ICR.

Technowrap™ Lifecycle Analysis

Emissons Comparison

icr-world.com

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Overview

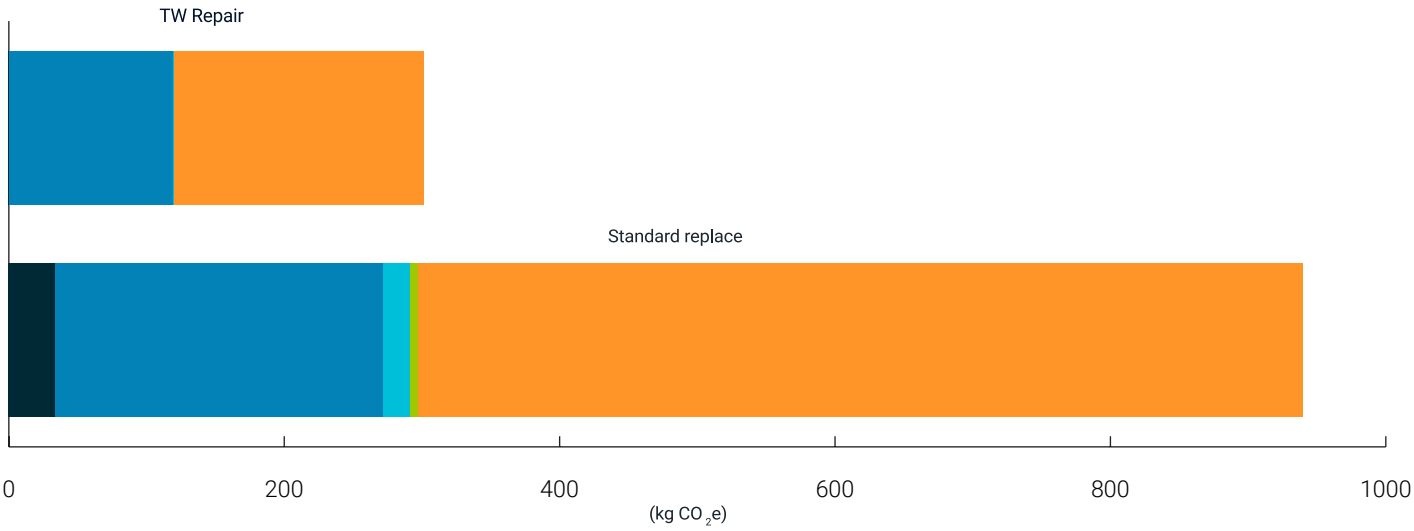
As a leading provider of engineered composite repair solutions ICR supports clients with a wide range of pipework, pipeline, caisson, and structural integrity challenges. Our Technowrap™ technology provides exceptional strength and with ICR's adaptable range of products, we deliver a long-term alternative to steel replacement. Our repair systems can not only be applied to live systems with no impact on production but also offer a low greenhouse gas (GHG) emissions alternative to steel replacement. Replacing large steel equipment is energy intensive and requires the production of a new replacement. By repairing the equipment our clients avoid the emissions associated with steel production and transportation as well as the energy required to perform the replacement.

Our repair solutions can last up to 20 years, equal to the lifetime of a replacement part and as such is directly comparable to a replacement solution. We have compared the carbon impact of using our repair system technology for the repair of a 2-metre section of 8" carbon steel pipework (85.1 kg) located 225 miles off-shore from Aberdeen. We found that our repair system gave a total reduction in emissions of 66% compared to the traditional replacement method.

Scenario Overview

For the purposes of this calculation, we considered the scenario where a 2-metre length of 8-inch-diametre piece of carbon steel pipework has been damaged and either needs to be replaced (traditional method) or repaired (our method)

	TW Repair (kg CO_2e)	Standard replace (kg CO_2e)
Energy consumption	0.1	33.5
Transport – helicopter	119.1	238.2
Transport – sea	0.5	19.5
Transport – land	0.2	5.5
Material production	181.5	642.8



Key Emissions Reductions in using ICR Technowrap™ Compared to Replacement:

97%
reduction in materials transport (land and sea)

69%
reduction in material production

99%
reduction in energy demand

50%
reduction in personnel transport*

Transportation Calculation

It is assumed that the pipework is located on an offshore oil rig located 225 miles (360 km) offshore. All equipment and materials, for both scenarios, is assumed to be in a warehouse 4 miles (6.4 km) from the port from which it can be shipped to the oil rig. The general process is assumed to follow a similar route as laid out below:

