Natural Resources Canada

Ressources naturelles Canada

EXPERIENCE WITH CAPSTONE AND INGERSOLL-RAND MICROTURBINES USING WASTE FUELS

Benny Benson, P.E.
SCS Energy

DOE/CETC/CANDRA Workshop on Microturbine Applications
January 21-23, 2003 Calgary, Alberta, Canada

PROJECT SUMMARY

PROJECT	SIZE	CONRACT TYPE	MICROTURBINE MANUFACTURE
JAMACHA LANDFILL	280 kW	TURNKEY	INGERSOLL-RAND
CALABASAS LANDFILL	300 kW	TURNKEY	CAPSTONE
OII LANDFILL	420 kW	TURNKEY	INGERSOLL-RAND
ACME LANDFILL	280 kW	DESIGN/ SUPPLY	INGERSOLL-RAND
BUTTERFIELD LANDFILL	70 kW	TURNKEY	INGERSOLL-RAND
MOUNTAIN VIEW LANDFILL	140 kW	DESIGN/ SUPPLY/ OVERSIGHT	INGERSOLL-RAND
ALLENTOWN WASTEWATER PLANT	390 kW	RETROFIT	CAPSTONE

SCS ENERGY

SCS ENERGY

PERFORMANCE SUMMARY

PROJECT	HOURS OF OPERATION	HEAT RATE Btu / kW – H (LHV)	AVAILABILITY (Best / Average)	
			HOURS	POWER
INGERSOLL-RAND				
JAMACHA LANDFILL	> 5000	13,700	77 % / 65 %	93 % / 75%
OII LANDFILL	> 2000	13,900	89 % / 67 %	92 % / 68 %
CAPSTONE				
CALABASAS LANDFILL	> 3000	14,300	> 98 %	> 95 %

SCS ENERGY

SCS ENERGY

SCS ENERGY

SCS ENERGY

SCS ENERGY

RAW FUEL SUMMARY

PROJECT	CH4 (%)	H2S (ppmv)	SILOXANE		
			D4 (ppbv)	D5 (ppbv)	TOTAL (ppbv)
JAMACHA LANDFILL	35 - 40	20	113	54	232
CALABASAS LANDFILL	45 - 50	75	200	< 140	705
OII LANDFILL	35 - 40	60	145	112	690
ACME LANDFILL	45 - 55	50	3158	884	5898
BUTTERFIELD LANDFILL	35 - 40	10	--	--	--
MOUNTAIN VIEW LANDFILL	40 - 45	--	--	--	--
ALLENTOWN WASTEWATER PLANT	62	800	164	1380	1600

PRE-TREATMENT SILOXANE SUMMARY

PROJECT	INLET	COMPRESSOR OUTLET	CHILLER OUTLET	CARBON OUTLET
JAMACHA LANDFILL	232	260	127	ND
CALABASAS LANDFILL	340	370	< 70	ND
OII LANDFILL	690	--	--	--
ACME LANDFILL ** Ex. Compressor/Chiller 20 yrs old	5898	--	8107	--

SCS ENERGY

SCS ENERGY

SCS ENERGY

PROJECT COST BREAKDOWN ($x1000)

PROJECT	DESIGN	ELEC.	WELL FIELD	PRE-TREATMENT	INFR.
JAMACHA 280 kW - Turnkey	60	80	40	190	30
CALABASAS 300 kW - Turnkey	50	95	20	185	25
OII 420 kW - Turnkey	109	220	30	190	170
ACME 280 kW – Design / Supply	50	40	--	20	25
BUTTERFIELD 70 kW - Turnkey	35	20	--	60	15
ALLENTOWN 390 kW - Retrofit	50	55	--	200	30

SCS ENERGY

PROJECT COST SUMMARY

PROJECT	SIZE	TOTAL COST	$ / kW
JAMACHA	280 kW	$ 700,000	$ 2,500
CALABASAS	300 kW	$ 770,000	$ 2,570
OII	420 kW	$ 1,300,000	$3,095
ACME ** Existing Compressor	280 kW	$ 425,000	$1,520
BUTTERFIELD ** Single Skid Package	70 kW	$ 190,000	$ 2,710

SCS ENERGY

SCS ENERGY

TYPICAL TURNKEY PROJECT TIMELINE

	MONTH					
DESCRIPTION	1	2	3	4	5	6
DESIGN	10 WEEKS					
INTERCONNECTION	12 WEEKS					
ELECTRICAL EQUIPMENT		14 WEEKS				
MECHANICAL EQUIPMENT		16 WEEKS				
SITE WORK					6 WEEKS	
START-UP						2

FACILITY DESIGN ISSUES

- COORDINATION
  - FUEL SUPPLY
  - PRE-TREATMENT
  - MICROTURBINES
- LEVEL OF PRE-TREATMENT
  - TYPE OF COMPRESSION
  - MOISTURE REMOVAL
  - H2S REMOVAL
  - SILOXANE REMOVAL
- CONTROL SYSTEM
- NOISE
- PROTECTIVE RELAY REQUIREMENTS
- EMISSIONS

MICROTURBINE SPECIFIC DESIGN ISSUES

PROJECT	CAPSTONE	INGERSOLL-RAND
SIZE / FOOTPRINT	30 kW	70 kW
NOISE (AT 3 METERS)	> 85 DBA	> 90 DBA
INLET FUEL PRESSURE	> 80 PSI	> 8 PSI W/ BOOSTER > 80 PSI W/O BOOSTER
CONTROLS INTEGRATION	MODBUS	MODBUS
OUTDOOR USE	NOT REQUIRED	REQUIRES COVER
PROTECTIVE RELAY	EMBEDDED	EXTERNAL
SERVICE	WARRANTY	BY MANUFACTURE

SCS ENERGY

OPERATIONAL ISSUES

- INTEGRATION
  - FUEL SUPPLY
  - PRE-TREATMENT
  - MICROTURBINES
- FUEL SUPPLY
- PRE-TREATMENT SYSTEM
  - CAPACITY
  - MOISTURE REMOVAL
- CONTROL SYSTEM
- NOISE
- MICROTURBINES
  - NATURAL GAS MIND SET
  - MAINTENANCE / DESIGN COORDINATION
  - SERVICE

SCS ENERGY

SUMMARY

- Capstone and Ingersoll-Rand can successfully operate on low-Btu (waste) fuels.
- Capstone gained experience from early market entry.
- Ingersoll-Rand willing to stand by their equipment while gaining similar experience.
- Present state of the technology requires extensive pre-treatment for successful operation.
- Pre-treatment costs can be lowered through additional study of moisture, H2S, and siloxane impacts.

Natural Resources Canada

Ressources naturelles Canada

EXPERIENCE WITH CAPSTONE AND INGERSOLL-RAND MICROTURBINES USING WASTE FUELS

Benny Benson, P.E.
SCS Energy
3711 Long Beach Blvd., 9th Floor
Long Beach, California 90807
(562) 426-9544
Bbenson@scseng.com

DOE/CETC/CANDRA Workshop on Microturbine Applications
January 21-23, 2003 Calgary, Alberta, Canada