BIODATA

1. Name: Dr. Raghunath Anant Mashelkar

2. Date of Birth: 01.01.1943

3. Present Position

CSIR.Bhatnagar Fellow,
National Chemical Laboratory
Pashan Road, Pune – 411 008, India
President, Global Research Alliance

4. Positions held:

- Director General, Council of Scientific & Industrial Research, New Delhi, INDIA, (1995-2006)
- Director, National Chemical Laboratory, Pune, INDIA (1989-1995)
  Scientist in Director's Grade, National Chemical Laboratory, Pune, INDIA (1986-1989)
- Deputy Director, National Chemical Laboratory, Pune, INDIA (1978-1986)
- Asstt. Director, National Chemical Laboratory, Pune, INDIA (1976-1978)
- Lecturer in Chemical Engineering, University of Salford, UK (1970-1976)
- Leverhume Research Fellow, Department of Chemical Engineering, University of Salford, UK (1969-1970)
- Director General, Indian Council of Agricultural Research, New Delhi (13 Nov. 2000 to 24 Dec., 2000) (Additional Charge).

5. Academic Qualifications: B.Chem. Engg. (1966), Ph.D. (1969) (Univ. of Bombay)

6. Honorary Doctorates in Science and Engineering:

- Symbiosis International University (2010)
- Mahatma Gandhi Kashi Vidyapith, Varanasi (2009)
- University of Goa (2009)
- Lucknow University, Lucknow (2007)
- Deendayal Upadhyay Gorakhpur University, Gorakhpur (2007)
- Sri Venkateswara University, Tirupati (2006)
- Visva Bharati, Santiniketan (2006) D.Lit. *(Desikottama)*
- Mohanlal Sukhadia University, Udaipur (2006)
- Guru Nanak Dev University, Amritsar (2005)
- Maharishi Dayanand University, Rohtak (2005)
- Govind Ballabh Pant University of Agriculture & Technology, Pantnagar (2004)
- Narendra Deva University of Agriculture & Technology, Faizabad (2004)

- University of Kalyani, Kalyani (WB) (2004)
- M.S. University of Baroda, Varodara (2003)
- University of Allahabad, Allahabad (2002)
- University of Wisconsin, USA (2002)
- Banaras Hindu University, Varanasi (2002)
- Tilak Maharashtra Vidyapeeth, Pune (2002)
- University of London, UK (2001)
- Pretoria University, Pretoria, South Africa (2000)
- Anna University, Chennai (2000)
- Guwahati University, Assam (2000)
- Bundelkhand University, Jhansi (2000)
- University of Delhi, Delhi (1998)
- Indian School of Mines, Dhanbad (1997)
- University of Roorkee, Roorkee (1997)
- University of Kanpur, Kanpur (1995)
- University of Salford, UK (1993)

7. Civilian Honours by President of India:

- Padmashri (1991)
- Padmabhushan (2000)

8. Election to Prestigious Academies and Scientific Bodies *(India and Abroad)*:

- Foreign Fellow, Australian Academy of Technological Sciences and Engineering (ATSE) (2008)
- Fellow, Royal Society of Chemistry, Cambridge, UK (2006)
- Foreign Associate, US National Academy of Sciences, USA (2005)
- Fellow, Indian Association for the Cultivation of Science, Kolkata (2005)
- President, Indian National Science Academy (2005-2007)
- President, Materials Research Society of India (2004-06)
- President, Institution of Chemicals Engineers, UK (2007-08)
- Foreign Associate, National Academy of Engineering, USA (2003)
- Fellow, Royal Society (FRS), London (1998)
- General President, Indian Science Congress (1999-2000)
- Fellow, World Academy of Art & Science, USA (2000)
- Fellow, The Institute of Physics, London (1998)
- Fellow, Institute of Electronics and Tele-communication Engineers (IETE) (1998)
- Foreign Member, Royal Academy of Engineering, UK (1996)

