Oil & Natural Gas Technology

DOE Award No.: DE-FC26-06NT15569

Quarterly Progress Report
With Summaries of Center-sponsored Research
(April - June 2009)

UTAH HEAVY OIL PROGRAM

Submitted by:
University OF Utah
Salt Lake City, UT

Prepared for:
United States Department of Energy
National Energy Technology Laboratory

July 27, 2009

Office of Fossil Energy

Utah Heavy Oil Program

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Quarterly Progress Report

April 2009 to June 2009

Submitted by:
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Project Period: June 21, 2006 to October 21, 2009

Prepared for:
U.S. Department of Energy
National Energy Technology Laboratory

EXECUTIVE SUMMARY

The six tasks (five research projects and the repository) that are funded the Utah Heavy Oil Program (UHOP) are nearly completed. Three PIs submitted final reports during this quarter for subparts of two different projects ("Detailed Study of Shale Pyrolysis for Oil Production" and "New Approaches to Treat Produced Water and to Perform Water Availability Impact Assessments for Oil Shale Development") and the report from a fourth PI is in the editing stages ("In Situ Oil Shale Recovery Modeling"). Hence, all experimental and modeling work on the shale pyrolysis project is complete and the second final report related to the project will be submitted in August 2009. For the project on treatment of produced water and water availability, only one PI is still performing work. In this quarter, a membrane bioreactor for biodegradation of naphthalene and BTEX was initiated with biodegradation expected to be completed by October 2009. For in situ production of oil sands, steam assisted gravity drainage (SAGD) simulations were run using the discretized wellbore option in the thermal simulator STARS. Because Utah oil sand reservoirs have bitumens with viscosities that are an order of magnitude higher than Canadian bitumens, the steam to oil ratio required for production is higher than what is considered favorable. In fluid flow modeling of the oil shale interval in the Uinta Basin, water flooding used to flush out oil led to higher recoveries (~18%). However, this recovery improvement was due to the heavier fractions of oil as lighter oil recovery dropped significantly with water flooding. The legal team is wrapping up work on the analysis of air and carbon issues relevant to oil shale development and beginning research on commercial leasing issues. The repository librarian has employed a copyright protocol to address the backlog of documents in the repository task pool. Of the original 1400 documents provided to UHOP by a geologist at the Utah Geological Survey from his personal files, 600 are now available as full text and 79 are available as abstracts only due to copyright restrictions. The remaining documents are duplications, preprints, or are waiting in the task pool pending permission requests.

PROJECT MILESTONES/PROGRESS PERFORMANCE

A. Progress in Program-Sponsored Projects

During this reporting period, several UHOP-sponsored projects and/or subparts of those projects were completed. Final reports were submitted for two of the three subparts of "New Approaches to Treat Produced Water and to Perform Water Availability Impact Assessments for Oil Shale Development." A final report was also submitted for one of two subparts of a "Detailed Study of Shale Pyrolysis for Oil Production." Brief summaries are provided below for ongoing work in the other projects.

1. Detailed Study of Shale Pyrolysis for Oil Production

Experimental Results: The final report entitled "Detailed Study of Shale Pyrolysis for Oil Production" was submitted in this quarter.

In-situ Oil Shale Recovery Modeling: Final report is being edited.

2. New Approaches to Treat Produced Water and to Perform Water Availability Impact Assessments for Oil Shale Development

Water Resources Sustainability: The final report entitled "Meeting Data Needs to Perform a Water Impact Assessment for Oil Shale Development in the Uinta and Piceance Basins" was submitted in this quarter.

Biological and Chemical Treatment of Produced Water: Electrolytic and advanced oxidation of naphthalene and BTEX have been completed. Bacteria capable of degrading naphthalene and BTEX were enriched and a membrane bioreactor is initiated. Our plan is to finish the biodegradation of naphthalene and BTEX using a membrane bioreactor by October, 2009.

Ozonation of Produced Water: The final report entitled "Bitumen Extraction and Treatment and Reuse of Process Water" was submitted in this quarter.

