Curriculum Vitae

1. **Full name and date**
   - Saxén, Henrik
   - male
   - April 12, 2018

2. **Date and place of birth, nationality, current residence**
   - Turku, Finland, 06.11.1959
   - Finnish
   - Heernummentie 228, FI-21500 Piikkiö, Finland

3. **Education and degrees awarded**
   - M. Sc. (Chem. Eng.), ÅA, 1983
   - Doctor of technology (Chem. Eng.), ÅA, 1988
   - Docent in Process simulation and knowledge-based applications in heat engineering, ÅA, 1991-1997

4. **Linguistic skills**
   - Swedish, mother tongue
   - Finnish, English: Fluent
   - German: Basic

5. **Positions**
   - Professor in Heat Engineering, 1.9.1997-, Åbo Akademi University (ÅA)
   - Adjunct Professor, Shanghai University, 2017-
   - Assistant Professor in Heat Engineering 1.1.1990-31.8.1997, ÅA
   - Acting Associate Professor in Heat Engineering and Process Design 1.8.1988-31.12.1989, ÅA
   - Assistant Professor in Heat Engineering 1.9.1987-31.7.1988, ÅA
   - Assistant in Heat Engineering 25.11.1983-31.8.1987, ÅA
   - Assistant in Process Control 1.6-31.8.1982, ÅA

6. **Research funding as well as leadership and supervision**
   - Numerous national projects funded by the Academy of Finland, Tekes and industry. Recent major projects: *Energy and lifecycle Efficient Processes*, FIMECC (2010-14, 550 k€), *Systems Integrated Metals Processing*, FIMECC (2014-17, 550 k€), *Efficient Energy Use*, CLEEN (2012-2016, 900 k€), *Computationally Intensive Signal Processing for Multi-scale Modeling and Control with Application to Metallurgical Processes* Academy of Finland (AF), (2010-2012, 340 k€), *Hidden Potential for Gross Reduction in the Energy Demand and Emissions in Steelmaking*, AF (2008-2011, 300 k€)
   - European programs under European Coal and Steel Community (ECSC), later Research Fund for Coal and Steel (RFCS): *Above Burden and In Burden Probe Data Interpretation By Neural Network Based Model to Improve Blast Furnace Control* (1999-2002), *Optimisation of sinter plant operating conditions and BF burden material resources using multivariate statistics* (2000-2003), *Investigation of accretion formation in the blast furnace shaft* (2000-2003), *Enhanced blast furnace operation and service life by improved monitoring and control of the hearth and uniformity* (2003-2007), *Improvement of hearth drainage efficiency and refractory life for high BF productivity and well adjusted PCI rate at varying coke quality* (2007-2010),

Optimizing Blast Furnace Hearth Inner State (2015-2019), and *Online Blast Furnace Stack Status Monitoring* (2016-2020).

- Recent projects with foreign companies: POSCO, South Korea (2007-2012), Tata Steel, India (2008-2009), Larsen & Toubro, India (2011-2014) and Tata Steel Europe (2016-2019).
- Main supervisor of post-doc researchers: Dr. Tom Fredman (2001-2003), Dr. Johnny Brännbacka (2004-2006), Dr. Jarmo Söderman (2007-2012), Dr. Mikko Helle (2009-), Dr. Lei Shao (2013-2014), Dr. Yaowei Yu (2013-2014), and Dr. Hamid Ghanbari (2014-2015).
- Supervision of doctoral students (with year of graduation): Tom Fredman (2001), Mats Nikus (2001), Jan Hinnelä (2002), Matias Waller (2003), Johnny Brännbacka (2004), Anette Rothberg (co-supervisor, 2004), Jarmo Söderman (2007), Jukka Heinonen (2007), Mikko Helle (2009), Niklas Engblom (2012), Yaowei Yu (2013), Lei Shao (2013), Hannu Helle (2014), Hamid Ghanbari (2014), Carl-Mikael Wiklund (2016) and Tamoghna Mitra (2016).
- Ongoing supervision of doctoral students: Alice Bittante, Göran Henriksson (part-time), Carl Haikarainen, Alia Joko (co-supervised by Hannu Toivonen), Markéta Mikolajková, Debanga Nandan Mondal, Mauricio Roche and Weiqiang Liu.
- Supervision of more than 80 Master's theses.

7. Merits in teaching and pedagogical competence

- Planning, implementing and lecturing courses at ÅA, including Introduction to Chemical Engineering 1988-1996, 2005, Refrigeration Technology 988, 1990, Transport processes 1989, Basic Fluid Mechanics 1989, 1990, Optimization, partly 1988-, yearly 1997-1999, Simulation 1997-2001, Thermodynamics 1997-2004, 2007-, Engineering Thermodynamics and Modeling/Principles of Process Engineering, 2009-, Advanced AI Methods/Neural Networks, 1991-, New Energy Technologies, 2014-.
- Many short-term courses on thermodynamics, heat transfer, mathematical modelling and ironmaking at other universities and technical training companies (INSKO/AEL, POHTO).

8. Awards, prizes and honours

- Per Brahe science award (1991)

9. Other academic merits

- Head of the Thermal and Flow Engineering Laboratory (former Heat Engineering Laboratory), ÅA, 1997-.
- Dean, Faculty of Chemical Engineering, ÅA, 1998-2000.
- Vice Rector, research, ÅA, 2006-2009.
- Board member: Faculty/Dept. of Chemical Engineering (deputy 1990-1991, member 1998-2005, deputy 2010-2012), ÅA (1998-2000, 2006-2009), Outokumpu Foundation (member/deputy 2003-2010), Forestcluster Ltd. (2008-2009), Runar Bäckström's foundation (2007-2010), Centrum Balticum (2008-2010, deputy 2011-), NORDTEK's executive subcommittee (2008-2011), Walter Ahlström's foundation (2012-), Tekniikan Edistämis-säätiö (2016-) and deputy member in the Fortum Foundation (2016-).
- Member of Audit group of the Quality assurance system of Helsinki University of Technology (2006-2007) and Tampere University of Technology (2013-2014), numerous committees within the own university and faculty and in Nordic steelmaking R & D groups.
- Director of the Graduate School in Chemical Engineering (2015-).
- Opponent (external reviewer at defense) of licentiate theses: Daniel Widlund (RIT, 1998) and Maria Swartling (RIT, 2009). (List of abbreviations at the end of the paragraph.)
- Pre-examiner of licentiate theses: Markku Sillanpää, Knut Ringbom, Anette Rothberg, Adebayo Otaru (ÅA 1993, 1994, 1996 and 1997) and Timo Aittokoski (UJ, 2006).

