Corn Oil Extraction System Final Report

By,

Blue Flint Ethanol

Report prepared for,

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SMAART Oil System at Blue Flint Ethanol

Schedule of Events

• Unit delivered		November 2009
• Initial Operation		November 12, 2009
• Shakedown and Training		November –January 2010
• Facility Shutdown (Evap Cleaning)	B	April 11-14, 2010
• Centrifuge Bowl Exchanged	C	April 27, 2010
• Original Bowl Returned	D	July 1, 2010
• Project Completion		September 1, 2010

Overall Performance

The SMAART Oil system is designed to recovery the maximum amount of oil available from the stillage stream being processed. It accomplishes this by first processing the stillage stream with a centrifuge to extract a modified stillage stream , also known as a light phase mixture, which consists of any unbound oil and any high lipid content emulsion material. The system is equipped with the Westfalia RS-220 centrifuge, specifically designed and modified for oil recovery form an ethanol plants stillage stream. The operation of the centrifuge is adjusted to achieve this recovery of the light phase mixture. The system then treats this light phase material to break the emulsion layer and release a large fraction of the oil as free oil which is then recovered and provided as product oil.

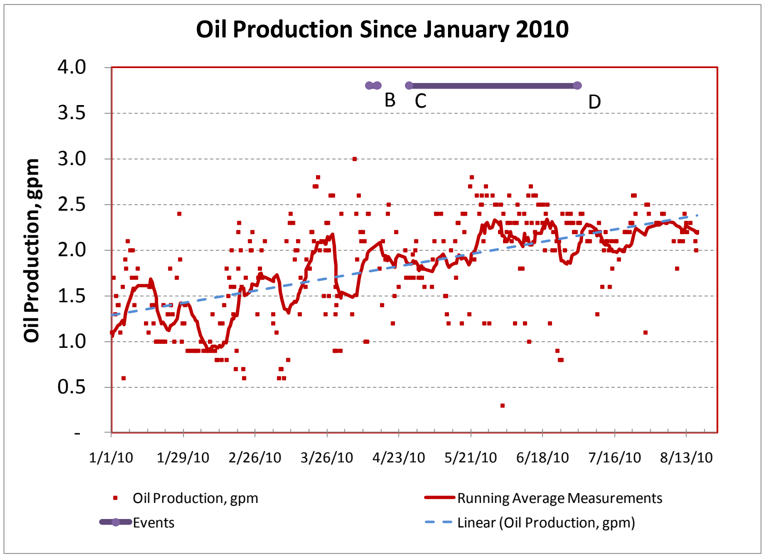

Figure 1 Historical Oil Production since January 2010

The SMAART Oil system was delivered to Blue Flint Ethanol in late 2009 and initial operation was achieved within a couple weeks. The first quarter of activities were focused on shakedown and operator training. Since January 2010 the system achieved an average oil recovery of 1.65gpm based on daily measurements of the product oil. Blue Flint collected, recorded and provided daily data on the system operation including centrifuge feed rate, oil production and spin tube samples of the feed stillage, de-oiled stillage, and product oil quality. This data was used to evaluate system performance and operation. The overall oil production history for the system is illustrated in

Figure 1. This data illustrates considerable scatter from day to day or hour to hour as shown by the individual data records plotted as small dots. The dashed blue line shows the linear trend of this data which indicates the steady improvement achieved by the operators during the first half of 2010. A running average of the last fourteen data points is shown by the solid red line, which still reveals weekly fluctuations in performance. Some of this data scatter can be related to changes in the operating parameters as the operators learned to improve system recovery with the fluctuations in stillage feed characteristics. During May and June the operators have been able to achieve an average recovery of 2.1gpm. In April the centrifuge bowl was exchanged to assess if lower performance observed during the initial few months was related to the bowl characteristics or the specific characteristics of the stillage in the facility. Based on the data to date no dramatic step change in performance was observed with this physical hardware change.

The performance of the system was based on the performance guarantee provided by Westfalia for the RS220 centrifuge designed for oil recovery applications. Their specification defined that when operational, the system will extract on average 98% (as measured volumetrically) of free, non-bound oil available from the feed, up to 75 gallons per minute. Blue Flint conducted daily spin tests of their feed material to determine variations in the material being feed to the centrifuge. One primary issue is the low level of unbound oil observed in these daily tests with a majority of samples illustrating only a trace amount of oil and mostly a light phase material consisting of a high lipid content emulsion of solids-aqueous-oils. When a trace of oil was defined an assumption of half a millimeter (approximately 0.5% by volume) was inserted to support numerical calculations. Besides the oil production data and its running 14 point average, Figure 2 illustrates the data that reflects the amount of free or unbound oil in the feed stillage. Two lines are shown. The blue line reflects the unbound oil in at the actual stillage feed rate to the centrifuge which could vary from 50 to 80gpm of stillage, and the dashed green line reflects the same spin data but assuming a 75gpm constant feed rate. Since the oil production for the quarter exceeds the amount of free, unbound oil by a factor of 3 to 4 times, the system obviously achieved the performance specification of the centrifuge.