- Fellow, UK Institute of Chemical Engineering (1996)
- Fellow, Third World Academy of Sciences (1994)
- Fellow, Indian National Science Academy (1984).
- Fellow, Indian Academy of Sciences (1983).
- Fellow, Maharashtra Academy of Sciences (1985).
- Fellow, National Academy of Engineering (1987).
- Fellow, National Academy of Sciences (1989).
- Fellow, Indian Institute of Chemical Engineers (1992)
- President, Physical Sciences, National Academy of Sciences (1991).
- President, Maharashtra Academy of Sciences (1991-94).
- President, Society for Polymer Science in India (1986-92).
- President, Indian Society of Rheology (1986-93).
- Vice-President, Materials Research Society of India (1993-95)
- Vice-President, Indian Academy of Sciences (1995-2000)
- Foreign Fellow, Australian Academy of Technological Sciences and Engineering (ATSE) (April 2008)

9. Awards:

A. For Scientific Research:

- Asutosh Mookherjee Memorial Award (2005) by Indian Science Congress Association;
- The TWAS medal (2005) by TWAS, the Academy of Sciences for the Developing World;
- Life Time Achievement Award (2004) by Indian Science Congress Association;
- Life Time Achievement Award (2003) by Bundelkhand University for contributions in advancement for chemical sciences;
- Hari Om Ashram Prerit Senior Scientist Award (2002) by Physical Research Laboratory, Ahmedabad;
- Shanti Swarup Bhatnagar Medal (2001) by Indian National Science Academy, New Delhi;
- Shanti Swarup Bhatnagar Award (2001) by Indian Science Congress Association, Calcutta;
- Material Scientist of the Year Award (2000), by Materials Research Society of India;
- Mehendra Lal Sircar Lecture Award in Chemical Sciences (1998) by Indian Association for the Cultivation of Science, Calcutta;
- Kamal Kumari National Award for Science & Technology (1997) by Kamal Kumari Foundation, Jorhat;

- Goyal Prize (1996) by Goyal Foundation, Kurukshetra;
- Raj Kristo Dutt Memorial Award (1995) Indian Science Congress Association;
- GD Birla Award for Scientific Research (1993);
- Professor Santappa Silver Jubilee Award (1983) by Society of Polymer Science, Chennai;
- Shanti Swarup Bhatnagar Prize (1982) for engineering sciences by CSIR, New Delhi;
- Herdillia Award for 'Excellence in Basic Research' (1982) by Indian Institute of Chemical Engineers, Calcutta.

B. For Technology & Industrial Research:

- World Federation of Engineering Organisations (WFEO) Medal of Engineering Excellence (2003) by WEFO, Paris
- A.V. Rama Rao Research Foundation Award (2003) by AVRA Laboratories Pvt. Ltd., Hyderabad;
- RMK Engineering Award for outstanding work in Science & Technology (2003) by Lakshmikanthammal Educational Trust, Tiruvallur, Chennai;
- Bharat Ratna Dr. M. Visvesvaraya Memorial Award (2002) by Engineers Foundation, Kolhapur;
- JEPPIAR Educational Trust Award (2001) by Jeppiar Trust, Chennai;
- H.K. Firodia Award (2000) by H.K. Firodia Foundation, Pune;
- Atur Sangtani Award (1998) by Atur Foundation, Pune;
- Durga Prasad Khaitan Memorial Gold Medal (1996) by Asiatic Society, Calcutta;
- National Research Development Corporation (NRDC) Republic Day Award (1995);
- OP Bhasin award (1991) by Bhasin Foundation, Delhi;
- Pandit Jawaharlal Nehru National Award in Engineering & Technology (1991) by Govt. of Madhya Pradesh;
- Vishwakarma medal (1988) by Indian National Science Academy;
- Federation of Indian Chamber of Commerce and Industry Award (1987) in physical and mathematical sciences;
- KG Naik Gold Medal in research in chemical sciences (1985);

C. For Leadership:

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- IIFA Ben Gurion Award (2009) for contributions in Science & Technology

