

CV - Leiv Kolbeinsen

Name: Leiv Kolbeinsen

Born: July 15 1949

Nationality: Norwegian

Present positions: Professor, Materials technology (Process metallurgy), Department of Materials Science and Engineering (IMA), Faculty of Natural Sciences (NV), Norwegian University of Science and Technology (NTNU).
Scientific adviser for SINTEF Mat. & Chem. – Process metallurgy. MSc (1974), PhD (1982) from NTNU (NTH).



Experience with emphasis on work related to innovation and business sector:

Professor of Materials Technology (Process metallurgy) at the Norwegian University of Science and Technology in 2000. Before that he has mainly been employed by NTH as a teaching assistant and at SINTEF Metallurgy/Materials Technology as (senior) research scientist. He has also been part time College lecturer at Trondheim College of Engineering (1984-1992) and a Visiting Scientist at Centre for Iron and Steel making Research (CISR) at Carnegie Mellon University, Pittsburgh, USA (1996-1997).

Present research activities and fields of interests

SFI (Centre for research driven innovation) Metal Production (2015 - 2023): Leader of **Research Domain 5: Materials and Society** Life Cycle and Material Flow Analysis, industry networking with a special responsibility to identify opportunities and disseminate research aspects that can attribute to the understanding of the social value of metals and how they can support a sustainable development of the society.

FME (Centre for Environment-friendly Energy Research) HighEFF (2015 - 2023) Centre for an Energy Efficient and Competitive Industry for the Future; Work-Package leader in Research Areas: RA4 Applications and RA6 Case Studies with main research on **Industrial clusters** defined as an assembly of several independent companies with agreements on the exchange of material and energy flows, such that the cluster as a whole is operating as close as possible to the optimum regarding material and energy flows and the economy.

GasMat (2008 – 2010) - & GasFerroSil-projects (2010-17): Processing of natural gas – “Where Gas Meets Ore”: The establishment of gas based industrial clusters producing materials. Through an integration of various activities/processes that are not individually large enough to develop independent solutions for landing natural gas more environmentally friendly, energy- and cost-efficient production is possible. Application of Natural Gas in the ferroalloy industry and for pre-reduction of ilmenite as well as DRI is investigated in several projects often including clusters of several industries.

CORALSEA-project (Chrome Oxide Reduction – an Atomic Level modelling and Spectrographic Experimental Approach) (2014 – 2018): The main objective of CORALSEA is to describe how surfaces of various chrome-containing oxides differ electronically, structurally and chemically, and how these differences manifest themselves in different reaction patterns with methane.

CarboMat Project: Carbon Materials Science; **DISvaDRI_Project:** Production of value added Direct Reduced Iron; **ROMA- and FUME-projects:** Optimization of Raw Materials' Properties and Process Operation to Minimize Losses of Materials and Exergy

International collaboration & Membership in academic and professional committees:

Luleå Technical University (Sweden), MEFOs (Sweden), The Royal Institute of Technology (Sweden), Helsinki University of Technology (Finland), RWTH Aachen (Germany), University of New South Wales (Australia), University of British Columbia (Canada), University of Alberta (Canada), and Carnegie Mellon University (USA).

Board member – Norwegian Ferroalloy Producers Research Organization (FFF), Member of Work Group 1 (WG1) “Profit through Innovation” of the European Steel Technology Platform (ESTEP).
Leiv Kolbeinsen has also been serving on the Program board of NRC “Effective Energy Technology

in Industry” (1992-1995). Norwegian Association of Standards Technical Support Group for ISO TC/207 SC4 Environmental Performance Evaluation EPE (1995-1998), and TMS - The Minerals Metals & Materials Society ASM Materials Life-Cycle Analysis Committee (1995-1999).

