. Nanofluids requires good characterization of composition, size, crystallinity, and morphology. Apart from, stability, non-agglomeration, and biocompatibility are essential properties(7).

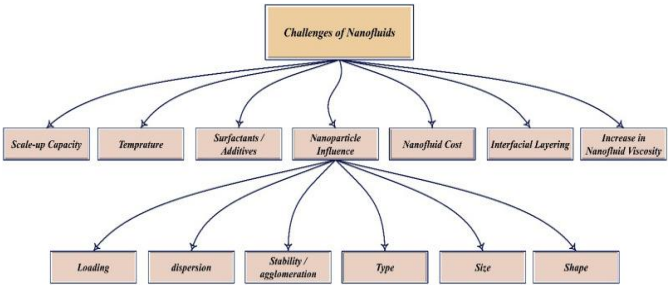

Fig.III; Challenges facing by Nanofluids.

The majority of nanofluids research has focused on materials, surface science, and colloid theory. Nanofluids' biological uses are far from simple in practice, and they require additional investigation. All nanoparticle-contained suspensions or nanosuspensions were addressed, and the uses of such fluids in drug delivery, antibacterial, and biomedical therapy were evaluated in this study, according to the nanofluids definition described above. This review study focuses on the application of nanofluids in a wide range of biological fields(7).

II. Mechanism of Action of Nanofluids

1. Stability mechanism of nanofluids:

Stability is the most crucial issue for nanofluids because of the tendency of mutual attraction between nanoparticles which caused by high surface energy of nanoparticles (8). According to DLVO theory, there are two forces between nanoparticles, the one is Vandeer Walls attractive force between nanoparticles while the other is electrical double layer repulsive force (9). The stability of nanofluids is the result of the two opposing forces citation three(10). If the repulsive force is much larger than the attractive force, & can overcome the attraction during the collisom process due to Brownian movement, the nanofluid is in a relative stable state citation four(11). Otherwise the nanofluid is in an unstable state.(12) Steric repulsion & electrostatic repulsion are the two types of mechanisms through which nanofluids are stabilized (13).

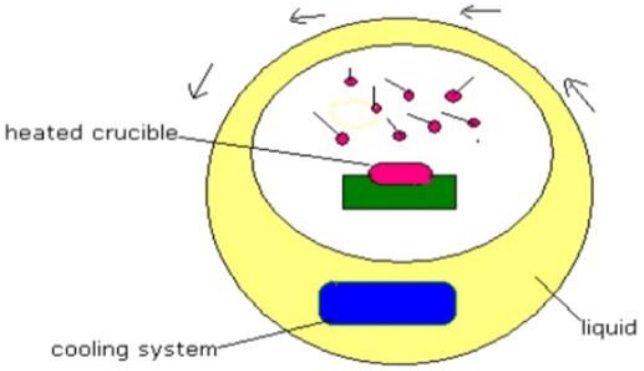

Fig.I: Schematic diagram of nanofluid (Vapour Deposition Method)

According to steric repulsion, several surfactants, such as SDBS, SDS, CTAB, can prevent the aggregation of dispersed nanoparticles in nanofluids (14). These surfactants usually have two tails, one is hydrophilic & one is hydrophobic (15). The hydrophilic tails adsorbs onto the surface of nanoparticles with a long loop & the hydrophobic tail extends out into the nanofluids (16). Thus, steric stabilized nanofluids remain well dispersed & sustain for a long period (17). In electrostatic stabilization, the nanoparticles in nanofluids bear some charge because of adsorption of ions (18). Electrical double layer is created around nanoparticles, and the repulsive force force produced by electrical layer will offset the attractive force between nanoparticles(19). Avraham et al. investigated the role of carbon chain in 3-alkyl thiophenes on the dispersing of CNTs, but also on the steric repulsion of carbon chain of adsorbed 3-alkyl thiophenes (20). Yang et al. prepared Al2O3 ammonia/water nanofluids with sodium

dodecyl benzene sulfonate (SDBS) as the dispersant (21). The stability of the nanofluids with different amount of SDBS was studied with light absorbancy ratio index method (22). The results shows that with the increasing amount of surfactant, the stability of nanofluid is lowered first, & then improved & then is lowered again (8).