- Punyabhushan Award (2008) for contributions in Science & Technology
- Rajiv Gandhi Life Time Achievement Award (2007) by Rajiv Rural Development Foundation, Tirupati.
- Life Time Achievement Award (2007) by Indore Management Association, Indore.
- Life Time Achievement Award (2006) by BioSpectrum;
- Life Time Achievement Award (2006) by Hi-Tech Pune-Maharashtra;
- Life Time achievement Award (2006) by Suryadatta Group of Institutes, Pune
- Baroda Sun Award (2005) by Bank of Baroda, Mumbai
- Lakshmipat Singhania – IIML National Leadership Award (2004) by Indian Institute of Management, Lucknow
- Lal Bahadur Shastri National Award (2002) by Lal Bahadur Shastri Institute of Management for Excellence in Public Administration and Management Sciences.
- IMC Juran Quality Medal (2002) by Indian Merchants Chamber for leadership and continuous involvement as a role model for improvement of quality in CSIR;
- HRD Excellence Award (2002) in the CEO (Non-Corporate) Category by National HRD Network, Birla Management Corporation Ltd., Mumbai;
- Golden Jubilee Award (1998) by Bank of India, Mumbai for excellence in R&D management;
- JRD Tata Award for Corporate Leadership (1998) by All India Management Association for exemplary leadership provided to CSIR.

D. For All Round Excellence:

- Inaugural BP Lecture, Judge Business School, University of Cambridge (2010)
- ETH Presidential Lecture at French Academy of Sciences, (2007) Zurich.
- Star of Asia Award (2005) of Business Week (USA)
- Maharashtra Bhushan Award (2005) by Government of Maharashtra, Mumbai for contributions to science and technology;
- Qimpro Award for Quality Evangelist (2003) by Qimpro Foundation, Mumbai
- Devi Ahilya National Award (2003) by Shri Ahilyotsava Samiti, Indore for contribution towards development in the scientific and industrial fields;
- ASSOCHAM New Millennium Innovation Award (2003) by Associated Chamber of Commerce for excellence in innovation;

- Maharashtra Bhushan Award (2003) by Maharashtra Times, Mumbai for all round excellence;
- Shraddhanand Award (2003) by Brahman Sabha, Mumbai for excellence in research;
- Shiromani Award (2002) for outstanding achievements in the field of science and commitment to national progress and human welfare
- Dadabhai Naoroji Memorial Award (2002) by the Dadabhai Naoroji Memorial Prize Trust, Mumbai for contributions to advancing S&T in India;
- Priyadarshani Global Award (2002) by Priyadarshani Academy, Mumbai for promoting S&T;
- Lifetime Achievement Award (2001) by Chemtech Foundation for all time lifetime achievement ;
- Abhimanshreemurti (Person of Pride) Award (1999) by Chaturang Foundation, Mumbai for being one of the leading National Role Models;
- Shri Guruji Puraskar (1998) Jankalyan Samiti, Pune for protecting India's traditional knowledge;
- Lifetime Achievement Award (1998), Indian Analytical Instruments Association for lifetime achievement;
- UDCT Diamond Award (1994) by Department of Chemical Technology, Mumbai;
- UDCT Outstanding Alumni Medal (1985) as one of the twenty outstanding performers from UDCT in fifty years.

10. Professorships (Honorary & others) etc.:

- Visiting Professor at Laboratory of Nanomedicine, Harvard University, Boston (2010)
- Sir Louis Matheson Distinguished Visiting Professor, Monash University, Australia (2007,2008,2009,2010)
- Visiting Professor at the Harvard/MIT, Boston (2007,2008)
- Honorary Professor, Banaras Hindu University (2005 -)
- Honorary Professor, Jawaharlal Nehru Centre for Advancement of Scientific Research (1990-)
- GP Kane Professor, University of Bombay (1990).
- Fellow, University Department of Chemical Technology (1992).
- Fellow, University of Salford, UK (1992-93);
- Visiting Professor, University of Delaware, USA (1975-76);
- Visiting Professor, Technical University of Denmark, Lyngby (1982)
- Honorary Visiting Professor, University of Pune (1985-86).

- Visiting Professor, University of Delaware, USA (1988)
- Visiting Fellow, University of Bombay (1985).
- UGC National Lecturer in Engineering and Technology (1985).