- Examiner ("opponent") at public defense of doctoral theses: Carl Erik Grip (LTU, 1998), Guangqing Zuo (LTU, 2000), Kalevi Raipala (HUT, 2003), Willemijn Husslage (TUD, 2004), Matti Luomala (OU, 2004), Mikael Larsson (LTU, 2007), Patrik Wikström (RIT, 2007), Sanni Eloneva (AU, 2009), Jari Ruuska (OU, 2012), Abraham Muwanguzi (RIT, 2013), Allert Adema (TUD, 2014), Maria Johansson (LIU, 2014), Shan Yu (AU, 2014), Timo Kulju (OU, 2014), Antti Kemppainen (OU, 2015), Antti Arasto (AU, 2015), Mats Brämming (LTU, 2016), Moshen Saffari Pour (RIT, 2016) and Mehdi Hasan (LUT, 2016).
- Pre-examiner/committee member of doctoral theses: Anders Mårtensson (LU, 1995), Gregor Schmitz (US, 1999), Pekka Savolainen (LUT, 2002), Willemijn Husslage (TUD, 2004), Matti Luomala (OU, 2004), Lena Sundqvist Ökvist (LTU, 2004), Joel Gustavsson (RIT, 2004), Subrata Pal (IIS/Bg, 2005), Subhrangshu Moitra (IIT/Kgp, 2007), Amitabh Shankar (RIT, 2007), Golap Mohammad Chowdhury (IIT/Kgp, 2007), Sari Siitonen (AU, 2009), Nawzad Mardan (LIU, 2012), Zhe Tan (RIT, 2013), Maria Lundberg (LTU, 2013), Allert Adema (TUD 2014), Nashrin Sultana (IIEST, 2016) and Kwbena A. Pambour (UG, 2018).
- Referee for positions as University Lecturer in Chemical Engineering and Research Assistant in Process Metallurgy (LTU, 1996 & 2001), two Lecturers in Energy Technology (AU, 2013) and Lecturer in Chemical Engineering (AU, 2015), Lecturer and Senior Lecturer in Chemical Engineering (AU, 2018), Senior Research Fellow in Reduction Metallurgy and Circular Economy (OU, 2016), Docents in (Process) Metallurgy (HUT, 2002, OU 2006, 2009), Sustainable Process Design (AU, 2013), Energy Technology (UV, 2015) and Radiative Heat Transfer in Energy Conversion Processes (LUT, 2016), Adjunct Professors in Reduction Metallurgy (RIT, 2000) and Energy Engineering (LTU, 2010 & 2012), Associate Professor in Process Metallurgy (LTU, 2016). Professor in Bioprocess Technology (OU, 1999), Professor in Sustainable Production of Iron Raw Materials (LTU, 2010), acting Professor in Energy and Environmental Engineering (AU, 2012), Professor (tenure) in Energy Technology for Communities (AU, 2012) and Professor (tenure) in Materials Science and Engineering (AU, 2016). Member of committee for preparation of two tenure positions in Energy Technology & Combustion (AU, 2012-2013, 2013-2014) and in Metallurgical Thermodynamics (AU, 2017).
- Referee of applications to the Academy of Finland (several), Energimyndigheten (Sweden, 2004, 2007, 2014, 2015), Norges Forskningsråd (Norway, 1997, 2006), the National Research Foundation of South Africa (2000), the Knowledge Foundation (Sweden, 2005), the Austrian Research Promotion Agency (FFG, 2009, 2010 & 2011), Science Foundation Ireland (SFI, 2012), National Center of Science and Technology Evaluation, Kazakhstan (2014), Fonds National de la Recherche Luxembourg (2015), the Estonian Research Council (2015) and STW, the Netherlands (2017).
- Member of Scientific Board/Advisory Committee of Econova (Sweden, 2004-2005) and PRISMA/Swerea MEFOS (Sweden, 2007-).
- Member of many international scientific/program committees and referee for papers in conferences on iron- and steelmaking, energy, soft computing and automation, recently including International Conference of Science and Technology of Ironmaking (Cleveland, OH, 2015), Symposium on Sustainable Iron and Steelmaking (in conjunction with the Conference of Metallurgists (COM 2015)), Toronto, 2015, 8th International Conference on Modelling and Simulation of Metallurgical Processes in Steelmaking, Toronto, 2019 (SteelSim2019).
- Member of the Editorial Board of *ISRN Materials Science* (2011-2013) and the International Advisory Board of *ISIJ International* (2013-2016), Editorial board of *Heliyon* (2017-). Guest editor (with T. Ariyama, T. Inada and C.H. Gao) of a special issue of *ISIJ International* on "Recent Progress in Modeling, Data-processing and Control of Ironmaking Process", 2010, and (with Z. Gao and C.H. Gao) of a special issue of *IEEE Transactions on Industrial*

Informatics on "Data-driven Approaches for Complex Industrial Systems", 2013. Reviewer of 40 papers annually in about 60 journals, mainly in chemical and metallurgical engineering, energy and soft computing.

