MEHAANIKATEADUSKOND
SOOJUSTEHNIKA INSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2014

1. Instituudi struktuur

Soojustehnika instituut, Department of Thermal Engineering
Instituudi direktor Aadu Paist (alates 1 jaanuarist 2015 on direktor Andres Siirde)

- Soojusenergeetika õppetool, Chair of Thermal Power Engineering, Aadu Paist
- Soojusjõuseadmete õppetool, Chair of Thermal Power Equipment, Andres Siirde
    - Põlemisprotsesside teadusuuringute laboratoorium. Sinna kuuluvad: Andres Siirde, Tõnu Pihu, Dmitri Nešumajev, Alar Konist, Indrek Külaots, Lauri Loo, Birgit Maaten, Martin Maidre, Sulev Soosaar, Ants Martins.
    - Nutikate kaugküttelahenduste uurimisgrupp. Sinna kuuluvad: Andres Siirde, Julija Gusca, Anna Volkova, Aleksandr Hlebnikov, Eduard Latõšov, Siim Link, Alar Konist.
    - Põlevkivikatelde katsetuste ja õhuheitmete määramise uurimisgrupp. Sinna kuuluvad: Tõnu Pihu, Dmitri Nešumajev, Teet Parve, Jüri Loosaar, Alar Konist.
    - Enefit-280 õlitehase termiliste ja keemiliste protsesside uurimisgrupp. Sinna kuuluvad: Dmitri Nešumajev, Andres Siirde, Tõnu Pihu, Alar Konist, Lauri Loo, Birgit Maaten.
- Tööstusliku soojustehnika õppetool, Chair of Heat Engineering, Ivan Klevtsov
    - Elektrijaamade kõrgrõhul seadmete diagnostika ja töökindluse uurimisgrupp. Sinna kuuluvad: Ivan Klevtsov, Andrei Dedov, Toomas Lausmaa, Tatjana Bojarinova

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

2.1 Struktuuriüksuse koosseisu kuuluvate uurimisgrupid

Põlemisprotsesside teadusuuringute laboratoorium – Research laboratory of combustion processes – Andres Siirde

Group deals with investigation of new opportunities for oil shale and other local fuels efficient and environment friendly utilisation. The topics involve following basic and applied research: Environmentally and economically competitive new technologies of low grade fuel based energy production – Clean Estonian Oil Shale; Local fuels fired power units safety, reliability and environmental problems; Combined utilization (gasification) of oil shale and biomass for energy production.

The main results will be: technology basis for oil shale combustion in oxygen rich environment. Ensuring Estonian electricity and heat production reliability, increase in competitiveness, environmental footprint reduction. Increase of effectiveness of energy equipment by augmentation of convective heat transfer. Fundamentals for Shale oil and power production optimization. Basic knowledge of local biofuels enhancement through gasification and pyrolysis. Consistency of professional science personnel.

1.1 − Konist, A.; Loo, L.; Valtsev, A.; Maaten, B.; Siirde, A.; Neshumayev, D.; Pihu, T. (2014). Calculation of Estonian Oil Shale Combustion Products in Regular and Oxy-fuel Mode in a CFB Boiler. Oil Shale, 31(3), 211 - 224.

Nutikate kaugküttelahenduste uurimisgrupp – Smart district heating systems research group – Andres Siirde

Group deals with developing new technical solutions for the transition of district heating (DH) systems towards an intelligent, highly efficient and regenerative energy supply concept. This reduces energy consumptions and carbon dioxide emissions within the Baltic Sea region (BSR). Transition measures and technical solutions for DH systems are developed for enhancing its energy efficiency. Therefore, processes characterising DH systems are analysed and optimised, taking relevant operational boundary conditions and legal frameworks into account.

Optimising the heat generation, distribution and consumption within DH systems, the primary energy use is improved. For this purpose, measures for reducing energetic and exergetic losses will be deployed. Group has failed to get Horizon 2020 funding's in the first call.

> 3.1 − Mašatin, V.; Link, S.; Siirde, A. (2014). The Impact of Alternative Heat Supply Options on CO2 Emission and District Heating System. In: Chemical Engineering Transactions: PRES 2014. 17th Conference Process Integration, Modelling and Optimisation for Energy Saving and Pollution Reduction. 23–27 August 2014, Prague, Czech Republic. (Toim.) P. S. Varbanov, J. J. Klemeš, P. Y. Liew, J. Y. Yong., 2014, (Chemical Engineering Transactions; 39), 1105 - 1110.

Põlevkivikatelde katsetuste ja õhuheitmete määramise uurimisgrupp – Oil Shale Boilers tests and air emissions research group – Tõnu Pihu

Group deals with investigation of new opportunities for oil shale and other local fuels efficient and environment friendly utilisation.

