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Project Summary

Selective Enhancement of RDF Fuels

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Conversion of the organic fraction of municipal solid waste (MSW) to a powdered fuel offers a number of advantages for improving both the quality and marketability of the product. This project concentrated on improving the embrittlement process and characterizing the properties of the powdered fuel thus obtained. The combustion characteristics of the powder alone and the powder mixed with powdered coal and with oil were extensively evaluated.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The processes to convert the organic fraction of MSW to a powdered material offer a number of advantages for improving both the quality and marketability of refuse-derived products. In the powdered form the refuse is a more effective fuel, it can be used as a filler material in plastic and rubber products and can be used as a feedstock in several biomass conversion processes (acid hydrolysis, pyrolysis, etc)

Characteristics of RDF Powder

Powder Characterization

Over 363 kg (800 lb) of refuse-derived fuel (RDF) were processed by embrittlement treatment for conversion to a fine powder (Table 1). The powder obtained by the embrittlement of RDF consisted primarily of short choppy fibers minus 150μ (-100 mesh) in size. Dispersed in the fibrous mix were irregularly shaped inert materials, predominantly silicate glasses The powder contained 5% to 7-1/2% moisture and 25% to 44% noncombustibles. The quantity of noncombustibles will vary considerably for different processes and for different areas of the country. Analysis indicated the powder contained about 52% volatiles and had a carbon content of 35% and a chlorine content of 3%. The powder had a loose density of 271 kg/m^3 (16.9 lb/ft^3) and an average heat content of 13025 Mj/kg (5600 BTU/lb). An RDF with a lower inert content would have a higher heat content. The inert fraction was calcium-, magnesium-, sodium-, aluminum-silicate

Table 1. Powder processing conditions.

Quantity of RDF Processed	*2.3 kg/5 lb*
Processing temperature	*149°C (300°F)*
Processing time	*3 to 5 min*
HCl flow rate	*439 cm^3/sec (0.93 ft^3/min)*
N_2 flow rate	*170 cm^3/sec (0.36 ft^3/min)*
HCl adsorbed by RDF	*2% by weight*
Ball mill time	*2 hr*
Screening time	*1 hr*

Table 2. *Results of the Combustor Experiments*

Run No.	Fuel: Type	Feed Rate kg/hr	Feed Rate (lb/hr)	Wall Temp.[a] Average °C	Wall Temp.[a] Average (°F)	Approximate Residence Time in Furnace, sec.	ppm CO	ppm SO_2	ppm NO	% CO_2	% O_2	Weight % (in ash) C	Weight % (in ash) H
1.	Coal	0.54	(1.2)	946	(1735)	0.85	550	2800	550	13.0	6	13.2	0.2
2.	RDF Powder	<0.9	(<2)	899	(1650)	3.71	100	60	150	14.4	9	8.1	0.3
2a.	RDF[b] Powder	<0.9	(<2)	871	(1600)	~4	<300	--	--	--	10.5	1.2	--
3.	75% Coal[c] 25% RDF Powder	0.54	(1)	963	(1765)	2.06	550	2200	--	15.8	6	24.1	0 5
4.	75% Coal[c] 25% RDF Powder	0.9	(2)	899	(1650)	0.96	320	2000	--	16.0	6	11.9	0.2
5	50% Coal[c] 50% RDF Powder	0.9	(2)	960	(1760)	0.98	140	1500	--	16.4	5	4.0	0.2
6.	50% Coal[c] 50% RDF Powder	1.36	(3)	935	(1715)	0.93	220	1500	--	14.4	3	9.6	0.2

[a]Thermocouple readings at 1 27 cm (0 5 in) from inside wall, inside wall temperature approximately 204°C (400°F) higher
[b]Minus 74μ (-200 mesh) RDF powder, and all other fuels minus 149μ (-100 mesh)
[c]Weight percent basis

glass, low in iron The fusion temperature was above 1360°C (2480°F). The RDF powder was easily ignited and burned readily

When compared with powdered coal, the RDF powder had a lower ignition temperature, higher volatile content, much lower carbon, about half the heat, twice the ash, one-tenth the sulfur, and 15 times the chlorine, and was four-tenths the density. As a fuel, the RDF powder will ignite and burn more rapidly than coal but generates less thermal energy. Combustion products will present about as much corrosion problems as coal (Cl versus S) but should present greater handling problems because of a lower density and high ash content.

