

Honorary Doctorate
Conferred on Prof. Arun S. Mujumdar
by Western University, Ontario



Honorary Doctorate Conferred on Professor Arun S. Mujumdar by Western University, Ontario

Professor Arun S. Mujumdar was conferred **D.Sc. Honoris Causa (Honorary Doctorate)** by **Western University, London, Ontario, Canada**, on June 17th, 2022. He addressed the graduating engineering students of this esteemed university.

Prof. Mujumdar has earlier been honored with honorary doctorates by Łódź Technical University, Poland, and the University of Lyon1, Lyon, France.

He attributes this recognition to his numerous students, mentees, collaborators, and colleagues around the globe.

Congratulations to all...!!

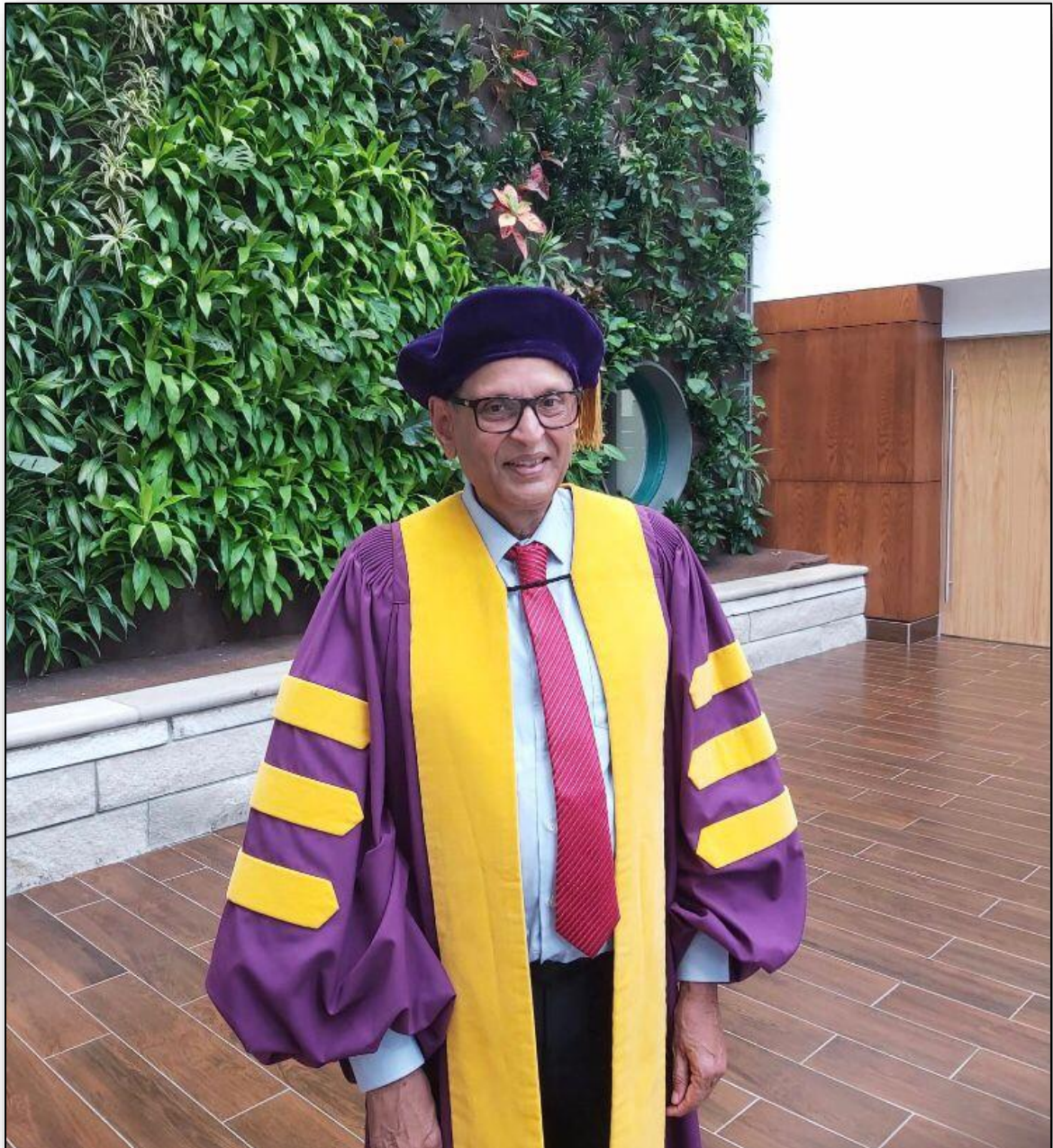
Shivanand S. Shirkole, PhD



About Professor Arun S. Mujumdar: Statistically Speaking...

The following is a quick look at just the numbers of various professional activities accomplished under Professor Mujumdar's guidance. It includes work at NUS as well as that carried out within the network of his mentees and collaborators in over a dozen institutions globally.

- Over 700 journal publications with 49,000+ citations and an h-index of 106 in May 2022
- World's top contributor to peer-reviewed publications in the field of Drying
- Over 350 conference papers; over 100 plenary/keynote lectures at international conferences
- Over 250 journal issues as Editor-in-Chief of Drying Technology journal
- Founder/ Chair of International Drying Symposium Series, Asia Pacific Drying Conference Series, etc.
- Over 60 international conferences as Organizer/Chair of Scientific Committees
- Over 100 PhDs mentored (McGill, NUS, Jiangnan University, and several other institutions); 35+ post-doctoral fellows
- 2 authored books; 70+ edited books; 150+ book chapters; 8 e-books (freely downloadable); 10+ M3TC Technical Reports at NUS for free downloads
- TPR Group network active across 18 countries
- Honorary Professor at several universities in China, Thailand, India
- Honored with Doctor Honoris Causa by Lodz Technical University, Poland (2008) and University of Lyon 1, France (2011), Western University, London, Canada (2022)
- Over 15 major international awards
- Prof. Mujumdar Medal for Excellence in Drying and Outstanding Mentorship (annual award since 2007)
- Sponsored Prof. Mujumdar Visiting Professorship/Fellowship at Institute of Chemical Technology, Several national-level awards from the Government of China as well as three provinces of China. See details - www.arunmujumdar.com



Professor Mujumdar During Convocation Ceremony at Western University

Convocation Citation

Dr. Arun Sadashiv Mujumdar is a distinguished scientist with an illustrious career in the chemical process engineering field, and his name is synonymous with Drying R&D worldwide. He was born in India and obtained his first degree in chemical engineering from the University Department of Chemical Technology (Mumbai, India) followed by master's and doctoral degrees in chemical engineering from McGill University. After a stint in industrial R&D sectors, he joined the Department of Chemical Engineering at McGill University in 1975 and served there until 2000 before moving across the globe to the National University of Singapore where he served as a Professor of Mechanical Engineering until 2013.

Professor Mujumdar is a leading personality in the world's drying technology and is often referred to as the "Drying Guru." He has provided global leadership to the drying R&D community, leading to near explosive growth in scientific and technical knowledge in industrial drying in diverse industries. He is credited globally for bringing to academia and industry the importance of thermal dehydration to enhance energy efficiency while improving the quality of dried products in a sustainable way. He is Editor-in-Chief of Drying Technology Journal and has started the biennial International Drying Conference series (IDS) in 1978 where he has provided outstanding leadership and vision to the world for engineering research in industrial R&D, and creativity in this field. Prof. Mujumdar has also been instrumental in leading the movement toward innovation, globalization, networking, and industry-academia collaboration in drying research and development. His recent research publications have focused on thermal energy storage and futuristic food processing technologies with significant industry interaction.

Professor Mujumdar has mentored over 125 graduate students at universities spanning Asia, Europe, and North America, and has published over 700 impactful publications receiving over 50,000 citations and an impressive h-index of 106. He has presented over 100 plenary lectures around the world. He has authored two books, edited over 70 books, and organized about 40 international conferences. Professor Mujumdar's Handbook of Industrial Drying has been the globally acclaimed quintessential source of information on drying. His distinguished academic record has been recognized internationally with numerous major awards and Honorary Professorships at several universities in China, India, and Thailand. He has been conferred the Doctor Honoris Causa by Lodz University of Technology (Poland) and the University of Lyon

(France). In 2014 Professor Mujumdar was conferred with the highest national award for International Cooperation in Science and Technology as well as the Friendship Award by the Government of China. In his free time, his creativity in paintings has become illustrations for many of his technical writings.

Madam Chancellor, on behalf of the Vice-Chancellor and in the name of the Senate, I ask you to confer the degree of D.Sc., Honoris Causa, upon Arun Sadashiv Mujumdar.



Professor Mujumdar While Signing Book of Honorary Doctorates



Convocation Address by Professor Arun S. Mujumdar

June 17, 2022

Honourable Chancellor, Vice-Chancellor, esteemed colleagues on the podium, and the graduating class and their family members and friends in the audience.

May I express my most sincere gratitude to President Shepard and Western University for conferring the DSc Honoris Causa on me. I am truly touched and humbled by this high honour. I wish to dedicate this honour to my students, colleagues, research collaborators, numerous mentors, my better half of fifty years as well as our children and family members. Without their support and hard work, I could not have accomplished whatever I managed to do.

My hearty congratulations to the engineering graduates for their successful academic achievement. I know it has been a hard and challenging journey but I am sure you have had many pleasant experiences and great learning throughout your stay in this internationally recognized esteemed university. Your family members as well as the numerous mentors, friends, and well-wishers you have had throughout your schooling and in this university are certainly happy and are celebrating your success. They deserve our congratulations for their important role in your success.

I wish I could trade places with you - and that is not just because of my age!

Your graduating class can look forward to a kaleidoscope of new challenging opportunities in a variety of new exciting fields in engineering as well as one of many non-engineering fields. You are an invaluable asset to Canada and eventually to the world regardless of what you choose to do in your life. I am sure you will be conscientious human beings with empathy and care for fellow human beings.

I would like to take this opportunity to provide the new graduates with a few words of advice based on my decades of experience as an academic and a consultant for many industries with interdisciplinary experience in several engineering disciplines at a number of universities in different parts of the world.

First of all, I would like to urge the graduating class to pursue excellence in whatever field they choose professionally. There are no shortcuts to excellence. Perseverance and singular determination to achieve the goals in life are essential traits that will lead to success.

Your background in problem-solving skills, quantitative analysis, critical thinking, expertise in various computational tools, will allow you to excel in many fields. There are major new challenges brought about by the need to follow principles of circular economy and

sustainability; these require the design of diverse and engineered systems as efficiently as possible with minimal waste of resources. I just came across a report which projects that Canada will need over 100,000 new engineers in the next five years. Some of you will take up employment in industry, some in business and some will pursue further academic studies including research which will allow you to make impactful original contribution to knowledge. I do hope that many of you will become entrepreneurs and create new employment opportunities and wealth for Canada and eventually for the world. It is necessary to have a creative mind and the ability to innovate, which you have learned in your engineering programs. Entrepreneurship requires an ability to take reasonable risks. We know ports are the safest places for ships but then ships are not built to remain parked safely at the port. Without facing turbulence at sea, the ship cannot go anywhere. Ditto for life. You will face unexpected challenges and hurdles but you can overcome them with the education and training you have received at this institution of higher learning.

Engineers are true wealth creators. You can help Canada to prosper and succeed in the highly competitive global environment - especially in the manufacturing sector. There is urgent need globally for engineers accomplished in the emerging areas such as artificial intelligence, advanced medical devices, advanced aerospace applications, additive manufacturing, robotics etc. to name a few. Many of you will be working in areas that are not even known today. This will be a big challenge young graduates need to be aware of and prepare for.

Hence life-long learning needs to be the norm and not an option to remain at the leading edge in any engineering discipline. This is also a requirement of professional engineering bodies as well. Furthermore, one should not underestimate the importance of professional ethics, techno economics, intellectual property rights as well as management skills.