- Recent invited keynote/plenary lectures at conferences: "Process Integration in Iron and Steel Industry - Some Examples", *International Process Integration Jubilee Conference*, Gothenburg, Sweden (2013), "Evolution of Charging Programs for Optimal Burden Distribution in the Blast Furnace", *KomPlasTech*, Zakopane, Poland (2013), "Reduction of CO_2 Emissions in Steelmaking by Process Integration", *International Conference on Smart Carbon Saving and Recycling for Ironmaking,* Hayama, Japan (2013), "Simulation and diagnosis of blast furnace drainage and hearth conditions", *International Workshop on Iron and Steelmaking*, Bangalore, India (2014), and "Investigation of burden distribution in the blast furnace", *6th Biennial Baosteel Academic Conference*, Shanghai, China (2015) and forthcoming *7th Biennial Baosteel Academic Conference*, Shanghai, October 2018.

Abbreviations: **Finland:** ÅA: Åbo Akademi University, AU: Aalto University, HUT: Helsinki University of Technology, LUT: Lappeenranta University of Technology, OU: Oulu University, UJ: University of Jyväskylä, UV: University of Vaasa. **Sweden:** LIU: Linköping University, LTU: Luleå Technical University, LU: Lund University, RIT: Royal Institute of Technology. **The Netherlands**: TUD: Technical University of Delft, UG: University of Groningen. **India:** IIS/Bg: Indian Institute of Science, Bangalore, IIT/Kgp: Indian Institute of Technology, Kharagpur, IIEST: Indian Institute of Engineering Science and Technology, Shibhur. **South Africa:** US: University of Stellenbosch.

10. Scientific and societal impact of research

- About 150 journal and 300 conference publications. Google Scholar statistics, April 2018: 2950 citations, h-index: 30, i10 index: 87.
- Some selected papers:
  ° F. Pettersson, N. Chakraborti, H. Saxén, A genetic algorithms based multi-objective neural net applied to noisy blast furnace data, Applied Soft Computing 7 (2007) 387-397.
  ° H. Saxén, F. Pettersson, Nonlinear prediction of the hot metal silicon content in the blast furnace, ISIJ International 47 (2007) 1732-1737.
  ° J. Torrkulla, H. Saxén, Model of the state of the blast furnace hearth, ISIJ International 40 (2000) 438-447.
  ° F. Pettersson, A. Biswas, P.K. Sen, H. Saxén, N. Chakraborti, Analyzing leaching data for low-grade manganese ore using neural nets and multiobjective genetic algorithms, Materials and Manufacturing Processes 24 (2009) 320-330.
  ° D.N. Mondal, K. Sarangi, F. Pettersson, P.K. Sen, H. Saxén, N. Chakraborti, Cu-Zn separation by supported liquid membrane analyzed through multi-objective genetic algorithms, Hydrometallurgy 107 (2011) 112-123.
  ° Y. Yu, H. Saxén, Experimental and DEM study of segregation of ternary size particles in a blast furnace top bunker model, Chemical Engineering Science 65 (2010) 5237-5250.
  ° F. Pettersson, H. Saxén, K. Deb, Genetic algorithm-based multicriteria optimization of ironmaking in the blast furnace, Materials and Manufacturing Processes 24 (2009) 343-349.
  ° B.K. Giri, F. Pettersson, H. Saxén and N. Chakraborti, "Genetic programming evolved through bi-objective genetic algorithms applied to a blast furnace", Materials and manufacturing Processes 28 (2014) 776-782.
  ° S. Datta, F. Pettersson, S. Ganguly, H. Saxén, N. Chakraborti, Designing high strength multi-phase steel for improved strength-ductility balance using neural networks and multi-objective genetic algorithms, ISIJ International 47 (2007) 1195-1203.

List of Publications

Henrik Saxén
August 2016

Journal Publications

1. Westerlund T. and H. Saxén, "On the Uniqueness in Equilibrium Calculations", *Chemical Engineering Science* **42** (1987) 188-190.

2. Westerlund, T. and H. Saxén, Authors reply to comments by R.A. Heidemann, *Chemical Engineering Science* **42** (1987) 2797-2799.

3. Saxén, H., "Blast Furnace On-Line Simulation Model", *Metallurgical Transactions B* **21B** (1990) 913-923.

4. Gustafsson, S., G. Henriksson and H. Saxén, "Parametric Optimization of a Paper Machine Heat Recovery System", *Industrial & Engineering Chemistry Research* **29** (1990) 2252-2257.

5. Bulsari, A.B. and H. Saxén, "A feed-forward artificial neural network for system identification a chemical process", *Journal of Systems Engineering* **1** (1991) 13-21.

6. Bulsari, A.B. and H. Saxén, "System identification of a biochemical process using feed-forward neural networks", *Neurocomputing* **3** (1991) 125-133.

7. Bulsari, A.B. and H. Saxén, "System identification using the symmetric logarithmoid as an activation function in a feed-forward neural network", *Neural network world* **1** (1991) 221-224.

8. Bulsari, A.B, A. Medvedev and H. Saxén, "Sensor fault detection using state vector estimator and feed-forward neural networks applied to a simulated biochemical process", *Acta Polytechnica Scandinavica, Chemical Technology and Metallurgy Series* **199** (1991) 1-20.

9. Bulsari, A. and H. Saxén, "Feed-forward neural networks with a continuum of nodes", *Journal of Systems Engineering* **2** (1992) 27-33.

10. Bulsari, A.B. and H. Saxén, "Implementation of a Chemical Reactor Selection Expert System in an Artificial Neural Network", *Engineering Applications of Artificial Intelligence* **5** (1992) 113-119.

11. Bulsari, A.B., A. Kraslawski and H. Saxén, "Continuous steel casting diagnostic fuzzy expert system in an artificial neural network", *Scandinavian Journal of Metallurgy* **21** (1992) 146-150.

12. Bulsari, A.B., H. Saxén and A. Kraslawski, "Fuzzy Simulation by an Artificial Neural Network", *Engineering Applications of Artificial Intelligence* **5** (1992) 401-406.

13. Bulsari, A.B. and H. Saxén, "Filtering, Smoothing and Prediction for a Biochemical Process Using Feed-Forward Neural Networks", *Neural network world* **5** (1992) 511-524.