Recent and Present doctoral students supervised:

1. Kim Andre Johnsen: “Sorption enhanced steam reforming of methane – Investigation of potential sorbents and reactor concepts for continuous hydrogen production”
2. Jafar Safarian: “Reaction mechanisms and reaction kinetics of selected forms and qualities of solid carbon in contact with MnO-containing silicate slags”
3. Dongju Zhao: “Processing, properties and performance in use of direct reduced iron pellets containing added material to control steel structure”
4. Stian Seim: “Slag properties and phase relations in the Ti-industry”
5. Stephen Lobo: “Reduction of Ilmenite with Natural Gas”
6. Vincent Canaguier: “Reduction of chromite ore by methane”
7. Rune Hagberg Stana: “Solidification of Titanium Slags and the Influence on Post Processing”

Selected academic and professional publications:

1. Monsen, Bodil E.; Olsen, Sverre E.; Kolbeinsen, Leiv. Prereduction of oxidized magnetite. Scandinavian journal of metallurgy 1995;24:28-38
2. G. Tranell, T. Hagelien, L. Kolbeinsen, A. Dahlstedt and M. Hallin, "Results and Visualisation from the First Campaign in LKAB's Experimental Blast Furnace in Lulea, Sweden", *Proceedings of the 59th Ironmaking Conference*, 2000, Pittsburgh, PA, ISS Warrendale, pp. 125-136.
3. Chung, Yongsug; Jimbo, Itaru; Sharan, Alok; Kolbeinsen, Leiv; Byrne, M.; Cramb, Alan. Dynamic interfacial phenomena in liquid steel-slag systems. Belton Memorial Symposium; 10.01.2000 - 11.01.2000
4. Brandvoll, Øyvind; Kolbeinsen, Leiv; Olsen, Niklas; Bolland, Olav. Chemical Looping Combustion - reduction of nickel oxide - nickel aluminate by hydrogen [Presentation]. ICheaP-6, The Sixth Italian Conference on Chemical and Process Engineering 2003. Published in: Proceedings of ICheaP-6, The Sixth Italian Conference on Chemical and Process Engineering, Pisa, Italy, 08 -11 June 2003
5. Johnsen, Kim A.; Kolbeinsen, Leiv; Eriksen, Dag; Grace, John R.. Sorption-Enhanced Steam Methane Reforming in Fluidized Bed Reactors [Presentation]. AIChE 2005 Annual Meeting; 30.10.2005 - 04.11.2005. Published in: 05AIChE 2005 Annual meeting proceedings (CD-ROM); 2005
6. Kolbeinsen, Leiv. Dispersoids and their effect on solidification structure [Presentation]. 150th ISIJ meeting; 28.09.2005 - 30.09.2005. Published in: Current Advances in Materials and Processes (CAMP-ISIJ); pp 853 - 856 September 2005
7. Lee, Young E.; Kolbeinsen, Leiv. Kinetics of Oxygen Refining Process for Ferromanganese Alloys. ISIJ INTERNATIONAL 2005;45(9):1282-1290
8. Chapters 3.2.3 Ferro alloys and 3.2.4 Silicon (technical) in Advanced Materials Norway 2005, Report from the Foresight project, Norwegian Research Council.
9. Grong, Øystein; van der Eijk, Casper; Tranell, Gabriella; Kolbeinsen, Leiv. Kornforfiningslegering [Patent]. Patentnr 20062484. Registrert 31.05.2006
10. Grong, Øystein; Kolbeinsen, Leiv; Tranell, Gabriella; van der Eijk, Casper. Microstructure Control of Steels through Dispersoid Metallurgy Using Novel Grain Refining Alloys. ISIJ International 2006;46(6):824-831
11. Safarian-Dastjerdi, Jafar; Grong, Øystein; Kolbeinsen, Leiv; Olsen, Sverre E.. A Process Model for the Carbothermic Reduction of MnO from High Carbon Ferromanganese - The Model. ISIJ International 2006;46(8):1120-1129
12. Johnsen, Kim A.; Grace, John R.; Elnashaie, Said S. E. H.; Kolbeinsen, Leiv; Eriksen, Dag. Modeling of Sorption-Enhanced Steam Reforming in a Dual Fluidized Bubbling Bed Reactor. Industrial & Engineering Chemistry Research 2006;45(12):4133-4144
13. Johnsen, Kim A.; Kolbeinsen, Leiv; Eriksen, Dag; Grace, John R.. Sorption-Enhanced Steam Methane Reforming in Fluidized Bed Reactors. AIChE 2005 Annual Meeting; 30.10.2005 - 04.11.2005. 05AIChE 2005 Annual meeting proceedings (CD-ROM)
14. Lee, Young E.; Kolbeinsen, Leiv. An analysis of hot spot phenomenon in BOF process. ISIJ International 2007;47:764-765
15. Safarian, Jaafar; Kolbeinsen, Leiv; Gaal, Sean; Tranell, Gabriella. "The effect of graphite properties on the rate of MnO reduction from high carbon ferromanganese slag." *INFACON XI: Innovations in the Ferro Alloy Industry, Volum 1*. Macmillan 2007 ISBN 978-0230-63069-7. pp. 321-334
16. Safarian, J; Kolbeinsen, Leiv. Kinetic of carbothermic reduction of MnO from high-carbon ferromanganese slag by graphite materials. *ISIJ International* 2008 ;Volum 48.(4) pp. 395-404.
17. Safarian-Dastjerdi, Jafar; Tranell, Gabriella; Tangstad, Merete; Kolbeinsen, Leiv; Gaal, Sean; Kaczorowski, Jakub. "Reduction kinetics of MnO from high-carbon ferromanganese slags by

