Dr. Ram Prakash Bharti

Post-doctoral Research Fellow
Department of Chemical and Biomolecular Engineering
University of Melbourne
Parkville 3001, Victoria, Australia
URL: http://www.geocities.com/ramprakash79

e-mail: prakashr@unimelb.edu.au
ramprakash79@yahoo.co.in
Phone: + 61 4 1377 6580 (Mobile)
+ 61 3 8344 0591 (Office)
Fax: + 61 3 8344 4153

Availability: May 15, 2009

ACADEMIC PROFILE

- **Ph.D.** *(Chemical Engineering)*. **2007.** CPI: 8.0/10

  Indian Institute of Technology (IIT) Kanpur, India.

  Ph.D. Thesis**:** "*Steady Flow of Incompressible Power-Law Fluids across a Circular Cylinder: A Numerical Study*".

  Thesis Supervisors: Prof. Raj P. Chhabra & Prof. V. Eswaran

- **M.Tech**. *(Chemical Engineering).* **2002.** CPI: 7.55/10

  Indian Institute of Technology (IIT) Bombay, India.

  M.Tech. Thesis**:** "*Monte Carlo Analysis of Molecular Weight Distribution of Vinyl Acetate Emulsion Polymers*". ***Supervisors***: Prof. H. Nanavati & Prof. K. Moudgalya

- **B.Tech**. *(Chemical Engg., Specialization in Paper Technology)*. **2000.** 69.86% (1st division)

  Sant Longowal Institute of Engineering & Technology (SLIET), Longowal, Punjab, India.

PROFESSIONAL EXPERIENCE

- May 2007 – Present: **Research Fellow – Computational Fluid Dynamics.** Department of Chemical & Biomolecular Engineering, The University of Melbourne, Australia.

  Project Title: Electroviscous effects in flow of Newtonian and non-Newtonian fluids through Microchannels.

  Supervisor: Prof. Malcolm R Davidson

- Jan 2007 – Apr 2007: **Senior Project Associate.**

  Department of Mechanical Engineering, IIT Kanpur, India

  Mentor: Prof. V. Eswaran

- Jul 2002 – Dec 2006: **Doctoral Student/Teaching Assistant.**

  Department of Chemical Engineering, IIT Kanpur, India

- Jul 2000 – Jan 2002: **Masters Student/Teaching Assistant.**

  Department of Chemical Engineering, IIT Bombay, India

FELLOWSHIPS/AWARDS

- 2007 – 2009: *Post-Doctoral Research Fellowship*. University of Melbourne, Australia.
- 2006 *Cash Award for publication* by students at IIT Kanpur, India.
- 2002 – 2006: *M.H.R.D Fellowship* during Ph.D., IIT Kanpur, India.
- 2000 – 2002: *M.H.R.D Fellowship* during M.Tech., IIT Bombay, India.

BROAD RESEARCH INTERESTS

- Microfluidics, Bio-fluidics, Bio-MEMS
- Computational fluid dynamics (CFD)
- Bluff bodies flow, Non-Newtonian fluid flow, Electrokinetic flow
- Development of algorithms for non-Newtonian flow simulation

RESEARCH GUIDANCE

M. Tech. Thesis (Supervised with main thesis supervisor Prof. R.P. Chhabra, IIT Kanpur)

- Flow past circular and elliptical cylinders: A numerical study. (P. Sivakumar, 2006)
- Flow over two circular cylinders in a tandem configuration: Drag and heat transfer. (Rahul C. Patil, 2007)
- Momentum and heat transfer from a cylinder to power-law fluids in the unsteady flow regime. (Vijaya K. Patnana, 2008)
- Mixed convection from a cylinder to power-law liquids. (Avadhani T. Srinivas, 2008)

CURRENT RESEARCH

Research fields: Microfluidics, CFD, Non-Newtonian fluids. **Tools being used**: Finite volume and finite difference methods, FORTRAN and Parallel programming, Linux clusters, Tecplot, Origin

Research overview: My current research is primarily focused on the investigation of the electroviscous effects in the pressure-driven flow of Newtonian and non-Newtonian fluids through electrically charged microfluidic devices (uniform and non-uniform microchannels) of different cross-sections by using an in-house CFD solver which is a hybrid solver based on the finite-difference and finite-volume methods. In this work, the Navier-Stokes equations (in conjunction with electrical body forces), Nernst-Planck equation and Poisson-Boltzmann equation are solved to investigate the electroviscous effects (i.e., influence of the uniformly charged microchannel wall and the Debye parameter) on the flow patterns, pressure drop and apparent viscosity in the electrolyte liquid flow at low Reynolds numbers. These relationships are germane for the design of microfluidic devices.