14. Bulsari, A.B. and H. Saxén, "Continuous Steel Casting Heuristics in a Feed-Forward Neural Network", *Journal of Systems Engineering* **2** (1992) 290-295.

15. Bulsari, A.B, A. Medvedev and H. Saxén, "A Sensor Fault Detection and Isolation Method", *Mathematical Modelling and Scientific Computing* **1** (1993) 318-328.

16. Bulsari, A.B. and H. Saxén, "Continuous Steel Casting Diagnostics in a Neural Network", *Modelling, Measurement & Control C* **35** (1993) 1-16, AMSE Press.

17. Bulsari, A.B. and H. Saxén, "A Neural Network Controller for a Biochemical Process", *Modelling, Measurement & Control C* **35** (1993) 17-28, AMSE Press.

18. Saxén, H. and M. Sillanpää, "A Model for Decision Support in Continuous Steel Casting", *Modelling and Simulation in Materials Science and Engineering* **2** (1994) 79-98.

19. Kuntze, T.M. and H. Saxén, "Simulation of Deep-Bed Kilning of Malt", *Industrial & Engineering Chemistry Research* **33** (1994) 321-328.

20. Saxén, H., "Short-term prediction of silicon content in pig iron", *Canadian Metallurgical Quarterly* **33** (1994) 319- 326.

21. Bulsari, A.B. and H. Saxén, "Using feed-forward neural networks for estimation of microbial concentration in a imulated biochemical process", *Biosensors and Bioelectronics* **9** (1994) 105-109.

22. Bulsari, A.B. and H. Saxén, "Filtering, smoothing and prediction for a biochemical process using neural networks", *Expert Systems: The International Journal of Knowledge Engineering and Neural Networks* **11** (1994) 159-166.

23. Bulsari, A.B. and H. Saxén, "A Recurrent Network for Modeling Noisy Temporal Sequences", *Neurocomputing* **7** (1995) 29-40.

24. Bulsari, A.B. and H. Saxén, "Classification of Blast Furnace Probe Temperatures Using Neural Networks", *Steel Research* **66** (1995) 231-236.

25. Karilainen, L., H. Saxén and K. Raipala, "Interactive control of blast furnaces", *Steel Technology International* (1995/1996) 54-60.

26. Saxén, H., "Interpretation of probe temperatures in the blast furnace using polynomial approximations", *Steel Research* **67** (1996) 73-78.

27. Saxén, B. and H. Saxén, "A Neural-Network Based Model of Bioreaction Kinetics", *Canadian Journal of Chemical Engineering* **73** (1996) 124-131.

28. Nikus, M. and H. Saxén, "On-line Model of Gas Distribution in the Blast Furnace", *Steel Research* **67** (1996) 121-126.

29. Saxén, H. and R. Östermark, "State realization with exogenous variables - A test on blast furnace data", *European Journal of Operational Research* **89** (1996) 34-52.

30. Östermark, R. and H. Saxén, "VARMAX-modelling of blast furnace process variables", *European Journal of Operational Research* **90** (1996) 85-101.

31. Saxén, H., "Nonlinear Time Series Analysis by Neural Networks: A Case Study", *International Journal of Neural Systems* **7** (1996) 195-201.

32. Nikus, M. and H. Saxén, "Prediction of a blast furnace burden distribution variable", *ISIJ International* **36** (1996) 1142-1150.

33. Saxén, H., "On the approximation of a quadratic map by a small neural network", *Neurocomputing* **12** (1996) 313-326.

34. Fredman, T.P. and H. Saxén, "Model for Temperature Profile Estimation in the Refractory of a Metallurgical Ladle", *Metallurgical and Materials Transactions B* **29B** (1998) 651-659.

35. Saxén, H., "Simplified simulation of the transient behavior of temperatures in the upper shaft of the blast furnace", *Metallurgical and Materials Transactions B* **29B** (1998) 691-697.

36. Saxén, H., M. Nikus and J. Hinnelä, "Burden Distribution Estimation in the Blast Furnace from Stockrod and Probe Signals", *Steel Research* **68** (1998) 406-412.

37. Fredman, T.P. and H. Saxén, "On A Recurrent Neural Network Producing Oscillations", *International Journal of Neural Systems* **8** (1998) 499-508.

38. Fredman, T.P., J.R.E. Torrkulla and H. Saxén, "Two Dimensional Dynamic Simulation of the Thermal State of Ladles", *Metallurgical and Materials Transactions B* **30B** (1999) 323-330.

39. Östermark, R, R. Höglund and H. Saxén, "Estimating system response to a regime shift: some evidence on international asset pricing", *Kybernetes* **28** (1999) 732-752.

40. Waller, M. and H. Saxén, "Estimating the degree of time-variance in a parametric model", *Automatica* **36** (2000) 619-625.

41. Saxén, H., L. Lassus, M. Seppänen and T. Karjalahti, "Pattern recognition and classification of blast furnace wall temperatures", *Ironmaking and Steelmaking* **27** (2000) 207-211.

42. Waller, M. and H. Saxén, "On the development of predictive models with applications to a metallurgical process", *Industrial & Engineering Chemistry Research* **39** (2000) 982-988.

43. Torrkulla, J. and H. Saxén, "Model of the state of the blast furnace hearth", *ISIJ International* **40** (2000) 438-447.

44. Hinnelä, J. and H. Saxén, "Neural network model of burden layer formation dynamics in the blast furnace", *ISIJ International* **41** (2001) 142-150.

45. Brännbacka, J. and H. Saxén, "Modeling the liquid levels in the blast furnace hearth", *ISIJ International* **41** (2001) 1131-1138.

46. Saxén, H. and M. Nikus, "On-line estimation of the ore-to-coke ratio in the blast furnace center", *ISIJ International* **42** (2002) 115-117.

47. Waller, M. and H. Saxén, "Application of nonlinear time series analysis to the prediction of silicon content of pig iron", *ISIJ International* **42** (2002) 316-318.