- Materials and equipment are transported by land (Rigid HGV (>3.5 – 7.5 tonnes)) from the warehouse to the port.
- Materials and equipment are transported by sea (general cargo ship, 0 – 4999 dwt)
- Repair / replacement is carried out
- Materials and equipment are transported by sea back to the port (general cargo ship, 0 – 4999 dwt)
- Materials and equipment are returned to the warehouse by land (Rigid HGV (>3.5 – 7.5 tonnes))

For this calculation we estimated the weight of all materials and equipment required for either the repair or replacement scenario and then calculated the associated carbon footprint by multiplying the total weight by the distance travelled by the tonne/km conversion factor for the appropriate transport type: Calculations were performed using emissions factors published by DEFRA.

Emissions [kgCO_2e] = Weight of Materials and Equipment [tonnes] × Distance Travelled [km] × Emission Factor

Transportation of personnel by helicopter was calculated using published data on helicopter fuel consumption[1]. It was assumed that the helicopter maximum passenger occupancy was 19 and as such each passenger would be responsible for 1/19 of the journey's emissions.

Total Emissions [kgCO_2e] = Distance of flight [km] × Fuel Consumption per km [l/km] × Emission Factor

Passenger Emissions [kgCO_2e] = Total Emissions [kgCO_2e] ÷ 19

1 R. Villasenor et.al. Atmospheric Environment, 37, 2003, 3713 – 3729. DOI: 10.1016/S1352-2310(03)00445-X

Materials Calculation

To calculate the emissions associated with the production of the materials required for the different scenarios weight and composition data was collected for consumable materials required for each method. Once weight and composition data had been collected the appropriate emissions factor was applied. Where possible "market for" emissions factors were used which encompass the full cradle to gate emissions associated with production and transportation. Where consumables were formed of multiple different materials, emission factors were applied to proportionate amounts of the items total weight composition. Emissions factors were taken from the Ecoinvent LCIA database.

Emissions [kgCO_2e] = Weight of Materials [kg] × Material Emission Factor

In some instances where processing of material was required to produce a consumable an appropriate emission factor was applied:

Emissions [kgCO_2e] = Weight of Materials [kg] × Processing Emission Factor

It should be noted that equipment that was reusable was excluded from this calculation as it is assumed that the equipment would not be purchased exclusively for this job and that lifetime of the equipment would make its contribution to the calculation negligible.

Energy Consumption Calculation

To calculate the energy required for the two scenarios a list of equipment and the associated power required was produced. By estimating the amount of time equipment would be running for it was possible to estimate the total electrical consumption required to carry out each scenario. Calculations were performed using emissions factors published by DEFRA.

Emissions [kgCO_2e] = Energy Consumption [kWh] × Emission Factor

It should be noted that in the calculation for the replacement process we have included the use of a pressurised habitat which is optional. Without this the energy consumption carbon footprint would reduce by 10.2 kgCO_2e (~30 % of energy consumption emissions)

Calculation Data – Repair

Quantity	Description	Description	Total Quantity	Unit	kg CO_2e
9.7 kg	Resin Part A	Epoxy Resin	9.700	kg	47.355
10.5 kg	2K Substrate - Fiberglass	Woven Fiberglass	10.500	kg	41.707
25m	1 m Wide Polythene		12.000	kg	30.542
10 litres	Acetone		7.900	kg	19.229
10 rolls	Compression Film (5"X 300ft)	Polyethylene	4.000	kg	10.181
2 kg	Resin Part B	Epoxy Resin	2.000	kg	9.764
2 boxes	Nitrile Gloves (Box 100)	Nitrile Rubber	0.840	kg	8.046
100 Ea.	Plastic Mixing Cups	Polypropylene	1.000	kg	3.445
2 rolls	Duct Tape	Cotton, Polyethylene, Polymethacrylate (Rubber Adhesive), Cardboard	0.180	kg	2.993
25 off	Wooden Mixing Sticks	Wood	1.250	kg	2.611
6 off	Paper Suits	Polypropylene	0.600	kg	2.067
1 off	3/4" Crows Foot Connector	Steel	0.500	kg	1.306
6 off	Bristle Blaster Heads	Carbon Spring Steel	0.360	kg	0.940
2 off	Safety Goggles	Polycarbonate	0.050	kg	0.487
50 ml	3K Primer A	(3-(2,3-Epoxypropoxy) Propyl) Trimethoxy Silane Density	0.054	kg	0.340
500 ml	3k Primer B	Methanol	0.396	kg	0.278
5 Ea.	Plastic Spreaders	Plastic	0.150	kg	0.160
1 off	Air Driven Bristle Blaster	Power Consumption 1320 kWh / Year, Use Time (240 Mins)	0.603	kWh	0.128
1 off	Testex Tape	Plastic Microfilm with Polyester Substrate	0.001	kg	0.004
1 off	Electronic Measuring Scales	Reusable	0.063	kg	
4 pairs	Scissors	Reusable	0.160	kg	
2 off	Vapour Masks	Reusable	0.480	kg	
1 off	Digital Hygrometer	Reusable	0.075	kg	
1 off	Micrometre	Reusable	0.600	kg	
1 off	Barcol Impresser	Reusable	0.900	kg	
1 off	Magnetic Thermometer	Reusable	0.270	kg	
1 off	Measuring Tape	Reusable	0.030	kg	