11. Board of Directors of Companies

- IKP Centre for Technologies in Public Health (ICTPH) (2009-)
- Reliance Industries Ltd. (2007-)
- Tata Motors Ltd. (2007-)
- Reliance GeneMedix (2008-) also Chairman
- ICICI Knowledge Park (1999-09)
- Thermax Limited (2008-)
- Indigene Pharmaceuticals Ltd. (2008-)
- Piramal Life Sciences Ltd.. (2008-).
- Hindustan Unilever Ltd. (2008-)
- KPIT Cummins InfoSystems Ltd. (2008-)
- Director on the Board of Sakal Papers Ltd. (2008-)
- IKP Centre for Technologies in Public Health (ICTPH) (2009-) also Chairman
- GenNext Ventures Pvt. Ltd (2010 -) also Chairman

12. Chairmanship/Membership of National Level High-Powered Committees/Bodies:

- Member, World Economic Forum's Global Agenda Council on Emerging Technologies (2009-)
- Chairman, Thermax Innovation Council (2008-)
- Chairman, Reliance Innovation Council (2007-).
- Chairman, National Innovation Foundation (2000-)
- Chairman, Marico Innovation Foundation (2005-)
- Member, Scientific Advisory Board, VTT, Finland (2007-09)
- Chairman, Committee on Reorganisation of Indian Council of Agricultural Research (ICAR) set up by Union Minister of Agriculture, Govt. of India (2005)
- Chairman, Task Force on Recombinant Pharma Sector constituted by the Government of India, Ministry of Environment & Forests, New Delhi (2004)
- Chairman, Expert Committee on 'A Comprehensive Examination of Drug Regulatory Issues, including the problem of Spurious Drugs' by Government of India (2003)
- Chairman, National Quality Council of India (2002-2006)
- Chairman, Scientific Advisory Committee on Hydrocarbons, Ministry of Petroleum & Natural Gas (2002)

- Chairman, National Auto Fuel Policy (2001)
- Chairman, Governing Body, National Institute of Pharmaceuticals Education and Research (2001-)
- Chairman, National Innovation Foundation (2000-)
- Chairman, Drugs and Pharmaceuticals Research Committee, Government of India (2000)
- Member, Board of Governors of National Council for Applied Economic Research (2001 -)
- Member, Governing Body, Indian Council for Research on International Economic Relations (2001-)
- Member, Prime Minister's Knowledge Task Force (2000)
- Chairman, High Powered Review Committee to review Regional Engineering Colleges (RECs) (1998)
- Chairman, Inquiry Committee for MGCC Accident, Government of India (1990)
- Member, Scientific Advisory Committee to the Cabinet (1997-1999)
- Member, Technology Development Board (1995-2002)
- Member, Science Advisory Council to the Prime Minister (1988-90), (2004-2006)
- Technical Assessor to one Man Inquiry Commission to Inquire into Bhopal Tragedy, Govt. of Madhya Pradesh (1984)

13. International Bodies/Committees:

- I-20 Global Innovation Leaders, San Francisco, USA (2009)
- Member, External Research Advisory Board, Microsoft, USA. (2007-) .
- Member, Scientific Advisory Board, Microsoft, India (2007-).
- Vice Chairman, Commission on Intellectual Property Rights, Innovation and Public Health, WHO (2004)
- Chairman, CSIR (South Africa) International Review Committee (2003)
- Member of the Committee of Third World Academy of Sciences (TWAS) in Engineering Science and Technologies (2003)
- One Man Committee to review WIPO's World Wide Academy (2003)
- Member, Research Advisory Committee, Department of Chemistry, Imperial College of Science & Technology, UK (2003)
- Member, Consultative Group on Agricultural Research (CGIAR) Working Group on Science Council, World Bank (2002)