48. Torrkulla, J., J. Brännbacka, H. Saxén and M. Waller, "Indicators of the internal state of the blast furnace hearth", *ISIJ International* **42** (2002) 504-511.

49. Helle, M. and H. Saxén, "Identification of the combustion degree of oil in the blast furnace tuyeres", *ISIJ International* **42** (2002) 1185-1187.

50. Waller, M. and H. Saxén, "Time-variant event-internal trends in predictive modeling – Methods with applications to ladlewise analyses of hot metal silicon content", *Industrial & Engineering Chemistry Research* **42** (2003) 85-90.

51. Hinnelä, J., H. Saxén and F. Pettersson, "Modeling of the blast furnace burden distribution by evolving neural networks", *Industrial & Engineering Chemistry Research* **42** (2003) 2314-2323.

52. Pettersson, F. J. Hinnelä and H. Saxén, "Evolutionary neural network modelling of blast furnace burden distribution", *Materials and Manufacturing Processes* **18** (2003) 385-399.

53. Brännbacka, J. and H. Saxén, "Model analysis of the operation of the blast furnace hearth with a sitting and floating dead man", *ISIJ International* **43** (2003) 1519-1527.

54. Saxén, H. and J. Hinnelä, "Model for burden distribution tracking in the blast furnace", *Mineral Processing and Extractive Metallurgy Review* **25** (2004) 1-27.

55. Östermark, R, J. Aaltonen, H. Saxén. and K. Söderlund, "Nonlinear Modelling of the Finnish Banking and Finance Branch Index", *The European Journal of Finance* **10** (2004) 277-289.

56. Brännbacka, J. and H. Saxén, "Novel model for estimation of liquid levels in the blast furnace hearth", *Chemical Engineering Science* **59** (2004) 3423-3432.

57. Saxén, H. and J. Brännbacka, "Dynamic model of liquid levels in the blast furnace hearth", *Scandinavian Journal of Metallurgy* **34** (2005) 116-121.

58. Pettersson, F., H. Saxén and J. Hinnelä, "A genetic algorithm evolving charging programs in the ironmaking blast furnace", *Materials and Manufacturing Processes* **20** (2005) 351-361.

59. Brännbacka, J., J. Torrkulla and H. Saxén, "Simple simulation model of the blast furnace hearth", *Ironmaking and Steelmaking* **32** (2005) 479-486.

60. Helle, M., F. Pettersson, N. Chakraborti and H. Saxén, "Modeling Noisy Blast Furnace Data using Genetic Algorithms and Neural Networks", *Steel Research International* **77** (2006) 75-81.

61. Laitinen, P. and H. Saxén, "Data-Driven Modeling of Quality and Performance Indices in Sintermaking", *Steel Research International* **77** (2006) 152-157.

62. Saxén, H. and F. Pettersson, "Method for the selection of inputs and structure of feedforward neural networks", *Computers & Chemical Engineering* **30** (2006) 1038-1045.

63. Pettersson, F. and H. Saxén, "Model for economic optimization of iron production in the blast furnace", *ISIJ International* **46** (2006) 1297-1305.

64. Helle, M. and H. Saxén, "Simulation of the tuyere-raceway system in the blast furnace", *Ironmaking and Steelmaking* **33** (2006) 407-412.

65. Saxén, H. and F. Pettersson, "Genetic evolution of novel charging programs in the blast furnace", *Transactions of the Indian Institute of Metals* **59** (2006) 593-605.

66. Pettersson, F., N. Chakraborti and H. Saxén, "A Genetic Algorithms Based Multiobjective Neural Net Applied to Noisy Blast Furnace Data", *Applied Soft Computing* **7** (2007) 387-397.

67. Laitinen, P.J. and H. Saxén, "A Neural Network Based Model of Sinter Quality and Sinter Plant Performance", *Ironmaking & Steelmaking* **34** (2007) 109-114.

68. Saxén, H., F. Pettersson and K. Gunturu, "Evolving Nonlinear Time-Series Models of the Hot Metal Silicon Content in the Blast Furnace", *Materials and Manufacturing Processes* **22** (2007) 577-584.

69. Brännbacka, J., H. Saxén and D. Pomeroy, "Detection and Quantification of the Dead-Man Floating State in the Blast Furnace", *Metallurgical and Materials Transactions B* **37B** (2007) 443-450.

70. Datta, S., F. Pettersson, S. Ganguly, H. Saxén and N. Chakraborti, "Designing high strength multi-phase steel for improved strength-ductility balance using neural networks and multi-objective genetic algorithms", *ISIJ International* **47** (2007) 1195-1203.

71. Kodukula, S.K., and H. Saxén, "Model of the radial distributions in the upper part of the blast furnace shaft", *Steel Research International* **78** (2007) 841-846.

72. Saxén, H. and F. Pettersson, "Nonlinear Prediction of the hot Metal Silicon Content in the Blast Furnace", *ISIJ International* **47** (2007) 1732-1737.

73. Datta, S., F. Pettersson, S. Ganguly, H. Saxén and N. Chakraborti, "Identification of Factors Governing Mechanical Properties of TRIP-Aided Steel by Genetic Algorithms and Neural Networks", *Materials and Manufacturing Processes* **23** (2008) 130-137.

74. Helle, M. and H. Saxén, "Data-Driven Analysis of Sulfur Flows and Behavior in the Blast Furnace", *Steel Research International* **79** (2008) 671-677.

75. Brännbacka, J. and H. Saxén, "Model for Fast Computation of Blast Furnace Hearth Erosion and Buildup Profiles", *Industrial & Engineering Chemistry Research* **47** (2008) 7793-7801.

76. Pettersson, F., C. Suh, H. Saxén, K. Rajan and N. Chakraborti, "Analyzing Sparse Data for Nitride Spinels Using Data Mining, Neural Networks, and Multiobjective Genetic Algorithms", *Materials and Manufacturing Processes* **24** (2009) 2-9.