Ph.D. RESEARCH SUMMARY

Ph.D. Research Summary: My Ph.D. research was focused on the investigation of momentum and forced convection heat transfer characteristics from circular and elliptical cylinders immersed in power-law fluids in the steady, unconfined cross-flow regime. The appropriate forms of the momentum and thermal energy equations in conjunction with power-law fluid model were solved using an in-house CFD solver and using FLUENT. In particular, the influence of the governing parameters (Reynolds number, power-law index, Prandtl number) on the detailed (streamline, vorticity, pressure, isotherm, local Nusselt number profiles) and global (drag coefficients and average Nusselt number) characteristics was studied to gain physical

insights into the nature of flow. The numerical results were used to developed simple predictive closure relationship as a function of dimensionless parameters.

Tools Used: Finite volume method, FORTRAN, FLUENT, Tecplot, Origin, Linux PCs

RESEARCH SKILLS

- *Numerical Methods*: Finite Volume Method (FVM) and Finite Difference Method (FDM)
- *CFD solvers*: FLUENT, POLYFLOW, FVM Solvers
- *Experience* on FVM solver (Prof. Eswaran's group) for Newtonian flow in a lid-driven cavity:
    - Development of grid & Implementation of boundary conditions for cylinder flow.
    - Implementation of non-Newtonian power-law fluid viscosity model
- *Developed* FDM algorithm and code for solving the electroviscous flow of power-law fluids through microchannel.
- *Experience* on FVM solver (Prof. Davidson's group) for electrokinetic flows of Newtonian and Non-Newtonian (Power-law and Carreau models) fluids through microchannels.
- *Programming languages*: C, FORTRAN, Parallel Programming
- *Other numerical solvers*: MATLAB, MATHEMATICA, MAPLE

LIST OF PUBLICATIONS

(A) Refereed international journals: [15: Published; 0: Communicated; 2: Under preparation]

1. N. Mangadoddy, **Ram Prakash**, R.P. Chhabra and V. Eswaran. Forced convection in cross flow of power law fluids over a tube bank. *Chemical Engineering Science* 59, 2213-2222, **2004**.
2. **R.P. Bharti**, R.P. Chhabra and V. Eswaran. Steady flow of power-law fluids across a circular cylinder. *Canadian Journal of Chemical Engineering* 84, 406-421, **2006**.
3. P. Sivakumar, **R.P. Bharti** and R.P. Chhabra. Effect of power-law index on critical parameters for power-law flow across an unconfined circular cylinder. *Chemical Engineering Science* 61, 6035-6046, **2006**.
4. **R.P. Bharti**, R.P. Chhabra and V. Eswaran. A numerical study of the steady forced convection heat transfer from an unconfined circular cylinder. *Heat and Mass Transfer* 43, 639-648, **2007**.
5. **R.P. Bharti**, R.P. Chhabra and V. Eswaran. Steady forced convection heat transfer from a heated circular cylinder to power-law fluids. *International Journal of Heat and Mass Transfer* 50, 977-990, **2007**.
6. P. Sivakumar, **R.P. Bharti** and R.P. Chhabra. Steady flow of power-law fluids across an unconfined elliptic cylinder. *Chemical Engineering Science* 62, 1682-1702, **2007**.
7. **R.P. Bharti**, R.P. Chhabra and V. Eswaran. Two-dimensional steady Poiseuille flow of power-law fluids across a circular cylinder in a plane confined channel: wall effects and drag coefficients. *Industrial & Engineering Chemistry Research* 46, 3820-3840, **2007**.
8. **R.P. Bharti**, R.P. Chhabra and V. Eswaran. Effect of blockage on heat transfer from a cylinder to power-law liquids. *Chemical Engineering Science* 62, 4729-4741, **2007**.
9. **R.P. Bharti**, P. Sivakumar and R.P. Chhabra. Forced convection heat transfer from an elliptic cylinder to power-law fluids. *International Journal of Heat and Mass Transfer* 51, 1838-1853, **2008**.