- carbonaceous materials in Ar and CO atmospheres". *Metallurgical and materials transactions. B, process metallurgy and materials processing science* 2008 ;Volum 39. s. 702-712
18. Kolbeinsen, Leiv "From Gas to Materials - A vision for Northern Europe". GassMaks Seminar; Trondheim & Tjeldbergodden 2008-09-23 - 2008-09-24
 19. Safarian, J; Kolbeinsen, L; Tangstad, M; Tranell, G. "Kinetics and Mechanism of the Simultaneous Carbothermic Reduction of FeO and MnO from HC Ferromanganese Slag". *Metallurgical and materials transactions. B, process metallurgy and materials processing science* 2009;40(6):929-939
 20. Eijk, Casper van der; Grong, Øystein; Haakonsen, Fredrik; Kolbeinsen, Leiv; Tranell, Gabriella. "Progress in the development and use of grain refiner based on cerium sulphide or titanium compound for carbon steel". *ISIJ International* 2009 ;Volum 49.(7) s. 1046-1050
 21. Kolbeinsen, Leiv. "Addressing the climate change challenge: the ULCOS breakthrough program." Dongbu Seminar; 2009-04-01
 22. Kolbeinsen, Leiv. "Development and Use of DRI-based Grain Refiners for Steel". Materials Science & Technology 2009 Conference & Exhibition; 2009-10-25 - 2009-10-29
 23. Kolbeinsen, Leiv. "Gass til materialer (GassMat) - Integrasjonsmodeller for material- og kraftproduserende industriklynger" Næringsinteresser Midt-Norge; 2008-03-13 - 2008-03-13
 24. Kolbeinsen, Leiv "International activity on the CO₂ reduction in the ironmaking field" 157th ISIJ Meeting, Tokyo, Japan; 2009-03-28 - 2009-03-30
 25. Kolbeinsen, Leiv "Noen industrielle muligheter for gass(anvendelse) i Nordområdene" Industripolitisk konferanse i Hammerfest; 2008-11-24 - 2008-11-24
 26. Kolbeinsen, Leiv "Thermodynamic and Kinetic Phenomena pertaining to Gaseous reduction of Iron Oxides" Posco Seminar; 2009-04-02
 27. Safarian, Jafar; Kolbeinsen, Leiv; Tangstad, Merete; Tranell, Gabriella: "Kinetics and mechanism of the simultaneous carbothermic reduction of FeO and MnO from high-carbon ferromanganese slag" *Metallurgical and materials transactions. B, process metallurgy and materials processing science* 2009 ;Volum 40.(6) s. 929-939
 28. Safarian-Dastjerdi, Jafar; Kolbeinsen, Leiv "Kinetic of carbothermic reduction of MnO from high-carbon ferromanganese slag by graphite materials" *ISIJ International* 2008 ;Volum 48.(4) s. 395-404