Although you are yet to be exposed to academic and industrial research, these are important topics you need to become familiar with. I assume some of you have already planned to undertake graduate studies in engineering or some other fields of your interest.

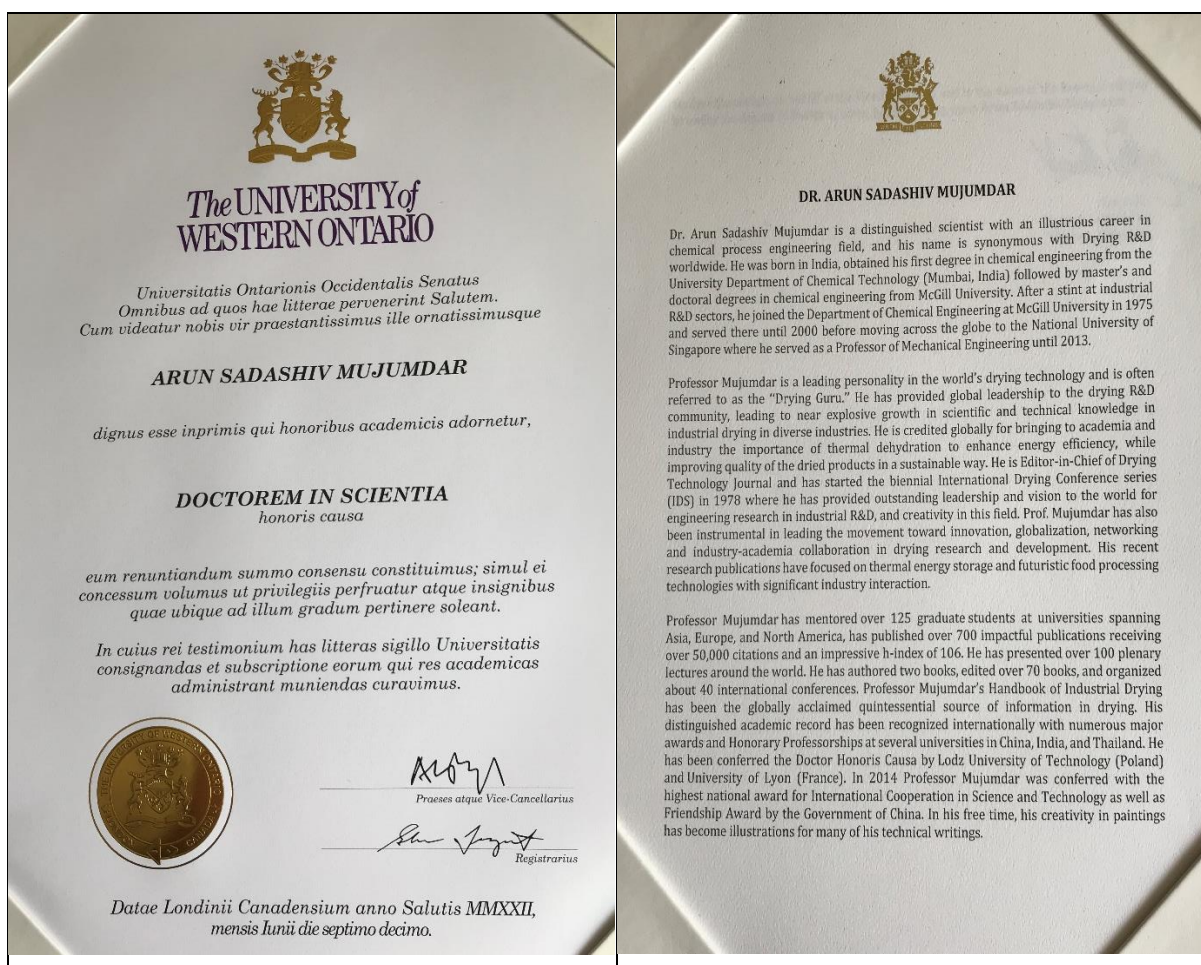
Your association with Western doesn't need to end once you leave this campus and set out on your careers. You are now proud lifelong members of a 330,000 strong network of Western alumni around the world. Giving back to Western, not only monetarily but also through volunteering and mentoring will also prove enriching to your personal and professional experience. Staying involved ensures that Western's elite reputation remains an indeed enhanced for the next generation.

Honorary Doctorate Conferred on Professor Arun S. Mujumdar by Western University, Ontario

In closing, my very best wishes to the graduates for rewarding careers and personal happiness. I am confident you will bring credit to your alma mater and to Canada through your accomplishments.

Thank you and hearty congratulations once more!

- **Professor Arun S. Mujumdar**





Convocation Address (Chinese Version) by Professor Arun S. Mujumdar

June 17, 2022

Honourable Chancellor, Vice-Chancellor, esteemed colleagues on the podium, and the graduating class and their family members and friends in the audience.

尊敬的校监、校长、主席台上的尊贵同事们，以及在座的毕业班学生和家长们，朋友们：

May I express my most sincere gratitude to President Shepard and Western University for conferring the DSc Honoris Causa on me. I am truly touched and humbled by this high honour. I wish to dedicate this honour to my students, colleagues, research collaborators, numerous mentors, my better half of fifty years as well as our children and family members. Without their support and hard work, I could not have accomplished whatever I managed to do.

首先请让我对谢泊德校长和西安大略大学授予我 荣誉博士学位 表示最诚挚的感谢。我对这份崇高的荣誉真的很感动并视之为鞭策。我谨将这一荣誉归功于我的学生、同事、研究合作者、众多导师、与我相助50年的另一半以及我们的孩子和家人。没有他们的支持和辛勤工作，我不可能取得今日的成就。

My hearty congratulations to the engineering graduates for their successful academic achievement. I know it has been a hard and challenging journey but I am sure you have had many pleasant experiences and great learning throughout your stay in this internationally recognized esteemed university. Your family members as well as the numerous mentors, friends, and well-wishers you have had throughout your schooling and in this university are certainly happy and are celebrating your success. They deserve our congratulations for their important role in your success.

我衷心祝贺工程专业毕业生成功的完成了大学学习之旅。我知道这是一段艰难而充满挑战的旅程，但我相信你们在这所国际公认的尊贵的大学里求学期间，一定有许多愉快的经历及非常大的收获。你们的家人以及你们在整个学习生涯包括这所大学中遇到的众多启蒙人、朋友和祝福者们今天一定很高兴，共同庆祝你们的成功。这些在你们的成功中扮演重要角色的人们，值得我们热烈的祝贺。

I wish I could trade places with you - and that is not just because of my age!

Your graduating class can look forward to a kaleidoscope of new challenging opportunities in a variety of new exciting fields in engineering as well as one of many non-engineering fields.

我奢望我能和你们交换位置——这不仅仅是因为我要年青！

各位毕业班同学即将走出校门，踏入工程界或者某一非工程领域，面对如万花筒般的各种令人兴奋的富于挑战的新机遇。

You are an invaluable asset to Canada and eventually to the world regardless of what you choose to do in your life. I am sure you will be conscientious human beings with empathy and care for fellow human beings.

无论你们选择将来做什么，你们都是加拿大进而全世界的宝贵财富。我相信你们会是具有同情心和自觉关心人类社会的人。

I would like to take this opportunity to provide the new graduates with a few words of advice based on my decades of experience as an academic and a consultant for many industries with interdisciplinary experience in several engineering disciplines at a number of universities in different parts of the world.

First of all, I would like to urge the graduating class to pursue excellence in whatever field they choose professionally. There are no shortcuts to excellence. Perseverance and singular determination to achieve the goals in life are essential traits that will lead to success.

基于我几十年来在世界不同地区的大学之学术研究经验和为几个工程产业提供跨学科咨询服务的经历，我想借此机会给应届毕业生几点忠告。

首先，我想敦促毕业生在你们选择的专业领域追求卓越。同时，请记住：追求卓越没有捷径，坚毅和恒心是通向成功的小路。

Your background in problem-solving skills, quantitative analysis, critical thinking, expertise in various computational tools, will allow you to excel in many fields. There are major new challenges brought about by the need to follow principles of circular economy and sustainability; these require the design of diverse and engineered systems as efficiently as possible with minimal waste of resources. I just came across a report which projects that Canada will need over 100,000 new engineers in the next five years. Some of you will take up employment in industry, some in business and some will pursue further academic studies including research which will allow you to make an impactful original contribution to knowledge.

解决问题的能力、定量分析、批判性思维、各种计算工具方面的专业知识方面的背景，将使你们在许多领域中脱颖而出。为了遵循循环经济和可持续性原则，我们需要面对新的重大挑战；这些挑战都要求我们设计多样化的工程系统，使之具有尽可能高的效率同时尽量减少资源浪费。我刚刚看到一份报告，预测加拿大未来五年将需要100,000多名新工程师。你们中的一些人将从事工业生产，有些人将从事商业活动，还

有一些人将继续深造包括进行学术研究 - 后者使您有机会对知识做出有影响力的原创性贡献。

I do hope that many of you will become entrepreneurs and create new employment opportunities and wealth for Canada and eventually for the world. It is necessary to have a creative mind and the ability to innovate, which you have learned in your engineering programs. Entrepreneurship requires an ability to take reasonable risks. We know ports are the safest places for ships but then ships are not built to remain parked safely at the port. Without facing turbulence at sea, the ship cannot go anywhere. Ditto for life. You will face unexpected challenges and hurdles but you can overcome them with the education and training you have received at this institution of higher learning.

我诚恳希望你们中的许多人会成为企业家，为加拿大乃至世界创造新的就业机会和财富。这要求你们必须具有创造性思维和创新能力，这正是你们在工程学科中所学到的。创业需要有能力和承担合理的风险。我们知道港口是船舶最安全的地方，但船舶并不是为了安全停泊在港口而建造的。不在海上乘风破浪，船就不能抵达远方。人生也同理。你们将面临意想不到的挑战和障碍，但你们一定可以利用在这所高校所接受的教育和培训来克服它们。

Engineers are true wealth creators. You can help Canada to prosper and succeed in the highly competitive global environment - especially in the manufacturing sector. There is urgent need globally for engineers accomplished in the emerging areas such as artificial intelligence, advanced medical devices, advanced aerospace applications, additive manufacturing, robotics etc. to name a few. Many of you will be working in areas that are not even known today. This will be a big challenge young graduates need to be aware of and prepare for.

工程师是真正的财富创造者。你们可以帮助加拿大繁荣并在激烈竞争的全球环境中胜出——尤其是在制造业。全球迫切需要在人工智能、先进医疗设备、先进航空航天应用、叠加制造、机器人技术等新兴领域取得成就的工程师。你们中的许多人将在一些今天甚至不为人知的新领域工作。这将是巨大的挑战，年轻毕业生们需要意识到它并做好应对准备。

Hence life-long learning needs to be the norm and not an option to remain at the leading edge in any engineering discipline. This is also a requirement of professional engineering bodies as well. Furthermore, one should not underestimate the importance of professional ethics, techno economics, intellectual property rights as well as management skills.

因此，终身学习需要成为常态，而不是一个选项。它是在任何工程学科中保持领先地位的不二法门。这也是对专业工程团体的要求。此外，请不要低估职业道德、技术经济学、知识产权和管理技能的重要性。

Although you are yet to be exposed to academic and industrial research, these are important topics you need to become familiar with. I assume some of you have already planned to undertake graduate studies in engineering or some other fields of your interest.

尽管你们尚未深入接触到学术和工业研究，但这些都是你们需要熟悉的重要课题。我认为你们中的一些人已经计划在工程学或其他感兴趣的领域继续进行研究生学习。

Your association with Western doesn't need to end once you leave this campus and set out on your careers. You are now proud lifelong members of a 330,000 strong network of Western alumni around the world. Giving back to Western, not only monetarily but also through volunteering and mentoring will also prove enriching to your personal and professional experience. Staying involved ensures that Western's elite reputation remains an indeed enhanced for the next generation.