- Member, Review of Chemistry Research in UK Universities (2002)
- Advisor, Development Gateway's Knowledge Economy, World Bank, USA (2002)
- Member, International Commission on Intellectual Property Rights, UK (2001)
- Member, Review Committee, Chemical Engineering Department, University of Cambridge, UK (2001)
- Member, Board of Trustees, Medicine for Malaria Venture, Geneva (2001)
- Chairman, Innovation in Developing World Committee, Third World Academy of Sciences, Trieste (2000)
- Member, Advisory Board, World Wide Academy (WIPO), Geneva (1999-)
- Member, Review Committee, Commonwealth Science Council, London (1998)
- Chairman, Standing Committee on Information Technology (WIPO), Geneva (1998)
- Member, CSIR (South Africa) International Review
- Committee (1997)

14. Original contributions to Scientific and Industrial Research

Overall Contributions

Mashelkar has made some path-breaking contributions in transport phenomena in and thermodynamics of swelling, superswelling and shrinking polymers, modelling of polymerisation reactors, and engineering analysis of non-Newtonian flows. His exceptional leadership has transformed CSIR, world's largest chain of national laboratories engaged in industrial R&D. In post-liberalised India, Mashelkar has been the dominant force in shaping the direction of S&T in India.

Swelling, Superswelling and Shrinking Polymers: Transport & Thermodynamics

Mashelkar made the first molecular level interpretation of volume phase transitions in stimuli responsive gels through his Lattice Fluid Hydrogels Bonding models. These studies led to an understanding of the role of the subtle hydrophilic-hydrophobic balance in determining these transitions and also in molecular tailoring of these intelligent gels. Mashelkar's original contributions, the first time ever, include biomimetic switching hydrogels (gelzymes), the discovery of molecular recognition induced macroscopic reversible morphological transitions and the discovery of self-healing phenomena in gels.

Sensitivity, selectivity, mobility, memory, self-organization, self-healing and enzyme like activity are some of the attributes of living materials. Synthetic hydrogels have been considered as potential candidates for mimicking life. Among these, it was Mashelkar, who demonstrated self-organization, self-healing & enzyme like activity for the first time.

Mashelkar's studies on lifetime of a dissolving polymeric particle are pioneering. The phenomenon of particle size independent dissolution in polymeric systems and the crucial role of reptation dynamics was demonstrated for the first time. His contribution to the interpretation of

the phenomenon of unusual retardation and enhancement in polymer dissolution is pathbreaking, since he was the first to show the crucial role of disengagement dynamics in dissolution, for which he provided a direct evidence through some probing in-situ NMR experiments. Later, he showed the critical role of disengagement dynamics in other macromolecular transport processes.

Engineering Analysis of Non-Newtonian Flows

Mashelkar has contributed to the understanding of diverse phenomena of interest to engineers in rheologically complex fluids. These cover laminar secondary flows, turbulent flows, free convection and particle motion and deformation.

He investigated the motion and deformation of bubbles, drops and solid spheres in rheologically complex fluids. His original contributions include the discovery of the phenomenon of delayed separation in non-Newtonian fluids, an original experimental discovery of the presence of dual wakes behind spheres moving in elastic liquids, anomalous wake formation in liquid drops and a new concept of 'elastic boundary layer' to explain some anomalous visco-elastic flows.

Role of energetic networks in non-Newtonian Flows

Mashelkar developed the Energetically Crosslinked Transient Network (ECTN) Model, where the role of transient network formed by hydrogen bonds and its distinct difference from the physical networks was explicitly taken into account. He provided the direct evidence of the different character of such networks by doing in situ Rheo-NMR experiments. The application of this model has resolved anomalies, which had baffled analysts for over three decades. These included double stress overshort, time dependent terminal velocities, unusually long restoration times in particle motion in viscoelastic media, etc.

The role of such energetic interactions in phase separation in flowing polymeric fluids was analysed to propose the concept of deformation induced hydrophobicity for the first time. Further, the use of such energetic interaction based networks was made to create shear stable clusters of drag reducers.

His unified transient network models for analysing the wall-slip problem have opened up new vistas. His pioneering work on role of convective constraint release is the first ever direct molecular level interpretation of the wall-slip phenomenon.