2. Lubricating mechanisms of nanoparticles in nanofluids:

During the past two decades, the application of nanofluids in lubrication has made substantiates progress (9). Because of the low melting point & high chemical reactivity, nanoparticles may deposit on the microdefects of rubbing surfaces, & play a role of "self-repairing" to a certain degree(10).This is a great potential advantage of nanofluids on lubrication(11). Furthermore, the thermal conductivity of nanofluids is usually higher than that of their base fluid, which will help to release that the heat produced in the friction & maintain the stability of tribo-pairs(13). There are 5 types of lubrication mechanism:-

1. Rolling mechanism
2. Tribo-fluid mechanism
3. Self-repairing mechanism
4. Mechanical polishing effect
5. Diversification of lubrication mechanism

Description:

1. Rolling mechanism:

The friction mode is influenced by the well distributed spherical nanoparticles in the nanofluids, because they can switch from sliding friction to rolling friction(16). Rolling mechanism theory proposes that two factors contribute to the excellent lubrication effect of nanofluids(15). One is that the nanoparticles are usually spherical, & they may act as "micro-bearing" during the friction; the other is at high temperature & load, the nanoparticles between two rubbing surfaces become flat & form a "sliding system", which ultimately reduces the friction & wear(21).

2. Tribo-film mechanism:

Tribo-film mechanism is the most prevailing theory to explain the anti-wear & friction reduction behaviour of nanofluids(19). Most scientists & researchers attributed better lubrication performance of nanofluids to the fact that nanoparticles being deposited on rubbing surfaces & forming a protected film(17). Nanoparticles that well dispersed in nanofluids are liable to form a thin film on the metal surface, & this film is dense & low shear, which can separate the rub surface & reduce the friction(20).

3. Self-repairing mechanism:

"Self- repairing" mechanism is not simply an accumulation of nanoparticles on the rubbing surface(18). With the decreasing size of nanoparticles, their melting points decline sharply(11). At the high temperature of rubbing surfaces, these nanoparticles are easily melted or sintered in the microcracks of the contact area, & sequential filler is formed & closely tied to the rubbing surface(13).

4. Mechanical polishing effect:

Hard nanoparticles in nanofluids acts as an excellent polishing tool & play a role in mechanical polishing on rubbing surfaces in the process friction (8). The real contacting area of tribo-pairs is increased due to smoother surface polished with hard nanoparticles, which ultimately lowers the friction coefficient & increase the load carrying capacity(16).

5. Diversification of lubrication mechanism:

In most cases, the nanoparticles do not work by a single lubrication effect, but by two or more mechanisms(11). Besides, there may be a transition during different mechanisms when changed lubrication condition occurs(9). Two mechanisms

were involved in the process of friction, one was the rolling effect & the other was self-repairing mechanism(20). In fact, the mutual interactions among the nanoparticles, dispersant & base fluid should be also taken into consideration(14).

Preclinical study of nanofluids

Inventor	Origin	Body part	Year
Information provided by: • Teresa Simon-Yarza • Angelika Mielcarek • Patrick Couvreur • Christian Serre	• Paris Diderot University Paris 13 University 75018, Paris, France • University Paris Saclay 92290 Chatenay Malabry, France • PSL Research University 75005, Paris, France	Numerous studies have demonstrated the great potential of nano particles of metal-organic frameworks at the preclinical level for biomedical applications.	2018
Information provided by: • Deepa Mohanan • Bram Slutter • Malou Henriksen-Lacey • Wim Jiskoot • Joke A. Bouwstra • Yvonne Perrie • Thomas M. Kundig • Bruno Gander • Pal Johansen	• Department of Dermatology, University Hospital of Zurich, Switzerland • Division of Drug Delivery Technology, Leiden/Amsterdam Center for Drug Research, the Netherlands • School of Life and Health Sciences, Aston University, United Kingdom	The goal of the study was to see how alternative approaches of immunising mice with ovalbumin-loaded liposomes, N-trimethyl chitosan (TMC) nanoparticles, and poly(lactide-co-glycolide) (PLGA) microparticles affected the immune response, both with and without specific immune-response modifiers.	2010