 29. Safarian-Dastjerdi, Jafar; Tranell, Gabriella; Tangstad, Merete; Kolbeinsen, Leiv; Gaal, Sean; Kaczorowski, Jakub "Reduction kinetics of MnO from high-carbon ferromanganese slags by carbonaceous materials in Ar and CO atmospheres" *Metallurgical and materials transactions. B, process metallurgy and materials processing science* 2008 ;Volum 39. s. 702-712
 30. Seim, Stian; Kolbeinsen, Leiv: "Alternative approaches for high temperature investigation of high titania slags" I: *HMC2009: Heavy minerals 2009*. South African Institute of Mining and Metallurgy 2009 ISBN 978-1-920211-22-6. s. 57-62
 31. AMONDARAIN, Zuriñe; Kolbeinsen, Leiv; ARANA, Jose Luis. Wetting Behavior of Sintered Nanocrystalline Powders by Armco Fe and 22CrNiMoV5-3 Steel Grade Using Sessile Drop wettability Technique. *ISIJ International* 2011 ;Volum 51.(5) s. 733-742 NTNU
 32. Kolbeinsen, Leiv. Anvendelse av Naturgass til Metallurgiske Formål - Muligheter og Utfordringer. GassArena Haugesund; 2011-10-26 - 2011-10-27 NTNU
 33. Kolbeinsen, Leiv. EU-ULCOS project: CO₂ reduction in iron making. CCS and Wind Turbine Technology; 2010-06-10 - 2010-06-11 NTNU
 34. Kolbeinsen, Leiv. GasFerroSil. FFF Seminar 2011; 2011-09-25 - 2011-09-25 NTNU
 35. Kolbeinsen, Leiv. Modelling of DRI Processes with Two Simoultaneously Active Reducing Gases. The Seetharaman Seminar; 2010-06-14 - 2010-06-15 NTNU
 36. Kolbeinsen, Leiv. Modelling of DRI Processes with Two Simoultaneously Active Reducing Gases. STEEL RESEARCH INTERNATIONAL 2010 ;Volum 81.(10) s. 819-828 NTNU
 37. Kolbeinsen, Leiv; Takla, Marit; Kjelstrup, Signe; Kamfjord, Nils Eivind. An Investigation of the opportunity to Recover Radiation Waste Heat by the Means of Thermoelectricity. Renewable Energy Research Conference 2010; 2010-06-07 - 2010-06-08 NTNU
 38. Safarian, Jafar; Kolbeinsen, Leiv; Tangstad, Merete. Liquidus of Silicon Binary Systems. *Metallurgical and materials transactions. B, process metallurgy and materials processing science* 2011 ;Volum 42.(4) s. 852-874 NTNU
 39. Safarian, Jafar; Tangstad, Merete; Kolbeinsen, Leiv. Thermodynamic activities in silicon binary melts. *Journal of Materials Science* 2012 s. - NTNU
 40. Seim, Stian; Kolbeinsen, Leiv Experimental determination of the slag/metal equilibrium line in the FeTiO₃-Ti₂O₃-TiO₂-system. Nasjonal konferanse for Materialteknologi 2010; 2010-06-03/04
 41. Seim, Stian; Kolbeinsen, Leiv. Update on the Equilibrium between Liquid Fe-Ti-O Slags and Metallic Iron. STEEL RESEARCH INTERNATIONAL 2010 ;Volum 81.(12) s. 1051-1055 NTNU