你们离开这个校园并开始职业生涯之日，并不是你们与西安大略的联系结束之时。你们现在是遍布世界各地 拥有330,000 名强大的西安大略校友网的自豪的终身成员。回馈母校，无论是通过金钱捐赠，还是提供志愿服务或指导在校生等，必将丰富你们的个人和专业经验。保持参与，确保西大的高贵声誉代代提升。

In closing, my very best wishes to the graduates for rewarding careers and personal happiness. I am confident you will bring credit to your alma mater and to Canada through your accomplishments.

最后，我向毕业生致以最良好的祝愿，祝大家事业有成，家庭幸福。我相信你们今后的成就一定会为母校和加拿大增光添彩。

Thank you and hearty congratulations once more!

谢谢你们并再次衷心祝贺各位！

Professor Arun S. Mujumdar 阿伦 牟久大

June 17, 2022

Glimpses of Convocation Ceremony



Professor Mujumdar with Florentine Strzelczyk, Provost & Vice-President (Academic) (Left) and Ken Coley, Dean, Faculty of Engineering (Right) During Convocation Ceremony at Western University



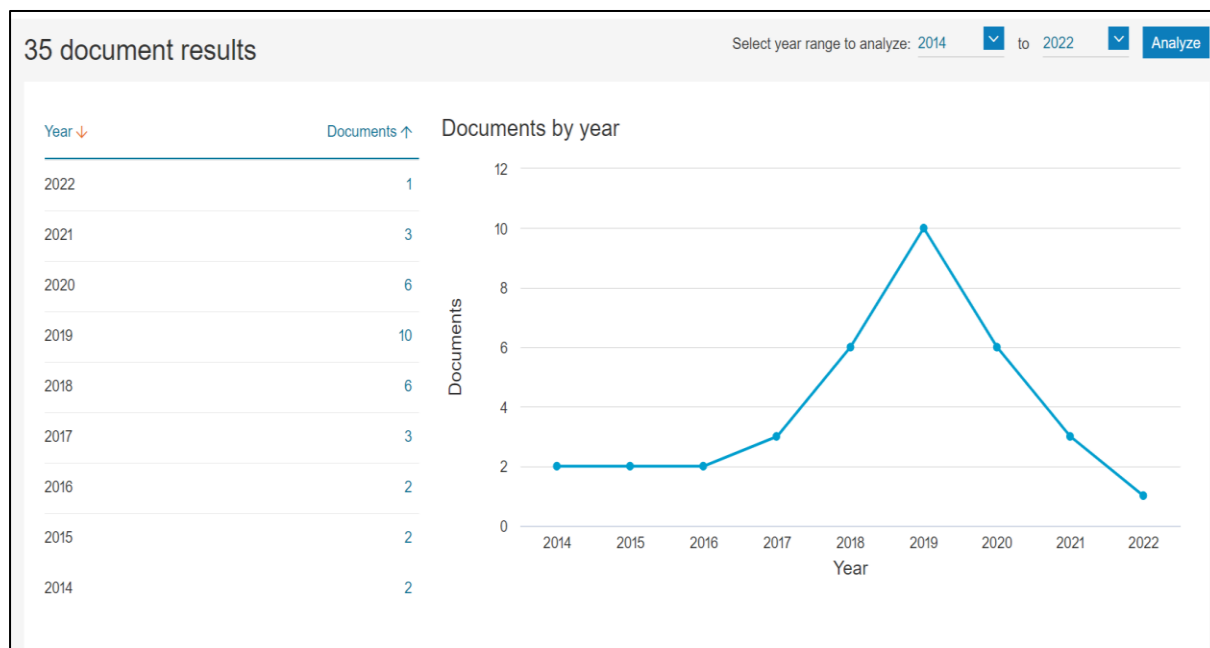
Professor Mujumdar with Florentine Strzelczyk, Provost & Vice-President (Academic) (Left) and Linda Hasenfratz, Chancellor (Right) During Convocation Ceremony at Western University

Annexure

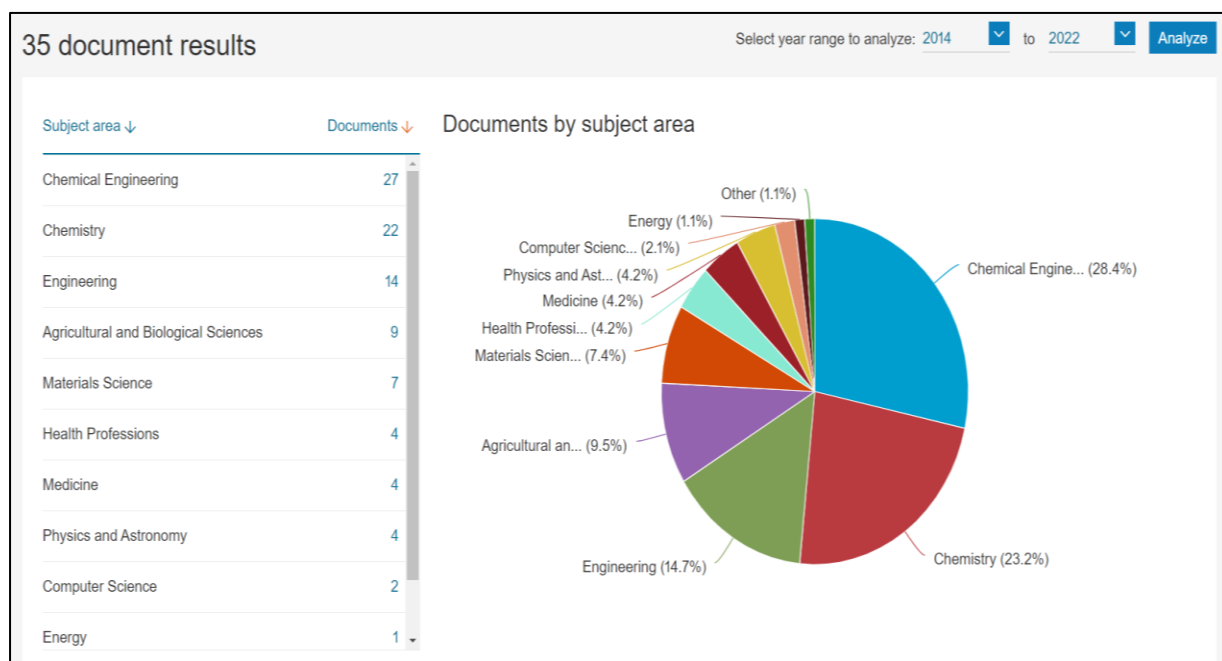
Publications of Professor Arun S. Mujumdar with Western University Affiliation during 2014-2022

Source: Scopus Database dated June 15, 2022

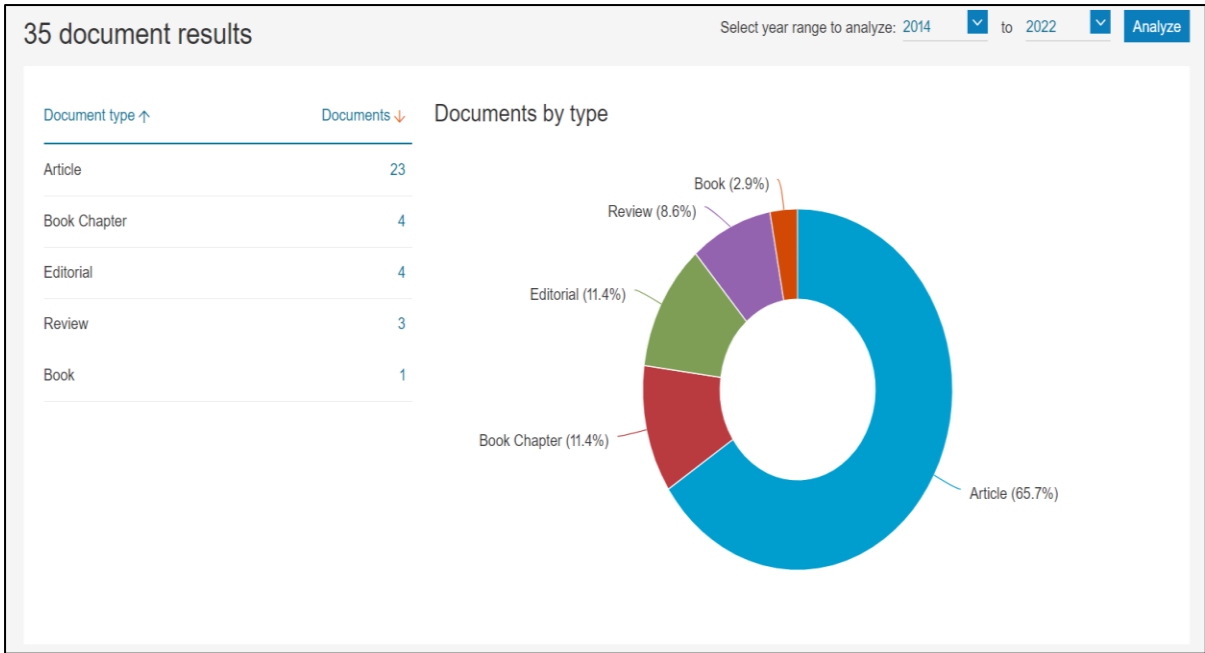
Documents by Years



Documents by Subject Area



Documents by Type





List of Publications with Abstracts:

1. **Mohan, B.; Puqing, J.; Sasmito, A. P.; Kurnia, J. C.; Jangam, S. V.; Mujumdar, A. S.,** *Energy-efficient novel heterogeneous gaseous T-junction microreactor design utilizing inlet flow pulsation. Industrial and Engineering Chemistry Research, 2014, 53, 18699-18710, DOI: 10.1021/ie500797f.*

The objective of the study is to investigate the effects of inlet flow pulsation on the mixing and reaction performance of a heterogeneous gaseous T-junction microreactor numerically. The idea is to have a novel modular microreactor design comprised of two microreactors (A and B), arranged in parallel, and a valve to control the flow direction. Flow pulsation can then be implemented to alternately supply reactant to microreactor A and microreactor B. Hence, by feeding the same amount of reactant and thus same pumping power/parasitic loads, the new design is able to run two microreactors and could achieve almost the same level of performance as that of a steady flow microreactor with an expense of one microreactor. The study was carried out for a case of mixing and heterogeneous catalytic reaction of methane (gaseous fuel) oxidation at the microreactor surface coated with a platinum catalyst. A detailed parametric study was performed to include the effect of frequency, amplitude, phase difference, and different waveforms on the conversion rate of gaseous fuel and pressure drop across the microreactor. The results suggest that the flow pulsation marginally affects the reaction performance, in which, the whole novel modular system produces almost double yields and energy (temperature) than that of conventional steady flow single microreactor design under the same amount of inlet reactants. This highlights the potential of this novel design in saving energy, enhancing reactants utilization, and increasing yield production for several applications. © 2014 American Chemical Society.

2. **Mujumdar, A. S., Editorial: Higher Education in Engineering: Need for Paradigm Shift. Drying Technology, 2014, 32, 1397, DOI: 10.1080/07373937.2014.928063.**
3. **Mujumdar, A. S., Editorial: Role of Global Networking in Research Collaboration. Drying Technology, 2015, 33, 513, DOI: 10.1080/07373937.2014.998504.**

4. ***Show, K. Y.; Lee, D. J.; Mujumdar, A. S., Advances and Challenges on Algae Harvesting and Drying. Drying Technology, 2015, 33, 386-394, DOI: 10.1080/07373937.2014.948554.***

Biodiesel production from algae offers a promising prospect for practical applications among the still developing biofuel technologies. The fact that algae are capable of producing much more yield provides an edge over other types of biofuel. Though algal biofuel research is still developing and its practical application is yet to be ascertained, promising work on laboratory- and pilot-scale algae harvesting systems has been extensively reported. Because algae harvesting and drying are vital elements in biofuel production, recent advances on various algae harvesting, dewatering, and drying technologies are reviewed and discussed. Challenges and prospects of algae harvesting and drying are also outlined. © 2015, Copyright © Taylor & Francis Group, LLC.

