IEA Task 34 Fast Pyrolysis
6.3.2.25
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Organization: PNNL

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Goal/Objective Statement

• The ultimate objective of IEA Bioenergy Task 34 is to **promote commercialization** of economical biomass fast pyrolysis for the production of refinery feedstock and fuel oil with subsequent production of transportation fuels and chemicals

M 6.17 Validate bio-oil production to stable intermediate

• In support of the task, PNNL contributes input on fast pyrolysis developments across the U.S. and in return learns of the work in the other participating countries

• The task undertakes several activities to address barriers to commercialization for fast pyrolysis and PNNL provides laboratory support to those activities and contributes to the information dissemination activities
Quad Chart Overview

Timeline

• Project start date: 10/1/2008
• Project end date: 9/30/2015
• 64 Percent complete

Budget (DOE & cost share)

• Total project funding $295K + $564K
• Funding received in FY 2011 $20K + $90K (including $20K U.S.)
• Funding received in FY 2012 $20K + $94.5K (including $20K U.S.)
• Funding anticipated for FY 2013 $25K + $99K (including $20K U.S.)

Barriers

• Barriers addressed
  – Tt-E. Pyrolysis of Biomass and Bio-oil Stabilization
  – Dt-B. Codes, Standards and Approval for Use
  – Mm-C. Insufficient or Inconsistent Regulations and Standards

Partners & Roles

• IEA Bioenergy Agreement through Task 34
• Task participants including Ensyn, VTT, BTG and their collaborators
Project Overview

- **IEA Bioenergy Agreement**
  - DOE is signatory for U.S.
  - U.S. participates in 7 tasks
  - U.S. leads Task 34 on Pyrolysis

- **Task participants have included Finland, Germany, United Kingdom, The Netherlands, Canada and Australia**

- **The task identifies barriers to commercialization of fast pyrolysis of biomass that can be addressed within the task framework**
  - Information exchange
  - Standards and analytical methods development
## 1 - Approach

### Priority Topics for Task 34

**2010-2012 Triennium**

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<td>Analysis – methods, comparison, new developments, protocols</td>
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<td>Country reports updates/Review of State of the Art</td>
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<td>Fuels and chemicals from pyrolysis</td>
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- Work scope determined by participating countries
- Tasks undertaken through support from participating countries
- Task progress is monitored by IEA Bioenergy Executive Committee

(View the PowerPoint “Notes” page for additional information)
Norms and Standards

- ASTM standard for fast pyrolysis bio-oil as a burner fuel. (2009)
- Draft mandate was developed for CEN for specifying a number of grades of bio-oil. (2011)
- Draft mandate was used to develop a revised bio-oil standard including a 2nd grade of bio-oil. (2012)
- A definition of bio-oil for a new CAS number. (2010)
- A seminar was presented on the transportation standards and definitions relevant to bio-oil. (2010)
- Testing for sustained combustion as alternative to flash point. Effort to replace flash point testing from standards is now underway led by the task members
- BIOTOX project data was forwarded to toxicity experts working on REACH
- Conclusions relevant to fast pyrolysis bio-oils were presented in a paper dealing with guidelines for transportation of fast pyrolysis bio-oils in Energy & Fuels
- A continuing effort in the new triennium will be the issuance of a new MSDS for bio-oil which will address the several points of confusion

(View the PowerPoint “Notes” page for additional information)
Analysis – methods, comparison, new developments, protocols

• Round robin on lignin fast pyrolysis results were published in 2010 in the *Journal of Analytical and Applied Pyrolysis*

• Round robin to compare viscosity results and its measurement in accelerated aging test
  – Participants in the round robin were 15 laboratories in the five participating countries
  – 2 bio-oils distributed in 2011 with the results received and documented
  – Published in *Energy & Fuels*
  – Further evaluation of the repeatability of the accelerated aging test by 10 day test.
  – Bio-oil stored for year’s time at 3 temperatures to evaluate the effect on the aging of the bio-oil and the resulting viscosity increase.
  – Published in *Energy & Fuels*

