

Upcycling of Polymer Composites

Aluminium Composite Panels (ACP)

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What's next...

Aluminium Composite Panels (ACP)



Construction:

- Aluminium sheets,
- Polyethylene core,
- 3-6 mm thickness.



Issues: Fire-safety

(2010 Shanghai fire in China; 2012 Al Tayer Tower fire in United Arab Emirates; 2014 Lacrosse Tower fire in Australia; 2017 Grenfell Tower fire in the United Kingdom).

Consequences:

- Regulatory change cladding systems.
- Early end-of-life for many ACP's.
- Excessive waste generation, disposal at landfills, low-volume recycling.



Recycling of ACP



Study:

- Investigate the feasibility of implementing an ACP up/re-cycling facility.

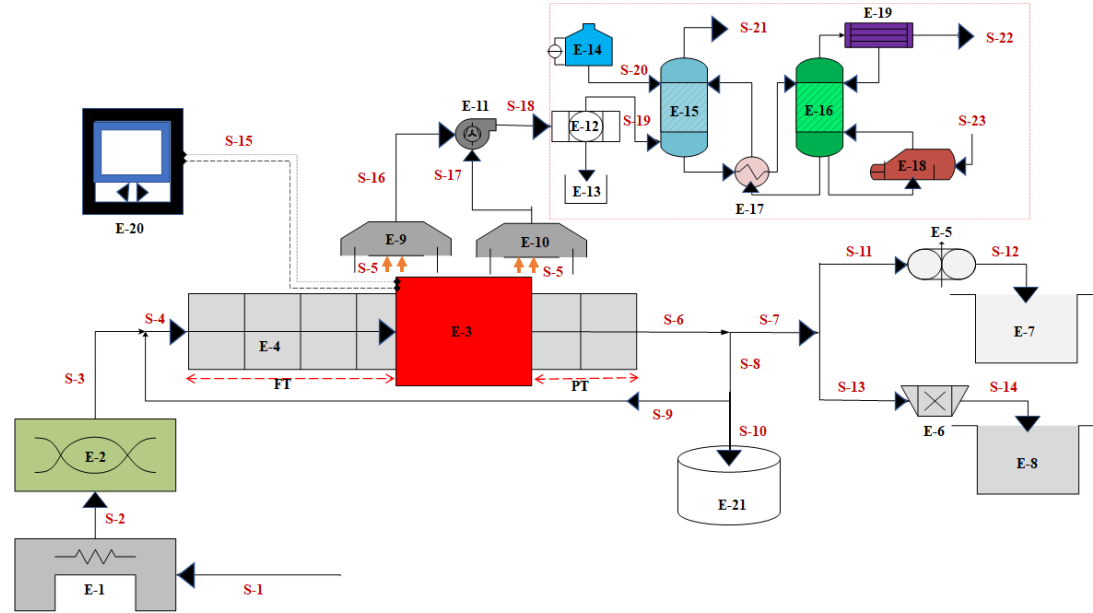
Objectives:

- To perform the recycling performance of cladding waste using a prototype separation unit/device under critical process parameters.
- To identify the limitations of the prototype unit/device for required optimization.
- To identify the compatibility of prototype device using various cladding waste.

Product potential



ACP separation process



ACP separation process



ACP Input:

- ACP consumption: 570 kg/day.

Output:

Aluminium

- Purity: 99%.
- Estimated unit price of final Al products (S-12): ~\$3-5 AU.

Polyethylene

- Grade: HDPE
- Estimated unit price of HDPE composite (S-14): ~\$1.5-3.0 AU.