	• Institute of Pharmaceutical Science, ETH Zurich, Switzerland		
Information provided by: • N J Darton • D Darling • M J Townsend • D J McNally • F Farzaneh • N K H Slater	• Department of Chemical Engineering and Biotechnology, New Museums Site, Pembroke St, Cambridge CB2 3RA, UK • King's College London, 123 Coldharbour Lane, London SE5 9NU, UK	The collection of lentiviral particles from unfiltered, unprocessed culture fluid containing cells and cell detritus further revealed the special features of chromatographic substrate that allow the passage of big particulates. This method eluted 56 percent of the collected lentivirus, or 1×10^7 ifu. A device based on this new material could be utilised to harvest lentiviral particles directly from bioreactors at an early stage in clinical lentiviral production.	2012
Information provided by: • Lalit Mohan Negi • Manu Jaggi • Sushama Talegaonkar	• Department of Pharmaceutics, Faculty of Pharmacy, Jamia Hamdard, New Delhi 110062, India • Pre-clinical Department, Dabur Research Foundation, Ghaziabad, Uttar Pradesh, India	In this work looks at the screening of formulation components as well as the quality difficulties with nanostructured lipid carriers (NLCs) for CPT-11, an anticancer drug. The selection of liquid lipid or oil for the stepwise screening of the components for the synthesis of NLCs is based on the relative solubility of CPT-11 in different oils. CPT-11 solubility was highest in capmul MCM-C8 (81 0.5 mg/ml). As a result, it was chosen as the liquid lipid for the creation of NLCs. On a systematic screening of several solid lipids, the solid lipids gelucire 39/1, glyceryl mono stearate (GSM), and compritol ATO 888 were shown to have good affinity for the medication.	2013
Information provided by: • Susana Patricia Egusquiaguirre • Manuela Igartua • Rosa Maria Hernandez	Biomedical Research Networking Center in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN) Vitoria, Álava, Spain	Traditional anticancer medications have several flaws that limit their effectiveness in cancer treatment. As a result, significant work has been made in the field of nanotechnology to address these issues and provide a potential and effective cancer	2012

• Jose Luis Pedraz		treatment option. The aberrant properties of tumour tissues are used by nanoparticle drug delivery systems to preferentially target their payloads to cancer cells, either passively, actively, or triggeredly.	
Information provided by: • Jeffrey Hrkach • Daniel Von Hoff • Mir Mukkaram Ali • Elizaveta Andrianova • Jason Auer • Tarikh Campbell • David De Witt • Michael Figa • Maria Figueiredo • Allen Horhota • Susan Low • Kevin McDonnell • Erick Peeke • Beadle Retnarajan • Abhimanyu Sabnis • Edward Schnipper • Jeffrey J. Song • Young Ho Song • Jason Summa • Douglas Tompsett • Greg Troiano • Tina Van Geen Hoven • Jim Wright • Patricia LoRusso • Philip W. Kantoff • Neil H. Bander • Christopher Sweeney • Omid C. Farokhzad • Robert Langer	• BIND Biosciences Inc., Cambridge, MA 02139, USA. • TGen Clinical Research Services at Scottsdale Healthcare, Phoenix, AZ 85004, USA. • Karmanos Cancer Institute, Detroit, MI 48201, USA. • Lank Center for Genitourinary Oncology, Dana-Farber Cancer Institute, Harvard Medical School, Boston, MA 02215, USA. • Weill Cornell Medical College, New York, NY 10065, USA. • Laboratory of Nanomedicine	Clinical studies in patients with advanced solid tumours showed that DTXL-TNP had a different pharmacological profile than sb-DTXL, including pharmacokinetics that match preclinical data and cases of tumour shrinking at doses lower than the normal sb-DTXL dose.	2012