Modelling of Industrial Polymerisation Reactors

Mashelkar modelled the entire process of industrial polymerisation of polyethylene terephthalate (PET). Many new important insights into the complex behaviour were obtained. The process of melt polycondensation of PET is accompanied by a desorption of a number of volatile side products accompanied by a series of reversible reactions. This diffusion - reaction problem poses conceptual as well as numerical difficulties in modelling. An apparently anomalous observation of the enhancement of polycondensation rate with increased side reactions, which had remained unexplained so far, was resolved. New strategies for enhancing productivity in industrial reactors emerged as a result of this work. This work has wide ranging impact globally on both theory and practice of polycondensation reactors.

15. Leadership in Science and Technology

1. As Director of National Chemical Laboratory (NCL) in 1989-1995, Mashelkar gave a new orientation to NCL's research programmes with strong emphasis on globally competitive technologies and international patenting. This was done even before India liberalised and opened up in 1991. NCL began exporting its knowledge even to Europe & USA, the first Indian laboratory to do so. India is becoming a global R & D platform now, with over 100 companies setting up their R & D centres in India, the largest being General Electric (2400 employees); their R & D Centre was stimulated by the success of the NCL partnership. Mashelkar created a polymer science and engineering division from scratch in NCL, rated as world class today.

2. As Director General of CSIR (38 laboratories and 22,000 employees), which is the largest chain of industrial R & D labs, conceived & successfully led the process of transformation of CSIR. His white paper **"CSIR 2001: Vision & Strategy"** set up a new agenda. The story of the transformation of CSIR has been internationally acknowledged. Its appreciation by the Indian business world, has been captured as a cover page story by Business India in 1998 and also in 'World Class in India', a book brought out by Penguin, which has ranked CSIR among the top twelve organisations, who have managed the radical change the best in post-1991 India. [www.csir.res.in]

3. Has played a pivotal role in framing India's national S & T policies in the post liberalization (post-1991) era. Has also contributed widely to restructuring and reforms in education, S & T institutions and industry, both nationally and internationally through several committees that he has chaired.

4. Mashelkar was responsible for creating a 'national movement' on IPR. His contributions have been varied.

    - Played a crucial role in creating patent awareness in Indian institutions, industry and the government for more than a decade. CSIR's IPR Management Policy (1996) resulted in CSIR occupying the first position in PCT filings (shared with Samsung) among all the developing nations in 2002. CSIR alone had 40% share of the US patents granted to Indians in 2002

    - As a member of the International IPR Commission set up by UK Government and also as a member of the World Wide Academy of WIPO, played a crucial role in creating a balanced view of IP in development.

    - As the first Chairman of SCIT of WIPO (1998-99) played an important role in piloting the 20 million US dollars WIPONET project benefiting the developing world and in framing the 'SCIT *vision of the Twentyfirst Century*'.

5. Another major contribution has been his efforts to recognise the role of traditional knowledge systems and integrating them with modern knowledge systems. Some key contributions are:

    - Mashelkar spearheaded the challenge of the successful revocation of the US patent on wound healing properties of *turmeric* (USP 5,401,5041) in 1996 and chaired the Technical Committee to challenge the revocation of the US patent on *Basmati rice* (USP 5,663,484) by Ricetec Company, Texas. The turmeric case was pathbreaking, since it was the first revocation of a US patent based on traditional knowledge in the third world.

    - Made a case at WIPO for treating traditional knowledge on par with industrial property systems, and successfully articulated the case for a Traditional Knowledge Digital Library (TKDL). Spearheaded the process, which ultimately is leading to the change of International Patent Classification System to include traditional knowledge. Such initiatives are likely to bring a better understanding between the developing and the developed world.

    - Set up the National Innovation Foundation to acknowledge and reward the grass root innovators. This has become a major movement spreading to other developing countries also.

