ENG8
INFINITE ENERGY

Report on Witness Testing of the Energy Cell on 4th December 2020

Summary

ENG8 have developed a device that converts electricity to heat. It is claimed more heat is generated than the electricity supplied via an undisclosed process. We requested a witness test to verify the heat to electrical power (Q/P) ratio achieved by a prototype device. This short report summarises the results of a witnessed test on the 4th December 2020. Key observations were:

1. The experimental setup and instrumentation were basic but entirely appropriate for a proof of concept test rig of this type
2. The device was operated without incident for one hour and shut down on completion of the agreed tests
3. Analysis of the data showed a ratio of heat produced to electricity supplied (Q/P) of 1.33 to 1.84
4. There is some concern over the flow measurement as there is no means of cross checking the flow and the flow meter appears to be affected by pressure pulsations. Recommendations have been made as how to verify the flow measurement to improve confidence in the results

Observations on Test Rig

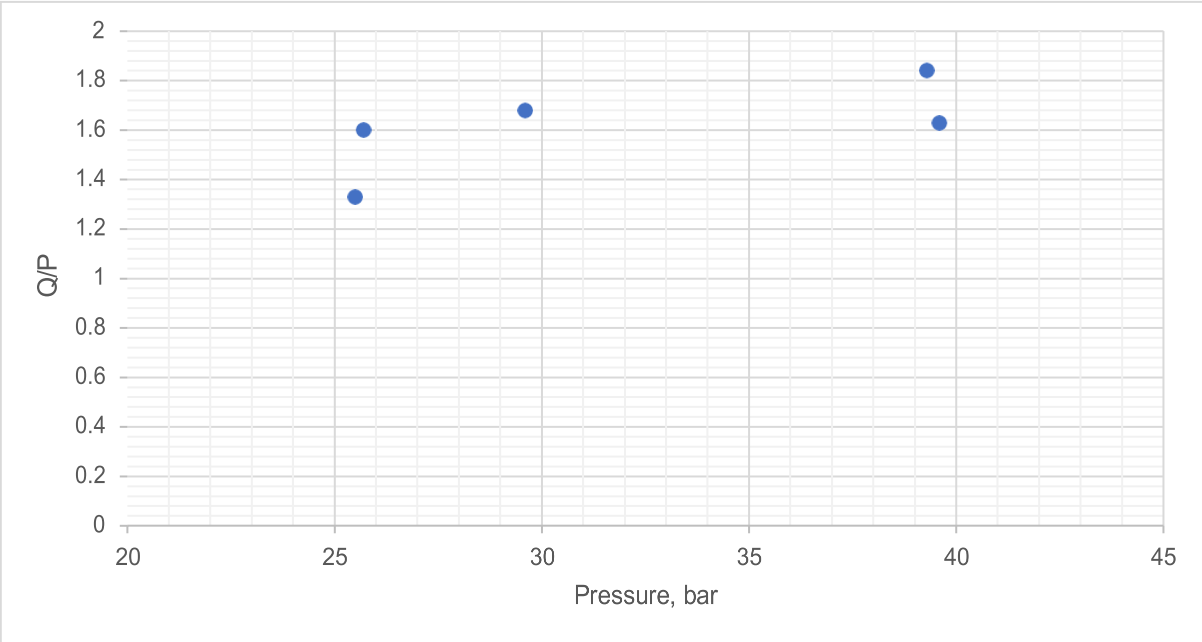
The test rig was visually inspected, including the locations of instrumentation and data acquisition. Thermocouple were in sensible positions with the sensor tips in the main flow. Similarly, pressure measurements were in sensible locations. The flow meter on the inlet is an impeller type device. The flow meter is correctly installed in a straight piece of pipework but may be affected by pulsations from the high-pressure pump. This could result in the meter misreading.