5. ***Kurnia, J. C.; Sasmito, A. P.; Mujumdar, A. S., Potential catalyst savings in heterogeneous gaseous spiral coiled reactor utilizing selective wall coating - A computational study. Computers and Chemical Engineering, 2016, 88, 59-72, DOI: 10.1016/j.compchemeng.2016.02.004.***

This study numerically evaluates the effect of secondary flow on the reaction performance in heterogeneous gaseous spiral coiled reactor utilizing selective wall coatings. Laminar multispecies gas flow in spiral coiled reactor with circular and square cross-section is investigated using a validated three-dimensional computational fluid dynamics (CFD) model. Various selective wall coating strategies are evaluated within a range of Reynolds number. The reactor performance is measured not only based on the conversion rate but also in terms of figure of merit (FoM) defined as reaction throughput per unit pumping power and catalyst coating active area. The results indicate that secondary flow enhance reaction performance and improve catalyst utilization, especially at the outer wall. By maximizing this effect, the requirement of expensive catalyst materials can be minimized. This study highlight the potential of selective catalyst coating in coiled reactor for process intensification and cost reduction in various applications. © 2016.

6. ***Xu, P.; Sasmito, A. P.; Qiu, S.; Mujumdar, A. S.; Xu, L.; Geng, L., Heat transfer and entropy generation in air jet impingement on a model rough surface. International***

Communications in Heat and Mass Transfer, 2016, 72, 48-56, DOI: 10.1016/j.icheatmasstransfer.2016.01.007.

Air jet impingement is an effective enhanced heat transfer technique which has been widely applied in cooling of electronic components and drying of continuous sheets of materials, etc. Although steady and unsteady impingement systems have led to many studies on jet impingement flow and heat transfer, the vast majority of them focus on smooth surfaces. As the flow and thermal physics of jet impingement on a rough surface are significantly different from that on a smooth surface, a numerical study was performed on the two-dimensional air jet impingement with a model rough surface by computational fluid dynamics method. A sinusoidal wave was employed to model the rough impinging target surface subjected to a slot jet nozzle. A dimensionless heat transfer enhancement factor was introduced to quantify the effect of jet flow Reynolds number, jet impingement dimension, and surface roughness as well as temperature difference between jet flow and impinging target on the heat transfer of jet impingement. It is observed that the roughness effect is minimal in the impingement zone while it is prominent in the wall jet region, and the surface roughness plays a dominant role on the enhancement factor of heat transfer rate compared with jet geometrical dimension, Reynolds number of jet flow as well as temperature difference. Furthermore, entropy generation analysis was also performed on the heat and mass transfer in air jet impingement, and optimal designs were found with entropy generation minimization principle accordingly. © 2016 Elsevier Ltd.

7. ***Jangam, S. V. Mujumdar, A. S., Developments in intermittent and non-stationary drying technologies, in Intermittent and Nonstationary Drying Technologies: Principles and Applications. 2017, CRC Press. p. 1-17.***

Intermittent drying generally refers to batch drying operations, wherein the operating conditions are altered during the course of removal of internal moisture to match the drying kinetics and allowable maximum product temperature so as to obtain enhanced thermal efficiency and higher product quality. The operating conditions include drying medium flow rate, temperature and humidity, as well as operating pressure. Different modes of heat input (e.g. convection, conduction, radiation, volumetric heating) may also be applied sequentially or concurrently as a function of time to match the drying kinetic characteristics of the product being dried. The objective of intermittency is to allow time for the internal moisture to migrate to the exposed surface before thermal energy is applied so that the moisture can be evaporated more efficiently without overheating the product. This chapter

provides an outline of the basic principle of intermittency, different types of intermittency, as demonstrated by selected published works, which focus on the effectiveness of the intermittency concept for higher thermal efficiency and product quality enhancement. On the negative side, the overall time may be increased marginally although it is compensated by overall reduction in energy. The concept of intermittency can also be applied to continuous drying for which heat input is varied spatially. © 2017 by Taylor & Francis Group, LLC.

8. **Mujumdar, A. S., Series preface. *Intermittent and Nonstationary Drying Technologies: Principles and Applications*, 2017, ix, DOI: 10.4324/9781351251303.**
9. **Wang, Y.; Mujumdar, A. S.; Zhang, M., *Microwave-assisted pulsed fluidized and spouted bed drying*, in *Intermittent and Nonstationary Drying Technologies: Principles and Applications*. 2017, CRC Press. p. 139-162.**

Fluidized and spouted bed dryers have been studied extensively in the literature and have also found numerous industrial applications to dry particulate materials in continuous as well as batch models. More recently, pulsing of the spouting air has been studied to enhance hydrodynamic mixing of the particles yielding better heat and mass transfer between the gas and the particles. In most instances, the heat transfer is by pure convection between the gas and particles. Addition of conduction heating enhances both the drying rate and the energy efficiency of the dryers. Another option is supplement heating by generating microwave field within the drying chamber. Volumetric heating of the wet particles enhances the drying rate without excessive heating of the particles, which can also improve product quality with lower energy consumption and smaller carbon footprint. © 2017 by Taylor & Francis Group, LLC.

10. **Deshmukh, R.; Mujumdar, A.; Naik, J., *Production of aceclofenac-loaded sustained release micro/nanoparticles using pressure homogenization and spray drying*. *Drying Technology*, 2018, 36, 459-467, DOI: 10.1080/07373937.2017.1341418.**

The aim of the present study was to characterize polymeric micro/nanoparticles of aceclofenac produced using a high-pressure homogenizer and a spray dryer. The micro/nanoparticles were characterized in terms of their encapsulation efficiency (E.E.), particle size, morphology, and in vitro drug release performance. Interaction between the

drug and the polymer (Eudragit RS 100 and ethylcellulose) was evaluated using Fourier transform infrared (FTIR) spectroscopy and X-ray powder diffractometry. Analysis of the results showed that speed and operating pressure have significant negative effect on E.E. of the micro/nanoparticles. The nanoparticles (970–197 nm) had E.E. of 74.09 ± 1.17 to $83.66 \pm 1.63\%$ while microparticles displayed EE. of $72.15 \pm 2.5\%$. The micro/nanoparticles were observed to be discrete and spherical. The FTIR analysis confirmed compatibility of aceclofenac with Eudragit RS 100 as well as ethylcellulose. In vitro study showed sustained drug release of 65 and 90% over a period of 12 h, thus prolonging the drug activity to treat the musculoskeletal disorder. © 2017 Taylor & Francis.

11. Gao, Y.; Wang, H.; Sasmito, A. P.; Mujumdar, A. S., *Measurement and modeling of thermal conductivity of graphene nanoplatelet water and ethylene glycol base nanofluids. International Journal of Heat and Mass Transfer*, 2018, 123, 97-109, DOI: 10.1016/j.ijheatmasstransfer.2018.02.089.

Three graphene nanoplatelet (GNP) nanofluids with different base fluids, viz. ethylene glycol (EG), deionized water (DW), and EG/DW (1:1) were prepared and characterized. The stability of GNP nanofluid was analyzed. Thermal conductivity was tested over the temperature range $-20\text{ }^{\circ}\text{C}$ to $50\text{ }^{\circ}\text{C}$. A new model is proposed for the effective thermal conductivity of the GNP nanofluid considering Brownian motion, length, thickness, average flatness ratio and interfacial thermal resistance of GNP, and it was compared with Maxwell, H-C and Chu models. The maximum thermal conductivity enhancement of EG, EG/DW (1:1) and DW based nanofluid is 4.6%, 18% and 6.8% respectively. Interestingly, the thermal conductivity of EG based GNP nanofluids does not show appreciable enhancement. The thermal conductivity enhancement of EG/DW (1:1) GNP nanofluid is greater than that of pure EG GNP nanofluid. In particular, the enhancement ratio at subzero temperature is larger than that at higher temperatures. The new model and Chu model are in agreement with the experimental data, and the new model is more rational for the GNP nanofluids. The new model shows that the influence of Brownian motion of GNP on thermal conductivity is significant at higher temperatures, higher concentration and smaller nanoparticles. © 2018

12. Jin, W.; Mujumdar, A. S.; Zhang, M.; Shi, W., *Novel Drying Techniques for Spices and Herbs: a Review. Food Engineering Reviews*, 2018, 10, 34-45, DOI: 10.1007/s12393-017-9165-7.

Spices and herbs are important parts of human daily food consumption and play an essential role in seasoning and/or preserving food, curing illness, and enhancing cosmetics. Proper processing is necessary because the fresh produce has high moisture content and often high load of microorganisms. Dehydration is the most common method used to lower moisture content and hence the water activity to a safe limit which prolongs shelf life. However, consumers' demand on processed products with most of the original characteristics of the fresh plants has increased. Consequently, drying must be executed carefully in the interest of retaining the taste, aroma, color, appearance, as well as nutritional value of the plants to maximum possible extent. In addition to quality considerations, drying efficiency is another key aspect for evaluating drying performance. This article reviews recent developments in the production of high dried spices and herbs. It attempts to detail the relative merits of selected recently developed drying techniques with focus on solar-assisted and microwave-assisted hybrid drying techniques which offer high-quality drying with excellent efficiency. Outlook for future research trends and challenges for dehydration of spices and herbs is also discussed. © 2017, Springer Science+Business Media, LLC.

13. Kulkarni, S.; Patil, P.; Mujumdar, A.; Naik, J., Synthesis and evaluation of gas sensing properties of PANI, PANI/SnO₂ and PANI/SnO₂/rGO nanocomposites at room temperature. Inorganic Chemistry Communications, 2018, 96, 90-96, DOI: 10.1016/j.inoche.2018.08.008.

Polyaniline nanofibers, PANI/SnO₂ and PANI/SnO₂/rGO nanocomposites were successfully prepared by an in-situ polymerization method. As synthesized nanofibers and nanocomposites were characterized by Fourier transform infrared spectroscopy, X-ray diffraction and Field emission scanning electron microscope which confirms the formation of nanofibers and nanocomposites, also gives the confirmation about an interaction between PANI nanofibers, SnO₂ nanoparticles, and rGO nanosheets, respectively. Polyaniline nanofibers, PANI/SnO₂ and PANI/SnO₂/rGO nanocomposites were used in gas sensing to detect the different gases at room temperature. All the nanocomposites and nanofibers had better selectivity and sensitivity towards the ammonia gas. PANI/SnO₂/rGO nanocomposite showed the best response of 0.83 for 10 ppm concentration of ammonia gas at room temperature with a recovery time of ~80 s. © 2018

- 14. Shrimal, P.; Sanklecha, H.; Patil, P.; Mujumdar, A.; Naik, J., Biodiesel Production in Tubular Microreactor: Optimization by Response Surface Methodology. *Arabian Journal for Science and Engineering*, 2018, 43, 6133-6141, DOI: 10.1007/s13369-018-3245-8.**

Transesterification of crude cottonseed oil with methanol in the presence of catalyst (NaOH) in tubular microreactor has been investigated experimentally. The transesterification reaction was performed in a silicon tube of 0.8 mm inner diameter, mounted in serpentine manner configuration on an acrylic sheet. Influence of process variables such as reaction temperature (35-45°C), NaOH concentration (0.5–1.5 wt%) and oil/methanol molar ratio (1:7–1:9) on fatty acid methyl ester (FAME) was studied. In order to further improve biodiesel yield, an experimental design was employed using the Box–Behnken method and analysis of variance. The %FAME was calculated by gas chromatography using methyl arachidate as an internal standard. Fourier transform infrared spectroscopy was used to investigate the functional groups present in biodiesel. Thermal stability of biodiesel was evaluated using a thermogravimetric analyser. The optimal condition found was oil/methanol molar ratio (1:8), catalyst concentration (1 wt%) and reaction temperature (45°C) while %FAME yield of about 94.1% at a residence time of 90 s. © 2018, King Fahd University of Petroleum & Minerals.