• Stephen Zale	and Biomaterials and Department of Anesthesiology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA 02115, USA. • Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, USA		
Information provided by: • Savita Bisht • Masamichi Mizuma • Georg Feldmann • Niki A. Ottenhof • Seung-Mo Hong • Dipankar Pramanik • Venugopal Chenna • Collins Karikari • Rajni Sharma • Michael G. Goggins • Michelle A. Rudek • Rajani Ravi • Amarnath Maitra • Anirban Maitra	• The Sol Goldman Pancreatic Cancer Research Center and Departments of Pathology, Oncology, and Internal Medicine, • Johns Hopkins University School of Medicine, Baltimore, Maryland; Department of Internal Medicine III • Center of Integrated Oncology	When compared to free curcumin, a polymeric nanoparticle encapsulated curcumin formulation displays significantly better systemic bioavailability in plasma and tissues after parenteral dosing. Parenteral NanoCurc effectively reduces primary tumour growth in both subcutaneous and submucosal xenograft models of human pancreatic cancer produced in athymic mice as well as orthotopic environments. The combination of parenteral NanoCurc with gemcitabine inhibits tumour growth more effectively than either treatment alone, implying an additive therapeutic effect in vivo.	2013

	Cologne-Bonn, University of Bonn, Bonn, Germany • Department of Pathology, University Medical Center, Utrecht, the Netherlands • Visvabharati University, Santiniketan, India		
Information provided by: • Mark E. Davis • Zhuo (Georgia) Chen • Dong M. Shin	• Chemical Engineering, California Institute of Technology, Pasadena, California 91125, USA. • Winship Cancer Institute, Emory School of Medicine, Atlanta, Georgia 30322, USA.	Due to qualities such as better focused localisation in tumours and active cellular uptake, nanoparticle therapies can exhibit improved efficacy while minimising side effects. Preclinical and clinical studies that are anticipated to have an impact on clinical investigations and their implications for improving cancer treatment.	2008
Information provided by: • Alex Sparreboom • Charity D. Scripture • Vuong Trieu • PaulJ.Williams • Tapas De • Andrew Yang • Bridget Beals • William D. Figg • Michael Hawkins • Neil Desai	• National Cancer Institute, Bethesda, Maryland • American BioScience, Inc.,SantaMonica, California • University of the Pacific, Stockton,	Comparison pharmacokinetic features of paclitaxel formulated as Cremophor-free, albumin-bound nanoparticle (ABI-007) vs paclitaxel synthesised in Cremophorethanol in preclinical and clinical studies (Taxol). Paclitaxel formulated as ABI-007 has a higher plasma clearance and a bigger distribution volume than Paclitaxel formulated as Taxol. This result is in line with the absence of paclitaxel-sequestering Cremophormicelles following ABI-007. This one-of-a-kind characteristic	2005

	California	of ABI-007 could be crucial to its therapeutic efficacy.	
Information provided by: • William C. Zamboni	• The Hillman Cancer Center, Research Pavilion, G.27c, 5117 Centre Avenue, Pittsburgh,	Increased solubility, extended exposure, targeted delivery of entrapped medication to the site of action, better therapeutic index, and the ability to overcome resistance associated with normal anticancer agents are all possible benefits of liposomal-encapsulated and carrier-mediated medicines. In preclinical development are new generations of liposomes that incorporate two anticancer drugs in a single liposome and antibody-targeted liposomes that may increase selective toxicity. Furthermore, antiangiogenesis medicines and antisense oligonucleotides are both viable liposomal formulation possibilities.	2005
Information provided by: • Aaron C. Eifler • C. Shad Thaxton	……	This study looked at CALAA-01, a nanoparticle therapy now in human clinical trials that represents several of nanoparticle treatments' potential benefits (Davis, Mol Pharm 6:659–668, 2009). The choice of CALAA-01 alludes to the therapeutic nanoparticle field's infancy; CALAA-01 was the first targeted siRNA nanoparticle therapy administered to people in 2008.	2011
Information provided by: • Scott Eliasofa • Douglas Lazarusa • Christian G. Petersa • Roy I. Casea • Roderic O. Colea • Jungyeon Hwanga • Thomas Schluepb • Joseph Chaoc • James Linc • Yun Yenc • Han Hand • Devin T. Wileyd	• Cerulean Pharma, Cambridge, MA 02139 • Calando Pharmaceuticals, Pasadena, CA 91101 • City of Hope Comprehensive Cancer Center, Duarte, CA 91010 • Chemical Engineering, California	In this pre-clinical investigation, researchers will look at how CRLX101 accumulates in solid tumours and releases camptothecin over many days to inhibit its target in animal xenograft models of cancer and human cancers. Overall, the evidence from animal models on the mechanism of action of CRLX101 implies that the behaviour of CRLX101 in animals can be translated to human behaviour.	2013