10. R.C. Patil, **R.P. Bharti** and R.P. Chhabra. Steady flow of power-law fluids over a pair of cylinders in tandem arrangement. *Industrial & Engineering Chemistry Research* 47, 1660-1683, **2008**.
11. **R.P. Bharti**, D.J.E. Harvie and M.R. Davidson. Steady flow of ionic liquid through a cylindrical microfluidic contraction-expansion pipe: Electroviscous effects and pressure drop. *Chemical Engineering Science* 63, 3593-3604, **2008.** [POST-DOCTORAL RESEARCH]
12. R.C. Patil, **R.P. Bharti** and R.P. Chhabra. Forced convection heat transfer in power law liquids from a pair of cylinders in tandem arrangement. *Industrial & Engineering Chemistry Research* 47, 9141-9164, **2008**.
13. **R.P. Bharti**, D.J.E. Harvie and M.R. Davidson. Electroviscous effects in steady fully developed flow of a power-law liquid through a cylindrical microchannel. *International Journal of Heat and Fluid Flow* xx, xxxx-xxxx, in press **2009**. doi:10.1016/j.ijheatfluidflow.2009.01.012 [POST-DOCTORAL RESEARCH]
14. V.K. Patnana, **R.P. Bharti** and R.P. Chhabra. Two-dimensional unsteady flow of power-law fluids over a cylinder. *Chemical Engineering Science* xx, xxxx-xxxx, in press **2009**.
15. A.T. Srinivas, **R.P. Bharti** and R.P. Chhabra. Mixed convection heat transfer from a cylinder in power-law fluids: Effect of aiding buoyancy. *Industrial & Engineering Chemistry Research* xx, xxxx-xxxx, in press **2009**.
16. **R.P. Bharti**, D.J.E. Harvie and M.R. Davidson. Steady electroviscous flow of shear-thinning fluid through a cylindrical microfluidic contraction-expansion pipe. *Manuscript under preparation*. [POST-DOCTORAL RESEARCH]
17. V.K. Patnana, **R.P. Bharti** and R.P. Chhabra. Two-dimensional unsteady forced convection heat transfer in power-law fluid from a heated cylinder. *Manuscript under preparation*.

(B) Conference Proceedings[1]/Abstracts[2] (Presenting author*)**

1. **R.P. Bharti**, A.K. Dhiman, S.D. Dhole, R.P. Chhabra and V. Eswaran. Steady flow and forced convection heat transfer to non-Newtonian power-law fluids from heated complex geometries. *CSChE 2005: 55th Canadian Chemical Engineering Conference*, Toronto, Ontario, Canada, October 16-19, **2005**.[2]
2. **R.P. Bharti***, R.P. Chhabra and V. Eswaran. Forced convection heat transfer to non-Newtonian fluids from a heated circular cylinder. *CHEMCON 2005: 58th Annual Session of the Indian Institute of Chemical Engineers*, IIT Delhi, New Delhi, India, December 14-17, **2005**.[2]
3. P. Sivakumar, **R.P. Bharti*** and R.P. Chhabra. Steady power-law flow over a circular cylinder. *Recent Advances in Computational Mechanics and Simulations*, Vol. II, Paper No. 170, Pages 1254-1260, *Proceedings of 2nd International Congress on Computational Mechanics and Simulations (ICCMS-06)*, IIT Guwahati-781039, India, December 8-10, **2006**. (Edited by D. Maity & S. K. Dwivedy; Published by I.K. Int. Publishing House Pvt. Ltd., New Delhi, India).[1]
4. M.R. Davidson*, **R.P. Bharti**, P. Liovic and D.J.E. Harvie. Electroviscous effects in low Reynolds number flow through a microfluidic contraction with rectangular cross-section. *FMHT 2008: 5th International Conference on Fluid Mechanics, Heat Transfer and Thermodynamics*, July 4-6, **2008**. Paris, France. (*Proceedings of World Academy of Science, Engineering and Technology (PWASET)*, Volume 30, Pages 256-260, **2008.**)[1][POST-DOCTORAL RESEARCH]
5. R.C. Patil, **R.P. Bharti** and R.P. Chhabra. Forced convection in cross flow of power-law fluids over a pair of circular cylinder in tandem arrangement. *ASME Fluids Engineering Division Summer Conference (FEDSM2008), 7th Symposium on Transport Phenomena in Manufacturing Processes*, 10-14 August **2008**. Jacksonville, Florida, USA. (**Paper No.:** FEDSM2008-55056)[1]
6. **R.P. Bharti**, D.J.E. Harvie and M.R. Davidson. Fully Developed flow of power-law fluid through a cylindrical microfluidic pipe: pressure drop and electroviscous effects. *ASME Fluids Engineering Division Summer Conference (FEDSM2008), 7th Symposium on Transport*