3. In Situ Production of Utah Oil Sands

In this period we looked at the sensitivity of the Steam Assisted Gravity Drainage (SAGD) process to process parameters. A discretized wellbore option in the thermal simulator STARS from CMG was used in these simulations. A schematic of how this option works is shown in Figure 1. As steam is injected into the annulus, the bitumen is heated and viscosity is reduced. This option allows more of the steam to enter the wellbore.

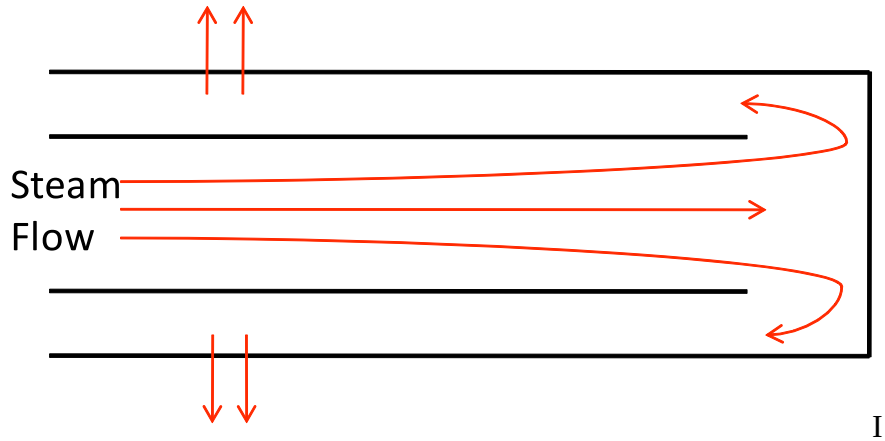

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Figure 1: Schematic of the discretized wellbore option used in examining the SAGD process.

An example of oil and water production and oil-water ratio is shown in Figure 2. The simulated conditions were typical of a Utah bitumen-bearing formation.

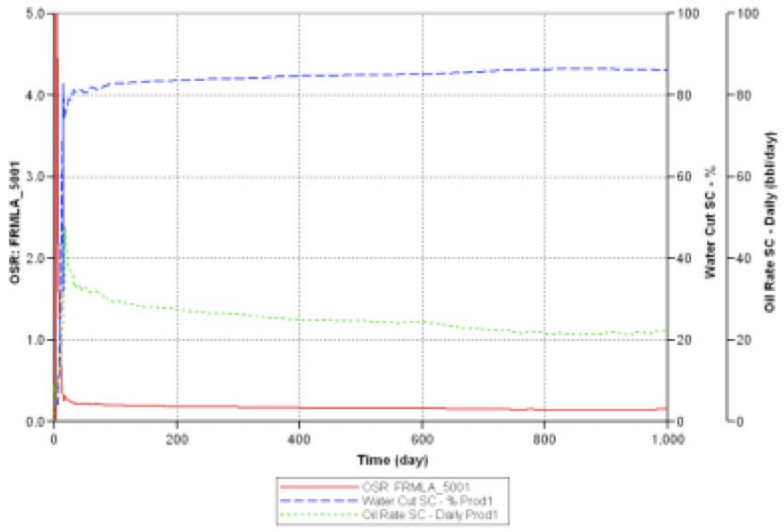

Figure 2: A typical production plot showing oil and water rates and oil-steam ratio

An oil steam ratio of three is considered favorable. Viscosity of the oil as a function of temperature has significant impact on this ratio. The Utah oil sand reservoirs have oils (bitumens) with viscosities that are an order of magnitude higher than Canadian bitumens. Other significant observations are:

- Reservoir pressure must always be lower than steam pressure in the annulus to prevent backflow into the annulus.

- Reservoir characteristics must allow for steam permeation.
- Water requirements and water cut can be very high depending on how steam enters and flows through the reservoir. Relative permeability of water is a major factor for these process parameters.

These studies will help us identify SAGD parameters suitable for Utah reservoirs.