Gaseous by-products (S-5)

- Emissions*: ~500 g/day (0.15 ton/year)

Emission tests

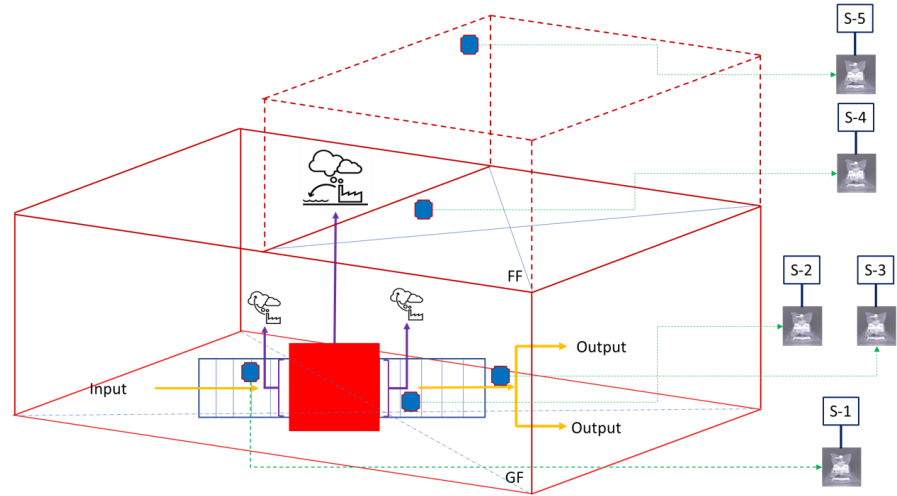


Emission sampling:

- 8-hour shifts,
- Multiple locations within facility,
- Multiple (4) days of operation.

Detected gases:

- Hydrogen (H_2),
- Methane (CH_4),
- Nitrous oxide (N_2O), and
- Carbon oxides (CO , CO_2).



Emission tests



Sample ID	Concentration (ppm)				
	H ₂	CH ₄	CO ₂	N ₂ O	CO
GF – R	1.2	<0.1	555	0.45	1.5
GF – 2	1.2	<0.1	581	0.43	1.5
GF – 4	1.5	<0.1	626	0.47	1.6
GF – 6	1.4	<0.1	679	0.45	1.6
GF – 7	1.3	<0.1	639	0.44	1.6
FF – R (day 1)	1.2	<0.1	568	0.47	1.5
FF – 0.083 (day 1)	1.3	<0.1	595	0.46	1.5
FF – 2 (day 1)	2.0	<0.1	584	0.45	2.8
FF – 4 (day 1)	1.4	<0.1	578	0.46	3.0
FF – 7 (day 1)	5.3	<0.1	635	0.45	48
FF – 7 (day 2)	8.2	3.2	647	0.46	86
FF – 7 (day 3)	10.5	1.4	1630	0.75	89
FF – 7 (day 4)	3.0	1.2	629	0.46	60
	3 rd	4 th	Highest	Lowest	2 nd

Emission tests



All gas concentrations appear to remained below allowable TWA and STEL values.

Chemical name	Symbol	CAS No.	TWA		STEL		Advisory carcinogen category	Other advisory information
			(ppm)	(mg/m ³)	(ppm)	(mg/m ³)		
Hydrogen	H ₂	1333-74-0	-	-	-	-		
Methane	CH ₄	74-82-8	-	-	-	-		
Carbon monoxide	CO	630-08-0	30	34	-	-		-
Carbon dioxide	CO ₂	124-38-9	5,000	9,000	30,000	54,000	-	-
Nitrous Oxide	N ₂ O	10024-97-2	25	45	-	-	-	-

Limitations:

- Incremental gas sampling measurements different from that used for TWA and STEL.
- Emissions increase proportionally with consumption. Gas absorption units important to achieve max operation consumption.

Feasibility of optimised process



The feasibility study on the pilot plant of ACP recycling was conducted to determine the total capital cost, total operating cost, and profitability indicators.

- Total capital cost: ~\$728,750 AU.
- Total operating cost: ~\$383,208 AU.

- ACP consumption: 0.5 tonne/day

- Annual profit: ~\$816,792 AU.
- Payback period: 1.7 years.



Thankyou