

**MEHAANIKATEADUSKOND**  
**SOOJUSTEHNKA INSTITUUT**  
**TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2013**

## **1. Instituudi struktuur**

**Soojustehnika instituut, Department of Thermal Engineering**  
**Instituudi direktor Aadu Paist**

- Soojusenergeetika õppetool, Chair of Thermal Power Engineering, Aadu Paist
- Soojusjõuseadmete õppetool, Chair of Thermal Power Equipment, Andres Siirde
- Tööstusliku soojustehnika õppetool, Chair of Heat Engineering, Ivan Klevtsov

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

### 2.1 Struktuuriüksuse koosseisu kuuluvad uurimisgrupid

#### ***Põlemisprotsesside teadusuuringute laboratoorium – Research laboratory of combustion processes – Tõnu Pihu***

Group deals with investigation of new opportunities for oil shale and other local fuels efficient and environment friendly utilization. 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. Konist, A.; Pihu, T.; Neshumayev, D.; Siirde, A. (2013). Oil shale pulverized firing: boiler efficiency, ash balance and flue gas composition. *Oil Shale*, 30(1), 6 - 18.
2. Kann, J.; Raukas, A; Siirde, A. (2013). About the gasification of kukersite oil shale. *Oil Shale*, 30(2s), 283 - 293.
3. Siirde, A.; Eldermann, M.; Rohumaa, P.; Gusca, J. (2013). Greenhouse Gas Emissions Analysis of Energy Production Processes from Estonian Oil Shale. *Life Cycle Energy Analysis Perspective*. *Oil Shale*, 30(2S), 268 - 282.
4. Konist, A; Pihu, T; Neshumayev, D; Külaots, I (2013). Low-grade fuel–oil shale and biomass co-combustion in CFB boiler . *Oil Shale*, 30(2S), 294 - 304.

#### ***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 2013 the investigation of metal condition of the basic components of units 2, 3, 6 and 7 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.

1. Dedov, A.; Klevtsov, I.; Lausmaa, T. (2013). Experience in integrity assessment of steam turbine casings operated beyond the design lifetime. P. Auerkari & J. Veivo (Toim.). Baltica IX International Conference on Life Management and Maintenance for Power Plants (619 - 629). VTT Technology 106
2. Klevtsov, I.; Dedov, A. (2013). Determination of tensile properties of power plant steels by testing of miniature specimens. ASME 2013 Pressure Vessels & Piping Conference, PVP2013, July 14-18, 2013, Paris, France. , 2013.

### ***Biomassi ja jäätmete kasutamine - Utilization of biomass and wastes – Aadu Paist***

EU COFREEN project relied on the existing knowledge of the previous reed projects and brought that together with the added new perspectives to utilisation reed in construction and energy and reed business possibilities. To enable substantial reed utilisation, firstly recognized the obstacles in reed harvesting and integrated management. Secondly logistics and end users identified and optimized to achieve a successful production chain accordance with economical values. Result of the work offers the visions to wide range reed utilisation opportunities and preconditions.

The calorific value of the biological share of municipal solid waste gathered in Estonia (MSW) was assessed on the base of content of bio-waste types in MSW and their previous analysis.

A comprehensive review of the Estonian wood fuel resources by tree species, the database and map of wood fueled boiler houses and CHP was compiled. The possibility of extending the use of wood fuels was estimated and proposed national measures of wood fuel for its implementation. Described and suggested technologies and equipment to take into use in Estonia for liquid and gaseous bio-fuels from woody biomass products. A series of feasibility studies of the use of wood fuel in small and medium scale buildings were prepared.

1. Link, S.; Kask, Ü.; Paist, A.; Siirde, A.; Arvelakis, S.; Hupa, M.; Yrjas, P.; Külaots, I. (2013). Reed as a gasification fuel: a comparison with woody fuels. *Mires and Peat*, 13, 1 - 12.
2. Kask, L.; Kask, Ü.; Link, S. (2013). Combustion characteristics of reed and its suitability as a boiler fuel. *Mires and Peat*, 13, 1 - 10.
3. Guidebook of Reed Business. Edit. Ü. Kask. Salibar OÜ. Tartu. pp 106.

### ***Katelde katsetused ja õhuheitmed – Boiler tests and air emissions – Jüri Loosaar***

Two application projects related to the testing of flue gas cleaning facilities (deSO<sub>x</sub> and deNO<sub>x</sub>) of Narva Power Plants pulverized oil shale fired boilers were executed. Lime Injection Units as deSO<sub>x</sub> system related accessory was tested for operational capability and efficiency at all 4 power units equipped with deSO<sub>x</sub> facilities at Eesti PP.

Fortum OY delivered deNO<sub>x</sub> system at boiler 3A proved to be reliable and NO<sub>x</sub> concentration below the limit value of 200 mg/nm<sup>3</sup> were reached at different oil shale fuels and loads even without urea injection (SNCR). Boiler heat balance tests and air emission determinations at different biofuel fired boilers and factories were executed (Kuressaare, Vana-Võidu, Patküla, Jõgeva etc). Conclusions of the former tests (NO<sub>x</sub> BASELINE TESTS FOR EEJ BOILER TP-101, June 2011) about possibility of cutting down NO<sub>x</sub> emissions at oil shale pulverized firing by modification of combustion air feeding system proved to be right.

1. Reinik, Janek; Irha, Natalya; Steinnes, Eiliv; Urb, Gary; Jefimova, Jekaterina; Piirisalu, Ero; Loosaar, Jüri (2013). Changes in trace element contents in ashes of oil shale fueled PF and CFB boilers during operation. *Fuel Processing Technology*, 115, 174 - 181.

**2.2** Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

**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 Sõe Nõuandva töögrupi liige. Euroopa Komisjon, Teras ja Sõe Uurimisfond.

Eesti Teaduste Akadeemia energeetikanõukogu liige.

Alar Konist:

2012- ... IEA Eesti esindaja