77. Helle, M., H. Saxén and O. Kerkkonen, "Assessment of the State of the Blast Furnace High Temperature Region by Tuyere Core Drilling", *ISIJ International* **49** (2009) 203-209.

78. Agarwal, A., F. Pettersson, A. Singh, C. Sun Kong, H. Saxén, K. Rajan, S. Iwata and N. Chakraborti, "Identification and optimization of AB2 phases using principal component analysis, evolutionary neural nets and multi-objective genetic algorithms", *Materials and Manufacturing Processes* **24** (2009) 274-281.

79. Pettersson, F., A. Biswas, P. Kumar Sen, H. Saxén and N. Chakraborti, "Analyzing leaching data for low grade manganese ore using neural nets and multi-objective genetic algorithms", *Materials and Manufacturing Processes* **24** (2009) 320-330.

80. Pettersson, F, H. Saxén and K. Deb, "Genetic-algorithm based multi-criteria optimization of ironmaking in the blast furnace", *Materials and Manufacturing Processes* **24** (2009) 343-349.

81. Toukoniitty, B., J. Wärnå, J.-P. Mikkola, M. Helle, H. Saxén, D. Yu. Murzin and T. Salmi, "Modelling of enantioselective andracemic hydrogenation of ethyl pyruvate on a Pt/Al_2O_3 catalyst in the presence of microwave irradiation", *Chemical Engineering and Processing*: *Process Intensification* **48** (2009) 837-845.

82. Helle, M., H. Saxén and O. Kerkkonen, "Data-driven analysis of results from blast furnace tuyere core drillings", *Steel research international* **80** (2009) 392-397.

83. Helle, H., M. Helle, H. Saxén and F. Pettersson, "Mathematical optimization of ironmaking with biomass as auxiliary reductant in the blast furnace", *ISIJ International* **49** (2009) 1316-1324.

84. Helle, H., M. Helle, F. Pettersson and H. Saxén, "Optimization of blast furnace operation under top gas recycling", *Journal of Iron and Steel Research International* **16** (2009) 613-618.

85. Helle, H., M. Helle, H. Saxén and F. Pettersson, "Optimization of top gas recycling conditions under high oxygen enrichment in the blast furnace", *ISIJ International* **50** (2010) 931-938.

86. Agarwal, A., U. Tewari, F. Pettersson, S. Das, H. Saxén and N. Chakraborti, "Analyzing blast furnace data using evolutionary neural network and multi-objective genetic algorithms", *Ironmaking & Steelmaking* **37** (2010) 353-359.

87. Yu, Y. and H. Saxén, "Experimental and DEM study of segregation of ternary size particles in a blast furnace top bunker model", *Chemical Engineering Science* **65** (2010) 5237-5250.

88. Helle, H., M. Helle, F. Pettersson and H. Saxén, "Multi-criteria optimization of ironmaking in the blast furnace with top gas recycling", *ISIJ International* **50** (2010) 1380-1387.

89. Helle, H., M. Helle, F. Pettersson and H. Saxén, "An optimization study of ironmaking with biomass use", *Ironmaking & Steelmaking* **37** (2010) 590-598.

90. Yu, Y., F. Pettersson and H. Saxén, "Optimization of hopper design by genetic algorithms", *Computer Methods in Materials Science (Informatyka w Technologii Materiałów)* **11** (2011) 28-33.

91. Shao, L. and H. Saxén, "A simulation study of blast furnace hearth drainage using a two-phase flow model of the taphole", *ISIJ International* **51** (2011) 228-235.

92. Mitra, T., M. Helle, N. Chakraborti, H. Saxén and F. Pettersson, "Optimization of top gas recycling conditions in the blast furnace by genetic algorithms", *Materials and Manufacturing Processes* **26** (2011) 475-480.

93. Yu, Y. and H. Saxén, "Discrete element method simulation of properties of a 3D conical hopper with mono-sized spheres", *Advanced Powder Technology* **22** (2011) 324-331.

94. Toivonen, H.T., A. Meinander, T. Asaoka, M. Westerlund, F. Pettersson, A. Mikhailov, J. E. Eriksson and H. Saxén, "Modeling reveals that dynamic regulation of c-FLIP levels determines cell-to-cell distribution of CD95-mediated apoptosis", *Journal of Biological Chemistry* **286** (2011) 18375-18382.

95. Mondal, D. N., K. Sarangi, F. Pettersson, P. Kumar Sen, H. Saxén and N. Chakraborti, "Cu-Zn separation by supported liquid membrane analyzed through multi-objective genetic algorithms", *Hydrometallurgy* **107** (2011) 112-123.

96. Shao, L. and H. Saxén, "Investigation of pressure drop in the blast furnace hearth with a sitting dead man", *ISIJ International* **51** (2011) 1014-1016.

97. Yu, Y., A. Westerlund, T. Paananen and H. Saxén, "Inter-particle percolation segregation during burden descent in the blast furnace", *ISIJ International* **51** (2011) 1050-1056.

98. Nurkkala, A., F. Pettersson and H. Saxén, "A Nonlinear Modeling Method Applied to Prediction of Hot Metal Silicon in the Ironmaking Blast Furnace", *Industrial & Engineering Chemistry Research* **50** (2011) 9236-9248.

99. Yu, Y. and H. Saxén, "Analysis of rapid flow of particles down and from an inclined chute using small-scale experiments and discrete element simulation", *Ironmaking & Steelmaking* **38** (2011) 432-441.

100. Engblom, N., H. Saxén, R. Zevenhoven, H. Nylander, G.G. Enstad and M. Murtomaa, "Effect of material properties on segregation of binary and ternary powder mixtures in a small scale cylindrical silo", *Industrial & Engineering Chemistry Research* **50** (2011) 11097-11108.

101. Ghanbari, H., M. Helle, F. Pettersson and H. Saxén, "An optimization study of steelmaking under novel blast furnace operation combined with methanol production", *Industrial & Engineering Chemistry Research* **50** (2011) 12103-12112.