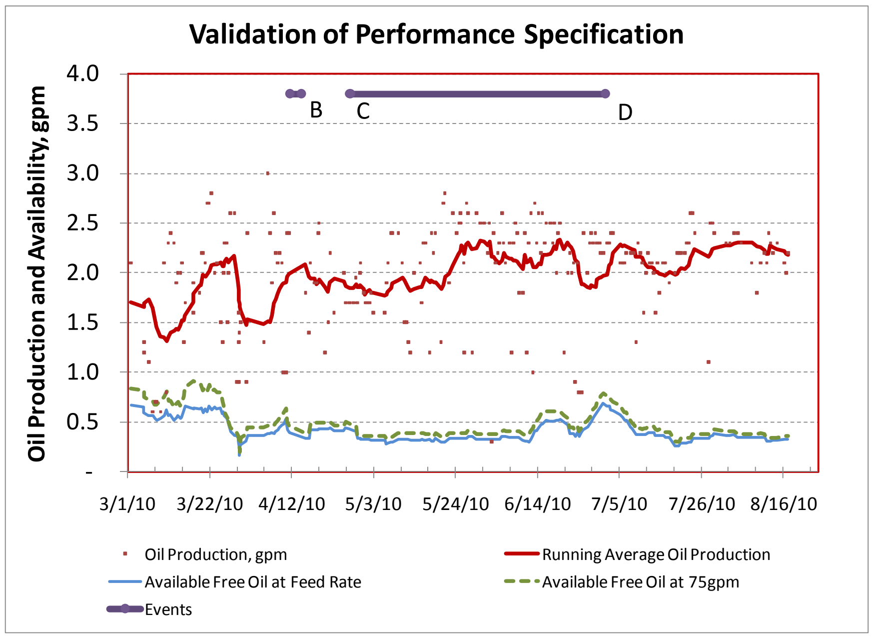

Figure 2 Validation of Performance Specification

The potential exists to increase performance in the future. This is illustrated in Figure 3 that shows the estimated maximum amount of oil material in the feed stillage at Blue Flint. As part of their daily sample analyses the emulsion layer volume was measured, which can be related to the potential for maximum oil content in the stillage stream. By estimating that 40% of the emulsion layer is oil that could be released and adding the measured amount of unbound oil an estimated maximum oil content in the stillage can be determined. This data is shown by the running average (14 point) of the daily spin samples shown in green in Figure 3 and the period average by the dashed line. Generally, the difference between the red actual production line and the maximum oil content line is between 0.5gpm and 1.0gpm. Additional testing and evaluation of the system is needed to determine the system operational adjustments or the stillage characteristics, which are needed to enhance system performance to this maximum level. The removal of oil from the stillage effects the levels of fat in the DDGS, we have been careful not to drop fat levels below our minimum specification as to negatively affect our DDGS quality. We have also adjusted syrup solids as to optimize oil production, this was challenging as changes were made to solids levels changes had to be made to centrifuge partials and full chutes to gain maximum oil production.

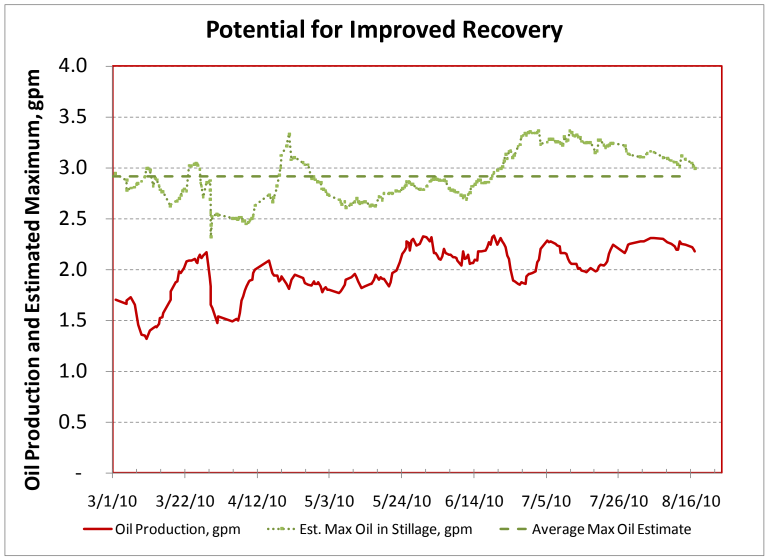

Figure 3 Potential for Improvement

During the May and June period data from actual truck deliveries of oil were analyzed. Typically, a truck would be loaded every two to three days, with each truck averaging around 25k lb of oil. The actual truck deliveries are shown on Figure 4 represented by the truck capacity divided by the number of days between deliveries. Since actual times for each delivery was not provided there appears to be more scatter in this data than actually, and therefore, two averages are also shown. A period average delivery rate of 20.8k lb per day was achieved