Phenomena in Manufacturing Processes, 10-14 August 2008. Jacksonville, Florida, USA. (**Paper No.:** FEDSM2008-55128)[1][POST-DOCTORAL RESEARCH]

7. M.R. Davidson*, **R.P. Bharti** and D.J.E. Harvie. Electroviscous effects in steady flow of a shear-thinning Carreau liquid through a microfluidic contraction. *2nd South-East European Conference on Computational Mechanics (SEECCM 2009).* An IACM-ECCOMAS Special Interest Conference. M. Papadrakakis, M. Kojic, V. Papadopoulos (Eds.) Rhodes, Greece, 22-24 June 2009. [1][POST-DOCTORAL RESEARCH]

INVITED SEMINARS

- National Chemical Laboratory (NCL), Pune, India (2006).

PROFESSIONAL RECOGNITION

Reviewer for Chemical Engineering Science, Heat and Mass Transfer, Industrial & Engineering Chemistry Research, Chemeca 2008

TEACHING EXPERIENCE

- *Teaching assistant* at ***I.I.T. Kanpur***: Heat and Mass Transfer Lab (ChE391, Instructor: Prof. J. P. Gupta), Reaction Engineering Lab (ChE 491, Instructor: Prof. D. P. Rao), Process Control Lab (ChE 492, Instructor: Prof. A. Khanna), Departmental Web & Computers (Task Supervisor: Prof. V. Shankar)
- *Teaching assistant* at ***I.I.T. Bombay***: Thermodynamics (B. Tech. 2nd Yr course), Experimental and Computational Methods in Chemical Engineering (M. Tech. 1st Semester course).

INDUSTRIAL TRAINING

- Kanha Vanaspati Limited, Ujhani, Budaun, India (**4 weeks**).
- Tata Chemicals Limited (Fertilizer Division), Indradham, Babrala, Budaun, U.P., India (**6 weeks**).
- Indian Formers Fertilizers Cooperative (IFFCO) Ltd., Aonla, Bareilly, U.P., India (**6 weeks**).

OTHER ACADEMIC ACTIVITIES

- Attended a two day workshop on (Sept 1-2, 2008) "***Complex Fluids & Microfluidics Workshop 2008 (CFMW08)***" organized by Australian Society of Rheology (ASR) at RMIT University Melbourne, Australia.
- Attended the "***DST-SERC School-cum-Symposium on Rheology of Complex Fluids***" organized by Department of Chemical Engineering, IIT Kanpur, India, December 10-15, 2006.
- Organizing member of the "***CHEMFERENCE-2003***": the first annual series of seminars presented by the research scholars of the department of chemical engineering, I.I.T. Kanpur.
- Chemical engineering department web site development and maintenance at I.I.T. Kanpur.

PERSONAL PROFILE

- Date of Birth: April 07, 1979
- Nationality: Indian
- Gender/Marital Status: Male/Single
- Permanent Address: S/O Shri Mangli Lal
  V.P.O. Jhukhsa -243635, District - Budaun (U.P.), India

REFERENCES

- **Dr. Raj P. Chhabra,** *Professor*
  Department of Chemical Engineering
  Indian Institute of Technology Kanpur-208016, India
  E-mail: chhabra@iitk.ac.in, rpc1953@yahoo.com
  Tel.: +91-512-2597393; Fax: +91-512-2590104
  URL: http://www.iitk.ac.in/che/rpc.htm

- **Dr. Vinayak Eswaran,** *Professor*
  Department of Mechanical Engineering
  Indian Institute of Technology Kanpur-208016, India
  E-mail: eswar@iitk.ac.in
  Tel.: +91-512-2597429; Fax: +91-512-2597408
  URL: http://home.iitk.ac.in/~eswar/

- **Dr. Malcolm R. Davidson,** *Associate Professor*
  Department of Chemical and Biomolecular Engineering
  The University of Melbourne, Parkville 3010, VIC, Australia
  E-mail: m.davidson@unimelb.edu.au
  Tel.: + 61 3 8344 6615; Fax: +61 3 8344 4153
  URL: http://www.chemeng.unimelb.edu.au/people/staff/davidson.html

I hereby declare that all the information furnished above is true to the best of my knowledge and belief.

(**Ram Prakash Bharti**)