RESEARCH PUBLICATIONS OF R.A. MASHELKAR

Sr. No.	Title	Author	Reference
1.	Absorption with Reaction in Bubble Columns	M.M. Sharma R.A. Mashelkar	Pirie J.M.(Ed) Inst.Chem. Eng. (London), Symp. Ser.,1968,p.10
2.	Mass Transfer in Plate Columns	M.M. Sharma R.A. Mashelkar	Brit.Chem.Eng., 1969, **1** ,70
3.	Mass Transfer in Bubble and Packed Bubble Columns	R.A. Mashelkar M.M. Sharma	Trans.Instn.Chem. Engrs.,1970, **48**,T162
4.	Bubble Columns	R.A. Mashelkar	Brit.Chem.Eng., 1970, **15**, 1297
5.	Extrapolation Procedures for Zero Shear Viscosity with a Falling Sphere Viscometer	V. Subbaraman R.A. Mashelkar J. Ulbrecht	Rheol.Acta, 1971,**10**, 429
6.	Mixing Times in Newtonian and Non-Newtonian Fluids	D.E. Ford R.A. Mashelkar J. Ulbrecht	Process Techn. Int., 1972, **17**, 803
7.	Determination of Material Parameters of Viscoelastic Fluids by Rotational Non-Viscometric Flows	R.A. Mashelkar D.D. Kale J.V. Kelkar J. Ulbrecht	Chem.Eng.Sci., 1972, **27**, 973
8.	On the Rotational Visco-elastic Flows Around Simple Bodies and Agitators	J.V. Kelkar R.A. Mashelkar J. Ulbrecht	Trans.Instn.Chem. Engrs., 1972, **50**, 343
9.	Drag Reduction in Dilute Polymer Solutions	J.V. Kelkar R.A. Mashelkar	J.Appl.Polym.Sci., 1972, **16**, 3047
10.	Gas Absorption in Falling Non-Newtonian Films	V.V. Chavan R.A. Mashelkar	Chem.Eng. J., 1972, **4**, 223
11.	On the Scale-up Method for Power Consumption in Creeping Flow Regime	J.V. Kelkar R.A. Mashelkar	Chem.Eng.Sci., 1973, 28, 664
12.	Drag Reduction in Rotational Visco-elastic Boundary Layer Flows	D.D. Kale R.A. Mashelkar J. Ulbrecht	Nature 1973, **242**, 29
13.	Drag Reduction in External Rotational Flows	R.A. Mashelkar	AIChE J., 1973,**19**, 382
14.	A Rotating Sphere Viscometer	J.V. Kelkar R.A. Mashelkar	J. Appl. Poly. Sci. 1973,**17**, 3069
15.	Solid Dissolution in Falling Films of Pseudoplastic Fluids	R.A. Mashelkar V.V. Chavan	J. Chem.Eng., Japan, 1973,**5**, 160

16.	Friction Factors for a Tube Rotating around its own Axis	R.A. Mashelkar G.V. Devarajan	Can.J.Chem.Eng., 1973, **51**, 390
17.	Applicability of Axial Dispersion Model for Non-Newtonian Laminar Flow Tubular Reactors	R.A. Mashelkar	Can.J.Chem.Eng., 1973, **51**, 613
18.	Solution of the Problem of Gas Absorption in Falling Films of Non-Newtonian Fluids by Orthogonal Collocation Technique	R.A. Mashelkar V.V. Chavan N.G. Karanth	Chem.Eng.J., 1973, **6**, 75
19.	Interpretation of Normal Stress Differences in Polymer Solutions and Melts	M. Soylu R.A. Mashelkar J. Ulbrecht	Rheol.Acta, 1974, **13**, 216
20.	Mass Transport in Visco-elastic Boundary Layer Flows around a Rotating Disc: Significance in Diffusion Coefficient Measurement	R.A. Mashelkar	Int.J.Heat and Mass Transfer, 1974, **17**, 367
21.	High Speed Agitation of Non-Newtonian Fluids: Influence of Elasticity and Fluid Inertia	D.D. Kale R.A. Mashelkar J. Ulbrecht	Chemie Ing. Tech., 1974, **46**, 69
22.	Diffusion in Flowing Films of Dilute Polymeric Solutions	R.A. Mashelkar M. Soylu	Chem.Eng.Sci., 1974, **29**, 1089
23.	Hydrodynamic Entrance Region Flow of Pseudo-plastic Fluids: A Simplified Theory	R.A. Mashelkar	Proc.Instn. Mech.Engrs. 1974, **188**, 683
24.	Viscoelastic Laminar Boundary Layer Flow Around a Rotating Disc	D.D. Kale R.A. Mashelkar J. Ulbrecht	Rheol.Acta., 1975, **14**, 631
25.	Convective Diffusion from a Non-Uniformly Distributed Source in Flowing Blood	R.A. Mashelkar C.V. Venkatasubra-manian	Appl.Sci.Res., 975, **30**, 321
26.	Rotational Flows of Non-Newtonian Fluids (1): Turbulent Flow of Inelastic and Visco elastic Fluids Around Discs	R.A. Mashelkar D.D. Kale J. Ulbrecht	Trans.Instn. Chem.Engrs., 1975, **53**, 143
27.	Rotational Flows of Non-Newtonian Fluids (2): Torque Suppression with Agitators	R.A. Mashelkar D.D. Kale J. Ulbrecht	Trans.Instn. Chem. Engrs. 1975, **53**, 150
28.	Axial Dispersion Model Calculations for Gas Absorption with Surface Resistance	R.A. Mashelkar P.A. Ramachandran	Chem.Eng. J., 1975, **2**, 87
29.	Axial Dispersion Model Analysis of Homogeneous-Heterogeneous Reactions in a Tubular Reactor	P.A. Ramachandran R.A. Mashelkar	Letters in Heat and Mass Transfer, 1975, **2**, 213