4. Depositional Heterogeneity and Fluid Flow Modeling of the Oil Shale Interval of the Upper Green River Formation, Eastern Uinta Basin, Utah

Some of the oil released during pyrolysis is not recovered by primary depletion or gravity drainage. In this case, water flooding strategies will have to be used to flush out the oil. The water flooding also helps scavenge the residual heat in the reservoir. We have looked at incremental recovery from water flooding after pyrolysis operation. In Figure 3, simulations with (Plan A) and without (Plan C) water flooding are compared. It is clear that water flooding leads to significantly higher recoveries (~18%). Most of this recovery is in the form of the heavier fraction of oil. The lighter oil recovery (right axis) is significantly lower with water flooding, indicating lower operating temperatures overall and perhaps gravity segregation of heavier components.

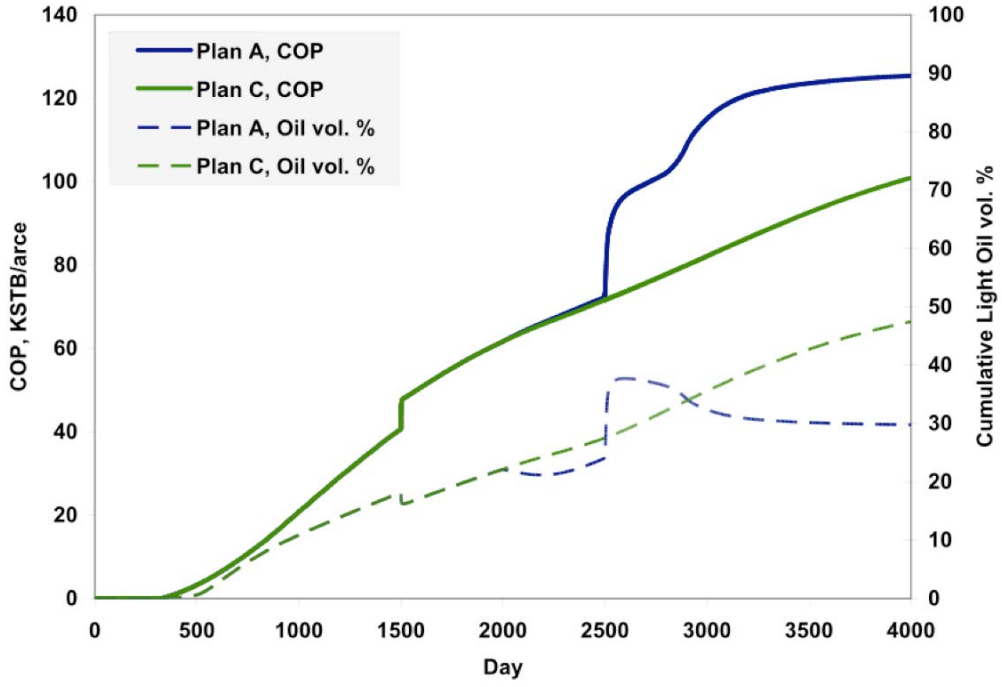

Figure 3: Cumulative oil production (COP) with and without water flooding. Plan A implements water flooding at around the 2000th day leading to the "oil bank" arriving at the production well at the 2500 day mark. Plan C is the base case, where the production pressure is reduced from 1500 to 500 at the 1500 day mark.

5. **Analysis of Environmental, Legal, Socioeconomic and Policy Issues Critical to the Development of Commercial Oil Shale Leasing on the Public Lands in Colorado, Utah, and Wyoming under the Mandates of the Energy Policy Act of 2005; Economic Evaluation of Bitumen Upgrading**

The legal team continued its research and analysis of air and carbon issues relevant to oil shale development. The team also began research on commercial leasing issues presented by ownership of non-federal oil shale resources, potential methods of consolidating land ownership in the context of a commercial oil shale leasing program, and the impacts of existing leasing models for various resources co-located with shale resources suitable for commercial oil shale development. Michael Hogue, the economist working on the project, continued economic research and analysis relevant to addressing the economic and socioeconomic issues associated with federal commercial oil shale leasing decisions.