• Jonathan E. Zuckermand • Mark E. Davis	Institute of Technology, Pasadena, CA 91125		
Information provided by: • Michael E.Werner • Natalie D.Cummings • Manish Sethi • Edina C.Wang • Rohit Sukumar • Dominic T.Moore • Andrew Z.Wang		Identifying compounds that can improve chemoradiation therapy is an important research goal in radiation oncology. Nanoparticle (NP) chemotherapeutics have various features that make them ideal for chemoradiation therapy, including as preferential tumour accumulation. They used non-small cell lung cancer (NSCLC) as a model disease to conduct preclinical evaluation of Genexol-PM, the only clinically licenced NP chemotherapeutic with a regulated drug release profile, as a radiosensitizer to aid clinical translation of NP chemotherapeutics in chemoradiation treatment.	2013
Information provided by: • Alessio Malfanti • Ivana Miletto • Emanuela Bottinelli • Daniele Zonari • Giulia Blandino • Gloria Berlier • Silvia Arpicco	• Dipartimento di Scienza e Tecnologia del Farmaco, Università di Torino, Via P. Giuria 9, 10125 Torino, Italy • Dipartimento di Chimica and NIS (Nanostructured Interfaces and Surfaces) Centre, Università di Torino, Via P. Giuria 7, 10125 Torino, Italy	The antitumoral medication gemcitabine (GEM) and its 4-(N)-acyl derivatives (4-(N)-valeroyl-(C5GEM), 4-(N)-lauroyl-(C12GEM), and 4-(N)-stearoyl-gemcitabine (C18GEM) were examined by them using mesoporous silicon nanoparticles (MSNs). The loading of GEM lipophilic prodrugs on MSNs was investigated with the goal of protecting GEM against rapid plasmatic metabolization both physically and chemically.	2016
Information provided by: • Remy Guillet-Nicolas • Myriam Laprise-Pelletier	• Departement de chimie, University Laval, Quebec, QC G1V 0A6, Canada	Manganese oxide was injected into the porous network of MCM-48 silica nanoparticles (Mn–M48SNs) in this study. The particles have a limited size distribution (˜140 nm diam.) and a high porosity (˜60 percent vol.) that	2013

• Mahesh M. Nair • Pascale Chevallier • Jean Lagueux • Yves Gossuin • Sophie Laurent • Freddy Kleitz • Marc-Andre Fortin	• Centre de recherche sur les materiaux avances (CERMA), University Laval, Quebec, QC G1V 0A6, Canada • Departement de genie des mines, de la metallurgie et des materiaux, University Laval, Quebec, QC G1V 0A6, Canada • Axe Medecine Regeneratrice, Centre de recherche du Centre hospitalier universitaire de Quebec (AMSVR-CRCHUQ), 10 rue de l'Espinay, Quebec, QC G1L 3L5, Canada • Service de physique experimentale et biologique, University de Mons, 20, Place du Parc, Mons, Belgium • Service de chimie generale, organique et biomedicale, University de Mons, Mons,	was confirmed after Mn was inserted.	

	B7000, Belgium		

PHARMACOLOGICAL APPLICATION OF NANO FLUID

Nano-fluidsare dilute liquid suspensions of nanoparticleswith at least one of their principal dimensions smaller than100 nm.Nano-fluid are suspensions of nano particles in a base fluid,typically water.The term nano-particles comes from the Latin prefix 'Nano'.The prefix used to denote the 10-9 part of the unit.Recent development of nanotechnology brings out a new (23)heat transfer coolant called 'nano-fluid'.These fluid exhibits larger thermal properties than conventional coolants.