30.	A New Model for Hollow Fibre Enzyme Reactor	R A. Mashelkar P.A. Ramachandran	J. Appl.Chem. Bio-Tech., 1975, **25**, 867
31.	Longitudinal Dispersion in Circulation Dominated Bubble Columns	R.A. Mashelkar P.A. Ramachandran	Trans.Instn. Chem.Engrs., 1975, **53**, 274
32.	Homogeneous Reactions in Turbulent Flows	P.A. Ramachandran R.A. Mashelkar	Chem.Eng.J., 1976, 11, 73
33.	Comments on the Strength of Polymeric Composites Containing Spherical Fillers	L. Nicolais R.A. Mashelkar	J.Appl.Polym. Sci., 1976,**20**, 561
34.	Secondary Flows of Non-Newtonian Fluids (1): Laminar Boundary Layer Flow of a Generalized Newtonian Fluid in a Coiled Tube	R.A. Mashelkar G.V. Devarajan	Trans.Instn. Chem.Engrs., 1976, **54**, 100
35.	Secondary Flows of Non-Newtonian Fluids (2): Frictional Losses in Laminar Flow of Visco elastic Fluids Through Coiled Tube	R.A. Mashelkar G.V. Devarajan	Trans.Instn. Chem.Engrs., 1976, **54**, 108
36.	Torque Suppression in Mechanically Agitated Multiphase Liquid Systems	A. Quraishi R.A. Mashelkar J. Ulbrecht	J.Non-Newtonian Fluid, Mech., 1976, **1**, 223
37.	Flow of Inelastic and Visco-elastic Fluids Past a Sphere (1): Drag Co- efficient in Creeping and Boundary Layer Flows	A. Acharya R A. Mashelkar J. Ulbrecht	Rheol.Acta., 1976, **15**, 454
38.	Flow of Inelastic and Visco-elastic Fluids Past a Sphere (2): Anomalous Separation in the Viscoelastic Fluid Flow	A. Acharya R.A. Mashelkar J. Ulbrecht	Rheol.Acta., 1976, **15**, 454
39.	Gas-Liquid Contactors in Non-Newtonian Technology	R.A. Mashelkar	Chem.End. Develop., 1976, **10** (9),17
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List of Patents

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26. An improved process for the micro-encapsulation of active ingredients in polymers
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27. An improved process for micro encapsulation of active ingredients in polymers
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28. A process for the preparation of polymeric adsorbents
    VP Joshi, MG Kulkarni, RA Mashelkar
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29. A process for the preparation of thermoprecipitating affinity polymers
    AA Vaidya, BS Lele, MG Kulkarni, RA Mashelkar
    (Patent No. 216559/IN)