Co-firing of bio mass and oil shale in CFB boilers have been investigated lately. The main concern here was possible fouling of convective heat transfer surfaces because of changed fly ash properties. Analyzing the ash and deposits properties has proved that co-firing of biomass with 40-50% moisture up to 15% by mass is possible without major changes in CFB boiler operation conditions. Tests with bio mass ratio up to 30% are planned to near future.

Investigations of different oil shale fired boilers PM 2,5 and PM 10 emissions resulted to conclusions, that approximately half of emitted particulates belong to PM2,5 grade and the finest particulate emissions comes from CFB boiler.

Tests at Narva Power Plants old pulverized oil shale fired boilers proceeded with the aim of decreasing NOx emissions to the acceptable level.

Flue gas recycling and two stage burners for retort gas firing at boiler 2A makes possible to lower NOx levels. Retort gas share was up to 40% from primary energy. Operational reliability problems of flue gas recycling fans should be solved by the solution deliverer ENTEH Ltd.

Fortum DeNOx system tests without urea injection at boiler 3B proved the system to be reliable and NOx concentration below the limit value of 200 mg/nm3 were reached at different oil shale fuels and loads. During 2015 similar system will be installed and tested at Power Units 5, 6 and 4.

Hard coal and oil shale co-firing at CFB boiler (11 A) was tested. Main problem was much higher NOx emission (>500 mg/Nm3) because of hard coal higher nitrogen content, but also elevated temperature (~20 oC) level in furnace and flue gas.

Enefit-280 õlitehase termiliste ja keemiliste protsesside uurimisgrupp – Enefit-280 shale oil factory thermal and chemical process research group – Dmitri Nešumajev
The research work of this group is CONFIDENTIAL.

3.1 − Gusca, J.; Siirde, A.; Eldermann, M.; Rohumaa, P. (2014). Production of Fuel Oil from Estonian Oil Shale: an Indicator-based Decomposition Analysis. 27st International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact, Turku, Finland, 15th - 19th June 2014. , 2014.

Elektrijaamade kõrgrõhul seadmete diagnostika ja töökindlus - Diagnostics and reliability of high pressure equipment of power plants – Ivan Klevtsov
95% of electricity in Estonia is produced at thermal power plants by firing of oil shale, low-grade local fuel. Most of the units of Narva power plants were built about 50 years ago and all of them have exceeded their design lifetime. Further operation of these units is allowable only if careful metal condition monitoring of the blocks main elements is carried out. In 2014 the investigation of metal condition of the basic components of units 3, 6, 7 and 8 in Eesti Power Plant and unit 11 in Balti Power Plant was carried out by Department of Thermal Engineering. These components were main steam piping, hot reheat steam piping, boiler drums, turbine casings and rotors. The research was performed by NDT methods: hardness measurement, investigation of the metal structure (replication), mechanical properties measurement of the metal using miniature tensile specimens sampled from the components, the measurement of creep deformation of the internal rotor boors. Based on the results of the investigation have been issued permission for a certain period of operation till the next mandatory inspection.
The high temperature corrosion of heating surfaces, particularly steam super heaters was also studied. The strength calculation of hot reheat piping of power unit 8 in Eesti Power Plant was carried out to check the stress level and reveal the most loaded components of the piping.

1.1. Priss, J.; Rojacz, H.; Klevtsov, I.; Dedov, A.; Winkelmann, H.; Badisch, E. (2014). High temperature corrosion of boiler steels in hydrochloric atmosphere under oil shale ashes. Corrosion Science
3.1. Priss, J.; Klevtsov, I.; Dedov, A.; Antonov, M.; Rojacz, H.; Badisch, E. (2014). High Temperature Cyclic Impact/Abrasion Testing of Boiler Steels. D. Loca (Toim.). Engineering Materials & Tribology XXII (289 - 292).Trans Tech Publications Ltd

2.2 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustustest.

2.3 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

Andres Siirde:
2011 - … Maailma Energeetikanõukogu Eesti Rahvuskomitee (WEC-Estonia) juhatuse liige
2010 - ... Ajakirja "Scientific journal of Riga Technical University" rahvusavalise toimetuskolleegiumi liige,
2008 - ... Rahvusvahelise Sümpoosiumi „11th International Symposium on District Heating and Cooling , Reykjavik, ICELAND, 2008 teaduskomitee liige,
2008 - ... Oil Shale ajakirja peatoimetaja asetäitja,
2005 - ... Euroopa Komisjoni Söe Nõuandva töögrupi liige. Euroopa Komisjon, Terase ja Söe Uurimisfond.
Eesti Teaduste Akadeemia energeetikanõukogu liige.

Alar Konist:
2012- 2014 IEA Eesti esindaja
2014-2015 külalisteadlane Browni Ülikoolis
Aadu Paist
2013- Tallinna Energiaagentuuri nõukogu liige
2014 – Riikliku keskkonnaseire seirenõukogu liige
2003 – Ajakirja Oil Shale kolleegiumi liige