VARIOUS WORKING SECTOR:-

(1)Nano-crystal & Nano-fluid:-

The various nanocrystal pharmaceutical products are available in the market:-Budenoside, Indomethacin, Griseofulvin & Naproxen are some of the nanocrystal drugs. Due to decreased particle size range are the various advantage of the nanocrystals enhanced oral bioavailability, improved dose proportionality, reduced food effects, suitability for administration by all routes & possibility of sterile filtration has been seen. ZnO nanoparticles and their combinations are the best in nanobiotechnology and nanomedicine applications. In a study by Abdol Mohammadi et al in 2017, the cytotoxic effects of two types of ZnO nanomaterials on the growth of MCF-7 cell lineage in breast cancer were investigated. The results of this study presented that, with having maximum the concentrations of ZnO NPs in 48 and 72 hours of treatment, the survival rate of MCF-7 cell lines in breast cancer decreased.

A nanoparticle or ultrafine particle is usually defined as a particle of matter then is between 1 and 10 nanometers in diameter. The term is sometimes used for larger particles, up to 500 nm, or fibers & tubes that are less than 100 nm in only two directions.

High stability, high carrier capacity, the feasibility of incorporation of both hydrophilic and hydrophobic substances, including oral application & inhalation are the various technological advantage of nanoparticles. Apart from that, nanoparticles in sun creams can be absorbed deeper into the skin.

(2) Hyperthermia treatment:-

The state of having a body temperature that is significantly higher than normal. When the body can no longer release enough heat to maintain a normal temperature, hyperthermia ensues. To get rid of excess body heat, the body uses a variety of coping mechanisms, including breathing, sweating, and boosting blood flow to the skin's surface. When cancer cells are exposed to temperatures between 41 and 46^{o} C for an extended period of time, their growth is halted.Advantage of magnetic nano particles over other metal type nano particles are, these provides a chance for handling& manipulation of the nanofluid by magnetic force.These combination has a possibility of decreasing the systemic toxicity since the drug is encapsulated & biologically unavailable during passing in systemic circulation.`

The energy distribution has been shown using SAR (specific absorption rate), whose unit is (W/g). This value represents the ability of magnetic NPs to kill malignant cells, as determined by a series of temperature sensors embedded in an agarose gel. Nanofluids were injected into an agarose gel to investigate their mobility in extracellular tissue in a 2007 research by Salloum et al. This study was conducted in vitro, with an agarose gel serving as a tissue substitute. The objective of this work was to develop a mechanism for controlled tumour heating; it was discovered that this goal could be achieved if the nanofluid distribution inside the gel was spherical. The repeated injection approach has been developed to produce a consistent growth in the tumour size in tumours with irregular geometry. The cubic shape of NPs has greater SAR than the other forms, according to research (spherical, rod, start, polyhedron, and cone).

(3) Nano drug delivery:

In the last several decades, colloidal drug delivery systems have improved in terms of efficiency and specificity of drug activity. Nanoparticles' tiny size,

customizable surface, enhanced solubility, and multi-functionality bring up a slew of new biological possibilities. Nanoparticles have the capacity to engage in novel ways with complicated biological activities. Nontoxic carriers for medication and gene delivery applications are gold nanoparticles. It interacts with thiol and facilitates intracellular release. Graphene-based medication delivery systems have gotten a lot of interest in recent years. Sun et al. were the first to disclose the use of nano-graphene oxide (NGO) for cellular imaging and drug delivery in 2008.They created functionalization chemistry to improve NGO solubility and compatibility in biological settings. Loading doxorubicin, a commonly used cancer medication, onto NGO functionalized with antibody for selective death of cancer cells in vitro may be done via simple physico sorption through -stacking. A new nano carrier for the loading and targeted delivery of anticancer medicines has been discovered in the form of functional nanoscale graphene oxide.

