Energy Flows — Huasna Valley Oil Operations

(2009-02-18)

This note contains estimates that we have made of energy flow rates associated with oil recovery operations proposed for Huasna Valley. All data used was obtained from a recent document (ND)[1].

The concept of energy flow has been used in an attempt to unify the various quantities described in ND. Energy flow occurs when propane is used to heat water oil and containers, when diesel or propane fuel is used to generate electricity, when diesel fuel is used in trucks to transport oil, and when the oil, itself, is transported. No attempt has been made to describe the temporal variation in energy flow over the duration of the proposed oil recovery operations; only the average will be used.

1. Components of Energy Flow

The document, ND, has distinguished the activities as stationary or mobile (e.g., pages 280-281). Propane use for heating and for generators is included in the stationary activities while trucking of oil is included in mobile activities. To evaluate an energy flow rate, it is necessary to know how much energy is transformed or transported per unit mass or unit volume. We will use the heat of combustion values to obtain our estimates since this is independent of details of use of the energy sources. Table 1 gives typical values for propane, diesel fuel, heavy crude oil and gasoline.

Table 1. Physical Properties

	Density	Heat of Combustion		
Substance	kg/L	MJ/kg	MJ/L	kWh/USgallon
diesel fuel	0.82	45	37	39
gasoline	0.74	47	35	37
heavy crude	0.83	44	37	39
propane	0.58	50	29	31

The density and leftmost value of heat of combustion (megajoules per kilogram) are typical of values obtained from physical tables. The fourth column of the table is the product of the second and third columns and the last column is a units conversion of the fourth column (kilowatt.hours per US gallon) using the fact that a watt is a joule per second, there are 3600 seconds in an hour and a US gallon is about 3.785 liters.

Table 2 gathers data from ND and other sources that will be used, along with values from Table 1, to calculate energy flow rates.

Table 2. Supporting Data

Quantity	Source	Comments
452.7 USGallons	ND p. 280	Daily use of propane for average daily heat for water injection at 750 bbl/day oil production
7.1 USGallons	ND p. 280	Daily use of propane for maintaining heat in stock tanks at 750 bbl/day oil production
391.9 USGallons	ND p. 280	Daily use of propane for 150 kilowatt generator at 75% load
138 miles	ND p. 281	One-way distance to oil depot (20.37 + 91.5 + 26.1 = 137.97)
36 liters/100 km	15-ton truck specs	Diesel fuel usage rate (6.57 miles/USGallon). Typical mid-range of diesel truck specifications
12 round trips per day	ND p. 4	Round trips per day for oil tanker trucks
63000 USGallons	ND p. 7	Daily total maximum gross throughput of initially extracted oil/water mix
2800 USGallons	ND p. 47	Capacity of tanker truck

[1] *Negative Declaration & Notice of Determination,* San Luis Obispo County Department of Planning and Building (February 5, 2009). The document is available in PDF as the file 02-05-09_Excelaron_Negative_Declaration.pdf. It contains 640 pages. All references to page numbers in this note will be to the numbers as reckoned by the Adobe Acrobat 6.0 Professional application.

2. Energy Flow Rates

We assume a production of 800 barrels of oil per day that is 800 barrels/day × 42 USgallons/barrel = 33600 USgallons/day of heavy crude oil. This is consistent with 12 tanker truck trips per day with 2800 USgallons each for a total of 12 × 2800 = 33600 USgallons/day.

The energy flow (energy per unit time) from the use of diesel fuel for the tanker trucks would then be

$$12\ \frac{trips}{day} \times 276\ \frac{miles}{trip} \times \frac{1}{6.57}\ \frac{gallons}{mile} \times 39\ \frac{kW\ hours}{gallon} \times \frac{1}{24}\ \frac{day}{hour} = 819 kW$$

This 819 kilowatts is the same as the energy flow rate required to keep 8190 100-watt lamp bulbs lit. Similar calculations are used to obtain the entries in Table 3.

Table 3. Energy Flows

	Energy Flow Rate (kW)		
Energy Flow	Depletion	Production	Comments
Heater (water injection)	624		At 63000 gallons water/oil mix (maximum) per day. Is enough energy flow to give 63000 gallons a temperature rise of 54° C.
Heater (stock tanks)	10		At 63000 gallons water/oil mix (maximum) per day
150 kW generator	506		Electrical supply — (0.75 × 150)/506 → 22.2% efficiency
Tanker truck fuel	819		12 round trips daily
Crude oil		54600	Corresponds with 12 × 2800 = 33600 USgallons per day of crude oil from the 63000 USgallons per day of water/oil mix at 46.7% water. Will be less if more water is present in mix. If water is less than 46.7%, cannot exceed 54600 kW due to truck load and frequency limitations.
TOTAL	1959 kW	54600 kW	

3. Summary and Comments

Some of the energy flows corresponding with depletion have been neglected. These include, at least, personnel travel, service travel and amortization of energy used during construction.

The energy rate associated with crude oil production assumes that the oil being transported has essentially no water remaining in the mix.

If the oil plus water mix flow is 63000 USgallons/day and the tanker truck fuel used is proportional to the amount of crude oil produced, the net energy flow (production minus depletion) is zero when the water volume is about 98.9% in the mix. This reduced production of oil corresponds will require only one tanker truck trip every three or four days. The economic break-even point is probably with the water volume well below 98.9%.

Using Table 1 with a generator efficiency of 22.2%, use of commercial electricity will be less expensive than using a generator if 31 × 0.222 = 6.88 kWh of commercial electricity is less costly than a USgallon of propane. The actual economic advantage of using commercial electricity is greater than this if the costs of amortization and maintenance of the generator are recognized.