Test Method

The test rig was pre-heated by supplying electricity to the cell. The input electrical supply was then adjusted to form a plasma and the high-pressure water pump was then started. The pump speed, electrical supply and cell pressure were adjusted to stabilise the plasma and the rig was run for around ten minutes to stabilise the temperature. The test rig was controlled open loop. The pressure set point was set using a pressure maintaining valve and the electrical supply adjusted to stabilise the plasma. The rig was then allowed to stabilise, and data was recorded without operator adjustment for a five-minute period. Analysis indicated the rig would achieve thermal stability in under one minute, so the settling period was sufficient. Tests were then performed (in order) at about 25, 40, 30, 25, 40 bar. On completion of the final 40bar test point, the rig was shut down and cooled.

Results

Data was recorded using a data logger at one second intervals. The data was plotted and a section at each condition where the pressure, temperatures and flow were stable for at least two minutes was selected. The data was time averaged and then processed to calculate the enthalpy rise across the rig. This was done using the ‘plasma lower’ and ‘plasma upper’ temperatures and cell pressure. At each data point Refprop, (the NIST database 23 v8.0), was used to calculate the enthalpy at the inlet and outlet of the rig. The three phase power measurement was used for the power. The power required to drive the high pressure pump was not measured but the ideal pump work was estimated and found to be negligible compared to the thermal power. The resulting ratio of the enthalpy rise across the cell (Q) divided by the input electricity (P) are show in the graph below.



The uncertainties in the measurement chain are as follows:

Temperature – confidence high, but the 'plasma cell' thermocouple could be influenced by a hot or cold spot in the plasma cell. However, cross checking the enthalpy against the value after the pressure maintaining valve suggests the thermocouple is reading a representative cell outlet temperature

Electrical Power – this was done using a calibrated power meter so confidence is high

Flow – the flow readings were observed to oscillate, probably due to interaction with the high pressure pump. This could result in an under or over-reading of the flow.

Conclusions and Recommendations

The current experimental set up is basic but appropriate for a proof of concept test rig. Based on the tests witnessed, the heat to power ratio of the rig is 1.33 to 1.84 (rising with cell pressure) subject to the concern raised over the flow measurement. To improve confidence in the measurement the following are recommended:

- Verify the flow measurement with the pump operational using a 'bucket and stopwatch' on the inlet and outlet flows
- I understand a second flow meter has been purchased. I recommend installing this on the low pressure outlet after the condenser to provide an outlet flow measurement which should be isolated from the pulsations from the water pump
- Install a thermocouple in the high pressure outlet pipework to verify fully mixed outlet temperature from the cell

Ultimately, verifying the full energy balance is recommended as the concept is developed. This should include the heat removed from the condenser, power to the high pressure pump and thermal losses from the cell,

ENG8
INFINITE ENERGY

Robert Morgan

9/12/2020

ENG8
INFINITE ENERGY

Robert Morgan

Professor Morgan joined the university of Brighton in 2011 after 20 years in industry, working in the automotive and energy industries. He has worked on several model year programmes taking automotive technology to market at Ricardo. He built and lead the engineering team at Ceres Power, delivering the first compact fuel cell powered micro CHP demonstrator. Before joining the university, he was appointed Chief Technical Officer at Highview Power and lead the development of the companies novel liquid air energy storage technology and building of the a grid connected pilot plant at Slough. He has published over 70 peer reviewed articles and secured over £5M of research income since joining the university.

Present Appointment

Professor, Thermal Propulsion Systems, School of Computing Engineering and Mathematics. Appointed 1st September 2018

Previous Appointments

Reader, School of Computing Engineering and Mathematics. Appointed 20th May 2014.

Principle Research Fellow, University of Brighton – October 2011 to May 2014.

Chief Technical Officer & Head of Engineering, Highview Power Storage – October 2008 to January 2012.

CHP Business Manager, Ceres Power – November 2005 to September 2008.

Ricardo Consulting Engineers – Senior Manager. March 2003 to October 2005.

Career break – October 2002 to March 2003.

Ricardo Consulting Engineers – Senior Project Engineer. October 1994 to September 2002.

Academic Qualifications

The Open University. 2006 to 2011. MBA. Optional modules - Technology Management and Practical Problem Solving. Awarded a merit.

ILEX Level 1 qualification in Law.