(4)Nano cryosurgery:

Cryosurgeryis an energy based surgical technique.Cryosurgery, which is also called cryotherapy or cryoablation, is a technique thatemploys freezing to destroy undesired tissues. This therapy is becoming increasingly popularbecause it has various clinical advantages compared with traditional surgery. Specifically, it isless invasive, less expensive, and results in less pain, bleeding, and other complications thatoften arise from surgery. Cryosurgery therefore requires a much shorter recovery time andhospital stay than traditional surgical resection.The basic feature of nano cryosurgery are:-1)Enhancefreezing and thus improvetarget killing efficiency; 2)A void insufficient freezingbetween multiple cryoprobes during treating large scaletumor; 3)Regulate growth direction and orientation ofan ice ball and thus guarantee a conformal cryosurgeryon complex tumor; 4)Weaken a freezing on healthy tissuesand thus reduce injury there;5)Improve image contrastand offer a better image guidance for the cryosurgicaloperation; 6)Improve delivery efficiency of anti-cancerdrug during nano-cryosurgical chemotherapy.

Cryosurgery becomes more flexible for tumor treatment because the ice ball growth, during cryosurgery can be artificially controlled via asymmetrically loading nano suspensions to the targeted tissue. Generally, the conventional cryosurgical technique is often hard to produce an optimal cryolesion area due to the irregularly shaped tumor. To evaluate the capacity of controlling the size, shape and orientation of the ice ball formation via injecting nanoparticle suspensions with specific thermal properties into the target tissues.

(5)Biomedial application:

(a)Operative dentistry:-

Nanofillers constitute spherical silicon dioxide particles with an average size of 5-40 nm. The real innovation about nanofillers is the possibility of improving the load of the inorganic phase. The nanofillers used are aluminosilicate powder with1:4 M ratio of alumina to silica & a refractive index of 1.508. These nanocomposites have superior hardness & also have excellent handling properties.

(b)Application in ophthalmology:

Some applications of nanotechnology to ophthalmology are included treatment of oxidative stress, measurement of intraocular tension. Use of nanoparticles for treatment of choroidal new vessels to prevent scars after glaucoma surgery & for treatment of retinal degenerative disease using gene therapy. A novel nanoscale dispersed eye ointment for the treatment of severe evaporative dry eye has been successfully developed. The excipients used as semisolid were petrolatum & lanolin as used in conventional eye ointment, which is coupled with medium chain triglyceride as a liquid lipid. Both phases are then dispersed in polyvinyl pyrrolidone solution to form nanodispersion.

(c)visualization:

Traveling movement can be used to evaluate drug distribution and metabolism. Magnetic Resonance Imaging (MRI) is a non-invasive technology for seeing within the human body. It necessitates the use of opposing substances to aid the method. Iron oxide nanoparticles that are uniform and extremely tiny in size work well as MRI contrast agents. Because of their small size, nanoparticles are employed as a

contrast agent for a variety of reasons, including generating a sharper picture and having a lengthy half-life. Traditional gadolinium-based contrast agents have been discovered to have a shorter half-life than iron oxide nanoparticles. Because of the extended half-life, MRI can be used to follow blood pooling in patients.

The biomedical engineering field is expanding fast. Biomedical engineers will take a big role in the investigation in the life sciences and device evolution for adequate healthcare delivery. The biomedical engineering scope ranges from bio-nanotechnology to the assisting instruments, from cellular and molecular engineering to the robotics of surgery, and from the neuromuscular regimes to the synthetic lungs. The ideas introduced in this context will assist biomedical engineers to operate in such a variant field.

(6) Other application:

Nanofluid Detergent*:*

Nanofluids act differently on solid surfaces than ordinary liquids, as far as spreading and adhesion are concerned. This finding suggests that nanofluids might be good candidates for soil remediation, lubrication, oil recovery, and detergency operations. Such methods might have a plethora of future technical applications

Advantages of Nanofluids:

