



Memorandum

24 November 2010

To	Robert Grover		
Copy to	Mike Blake		
From	Shastri Sitharamarao	Tel	6222 8351
Subject	Fushun Test Results	Job no.	61/24140

Background

Boss Energy engaged Fushun Mining Group to conduct trials on its oil shale to determine the suitability of the Fushun Vertical Retort Technology to process Tasmanite from the Latrobe project. An indicative 500 kg sample of oil shale was shipped to Fushun for these trials. The quantity was in excess of that required to ensure that there was adequate oil shale for the various tests. As part of their quality process tests were repeated and enough sample was required for the tests. The Fushun tests mimicked the various internal processes of retorting. Products from retorting, which include oil, water, semi-coke and ash, were further analysed.

Fushun technology was chosen because:

1. Fushun represents an established commercial oil shale to oil process
2. Fushun's Energy Testing Research Centre is the only nationally accredited testing facility in China for oil shale. Being nationally accredited, the results are internationally accepted.

Key highlights of the Report

- ▶ *The physical / chemical parameters of Tasmanian oil shale of the Latrobe project are similar to Fushun's oil shale and hence it can be processed and treated using Fushun Retort technology*
- ▶ In the sample sent, the oil content is 93.3 kg/dry tonne of oil shale, which compares favourably with other Australian oil shales and Fushun oil shale.
- ▶ Oil from Latrobe oil shale can be classified as a wax-free crude oil with light crude fraction of 10% and diesel fraction of 50%
- ▶ Oil from Latrobe oil shale has a low pour point (-22°C) and a heating value of 42.4 MJ/kg (conventional crude oil is 42.7 MJ/kg)
- ▶ Light crude content of the oil is high and it can be used directly as a fuel oil
- ▶ The tests indicate that Latrobe oil shale can be retorted at lower temperatures than standard retorting temperatures, which are about 450°C; majority of the oil was released between 170 and 480°C
- ▶ The process has sufficient energy to be self sustaining
- ▶ Tasmanian oil shale would produce less gas than Fushun oil shale, but has a significantly higher heating value (a little over 20 MJ/m³)

- ▶ The water content (11.2%) was lower than the threshold moisture content for the Fushun process (15%), implying that external drying would not be required prior to retorting
- ▶ Low dust is produced during crushing operations owing to moisture content

The report indicates that the sample from the Latrobe project is comparable to Fushun oil shale in physical and chemical characteristics and products from retorting.

Summary of Technical Results

Summary of main results are tabulated below.

Table 1 Physical/Chemical Parameters

Item	Sample Name		
	Oil Shale	Semi coke	Ash
Water content (%)	11.2	0.4	0.4
Oil content (%)	9.5	0.5	0.0
Semi coke	76.4	98.8	99.5
Gas loss	2.9	0.3	0.1
Water content (Mad%)	1.12	0.07	0.05
Ash content (Ad%)	78.94	91.73	94.84
Volatile matter (Vd%)	18.49	3.81	3.04
Fixed carbon (Cd%)	2.57	4.46	2.12
bomb calorific value Qb.ad(J/g)	6573	2226	1343
Total sulphur	2.31	1.65	1.19

Table 2 Cylindrical test data (retorting test)

Oil shale weight(as received)	kg	7
Oil shale weight (as processed)	kg (dry oil shale)	6.2
Oil yield	kg/t (dry oil shale)	93.3
Cylindrical kiln oil content	mass % (dry oil shale)	9.3
Unit retort gas	Nm ³ /t (dry oil shale)	17.7
Unit air flow	Nm ³ /t (dry oil shale)	108.1
Unit gasification gas	Nm ³ /t (dry oil shale)	195.3
Degree of saturation of air flow	Degree	60-70
H ₂ S yield	kg/t (dry oil shale)	5.9

Oil shale weight(as received)	kg	7					
Retort process pressure	Pa	823					
Gasification process pressure	Pa	2760					
Retort gas heating value	kJ/m ³	20027.33					
Gasification gas heating vale	kJ/m ³	749.96					
Retort Process gas composition (volumetric %)							
H ₂	CO	CO ₂	CH ₄	H ₂ S	C _n H _m	N ₂	
27.6	3.8	3.8	15.1	22.1	17.6	10	
Gasification Process gas composition (volumetric %)							
H ₂	O ₂	CO	CO ₂	CH ₄	H ₂ S	C _n H _m	N ₂
0.7	3.4	0.7	13.9	0.2	0.6	0.6	79.9

Table 3 Shale Oil Analysis

No.	Test Item	Value	Remarks
1	Density @ 20 °C (kg/m ³)	0.9113	20 °C standard Density
2	Water Content (%)	0.0	
3	Pour Point (°C)	-22	
4	Freezing Point (°C)	-25	
5	Flash Point (°C)	50	
	Fire Point (°C)	55	
6	Kinematic Viscosity @ 80°C (mm ² /s)	2.4639	
7	Ash Content (%)	0.001	
8	Carbon Residual (%)	1.6	
9	Asphalt Content (%)	0.127	
10	Sulphur Content (%)	2.66	
11	Paraffin Wax Content (%)	0.153	
12	Mechanical Impurities (%)	0.007	
13	Bomb Calorific Value (J/g)	42353	10128 Kcal/kg
14	Acid Value (mgKOH/g)	16.6909	

No.	Test Item		Value	Remarks
15	Gum Content	(%)	41.41	
16	Distillation (+260°Cm/m)	(%)	85.56	
			% (v/v)	°C
			Initial	131
			5	150
			10	199
			20	252
			30	198
17	Distillation Process (TBP)		40	324
			50	347
			60	362
			70	393
			80	418
			90	448
			95	503

Key Observations from visit to Fushun

- ▶ Fushun Mining Group is currently the world's largest processor of oil shale to shale oil
- ▶ All produced water is used within the process and there is no water discharge
- ▶ Modularity of the process equipment indicates that capital investment could be staggered
- ▶ Potential and evidence for use of spent shale (ash) for a variety of products such as fertilisers, building materials and insulation

The testing results and site visit indicate that there is an opportunity for the application of the Fushun Retort Technology to process Tasmanian oil shale of the Latrobe project. The tests have also raised the profile of Tasmanian oil shale showing that the Latrobe resource is world class. However, only a detailed review that includes a fatal flaw analysis and financial modelling will determine the viability of the opportunity.

Should the review suggest proceeding with the technology, the next technical stage would require pilot plant testing at Fushun Mining Group's pilot facilities and this may require about 150 tonnes of oil shale and take a month to complete.



Memorandum

Fushun visit photographs



Ash, coke, oil shale, and retorted oil from Tasmanite sample



Oil Sample



Fushun Oil shale plant, China



Fushun Oil Shale retort (<http://english.fkjt.com.cn/>)