Powder/Oil Slurries

Suspension of the RDF powder in a fuel oil offers a number of advantages for enhancing the use of the RDF powder as a fuel. easier transport and storage, greater safety, etc The procedure for preparing powder/oil slurries and selected properties were evaluated.

The powdered RDF can be easily slurried in oil, up to about 40 weight percent. The only problem was the sedimentation of the powder within 4 hours More stable suspensions (exceeding 20 hours) were obtained with small (1%) additions of the dispersion agent (Rheotol*). As would be expected, the density and viscosity of the powder/oil slurry is considerably higher than the pure fuel oil. Stabilized slurry does not appear to present transport and handling difficulties, although long-term experience with these fuel mixtures will be required

Combustor Experiments

RDF Powder and RDF Powder/Coal Mixtures

The RDF powder and mixtures of 25 and 50 weight percent RDF powder with coal were fired in a pulverized coal test combustor Although some handling problems were encountered with the RDF powder because of its lower density and heat content, the RDF powder/coal mixtures (particularly the 50/50 blend) handled very well and all the compositions tested burned well (Table 2) In addition to its good handling characteristics, the 50/50 blend proved to be the most effective fuel mix studied The lower ignition temperature and higher quantity of volatiles in the RDF aided the combustion of the coal

*Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U S Environmental Protection Agency

The coal was also more completel combusted when it was mixed with the RDF powder The very low sulfur and alkali content of the RDF powder effec tively reduced SO_2 in the combustion gas emissions. The high chlorine content in the RDF powder may, how ever, cause corrosion problems and some environmental concerns. The use of a less corrosive embrittling agen (e g., HNO_3, H_3PO_4, O_3, H_2O_2, etc), i effective, could reduce or eliminate this problem.

RDF Powder/Oil Slurries

The RDF powder/oil slurries with up to 30 weight percent RDF burned well in the test furnace. Above the 15 weigh percent, however, there were a numbe of problems in transporting the slurry The primary problem was powder sedi mentation plugging the pump and feed lines Using a dispersion agent should alleviate this problem The combustion of the powder/oil slurries produced considerably more ash than is obtained when the oil is burned alone. This causes handling problems since the conventional oil burning units are no designed to process large quantities o ash The ash content of the RDF powde is likely to be the limiting factor fo determining the RDF powder-to-oil ratio for slurry preparation

Conclusions

An effective procedure for converting RDF to a fine powder by embrittlement treatment was developed. The RDF powder appears to be an effective fuel compatible with coal and some oil burning equipment. Although the RDF powder can be burned alone or in combination with coal and oil, its best performance was in a mix with pulverized coal—as a 50/50 mix This fuel mixture burns well (better than either component) and results in lower SO_2 emissions

The major difficulties with using the RDF powder as a fuel is the high inert content (ash) and the potential problems from the high chlorine content Using screening and other classification processing of the raw refuse should significantly reduce the inert content, and using different embrittlement reagents (HNO_3, H_3PO_4, etc) should eliminate potential corrosion and environmental problems Additional research studies will be required, however, to select effective unit processing procedures that will reduce inert content and to select a less corrosive embrittlement agent

In the course of this work, a technology for converting refuse to a fine powder was established based on the use of cellulose embrittlement techniques. The mechanisms of the process are not completely understood, however, and need further elucidation Identifying effective alternative embrittlement reagents, particularly reagents that would not leave corrosive or detrimental residues, is also needed.

The RDF powder, when used in a 50/50 (by weight percent) mix with pulverized coal, enhanced combustion of the coal More needs to be known, however, about the handling (transport, storage, etc) behavior of both the RDF powder and the powder in a 50/50 mix with pulverized coal. In addition, more needs to be known about the emissions from combustion of RDF/coal mixtures.

Apparently a variety of biomass materials, particularly cellulose wastes from industrial and agricultural sources (stalks, husks, bark, wood and crop residue, straw, etc.) could also be converted to a powder for use as a fuel or as a feedstock for biomass conversions Effective processing procedures for powdering the variety of biomass materials that might be available for conversion to a powdered fuel are needed

Based on these observations, the following recommendations for future work are proposed (1) further elucidation of the embrittlement mechanisms; (2) identification of alternate embrittlement reagents; (3) further characterization of the RDF powder mixed with pulverized coal; and (4) extention of the embrittlement process to other biomass materials

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The complete report, entitled "Selective Enhancement of RDF Fuels," (Order No. PB 81-179 269; Cost: $8.00, subject to change) will be available only from:
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