102. Helle, H., M. Helle and H. Saxén, "Nonlinear optimization of steel production using traditional and novel BF operation strategies", *Chemical Engineering Science* **66** (2011) 6470-6481.

103. Engblom, N., H. Saxén , R. Zevenhoven, H. Nylander and G.G. Enstad, "Descriptive models for segregation of powder mixtures at filling and complete discharge of silos", *Powder Technology* **125-126** (2012) 104-116.

104. Wiklund, C., F. Pettersson and H. Saxén, "Optimal resource allocation in integrated steelmaking with biomass as auxiliary reductant in a blast furnace", *ISIJ International* **52** (2012) 35-44.

105. Shao, L. and H. Saxén, "Model of blast furnace hearth drainage", *Steel research international* **83** (2012) 197-204.

106. Engblom, N., H. Saxén, R. Zevenhoven, H. Nylander and G.G. Enstad, "Segregation of premixed construction materials in silos. Part 1: Experimental findings on different scales", *Particulate Science and Technology* **30** (2012) 145-160.

107. Engblom, N., H. Saxén, R. Zevenhoven, H. Nylander and G.G. Enstad, "Segregation of premixed construction materials in silos. Part 2: Identification of segregation mechanisms", *Particulate Science and Technology* **30** (2012) 161-178.

108. Yu, Y. and H. Saxén, "Effect of DEM parameters on the simulated inter-particle percolation of pellets into coke during burden descent in the blast furnace", *ISIJ International* **52** (2012) 788-796.

109. Yu, Y. and H. Saxén, "Flow of pellet and coke particles in and from a fixed chute", *Industrial & Engineering Chemistry Research* **51** (2012) 7383-7397.

110. Swartling, M., A. Tilliander, H. Saxén and P.G. Jönsson, "Interpretation of tap induced cyclic temperatures in the blast furnace lining**",** *Steel research international* **83** (2012) 695-704.

111. Engblom, N., H. Saxén, R. Zevenhoven, H. Nylander and G.G. Enstad, "Analysis of segregation data for a dry mineral-based construction materials plant", *Industrial & Engineering Chemistry Research* **51** (2012) 9427-9440.

112. Engblom, N., H. Saxén, R. Zevenhoven, H. Nylander and G.G. Enstad, "Effects of process parameters and hopper angle on segregation of cohesive ternary powder mixtures in a small scale cylindrical silo", *Advanced Powder Technology* **23** (2012) 566-579.

113. Shao, L. and H. Saxén, "Numerical prediction of iron flow and bottom erosion in the blast furnace hearth", *Steel research international* **83** (2012) 878-885.

114. Ghanbari, H., M. Helle, F. Pettersson and H. Saxén, "Steelmaking integrated with a polygeneration plant for improved sustainability", *Chemical Engineering Transactions* **21** (2012) 1033-1038.

115. Ghanbari, H., M. Helle and H. Saxén, "Process integration of steelmaking and methanol production for suppressing CO_2 emissions – A study of different auxiliary fuels", *Chemical Engineering and Processing*: *Process Intensification* **61** (2012) 58-68.

116. Nurkkala, A., F. Pettersson and H. Saxén, "A study of blast furnace dynamics using multiple autoregressive vector models", *ISIJ International* **52** (2012) 1763-1770.

117. Mitra, T., D. N. Mondal, F. Pettersson and H. Saxén, "Evolution of charging programs for optimal burden distribution in the blast furnace", *Computer Methods in Materials Science* (*Informatyka w Technologii Materiałów*) **13**(1) (2013) 99-106.

118. Wiklund, C., F. Pettersson and H. Saxén, "Optimization of a steel plant with multiple blast furnaces under biomass injection", *Metallurgical and Materials Transactions B* **44B** (2013) 447-458.

119. Shao, L. and H. Saxén, "A simulation study of blast furnace drainage using a two-fluid model", *Industrial & Engineering Chemistry Research* **52** (2013) 5479–5488.

120. Shao, L. and H. Saxén, "A simulation study of two-liquid flow in the taphole of the blast furnace", *ISIJ International* **53** (2013) 988-994.

121. Giri, B.K., F. Pettersson, H. Saxén and N. Chakraborti, "Genetic programming evolved through bi-objective genetic algorithms applied to a blast furnace", *Materials and Manufacturing Processes* **28** (2013) 776-782.

122. Haikarainen, C., F. Pettersson and H. Saxén, "An MILP Model for Distributed Energy System Optimization", *Chemical Engineering Transactions* **35** (2013) 295-300.

123. Ghanbari, H. and H. Saxén, "A Techno-Economic Analysis of Using Residual Top Gases in an Integrated Steel Plant", *Chemical Engineering Transactions* **35** (2013) 169-174.

124. Ghanbari, H., H. Saxén and I. Grossmann, "Optimal Design and Operation of a Steel Plant Integrated with a Polygeneration System", *AIChE Journal* **59** (2013) 3659-3670.

125. Yu, Y. and H. Saxén, "Particle flow and behavior at bell-less charging of the blast furnace", *Steel research international* **84** (2013) 1018-1033.

126. Shao, L. and H. Saxén, "Flow patterns of iron and slag flow in the blast furnace taphole", *ISIJ International* **53** (2013) 1756-1762.

127. Saxén, H., C.H. Gao, Z. Gao, "Data-Driven Time Discrete Models for Dynamic Prediction of the Hot Metal Silicon in the Blast Furnace – A Review", *IEEE Transactions on Industrial Informatics* **9** (2013) 2213-2225.

128. Huitu, K., H. Helle, M. Helle, M. Kekkonen and H. Saxén, "Optimization of steelmaking using FASTMET direct reduced iron in the blast furnace", *ISIJ International* **53** (2013) 2038-2046.

129. Yu, Y. and H. Saxén, "Segregation behavior of particles in a top hopper of a blast furnace", *Powder Technology* **262** (2014) 233-241.