• Additional discussions were held on components that are potential problems for bio-oil utilization
  – Key impact on bio-oil utilization
  – Sulfur analysis was considered in detail with the range of analytical methods reviewed
  – Other trace components such chlorine and phosphorus were also considered

(View the PowerPoint “Notes” page for additional information)
Country reports updates/Review of State of the Art

- Presentation of country reports from the participants was a routine part of the agenda for each task meeting
- These country reports are also the basis for the country reports posted on the task website
- A state-of-the-art of fast pyrolysis in the participating countries was drafted into a common format for the journal publication
Fuels and chemicals from pyrolysis

- Collaboration with IEA Bioenergy Task 42 on Biorefineries
- Outgrowth of the previous triennium the interest in fast pyrolysis of lignin continued
- Research ongoing at ECN in the Netherlands
- Direct participation of Paul de Wild, the PI at ECN, continued his interaction with Task 34 by providing reports on his research in lignin pyrolysis and his investigations into biorefineries based on fast pyrolysis
- This work was published as his Ph.D. thesis from Groningen University in 2011

System evaluation lignin pyrolysis biorefinery

Co-operation IEA-Tasks 42 (Biorefining) & 34 (Pyrolysis)
• Continuation and updating of task internet site

• Two task meetings per year

• Two issues per year of the task newsletter
  – prepared with input from participants in each of the countries
  – published electronically by posting to the website

http://www.pyne.co.uk/
3 - Relevance

- The project identifies barriers to commercialization of fast pyrolysis of biomass and develops and executes a program of collaborative research to provide solutions.

- The participation of industrial partners in the task activities validates to utility of the effort and guides the scope of work.

- The inclusion of the countries which are leaders in the technology development insures leading edge R&D.

- The return on investment is high based on the large cost share involved in the project.
4 - Critical Success Factors

• Strong connection to industrial leaders in bio-oil production
  – Stefan Muller of Ensyn
    • 4 new plants in development, operating demonstration plant, several smaller plants in operation for chemical food flavoring products in operation since the 1990s
  – Anja Oasmaa from VTT in Finland (consortium of Metso, UPM, Fortum, and VTT)
    • Building a commercial biomass fast pyrolysis plants, operating a scaled-up demonstration plant
  – Bert Van de Beld from BTG
    • To build a fast pyrolysis plant in partnership with Akzo and others

• The task works with and through these participants to address the commercialization barriers
  – The task supported the development of the ASTM standards for bio-oil
    • The initial version from 2009
    • Revised version from 2012
  – Helped develop the mandate that was presented to CEN to initiate the standards writing process in Europe
  – The Task is providing continuing input to the REACH registration process for bio-oil which is currently underway in Europe
  – The task members wrote the description of bio-oil which provided the basis for the CAS number which issued in 2010 and now applies to that chemical composition
5. Future Work

Priority Topics for Task 34

2013-2015 Triennium

- Review of bio-oil applications
- Bio-oil standardization
- Round robin for analytical methods validation
- TEA of thermochemical liquefaction technologies
- Collaboration with Tasks 32, 33, 38, 39, and 42

Future work

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Summary

• Task 34 is a key resource for commercialization of fast pyrolysis of biomass:
  – Maintains a website with technical information, key contacts, and news items
  – Prepares and distributes a newsletter twice annually
  – Organizes, conducts and evaluates round robin assessment of important bio-oil analytical methods
  – Provides technical input to standards development efforts in Europe and North America

• This project was presented at the 2011 Platform Review, as part of the CORE Pyrolysis project
2011 reviewer comments

(reviewed as an element in CORE Pyrolysis project)

• Project Approach
  – “It would be useful to develop 'standards', e.g., ASTM standards for bio-oil burner fuels, is a useful first step.”

• Technology Transfer and Collaborations
  – “Norms and standards are addressed by the IEA Task 34 work and the work with Finland, Netherlands and Germany which is really good.”

• This project has continued these supported efforts.
Publications, Presentations, and Commercialization


- **Commercialization efforts supported by the task**
  - VTT (part of the Fortum/Metso/UPM commercialization group in Finland) has been involved in all the task activities
  - Ensyn has participated in all task meetings
  - BTG has been a member of the task in 2012 and will continue through next triennium