- High specific surface area & therefore more heat transfer surface between particles & fluids(22).
- High dispersion stability with predominant Brownian motion of particles(8).
- Reduced pumping power as compared to pure liquid to achieve equivalent heat transfer intensification(10).
- Reduced particle clogging as compared to conventional slurries, thus promoting system miniaturization(18).
- Adjustable properties, including thermal conductivity & surface wet ability, by varying particle concentrations to suit different applications(22).
- Compared with suspended particles of millimetre-or-micrometer dimentions which were used in base fluids to enhance heat transfer of such fluids exhibit higher thermal conductivities(14).
- Many types of particles such as metallic & non-metallic, can be added into fluids to form nanofluids(13).
- Micro & millimetre sized particles tend to settle rapidly. But nanoparticles can remain suspended in base fluids for a long time(20).
- The much larger relative surface area of nanoparticles compared to those of conventional particles improves heat transfer capabilities(19).
- Suspended particles of the order of millimetres or even micrometers may cause some severe problems such abrasive action of the particles causes the clogging of flow channels, erosion of pipelines etc which are not that severe in case of nanofluids(12).

Disadvantages of nanofluid:

1. Processing cost(15).
2. Agglomeration at higher pH value & also at high temperatures because of the ability of the particle to overcome thermal energy barrier leading to an increase in van der waals forces & hence resulting in decrease of conductivity(16).
3. Use of surfactants for stability which results in lowering of conductivity due to the formation of a thermal boundary layer around the particles(10).
4. High melting temperature(17).
5. High viscosity, low thermal conductivity(21).
6. Particle dispersion additives addition to the base fluid can change the surface properties of the particles, and nanofluids prepared in this way may contain unacceptable levels of impurities(18).
7. Most studies to date have been limited to sample sizes less than a few hundred millilitres of nanofluids(11). This is problematic since larger samples are needed to test many properties of

nanofluids and, in particular, to assess their potential for use in new applications(19).

III.CONCLUSION

Nanofluids are important because they can be used in a wide range of applications, including heat transmission and detergency. In biomedical engineering and the biosciences, colloids, which are also nanofluids, will be more widely used. In the applications, problems such as nanoparticle aggregation, settling, and erosion potential must be investigated thoroughly. Nanofluids used in experimental research must be properly defined in terms of particle size, size distribution, form, and clustering in order for the results to be generally applicable. Once the science and engineering of nanofluids are completely understood, as well as their full potential, they may be reproduced on a large scale and used in a wide range of applications. The uses of nanosuspension nanofluids in drug delivery, medical treatment, disease diagnosis, antibacterial cases, wound dressing, and cryopreservation are explored in this work. Based on the results of the research, a summary of closing remarks is provided, followed by some recommendations for further investigation. The primary goal of drug delivery has been to prevent aggregation and to maintain long-term stability. Many researchers have focused on the reduction in the bioavailability of nano-colloidal medicines, and numerous studies have been conducted in this respect. For their unique characteristics, nanocrystals, CNTs, gold, ZnO, and magnetic NPs have been used. Magnetic nanoparticle-based hyperthermia has been used to heat tumoral tissue, kill tumor cells, and make tumor cells more sensitive to the effects of anti-cancer drugs and radiation. Nanofluids increase tumor tissue destruction by increasing heat conductivity. As a consequence, various forms of magnetic nanofluids are recommended in order to achieve potentially beneficial findings for each type of sickness and cancer. The use of nanofluids in targeted MRI, the most interesting way of imaging and diagnosis, has grown significantly. Contrast agents play an important role in MRI, and several nanofluids, such as Fe_3O_4-based fluids, have been investigated for this scenario. Trying various nanofluids could be beneficial for optimizing the contrasting behavior of different agents in distinct diagnostic instances. Photosensitive NPs such as ZnO, TiO_2 and SiO_2 are more antibacterial than other NPs, but gold NPs are biocompatible and substantially less cytotoxic. The ideas mentioned in next for future study are proposed for the literature review and emphasis on the conducted research works: Developing novel nanofluid uses in biological and medical concerns. The rate of in vivo and in vitro testing trials on the nanofluids agents has been increased. To test different types of nanofluids in drug delivery, treatment, diagnosis, and bacterial disinfection. To compare different contrast agents for the diagnosis methods. Nonetheless, numerous new discoveries and advances concerning the properties of nanofluids in the surveyed applications have been found, and we are one step closer to designing systems that are more efficient and smaller, leading to a cleaner and healthier environment.

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