- 15. Yang, X. H.; Deng, L. Z.; Mujumdar, A. S.; Xiao, H. W.; Zhang, Q.; Kan, Z., Evolution and modeling of colour changes of red pepper (*Capsicum annuum* L.) during hot air drying. *Journal of Food Engineering*, 2018, 231, 101-108, DOI: 10.1016/j.jfoodeng.2018.03.013.**

In current work, the evolution kinetic models of moisture, surface colour (L^* , a^* , and b^*), natural pigment and non-enzymatic browning (NEB) of red pepper during hot air drying at drying temperatures of 60, 70, and 80 °C were investigated. The relationships between surface colour and natural pigment, as well as non-enzymatic browning were explored. Results showed that, the drying time of red pepper decreased with the increase of drying temperature, Weibull model fits the drying curves well. By comparing the fitting of kinetic models to the experimental data, it was found that the evolution kinetics of surface colour (L^* , a^* , and b^*) and NEB followed the Weibull and zero-order model, respectively. The degradation of natural pigment fitted well to both the Weibull and first-order model. The activation energy for L^* , a^* , b^* , natural pigment and NEB evolution were 42.47, 42.83,

44.92, 37.22, and 56.68 kJ/mol, respectively, which indicates that browning was most sensitive to heat. Furthermore, the surface colour parameters showed a positive correlation with natural pigment content, and a negative correlation with NEB. Equations to predict the concentration of the natural pigment in red pepper on the basis of CIELAB colour values were obtained. © 2018 Elsevier Ltd

- 16. Fan, K.; Zhang, M.; Mujumdar, A. S., *Recent developments in high efficient freeze-drying of fruits and vegetables assisted by microwave: A review. Critical Reviews in Food Science and Nutrition*, 2019, 59, 1357-1366, DOI: 10.1080/10408398.2017.1420624.**

Microwave heating has been applied in the drying of high-value solids as it affords a number of advantages, including shorter drying time and better product quality. Freeze-drying at cryogenic temperature and extremely low pressure provides the advantage of high product quality, but at very high capital and operating costs due partly to very long drying time. Freeze-drying coupled with a microwave heat source speeds up the drying rate and yields good quality products provided the operating unit is designed and operated to achieve the potential for an absence of hot spot developments. This review is a survey of recent developments in the modeling and experimental results on microwave-assisted freeze-drying (MFD) over the past decade. Owing to the high costs involved, so far all applications are limited to small-scale operations for the drying of high-value foods such as fruits and vegetables. In order to promote industrial-scale applications for a broader range of products further research and development efforts are needed to offset the current limitations of the process. The needs and opportunities for future research and developments are outlined. © 2017, © 2017 Taylor & Francis Group, LLC.

- 17. Jangam, S. V. Mujumdar, A. S., *Miscellaneous drying technologies, in Advanced Drying Technologies for Foods*. 2019, CRC Press. p. 205-222.**

- 18. Karim, A.; Colette, B.; Ezzeddine, A.; Tamara, A.; Mujumdar, A. S.; Sabah, M., *Drying and instant controlled pressure drop swell drying: Towards high-quality dried foods and starch-free snacks, in Advanced Drying Technologies for Foods*. 2019, CRC Press. p. 31-51.**

- 19. Khairnar, G.; Mokale, V.; Mujumdar, A.; Naik, J., Development of nanoparticulate sustained release oral drug delivery system for the antihyperglycemic with antihypertensive drug. *Materials Technology*, 2019, 34, 880-888, DOI: 10.1080/10667857.2019.1639019.**

The oral-sustained release dosage form containing Repaglinide (RPG, antidiabetic) and Diltiazem HCL (DIL, antihypertensive) loaded chitosan nanoparticles were prepared by the ionotropic gelation method. The chitosan concentration (A) and TPP concentration (B) were selected as independent variables while percentage drug loading of Repaglinide (Y1) and Diltiazem HCL (Y2) were chosen as the dependent variables. The RPG and DIL-loaded chitosan nanoparticles produced in this study were evaluated for drug-polymer interaction, surface morphology, encapsulation efficiency, drug loading, particle size and invitro drug release. The release of Repaglinide from the drug-loaded nanoparticles in a phosphate buffer (pH 7.4) solution was observed to be sustained over a period of 19 h (batch1) while Diltiazem showed sustained release behaviour over a period of 20 h in distilled water. FTIR analysis confirmed compatibility of the drug with excipients. Apparent particle size data showed that the particles were nano size with a low polydispersity index. © 2019, © 2019 Informa UK Limited, trading as Taylor & Francis Group.

- 20. Li, K.; Zhang, M.; Mujumdar, A. S.; Chitrakar, B., Recent developments in physical field-based drying techniques for fruits and vegetables. *Drying Technology*, 2019, 37, 1954-1973, DOI: 10.1080/07373937.2018.1546733.**

Modern physical field technologies mainly include microwave, radio frequency, infrared radiation, ultrasound, pulsed electric field, and so on. Nowadays, the application of physical field technology on conventional drying is one of the recent strategies to solve some problems in traditional drying. In this article, physical field-based drying techniques refer to hybrid drying methods consisting of the conventional heating combined with different physical field technologies, in which physical field technologies provide various heat sources differ from conventional ones. A review is presented of recent five-year literature in the development of selected physical field-based drying technologies (microwave, radio frequency, infrared radiation, and ultrasound) for fruits and vegetables. As shown by examples from the literature, these physical field-based drying techniques provide faster drying kinetics and better thermal efficiency and obtain dried products of improved quality (e.g. color, aroma, texture, and nutrition retention) relative to conventional hot air drying.

The combination of these techniques and conventional hot air drying showed enhanced cost-effectiveness as well. Furthermore, recommendations are made for further research and development needs and opportunities in this area. © 2019, © 2019 Taylor & Francis Group, LLC.

21. Mujumdar, A. S. Xiao, H. W., *Advanced drying technologies for foods. Advanced Drying Technologies for Foods. 2019: CRC Press. 1-246.*

The goal of all drying research and development is to develop cost-effective innovative processes that yield high-quality dried products with less energy consumption and reduced environmental impact. With the literature on drying widely scattered, *Advanced Drying Technologies for Foods* compiles under one cover concise, authoritative, up-to-date assessments of modern drying technologies applied to foods. This book assembles a number of internationally recognized experts to provide critical reviews of advanced drying technologies, their merits and limitations, application areas and research opportunities for further development. Features: Provides critical reviews of advanced drying technologies. Discusses the merits and limitations of a variety of food drying technologies. Explains drying kinetics, energy consumption and quality of food products. Reviews the principles and recent applications of superheated steam drying. The first four chapters deal with recent developments in field-assisted drying technologies. These include drying techniques with the utilization of electromagnetic fields to deliver energy required for drying, for example, microwave drying, radio frequency drying, electrohydrodynamic drying, and infrared radiation drying. The remainder of this book covers a wide assortment of recently developed technologies, which include pulse drying, swell drying, impinging stream drying, and selected advances in spray drying. The final chapter includes some innovative technologies which are gaining ground and are covered in depth in a number of review articles and handbooks, and hence covered briefly in the interest completeness. This book is a valuable reference work for researchers in academia as well as industry and will encourage further research and development and innovations in food drying technologies. © 2020 by Taylor & Francis Group, LLC. All right reserved.

22. Mujumdar, A. S. Xiao, H. W., *Preface. Advanced Drying Technologies for Foods, 2019, vii.*

- 23. Wagh, P.; Mujumdar, A.; Naik, J. B., Preparation and characterization of ketorolac tromethamine-loaded ethyl cellulose micro-/nanospheres using different techniques. *Particulate Science and Technology*, 2019, 37, 347-357, DOI: 10.1080/02726351.2017.1383330.**

Sustained-release micro-/nanospheres of the ketorolac tromethamine (KTC) were prepared using four different techniques viz., single emulsion solvent evaporation, high pressure homogenization, spray drying, and using a microreactor. Ethyl cellulose (EC) was used as an encapsulating agent for the preparation of sustained-release micro-/nanospheres of KTC. The Plackett–Burman design was employed for design of the experiments. The resulting micro-/nanospheres were characterized for their size, morphology, encapsulation efficiency, and in vitro drug release performance. Interactions between the KTC and EC were quantified by Fourier transform infrared (FTIR) spectroscopy and X-ray powder diffractometry (XRPD). Particle morphology characterization was performed using field emission scanning electron microscopy. The micro-/nanospheres showed encapsulation efficiency of 42.34–89.33% by the solvent evaporation technique, 76.36–91.13% by the high-pressure homogenization technique, 70.74–79.68% by spray drying, and 79.00–89.49% by the microreactor technique. The micro-/nanospheres were found to be spherical and oval with smooth surface. The FTIR analysis confirmed no interaction of KTC with EC polymer. The XRPD analysis revealed good dispersion of the drug within the micro-/nanospheres formulation. Sustained KTC release profile over 12 h was achieved successfully by EC polymer. In conclusion, EC sustained-release micro-/nanospheres containing KTC can be prepared successfully using different techniques. © 2018, © 2018 Taylor & Francis.

- 24. Waghulde, M.; Mujumdar, A.; Naik, J., Preparation and characterization of miglitol-loaded Poly (d, l-lactide-co-glycolide) microparticles using high pressure homogenization-solvent evaporation method. *International Journal of Polymeric Materials and Polymeric Biomaterials*, 2019, 68, 198-207, DOI: 10.1080/00914037.2018.1434652.**

Sustained release Miglitol-loaded poly (d, l-lactide-co-glycolide) (PLGA) microparticles were prepared using high pressure homogenization-solvent evaporation method. 2 3 full factorial design was employed to study effect of independent variables (X 1 -Polymer amount; X 2 -Surfactant concentration and X 3 -Homogenization Pressure) on percent

encapsulation efficiency (%EE) as response. The microparticles produced were characterized for particle size, morphology, % EE, drug polymer compatibility and in vitro drug release. An average particle size of Miglitol-loaded PLGA microparticles was 230.1 nm and found almost spherical with smooth surface. % EE ranged from 58.7% \pm 2.11 to 86.5% \pm 0.24 depending on the polymer amount, surfactant concentration and homogenization pressure. An absence of chemical interaction between drug-polymer and reduction in % crystallinity of drug was confirmed by FTIR and X-ray diffraction analysis respectively. In vitro release studies showed a sustained release of Miglitol from microparticles up to 12 hrs. © 2018, © 2018 Taylor & Francis.