Calculation Data – Replace

Qty	Description	Description	Value	Unit	kg CO_2e
1 off	Spool Piece	Steel	85.100	kg	222.303
6 off	Tig Gloves	Leather (~0.6 m2)	1.080	kg	122.400
6 off	Welder's Glove	Leather (~0.5 m2)	0.900	kg	102.000
5 tubes	Weld Consumables - Filarc PZ6513	Iron / Cellulose	25.000	kg	50.460
1 off	Box Of Rags	Textile Towelling	4.000	kg	45.472
1 off	TIG Plant	Energy consumption 475 watts / hour	91.200	kWh	19.364
10 off	5" Grinding Discs	Aluminium Oxide	9.000	kg	13.874
1 off	Argon Cylinder	30 Litres (9.4 kg Argon Gas, emissions for gas only)	59.580	kg	13.013
1 off	Roll Fire Blanket	Fibreglass	5.000	kg	12.363
1 off	Pressurised Habitat*	Energy consumption 250 Watts / Hour	48.000	kWh	10.192
1 off	Temporary Lighting	Energy Consumption 80 Watts / Hour	15.360	kWh	3.261
1 off	Lot Tig Spares	Ceramics / CDA Alloy	5.000	kg	3.195
1 off	Disposable Gloves	Nitrile Rubber	0.240	kg	2.299
4 off	Welding Goggles	Polycarbonate / Glass	0.225	kg	2.193
4 off	Safety Goggles	Polycarbonate	0.100	kg	0.975
2 off	Air Movers	Energy Consumption 0.44 kW / Hour	2.640	kWh	0.561
5 off	5" Wire Wheels	Steel	0.800	kg	0.442
5 off	Tungsten	Tungsten	0.063	kg	0.348
5 off	Insulators	CDA Alloy	0.550	kg	0.264
5 off	Ceramics	Ceramics	0.325	kg	0.259
5 off	Collets	CDA Alloy	0.250	kg	0.120
2 off	Inspection Lights 110 V	Reusable	0.480	kWh	0.102
5 off	Collet Bodies	CDA Alloy	0.150	kg	0.072
1 off	Roll Of Emery Paper	Paper	0.010	kg	0.007
1 off	50 kVA Heat Treatment Plant	Reusable	360.000	kg	
1 off	Selection Of Magnets for Heating Pads	Reusable	1.000	kg	
1 off	TIG Plant C/W Torch, Cables Regulator, Flow-meter, Hose.	Reusable	100.000	kg	
2 off	25 M 440V Extension Cables	Reusable	30.000	kg	
4 off	25 M Extension Hoses - Air	Reusable	10.000	kg	
1 off	Off-Shore Gas Rack	Reusable	820.000	kg	
2 off	Grinder (Corded) - 5"	Reusable	4.000	kg	
1 off	Internal Grinder (Corded)	Reusable	1.600	Kg	
1 off	Splitters 110V	Reusable	7.000	kg	
3 off	Electric Extension 110v	Reusable	150.000	kg	
1 off	Electric Adaptor 110v	Reusable	1.000	kg	
1 off	Cantilever Toolbox C/W Hand Tools	Reusable	12.000	kg	

Calculation Data – Replace (continued)

Qty	Description	Description	Value	Unit	kg CO_2e
4 off	Hammers (Range)	Reusable	40.000	kg	
1 off	Digital Thermometer	Reusable	0.300	kg	
1 off	Spanner Set	Reusable	6.000	kg	
1 off	Pry Bar Set	Reusable	10.000	kg	
2 off	Metal Buckets	Reusable	4.000	kg	
1 off	Brush Pan & Shovel	Reusable	5.000	kg	
4 off	Grinding Visor & Screen	Reusable	2.400	kg	
1 off	Argon Gauge	Reusable	0.500	kg	

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