130. Haikarainen, C., F. Pettersson and H. Saxén, "A Model for Structural and Operational Optimization of Distributed Energy Systems", *Applied Thermal Engineering* **70** (2014) 211-218.

131. Zhao, Q., Z. Shao, C.-J. Liu, M.-F. Jiang, X. Li, R. Zevenhoven and H. Saxén, "Preparation of Cu-Cr alloy powder by mechanical alloying", *Journal of Alloys and Compounds* **607** (2014) 118-124.

132. Zhao, Q., C.-J. Liu, P.-Y. Shi, B. Zhang, M.-F. Jiang, Q. Zhang, H. Saxén and R. Zevenhoven, "Sulfuric Acid Leaching of South African Chromite. Part I: Study on Leaching Behavior", *International Journal of Mineral Processing* **130** (2014) 95-101.

133. Jiang, M.-F., Q. Zhao, C-J. Liu, P.-Y. Shi, B. Zhang, H. Saxén and R. Zevenhoven, "Sulfuric Acid Leaching of South African Chromite. Part II: Optimization of Leaching Conditions", *International Journal of Mineral Processing* **130** (2014) 102-107.

134. Mitra, T. and H. Saxén, "A model for fast evaluation of charging programs in the blast furnace", *Metallurgical and Materials Transactions B* **45B** (2014) 2382-2394.

135. Mondal, D. N., S. Kallio, A. Hermanson and H. Saxén, "Length scales of solids volume fraction variations in a two-dimensional circulating fluidized bed of Geldart B particles", *Powder Technology* **269** (2015) 207-218.

136. Jokinen, R., F. Pettersson and H. Saxén, "An MILP Model for Optimization of a Small-scale LNG Supply Chain along a Coastline", *Applied Energy* **138** (2015) 423-431.

137. Saxén, H., "Drainage model of a blast furnace hearth with a low-permeability zone", *Metallurgical and Materials Transactions B* **46B** (2015) 421-431.

138. Zhao, Q., C.-J. Liu, P.-Y. Shi, B. Zhang, M.-F. Jiang, Q. Zhang, R. Zevenhoven and H. Saxén, "Sulfuric Acid Leaching Kinetics of South African Chromite", *Journal of Minerals, Metallurgy and Materials* **22** (2015) 233-240.

139. Mitra, T. and H. Saxén, "Evolution of charging programs for achieving required gas temperature profile in a blast furnace", *Materials and Manufacturing Processes* **30** (2015) 474-487.

140. Jha, R., F. Pettersson, G.S. Dulikravich, H. Saxén and N. Chakraborti, "Evolutionary Design of Nickel Based Super Alloys Using Data-driven Genetic Algorithms and Related Strategies", *Materials and Manufacturing Processes* **30** (2015) 488-510.

141. Ghanbari, H., F. Pettersson and H. Saxén, "Sustainable Development of Primary Steelmaking under Novel Blast Furnace Operation and Injection of Different Reducing Agents", *Chemical Engineering Science* **129** (2015) 208-222.

142. Murzin, D., G. Martin, C. Pereira, F. Pettersson, H. Saxen, A. Rodrigues and T. Salmi, "Combining reaction and separation in heterogeneous catalytic hydrogenation of ethylformate", *Chemical Engineering & Technology* **38** (2015) 804-812.

143. Huitu, K., M. Helle, H. Helle, M. Kekkonen and H. Saxén, "Optimization of Midrex DRI use in ore-based steelmaking", *Steel research international* **86** (2015) 456-465.

144. Zhao, Q., C.-J. Liu, M.-F. Jiang, H. Saxén and R. Zevenhoven, "Preparation of magnesium hydroxide from serpentinite by sulfuric acid leaching for CO_2 mineralization", *Minerals Engineering* **79** (2015) 116-124.

145. Ghanbari, H., F. Pettersson and H. Saxén, "Optimal operation strategy and gas utilization in a future integrated steel plant", *Chemical Engineering Research and Design* **102** (2015) 322-336.

146. Helle, M. and H. Saxén, "Operation windows of the oxygen blast furnace with top gas recycling", *ISIJ International* **55** (2015) 2047-2055.

147. Zhao, Q., C.-J. Liu, P.-Y. Shi, B. Zhang, M.-F. Jiang, Q. Zhang, R. Zevenhoven and H. Saxén, "Study of Extraction of Iron from Chromite", *Steel research international* **86** (2015) 1541-1547.

148. Mondal, D. N., S. Kallio, H. Saxén and J. Hassel, "Experimental study of cluster properties in a two-dimensional fluidized bed of Geldart B particles", *Powder Technology* **291** (2016) 420-436.

149. Haikarainen, C., F. Pettersson and H. Saxén, "A decomposition procedure for solving two-dimensional distributed energy system design problems", *Applied Thermal Engineering* **100** (2016) 30-38.

150. Wiklund, C., M. Helle and H. Saxén, "Economic assessment of options for biomass pretreatment and use in the blast furnace", *Biomass and Bioenergy* **91** (2016) 259-270.

151. Saxén, J.-E., H. Saxén and H. T. Toivonen, "Identification of switching linear systems using self-organizing models with application to silicon prediction in hot metal", *Applied Soft Computing* **47** (2016) 271-280.

152. Mitra, T. and H. Saxén, "Discrete Element Simulation of Charging Program and Mixed Layer Formation for an Ironmaking Blast Furnace", to appear in *Journal of Computational Particle Mechanics* **3** (2016).

153. Mohanty, K., T. Mitra, H. Saxén and N. Chakraborti, "Multiple criteria in a top gas recycling blast furnace optimized through a k-optimality based genetic algorithm", to appear in *Steel research international* **87** (2016).

154. Mitra, T. and H. Saxén, "Investigation of Coke Collapse in the Blast Furnace Using Mathematical Modeling and Small Scale Experiments", to appear in *ISIJ International* **56** (2016).