25. Waghulde, M.; Rajput, R.; Mujumdar, A.; Naik, J., *Production and evaluation of vildagliptin-loaded poly(dl-lactide) and poly(dl-lactide-glycolide) micro-/nanoparticles: Response surface methodology approach. Drying Technology, 2019, 37, 1265-1276, DOI: 10.1080/07373937.2018.1495231.*

A laboratory scale spray dryer was used to encapsulate vildagliptin (VLG), an antihyperglycemic drug, into different polymers such as poly(dl-lactide) (PDLA), poly(dl-lactide-glycolide)-50:50 (PLGA 50:50), and poly(dl-lactide-glycolide)-75:25 (PLGA 75:25). Response surface methodology (RSM) was employed to evaluate the effects of process and formulation factors on the encapsulation efficiency (EE). The physicochemical properties of the drug-loaded micro-/nanoparticles, mainly the drug loading (DL), particle size distribution, surface morphology, drug–polymer compatibility, and release rate were investigated. % EE of drug-loaded micro-/nanoparticles were in the range of 57.10% to 76.44%. PLGA50:50 micro-/nanoparticles showed highest EE as compared to PDLA and PLGA75:25 micro-/nanoparticles. The mean particle size of the micro-/nanoparticles containing PLGA 50:50, PLGA 75:25, and PDLA polymers were 428 nm, 640 nm, and 1.22 μ m, respectively. Surface morphology study revealed smooth, spherical and nonporous surface structures of the micro-/nanoparticles. Fourier transform infrared spectroscopy studies confirmed the drug–polymer compatibility. Powder X-ray diffraction analysis of micro-/nanoparticles revealed that VLG was present in the amorphous form within the micro-/nanoparticles formulations. In vitro release study demonstrated that VLG is slowly released from micro-/nanoparticles for 12 h and the drug release rate was influenced by type and viscosity of polymers used. This work suggests that PDLA, PLGA

50:50, and PLGA75:25 polymers are able to sustain the VLG release rates from micro-/nanoparticles. © 2018, © 2018 Taylor & Francis.

26. Gao, Y.; An, J.; Xi, Y.; Yang, Z.; Liu, J.; Mujumdar, A. S.; Wang, L.; Sasmito, A. P., *Thermal conductivity and stability of novel aqueous graphene oxide-Al₂O₃ hybrid nanofluids for cold energy storage. Applied Sciences (Switzerland), 2020, 10, DOI: 10.3390/APP10175768.*

Thermal ice storage has gained a lot of interest due to its ability as cold energy storage. However, low thermal conductivity and high supercooling degree have become major issues during thermal cycling. For reducing the cost and making full use of the advantages of the graphene oxide-Al₂O₃, this study proposes heat transfer enhancement of thermal ice storage using novel hybrid nanofluids of aqueous graphene oxide-Al₂O₃. Thermal conductivity of aqueous graphene oxide-Al₂O₃ nanofluid was measured experimentally over a range of temperatures (0-70 °C) and concentrations. Thermal conductivity of ice mixing with the hybrid nanoparticles was tested. The influences of pH, dispersant, ultrasonic power and ultrasonic time on the stability of the hybrid nanofluids were examined. A new model for the effective thermal conductivity of the hybrid nanofluids considering the structure and Brownian motion was proposed. The results showed that pH, dispersant, ultrasonic power level and ultrasonication duration are important factors affecting the stability of the hybrid nanofluids tested. The optimum conditions for stability are pH = 11, 1% SDS, 375 W ultrasonic power level and 120 min ultrasonic application time. The thermal conductivity of hybrid nanofluids increases with the increase of temperature and mass fraction of nanoparticles. A newly proposed thermal conductivity model considering the nanofluid structure and Brownian motion can predict the thermal conductivity of hybrid nanofluids reasonably well. © 2020 by the authors.

27. Naik, J. B.; Pardeshi, S. R.; Patil, R. P.; Patil, P. B.; Mujumdar, A., *Mucoadhesive Micro-/Nano Carriers in Ophthalmic Drug Delivery: an Overview. BioNanoScience, 2020, 10, 564-582, DOI: 10.1007/s12668-020-00752-y.*

The eye is a challenging organ for ophthalmic drug delivery due to the barriers associated with the anterior and posterior segments like nasolacrimal drainage, blinking, induced lacrimation, impermeability of corneal epithelial membrane, and blood-ocular barrier. Although there are conventional approaches, such as eye drop, ointment, suspension,

implants, and injection, they suffer from limitations of low bioavailability, poor patient compliance (due to invasive approach and repeated dosing), and potential for several side effects. This review explored the various mucoadhesive polymers, derivatized polymers, and different modification methods for such polymer derivatization (via carboxymethylation, thiolation, and quaternization) for their effective drug delivery toward ophthalmic application. Various types of micro and nanoparticulate systems of such derivatized mucoadhesive polymer-based carriers have been also exemplified and discussed here for their improved medicinal efficacy. To address the issues associated with conventional ophthalmic formulations, mucoadhesive drug delivery has been proposed. The emerging technologies play an important role in the development of more efficient mucoadhesive carriers obtained by derivatization or modification of core polymers with various functional groups such as carboxymethyl, amine, and new generation thiols. Mucoadhesive polymers form bonding with mucin (hydrogen, covalent, electrostatic bonding, etc.) and enhance corneal residence time and cellular uptake of the drug. Mucoadhesive carriers are designed to associate with the micro and nanoparticulate systems to overcome the ocular barriers with improved therapeutic efficacy. © 2020, Springer Science+Business Media, LLC, part of Springer Nature.

28. Pardeshi, S.; Patil, P.; Rajput, R.; Mujumdar, A.; Naik, J., *Preparation and characterization of sustained release pirfenidone loaded microparticles for pulmonary drug delivery: Spray drying approach. Drying Technology, 2020, 39, 337-347, DOI: 10.1080/07373937.2020.1833213.*

Pirfenidone (PFD) is a drug of choice for the treatment of idiopathic pulmonary fibrosis. For the preparation of sustained release microparticles of PFD, Ethyl cellulose (EC 300) with Eudragit RS 100 in combination was used as encapsulating agents. The 3-level 2-factorial design was employed for the design of experiments (DoE). The spray dried microparticles were studied for their particle size distribution, surface topography, drug entrapment, in-vitro drug release, and aerodynamic performance. Compatibility between drug and excipients were evaluated by Fourier Transform Infrared (FTIR) Spectroscopy and Differential Scanning Calorimetry (DSC). Particle morphology and size distribution were performed using Field Emission Scanning Electron Microscopy (FESEM) and Dynamic light scattering (DLS). The average particle size of the optimized PFD loaded formulation was found to be 3.99 µm. The surface topography study of the optimized

formulation showed that the microparticles are nearly spherical with a smooth surface. In addition, the in-vitro aerosol performance was studied by Anderson cascade impactor and developed microparticles showed favorable aerodynamic performance (MMAD 4.25 μm) with narrow particle diameter distribution (GSD 1.52), therefore developed microparticles can be used as a dry powder for inhalation (DPI) for the targeted delivery to the lungs. In conclusion, sustained release microparticles of PFD were successfully prepared by the spray drying technique. © 2020 Taylor & Francis Group, LLC.

- 29. Patil, J.; Rajput, R.; Patil, P.; Mujumdar, A.; Naik, J., *Generation of sustained release chitosan nanoparticles for delivery of ketorolac tromethamine: a tubular microreactor approach. International Journal of Polymeric Materials and Polymeric Biomaterials, 2020, 69, 516-524, DOI: 10.1080/00914037.2019.1581201.***

Sustained release ketorolac tromethamine (KT) loaded chitosan nanoparticles were generated using tubular microreactor with syringe pump. 32 full-factorial design was employed for the optimization of formulation parameters. The chitosan concentration (X1) and cross-linking agent concentration (X2) was designated as the independent variables while drug release (Y1) and encapsulation efficiency (Y2) was selected as dependent variables to achieve desired entrapment efficiency and sustained drug release. The obtained nanoparticles were evaluated for particle size, field emission scanning electron microscopy (FE-SEM), Fourier transform infrared spectroscopy (FT-IR), X-ray powder diffractometry (XRD), encapsulation efficiency and in vitro drug release study. Scanning electron microscopy of optimized run showed that the nanoparticles are spherical, and the particle size distribution of nanoparticles were found in the range of 164.2–255 nm. An encapsulation efficiency was obtained between 76% - 96%. Based on in-vitro drug release study, KT loaded chitosan nanoparticles exhibited sustained release action over a period of 12 h. An application of in-vitro drug release statistics to numerous kinetic equations designated that the diffusion (Higuchi model) of drug was responsible for drug release. © 2019, © 2019 Taylor & Francis Group, LLC.

- 30. Rajput, R. L.; Narkhede, J. S.; Mujumdar, A.; Naik, J. B., *Synthesis and evaluation of luliconazole loaded biodegradable nanogels prepared by pH-responsive Poly (acrylic acid) grafted Sodium Carboxymethyl Cellulose using amine based cross linker for topical targeting: In vitro and Ex vivo assessment. Polymer-Plastics Technology and Materials, 2020, 59, 1654-1666, DOI: 10.1080/25740881.2020.1759633.***

Fungal infection in immuno compromised patients causes skin syndromes and problems. At Present, innovative alternatives are required to cure skin disorders and infections. Luliconazole is a novel, broad spectrum, imidazole antifungal agent. The purpose of this study was to develop biodegradable, pH responsive, chemically cross-linked and Poly (acrylic acid) grafted sodium carboxymethyl cellulose nanogels. Nanogels had been synthesized to evaluate its applicability as an effective carrier of luliconazole for topical (skin) targeting. Chemically cross-linked sodium carboxymethyl cellulose-grafted-Poly acrylic acid (NaCMC-g-PAA) was synthesized from acrylic acid and sodium carboxymethyl cellulose using N, N'-methylene bisacrylamide (cross-linker) and potassium persulfate (initiator) using free radical polymerization. Variation of reaction parameters such as pH, cross linker, initiator and temperature has been used to optimize the best one. The developed nanogels reveal significant pH sensitive drug releasing behavior. NaCMC-g-PAA nanogels has been characterized using various physicochemical characterization techniques. Nanogels characteristics were evaluated through the In vitro drug release, Ex vivo permeation study, Nuclear magnetic resonance spectroscopy, Fourier Transform Infrared Spectroscopy, Field Emission Scanning Electron Microscope, Stability Study and antifungal activity. All batches were characterized for particle size analysis and ranged from 78.82 nm to 190 nm. The viscosity of developed nanogels was found to be 5941 cps. It was observed that the developed drug-loaded NaCMC-g-PAA nanogels were more effective in killing the fungus. Consequently, Nanogels incorporated with luliconazole could be a new approach with improved antifungal activity and increased topical delivery for a drug with poor aqueous solubility rather than coarse drug-containing cream. © 2020 Taylor & Francis.

31. Verma, U.; Mujumdar, A.; Naik, J., Preparation of Efavirenz resinate by spray drying using response surface methodology and its physicochemical characterization for taste masking. *Drying Technology*, 2020, 38, 793-805, DOI: 10.1080/07373937.2019.1590845.

In the present study, taste masked drug-resin complex (DRC) of efavirenz (EFV) was prepared by spray drying technique. The DRC was then incorporated in to a fast dissolving tablet dosage form. EFV is antiretroviral agent of very bitter taste and low oral bioavailability. To investigate the influence of the independent variables on encapsulation efficiency (EE) as well as on the bitter taste of EFV, response surface methodology was employed. Ion-exchange resin (tulsion-335) and amount of solvent were selected as the

independent variables while the EE was selected as the dependent variable. DRC was characterized for EE, X-ray diffraction, particle size distribution, Fourier transform infrared spectroscopy, surface morphology, and in vitro dissolution study. The spectrophotometric method was used for the evaluation of bitter taste of EFV. The EE was found to be 37–84%. The compressed tablets were evaluated for the hardness, Friability, wetting time, disintegration time and in vitro drug release studies. This study confirmed that complexation of the drug with an ion-exchange resin can effectively mask the bitter taste of the drug in combination with production of fast dissolving tablets. © 2019, © 2019 Taylor & Francis Group, LLC.