42. Nørstebø, Vibeke Stærkebye; Midthun, Kjetil Trovik; Bjørkvoll, Thor; Kolbeinsen, Leiv. Use of Natural Gas with High CO₂ Content in an Integrated Industrial Park. ISIJ International 2012 ;Volum 52.(8) s. 1439-1446
43. Safarian, Jafar; Kolbeinsen, Leiv; Tangstad, Merete. Thermodynamic Properties of the Silicon Binary Melts. TMS 2012 Annual Meeting & Exhibition!; 2012-03-11 - 2012-03-15
44. Safarian, Jafar; Tangstad, Merete; Kolbeinsen, Leiv. Thermodynamic activities in silicon binary melts. Journal of Materials Science 2012 s. –
45. Seim, Stian; Kolbeinsen, Leiv; Jung, In-Ho. High Temperature Experimental Investigations and Thermodynamic Modelling in the FeTiO₃-Ti₂O₃-TiO₂ Ternary Slag System. TMS 2012 Annual Meeting & Exhibition; 2012-03-11 - 2012-03-11
46. Takla, Marit; Burheim, Odne Stokke; Kolbeinsen, Leiv; Kjelstrup, Signe. A Solid State Thermoelectric Power Generator Prototype Designed to Recover Radiant Waste Heat. TMS 2012 Annual Meeting & Exhibition; 2012-03-11 - 2012-03-15
47. Takla, Marit; Kolbeinsen, Leiv; Tveit, Halvard; Kjelstrup, Signe. Eksergianalyse av silisiumproduksjonsprosessen. Nasjonal Konferanse for Materialteknologi; 2012-05-09 - 2012-05-10
48. Takla, Marit; Kolbeinsen, Leiv; Tveit, Halvard; Kjelstrup, Signe. Exergy analysis of the silicon production process. Ecos 2012- the 25TH International conference on efficiency, Cost, Optimization, simulation and environmental impact of energy systems 2012-06-26 - 2012-06-29
49. Holm, Magnus; Kolbeinsen, Leiv. IRONARC: Ny metode for jernutvinning kan halvere CO₂-utslipp. Norway [Business/trade/industry journal] 2013-02-14
50. Lobo, Stephen Ceasar; Kolbeinsen, Leiv; Seim, Stian. Pre-reduction of ilmenite with natural gas – model development and use. INFACON XIII - thirteenth international ferroalloys congress; 2013-06-09 - 2013-06-12
51. Lobo, Stephen Ceasar; Kolbeinsen, Leiv; Seim, Stian. Reduction of Ilmenite with Synthesis Gas. International Heavy Minerals Conference 2013; 2013-11-27 - 2013-11-29
52. Monsen, Bodil Elisabeth; Tang, Kai; Prytz, Steinar; Kolbeinsen, Leiv; Myrvågnes, Viktor. Possible use of natural gas for silicon or ferrosilicon production. I: Proceedings of the thirteenth international ferroalloys congress. Efficient Technologies in Ferroalloy Industry. Vol 1.. Almaty, Kazakhstan: P. Dipner 2013 ISBN 9965729352. p. 467-478
53. Lobo, Stephen Ceasar; Kolbeinsen, Leiv; Seim, Stian. Pre-reduction of mixed oxides. Nasjonal Konferanse for Materialteknologi, Sommermøte 2014; 2014-06-04 - 2014-06-05
54. Kolbeinsen, Leiv. Participatory knowledge building - Driving sustainability in industry. International Innovation 2014 (152) s. 106-108
55. Børset, Marit Takla. Energy Dissipation and Recovery in the Context of Silicon Production. Trondheim: NTNU 2015 (ISBN 978-82-326-1286-4) ;157 s. co-author chapters PhD thesis at NTNU
56. Børset, Marit Takla; Kolbeinsen, Leiv; Tveit, Halvard; Kjelstrup, Signe. Exergy based efficiency indicators for the silicon furnace. Energy 2015 ;Volum 90. s. 1916-1921
57. Safarian, Jafar; Kolbeinsen, Leiv. Microscopic Study of Carbon Surfaces Interacting with High Carbon Ferromanganese Slag. Metallurgical and materials transactions. B, process metallurgy and materials processing science 2015 ;Volum 46B. s. 125-134
58. Kolbeinsen, Leiv. Økt innovasjonstakt og implementering av ny kunnskap [Increased pace of Innovation and Implementation of Knowledge]. Industri 2015; 2015-09-23 - 2015-09-24
59. Kennedy, Mark William; MacRae, Allan; Jones, Rodney T.; Kolbeinsen, Leiv; Nos, Per; Filzwieser, Andreas. Some Considerations for Safer Furnace Cooling. I: Managing Furnace Integrity for Reliable Metal Production. Can. Inst. of Mining, Metallurgy and Petroleum 2015 ISBN 978-1-926872-32-2. s. –
60. Kolbeinsen, Leiv. Green competitiveness in the silicon industry?. Silicon Market Forum 2016; 2016-11-08 - 2016-11-09
61. Lobo, Stephen Ceasar; Kolbeinsen, Leiv; Seim, Stian. Reduction of Norwegian and Indian ilmenite with carbon monoxide and hydrogen gas blends. Canadian metallurgical quarterly 2016 ;Volum 55.(4) s. 455-462
62. Ringdalen, Eli; Adisty, Dian; Kolbeinsen, Leiv. Quartz-cristobalite transformation and its effect on reactions in si production: Initial studies. I: Celebrating the Megascale: Proceedings of the Extraction and Processing Division Symposium on Pyrometallurgy in Honor of David G.C. Robertson. John Wiley & Sons 2014 ISBN 9781118889619. s. 225-236
63. Safarian, Jafar; Kolbeinsen, Leiv. Smelting-reduction of bauxite for sustainable alumina production. 2016-Sustainable Industrial Processing Summit & Exhibition; 2016-11-06 - 2016-11-10
64. Safarian, Jafar; Kolbeinsen, Leiv. Sustainability in alumina production from bauxite. 2016-Sustainable Industrial Processing Summit & Exhibition; 2016-11-06 - 2016-11-10