B. On-line Repository

As noted in the previous quarterly report, this project will be considered complete once the 1400 documents received from the Utah Geological Survey (UGS) in 2006 have been verified for copyright permission and then been processed according to the results of the copyright verification. Repository collections from this original UGS document set include reports, bulletins, journal articles, books, maps, and presentations. The UGS document set includes an international research collection with an emphasis on regional oil shale and oil sands research and resources. All items in the repository collections are fully searchable and available as full-text where copyright permission has been secured. Of the original 1400 documents, 600 are now available as full text and 79 are available as abstracts only due to copyright restrictions. The remaining documents are duplications, preprints, or are waiting in the task pool pending permission requests.

CONCLUSIONS

One full quarter remains in the UHOP program. Five projects or subparts of projects remain to be completed with one final report in the editing stages. A project review will be held in September that will include all projects supported through UHOP.

COST STATUS

COST PLAN/STATUS

Baseline Reporting Quarter	Year 1							
	Q1		Q2		Q3		Q4	
	6/21/06 - 9/30/06		10/1/06 - 12/31/06		1/1/07 - 3/31/07		4/1/07 - 6/30/07	
	Q1	**Total**	Q2	**Total**	Q3	**Total**	Q4	**Total**
Baseline Cost Plan								
Federal Share	126,295	**126,295**	239,349	**365,644**	41,357	**407,001**	147,911	**554,912**
Non-Federal Share	31,574	**31,574**	34,342	**65,916**	25,969	**91,885**	38,387	**130,272**
Total Planned	157,869	**157,869**	273,691	**431,560**	67,326	**498,886**	186,298	**685,184**
Actual Incurred Cost								
Federal Share	126,295	**126,295**	239,349	**365,644**	41,357	**407,001**	164,491	**571,492**
Non-Federal Share	31,574	**31,574**	34,342	**65,916**	25,969	**91,885**	30,841	**122,726**
Total Incurred Costs	157,869	**157,869**	273,691	**431,560**	67,326	**498,886**	195,332	**694,218**
Variance								
Federal Share	0	**0**	0	**0**	0	**0**	16,580	**16,580**
Non-Federal Share	0	**0**	0	**0**	0	**0**	(7,546)	**(7,546)**
Total Variance	0	**0**	0	**0**	0	**0**	9,034	**9,034**

Baseline Reporting Quarter	Year 2							
	Q5		Q6		Q7		Q8	
	7/1/07 - 9/30/07		10/1/07 - 12/31/07		1/1/08 - 3/31/08		4/1/08 - 6/30/08	
	Q5	**Total**	Q6	**Total**	Q7	Total	Q8	Total
Baseline Cost Plan								
Federal Share	147,911	**702,823**	147,911	**850,734**	147,911	**998,645**	147,911	**1,146,556**
Non-Federal Share	38,620	**168,892**	38,620	**207,512**	38,620	**246,132**	38,620	**284,752**
Total Planned	186,531	**871,715**	186,531	**1,058,246**	186,531	**1,244,777**	186,531	**1,431,308**
Actual Incurred Cost								
Federal Share	161,343	**732,835**	178,570	**911,405**	165,243	**1,076,648**	114,429	**1,191,077**
Non-Federal Share	29,299	**152,025**	10,038	**162,063**	36,285	**198,348**	19,020	**217,368**
Total Incurred Costs	190,642	**884,860**	188,608	**1,073,468**	201,528	**1,274,996**	133,449	**1,408,445**
Variance								
Federal Share	13,432	**30,012**	30,659	**60,671**	17,332	**78,003**	(33,482)	**44,521**
Non-Federal Share	(9,321)	**(16,867)**	(28,582)	**(45,449)**	(2,335)	**(47,784)**	(19,600)	**(67,384)**
Total Variance	4,111	**13,145**	2,077	**15,222**	14,997	**30,219**	(53,082)	**(22,863)**