- 32. Gao, Y.; Xi, Y.; Yang, Z.; Sasmito, A. P.; Mujumdar, A. S.; Wang, L., experimental investigation of specific heat of aqueous graphene oxide Al₂O₃ hybrid nanofluid. *Thermal Science*, 2021, 25, 515-525, DOI: 10.2298/TSCI190404381G.**

The specific heat of aqueous graphene+Al₂O₃ (1:1) hybrid nanofluid was measured using the cooling method. The influence of nanoparticle mass fraction and temperature on the specific heat capacity of the hybrid nanofluids was investigated, the specific heat of the hybrid nanofluid was compared with that of aqueous graphene oxide nanofluid and Al₂O₃ nanofluid. A fitted formula of the specific heat of the hybrid nanofluid was proposed based on the experimental data. It indicates that the specific heat reduction ratio increases with increase of nanoparticle fraction and the maximum reduction ratio is 7% at 0.15 wt.% at 20 °C. The mass fraction of nanoparticle affects the specific heat of hybrid nanofluid more significantly at lower temperature. Temperature impacts the specific heat more distinctly than the nanoparticle fraction. The specific heat increases with temperature and the maximum specific heat reduction ratio of the hybrid nanofluid diminishes from 7% at 20 °C to 2% at 70 °C at the mass fraction of 0.05%. © 2021. Society of Thermal Engineers of Serbia.

- 33. Naik, J. B.; Rajput, R. L.; Narkhede, J. S.; Mujumdar, A.; Patil, P. B., Synthesis and evaluation of UV cross-linked Poly (acrylamide) loaded thymol nanogel for antifungal application in oral candidiasis. *Journal of Polymer Research*, 2021, 28, DOI: 10.1007/s10965-020-02377-x.**

Oral candidiasis is an infection that occurs inside of the cheek and oral cavity which is very painful. Treatment of oral candidiasis is very important for its commonness and the

inadequate medication options are available for the treatment. Synthesis and evaluation of Poly (acrylamide) loaded thymol nanogel alternative for conventional creams was the main aim of this study. Polyacrylamide nanogel was synthesized from acrylamide monomer using N, N'-methylene bisacrylamide (cross-linker) and Irgacure (initiator) by UV induced cross-linking. Variation of reaction parameters such as cross-linker, initiator, light intensity, and exposure time has been used for the optimization. Nanogel characteristics were evaluated through the In vitro drug release, Ex vivo permeation study, FTIR Spectroscopy, FESEM, and antifungal activity. From the results, the drug release was found 75.47% to 99.62%, while viscosity was observed in the range of 76.68 to 34.44 cps. The contour plots show that when cross-linker concentration varied from 0.12 w/v to 0.68 w/v, viscosity was increased from 34.44 cps to 76.68 cps with respect to UV curing time. The particle size distribution of nanogel was observed from 18.17 to 142.2 nm with average particle size of 132 nm and polydispersity index 0.4. Nanogel incorporated with thymol could be a new approach for topical delivery of thymol for antifungal activity compared to conventional cream. © 2021, The Polymer Society, Taipei.

34. Pardeshi, S.; More, M.; Patil, P.; Pardeshi, C.; Deshmukh, P.; Mujumdar, A.; Naik, J., *A meticulous overview on drying-based (spray-, freeze-, and spray-freeze) particle engineering approaches for pharmaceutical technologies. Drying Technology, 2021, 39, 1447-1491, DOI: 10.1080/07373937.2021.1893330.*

Drying is an indispensable operation in the preparation of pharmaceutical powders and always remained one of the energetic tasks in the pharmaceutical industry. Improving the stability, solubility, and dissolution of pharmaceutical products are being prime objectives of the drying process, intending to produce the products in the dry state. Although there are voluminous literatures available concerning drying operations, there is scant information available regarding the applicability of drying in drug delivery and process scale-up. The current communication embodies the different particle engineering technologies of drying viz. spray-, freeze-, and spray-freeze drying. In addition, potential uses of drying in the taste masking, and the development of inhalable powders presented briefly. Recent advancements in the drying of novel drug delivery systems is the major focus of the present review. In our opinion, the commercial aspects, regulatory guidelines, and scale-up strategies presented herein provide an opportunity to readers, researchers, and

industrialists to ruin the critical issues during drying operations and aid in developing quality pharmaceutical technologies. © 2021 Taylor & Francis Group, LLC.

- 35. Khairnar, G.; Mokale, V.; Khairnar, R.; Mujumdar, A.; Naik, J., *Production of antihyperglycemic and antihypertensive drug loaded sustained release nanoparticles using spray drying technique: Optimization by Plackett Burman Design. Drying Technology, 2022, 40, 626-637, DOI: 10.1080/07373937.2020.1825292.***

Repaglinide (RPG, antidiabetic) and Diltiazem HCL (DIL, antihypertensive) loaded ethyl cellulose (EC) nanoparticles were prepared by the spray drying process using Plackett Burman Design (PBD). The amount of EC (A, mg), Methanol (B, ml), Inlet temperature (C, °C), Feed rate (D, rpm), Nozzle diameter (E, mm) and Aspiration (F, rpm) were considered independent variables while EE of RPG (Y1) and EE of DIL (Y2) were selected as dependent variables. The optimized DIL and RPG loaded EC nanoparticles were further used for the development of oral fast disintegrating sustained release tablets by direct compression method. The tablets were evaluated for weight variation, thickness, hardness, disintegration time, friability and dissolution test. FTIR study showed no chemical interaction between drug and polymer. Scanning electron microscope showed spherical as well as oval shape and discrete nature of both nanoparticles. The physical parameters of oral fast disintegrating tablets developed with optimized formulation of drug loaded nanoparticles were found within the range. Drug loaded nanoparticles as well as oral fast disintegrating tablets showed very good sustained release behavior. © 2020 Taylor & Francis Group, LLC.

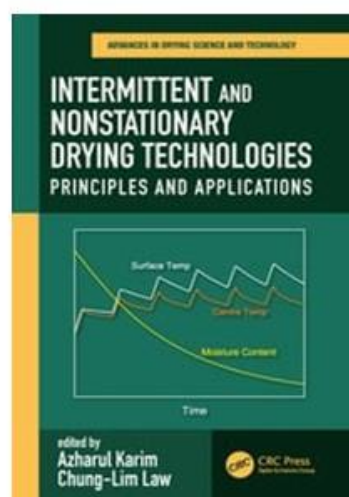
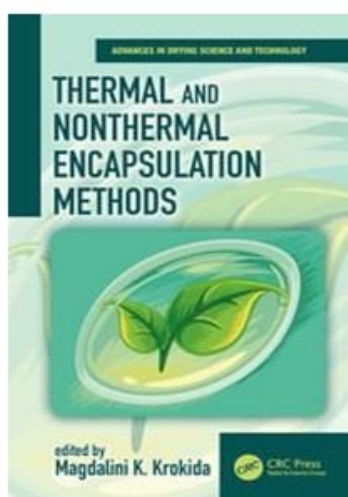
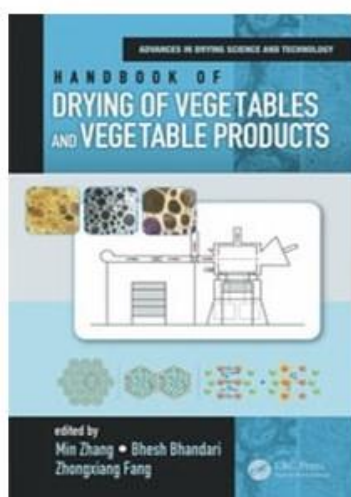
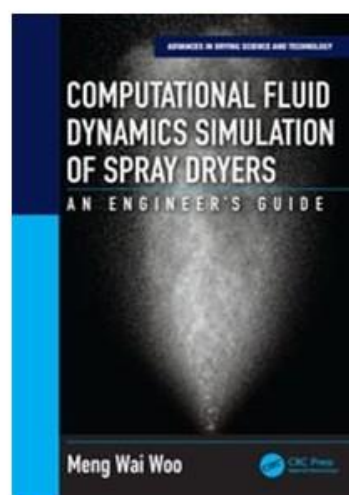
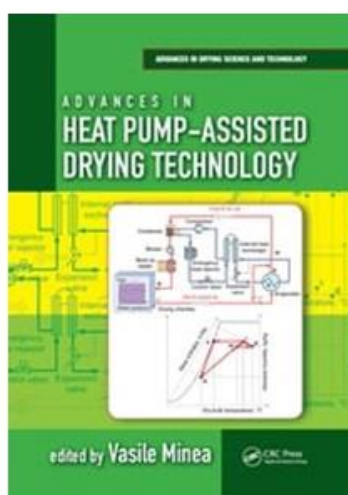
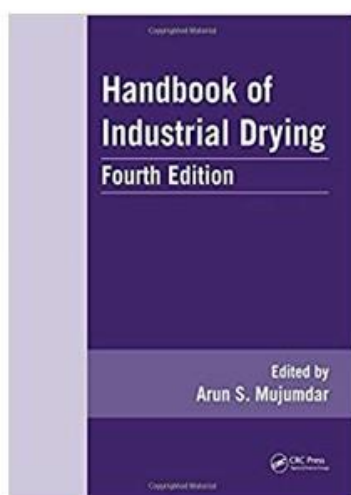