Imperial College, London. October 1991 to September 1994. PhD in Mechanical Engineering. Thesis Title: 'Ductile Brittle Transitions in Pipe Grade Polyethylene'. Awarded 21st December 1994.

Imperial College, London. October 1988 to July 1991. BEng (Total Technology) in Mechanical Engineering. Achieved Upper Second. Sponsored by Edwards High Vacuum for pre-university placement and vacation employment.

Research Outputs

Journal Publications (refereed)

1. Understanding Sub and Supercritical Cryogenic Fluid Dynamics in Conditions Relevant to Novel Ultra Low Emission Engines. Madana Gopal, M. J. V., Tretola, G., Morgan, R., De Sercey, G., Atkins, A. & Vogiatzaki, K., 12 Jun 2020, In : Energies. 13, 12, 3038. doi.org/10.3390/en13123038

ENG8 INFINITE ENERGY

2. Molten salt selection methodology for medium temperature liquid air energy storage applications. Bernagozzi, M., Panesar, A. & Morgan, R. Applied Energy. 248 p500-511 April 2019. doi.org/10.1016/j.apenergy.2019.04.136
3. Temperature-Tailored Molten Salts for Sustainable Energy Storage. Bernagozzi, M., Panesar, A. & Morgan, R. Journal of the Minerals, Metals & Materials Society. 12/11/2019
4. Novel approach for adaptive coefficient tuning for the simulation of evaporating high-speed sprays injected into a high-temperature and high-pressure environment. Nsikane, D., Vogiatzaki, K., Morgan, R., Heikal, M., Mustafa, K., Ward, A. & Winder, N., 18 Oct 2019, In : International Journal of Engine Research. doi.org/10.1177/1468087419878911
5. Statistical Approach on Visualizing Multi-Variable Interactions in a Hybrid Breakup Model under ECN Spray Conditions. Daniel M. Nsikane,Kenan Mustafa, Andrew Ward, Robert Morgan, David Mason, Morgan Heikal. *SAE Int. J. Engines* 10(5):2461-2477, 2017. DOI :10.4271/2017-24-0104
6. The Recuperated Split Cycle - Experimental Combustion Data from a Single Cylinder Test Rig. Robert E. Morgan, Neville Jackson, Andrew Atkins, Guangyu Dong, Morgan Heikal, Christopher Lenartowicz. *SAE Int. J. Engines* 10(5):2596-2605, 2017. doi:10.4271/2017-24-0169
7. Hydrogen-diesel fuel co-combustion strategies in light duty and heavy duty CI engines. Midhat Talibi, Paul Hellier, Robert Morgan, Christopher Lenartowicz, Nicos Ladommatos. doi.org/10.1016/j.ijhydene.2018.03.176
8. Organic Rankin cycle thermal architecture – from concept to demonstration. Angad Panesar, Robert Morgan & Dave Kennaird. Applied Thermal Engineering (2017). https://doi.org/10.1016/j.applthermaleng.2017.07.164
9. Liquid air energy storage – from theory to demonstration. R. Morgan International Journal of Environmental Studies. (2016). http://dx.doi.org/10.1080/00207233.2016.1189741
10. A comparative study between a Rankin cycle and a novel intra-cycle based waste heat recovery concept applied to an internal combustion engine. Robert Morgan, Angad Panesar, Guangyu Dong, and Morgan Heikal Applied Energy (2016). contribution) http://dx.doi.org/10.1016/j.apenergy.2016.04.026
11. Thermodynamic analysis and system design of a novel split cycle engine. Robert Morgan, Guangyu Dong, and Morgan Heikal. Energy (2016). http://dx.doi.org/10.1016/j.energy.2016.02.102
12. A novel split cycle internal combustion engine with separate compression and combustion cylinders and integral waste heat recovery. Guangyu Dong, Robert Morgan and Morgan Heikal. Applied Energy (2015). doi:10.1016/j.apenergy.2015.02.024
13. An analysis of a large scale Liquid Air Energy Storage system. Morgan, R., Nelmes, S., Gibson, E., and Brett, G. Proceedings of the ICivE (2015). http://dx.doi.org/10.1680/ener.14.00038
14. Liquid air energy storage – Analysis and first results from a pilot scale demonstration plant. Morgan, R., Nelmes, S., Gibson, E., and Brett, G. Applied Energy (2015). (Doi:10.1016/j.apenergy.2014.07.109
15. An assessment of the bottoming cycle operating conditions for a high egr rate engine at euro VI nox emissions. Panesar, A., Morgan, R., Miché, N., and Heikal, M. (30% contribution) INT J. Engines 6(3) (2013). doi:10.4271/2013-24-0089
16. *Working fluid selection for a subcritical bottoming cycle applied to a high exhaust gas recirculation engine.* Panesar, Angad S., Morgan, Robert, Miche, Nick and Heikal, Morgan. Energy, (2015). 388-400. ISSN 0360-5442
17. Characterisation of the soot formation processes in a high pressure combusting Diesel fuel spray Morgan, R.E., Gold, M.R., Laguitton, O., Crua, C., Heikal, M. (2003), Journal of Fuels and Lubricants, SAE transactions, 112 (4). pp. 2086-2094.