Baseline Reporting Quarter	Year 3							
	Q9		Q10		Q11		Q12	
	7/1/08 - 9/30/08		10/1/08 - 12/31/08		1/1/2009 - 3/31/09		4/1/09 - 6/30/09	
	Q9	Total	Q10	Total				
Baseline Cost Plan								
Federal Share	147,911	**1,294,467**	34,802	**1,329,269**	34,802	**1,364,071**	34,802	**1,398,873**
Non-Federal Share	38,620	**323,372**	8,758	**332,130**	8,758	**340,888**	8,758	**349,646**
Total Planned	186,531	**1,617,839**	43,560	**1,661,399**	43,560	**1,704,959**	43,560	**1,748,520**
Actual Incurred Cost								
Federal Share	144,808	**1,342,302**	31,909	**1,374,211**	72,324	**1,446,535**	(11,847)	**1,434,688**
Non-Federal Share	37,868	**255,236**	4,266	**259,502**	45,111	**304,613**	24,144	**328,757**
Total Incurred Costs	182,676	**1,597,538**	36,175	**1,633,713**	117,434	**1,751,147**	12,297	**1,763,445**
Variance								
Federal Share	(3,103)	**47,835**	(2,893)	**44,942**	37,521	**82,463**	(46,649)	**35,815**
Non-Federal Share	(752)	**(68,136)**	(4,492)	**(72,628)**	36,353	**(36,275)**	15,386	**(20,889)**
Total Variance	(3,855)	**(20,301)**	(7,385)	**(27,686)**	73,874	**46,188**	(31,263)	**14,925**

Baseline Reporting Quarter	Year 3							
	Q13		Q14					
	7/1/09 - 09/30/09		10/01/09 - 10/20/09					
	Q9	Total	Q10	Total				
Baseline Cost Plan								
Federal Share	34,802	**1,433,675**	8,701	**1,442,376**				
Non-Federal Share	8,758	**358,404**	2,190	**360,594**				
Total Planned	43,560	**1,792,080**	10,890	**1,802,970**				
Actual Incurred Cost								
Federal Share								
Non-Federal Share								
Total Incurred Costs	0	**0**	0	**0**				
Variance								
Federal Share								
Non-Federal Share								
Total Variance	0	**0**	0	**0**				

Note: The Cost Plan has been revised to reflect the agreement's extension through 10/20/2009.

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MILESTONE STATUS

Three project milestones have not been completed: Task 1.5, Develop on-line repository for all types of material pertaining to unconventional resources in North America; Task 1.8, Refine repository, incorporating information provided by user community; and Task 2.4, Complete technical report for Center-based research projects. A librarian hired in January 2009 will finish processing all 1400 documents by the end of September 2009. Three final reports representing subparts of two different projects were submitted in this quarter. A fourth report is in the editing stages. The remaining four reports representing projects and subparts of projects will be completed n the next 3 months.

PROBLEMS OR DELAYS

None

RECENT AND UPCOMING PRESENTATIONS/PUBLICATIONS

Steven Burian, Eric Jones, Ramesh Goel, Andy Hong, Liang Li, Zhixiong Cha, Beth Dudley-Murphy, Greg Nash," Oil Shale Development in the Western United States:Water Resources Challenges, Impacts and Solutions," American Water Resources Association, May 4-6, 2009, Anchorage, Alaska.

Andy Hong, "New Ozonation Process for Water Treatment Toward Sustainable Energy Development," Water/Energy Sustainability Symposium at the Groundwater Protection Council Annual Forum, September 13-16, 2009, Salt Lake City, Utah.

Z. Cha, A. Hong, C.F. Lin (2009). "Pressure-assisted Ozonation of Produced Water." Near completion for submission to review and journal publication.

S. Burian, E. Jones, and A. Kalyanapu (2009). "Impacts of Energy Development in Utah on Water Resources Availability." Journal of American Water Resources Association, to be prepared for submission in fall 2009.

E. Jones (2009). "Feasibility of White River to meet water requirements to support energy development in the Uinta Basin." MS thesis, Department of Civil & Environmental Engineering, University of Utah (in progress, to be completed fall 2009).

REFERENCES

None

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