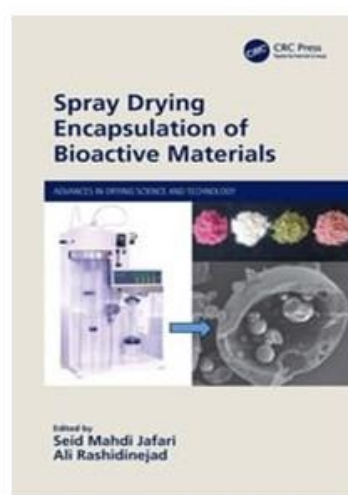
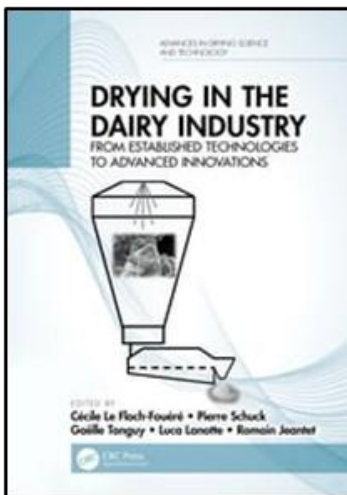
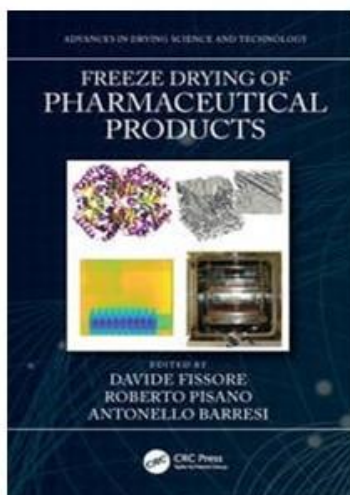
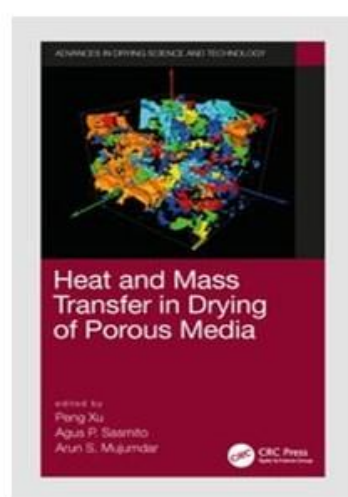
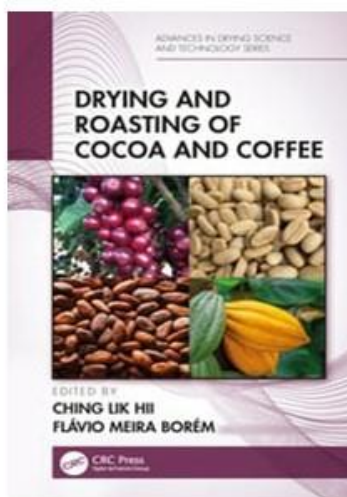
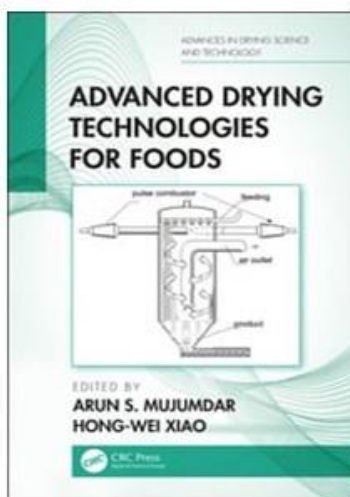
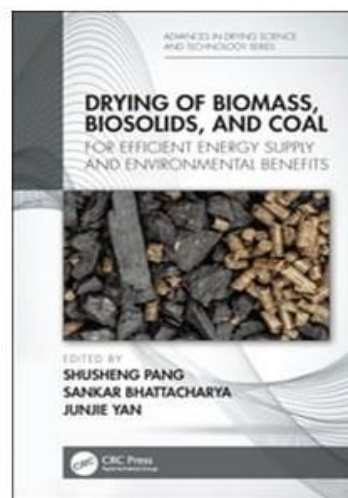
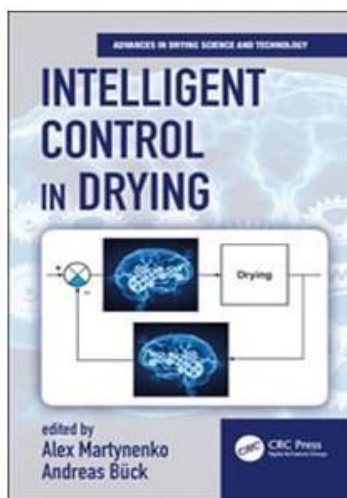
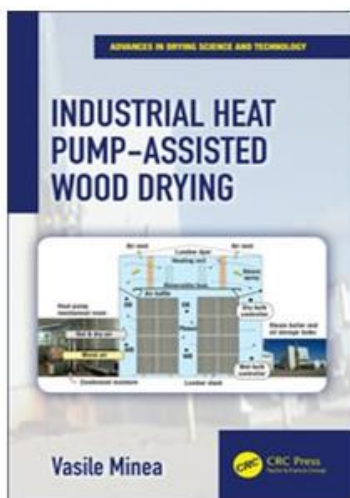
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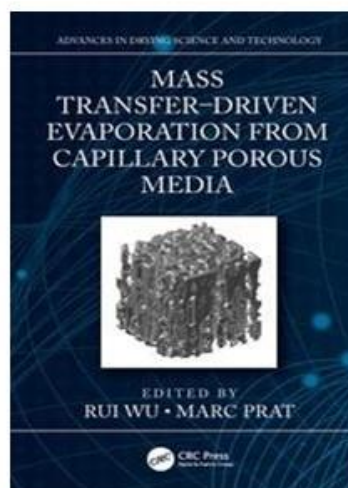
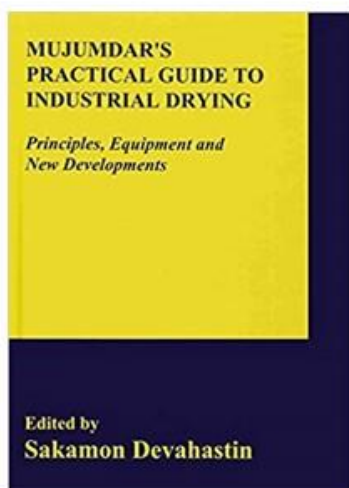
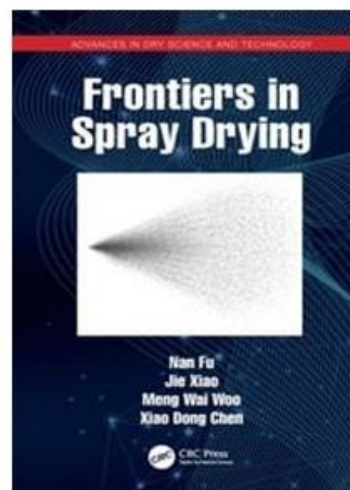
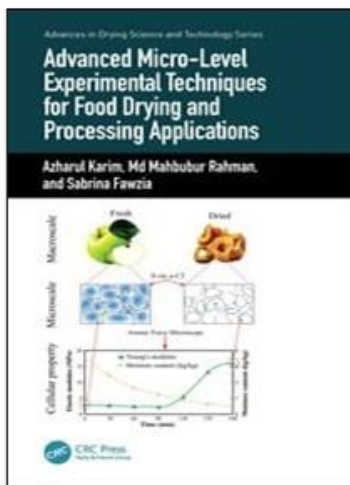
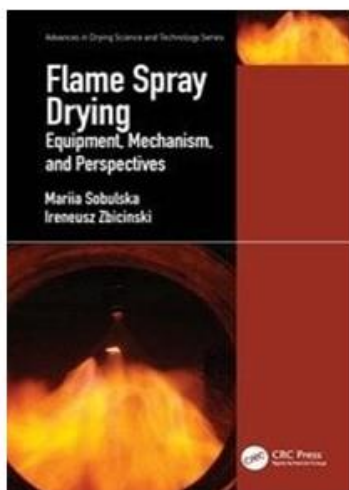
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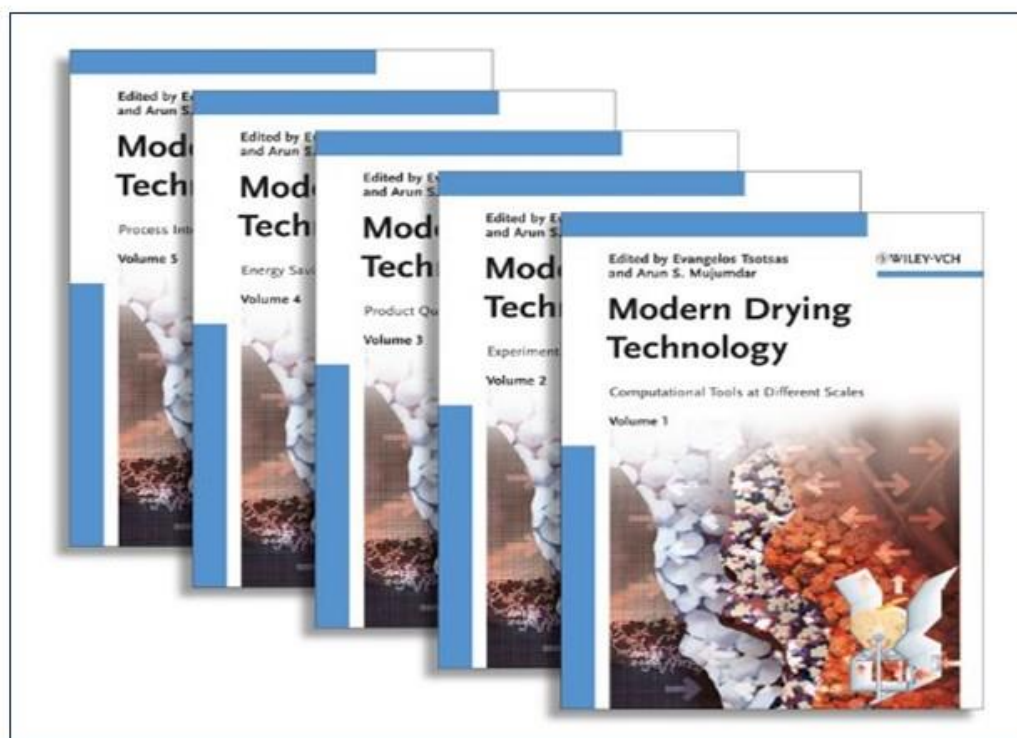
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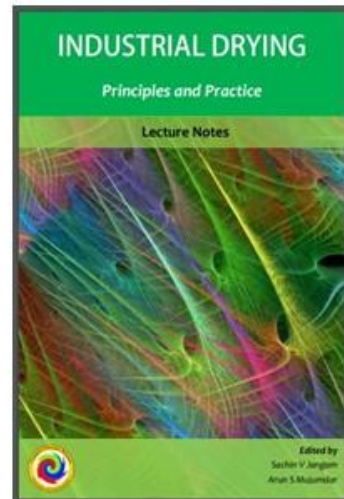
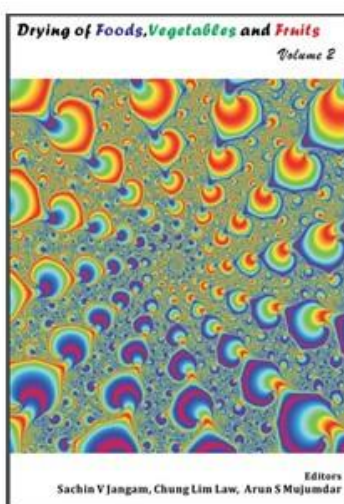
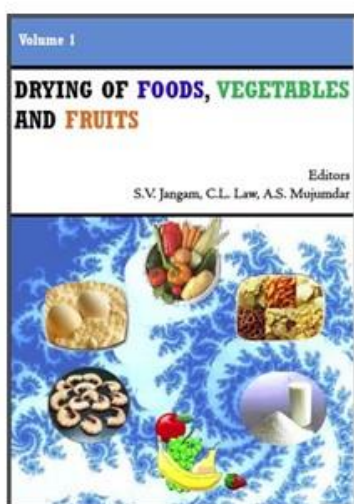


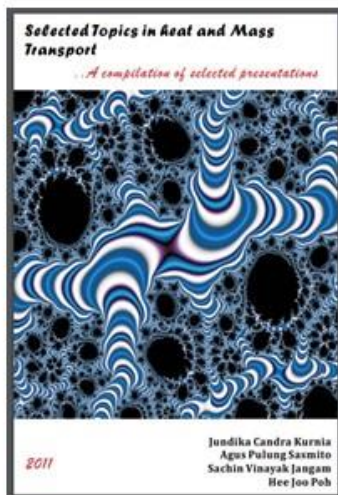
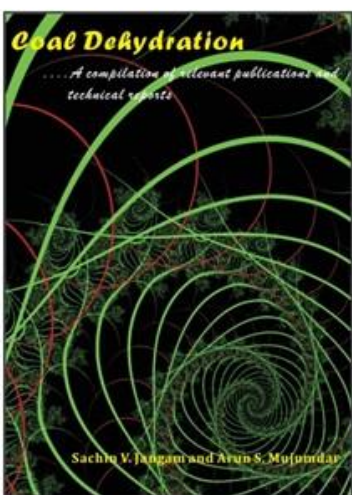
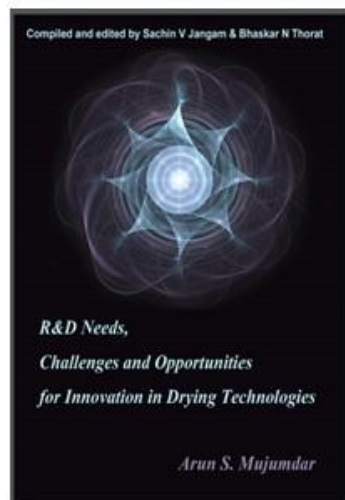
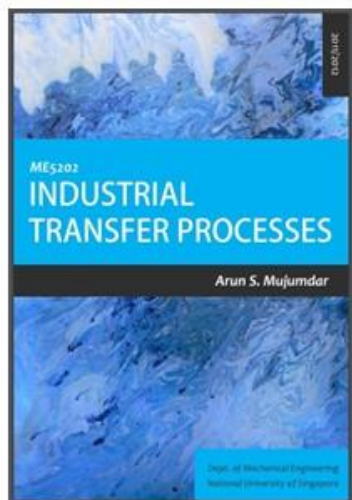
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