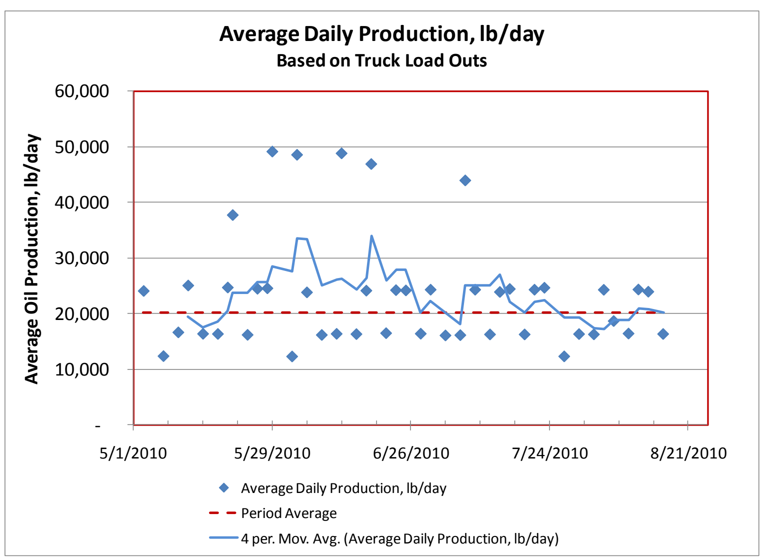

Figure 4 Average Daily Production based on Trucks

during the 56 days of information provided as shown by the dashed red line in Figure 4. Also illustrated is the 4 point running average for the data by the solid blue line that indicated the performance improvement toward the last thirty days.

One additional analysis was conducted to evaluate the consistency between the measured oil flow meter readings taken periodically during the day and used in the earlier flow rate (gpm) analyses. This comparison is shown on Figure 5 with the cumulative oil delivered during the period of May and June based on actual truck deliveries as blue diamond data points and the cumulative flow meter readings taken one or two times a day. An oil density of 7.7 lb/gallon was used as a standard and the measured reading was assumed constant between readings. Because the cumulative actual time based volumetric data was not provided an additional adjustment was needed to account for the auto de-slugging cycle of the centrifuge. The unit has a periodic bypass of the feed stillage and expels the contents of the bowl to remove solid that have built up in the outer diameter. To compensate for this period of no or low oil recovery, an additional adjustment of 0.93 was used. With these assumptions the data presented by the solid red line in Figure 5 appears to match the actual truck load out data over the two month period.

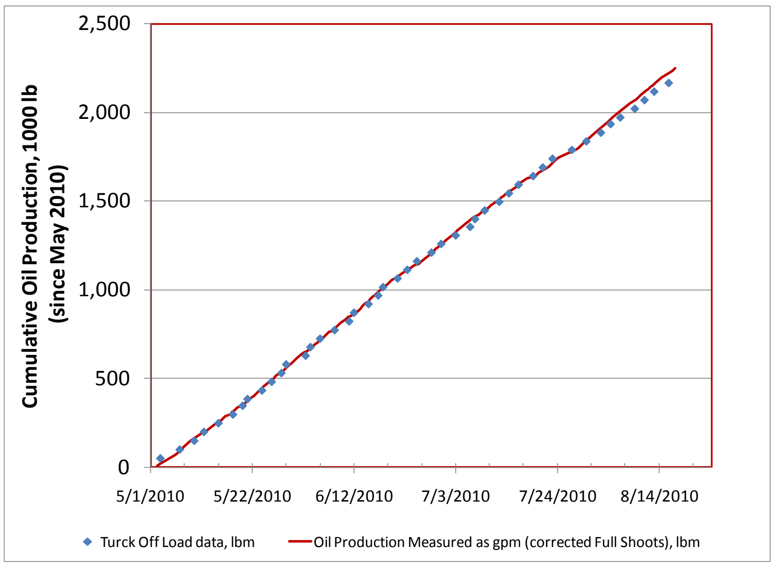

Figure 5 Comparisons of Oil Meter and Truck Load Out

In summary, the SMAART Oil system has been operating at the Blue Flint facility consistently since the beginning of 2010. The system has achieved its performance guarantee in the contract as shown by delivery 3-4 times the amount of free oil in the feed stillage. This also indicates that the additional features of the system provide improved performance over standard installation designed to only achieve recovery of free oil content. Experience with the system over the first half of 2010 has resulted in the operators being able to achieve a continuous steady improvement in oil recovery by adjustments to both the system and characteristics of the stillage feed. Analysis of the feed stillage and the de-oiled stillage indicates that additional improvements are feasible.

Budget

The project budget was proposed to be $1.8M. The project was contracted as “turn-key” with Primafuel with a project cost of $1.8M. The project was completed within the proposed budget.

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