18. The influence of injector parameters on the formation and break up of a Diesel spray. Morgan, R., Wray, J., Kennaird, D.A., Crua, C., Heikal, M. (2002), 2002 SAE Transactions – Journal of Engines, 110(3), 389-399.
19. Impact fracture of polyethylene: a non-linear-elastic thermal decohesion model P.S. Leevers & R.E. Morgan. Engineering Fracture Mechanics (1995)

Official Reports

1. Institution and expert partners' response to the OLEV 2035 Consultation IMechE. 27th July 2020. Contributor and reviewer
2. Thermal Propulsion System Technology Roadmap, 2017. Contributor and reviewer. http://www.apcuk.co.uk/technology-roadmaps/
3. Liquid air in the energy and transport systems: opportunities for industry and innovation in the UK. Centre for Low Carbon Futures. Contributor and reviewer http://www.lowcarbonfutures.org/sites/default/files/LIQUID%20AIR%20IN%20THE%20ENERGY%20AND%20TRANSPORT%20SYSTEMS%20-%20Summary%20Report%20and%20Recommendations.pdf
4. Energy Storage Systems in the UK Low Carbon Energy Future: Strategic Assessment. The Carbon Trust. Member of Steering Group and expert review 2012. https://pdfs.semanticscholar.org/bdee/ff7b4bed159ffbe82c03770fea1ad1fca298.pdf
5. Potential of Microgeneration in the UK. The Energy Savings Trust 2006. Member of Steering Group and expert review 2006.

Conference Publications (refereed)

1. Assessment of modelling capability for numerical simulations for designing higher efficiency and lower emission systems Filippo Gerbino, Robert Morgan, Penny Atkins, Konstantina Vogiatzaki Conference: The International Conference on Energy and Sustainable Futures (ICESF)At: Nottingham, UK , 9–11 September 2019
2. Low Temperature Molten Salts in Sustainable Energy Production. Marco Bernagozzi, Angad S. Panesar, Robert Morgan Conference: 7th European Conference on Renewable Energy SystemsAt: Madrid
3. Implementation of a 0-D/1-D/3-D Process for the Heat Release Prediction of a Gasoline Engine in the Early Development Stage. Rota, C. et al. Conference: WCX SAE World Congress Experience DOI: 10.4271/2019-01-0468
4. A New-Generation Lean Gasoline Engine for Reduced CO2 in an Electrified World. Osborn, R et al, Vienna Motor Symposium 2019.
5. Predictive Engine Simulations based on a novel DoE/RANS approach with coefficient tabulation. Daniel Nsikane, Konstantina Vogiatzaki, Robert Morgan Conference: IMechE, Fuel Systems-Engines At: London, UK
6. Effect of pressure in crossover port to the in-cylinder flow of split-cycle engine Firmansyah Firmansyah, Robert Morgan, M.R. Heikal. A.A.R. Aziz. DOI: 10.1063/1.5075602 Conference: 6TH INTERNATIONAL CONFERENCE ON PRODUCTION, ENERGY AND RELIABILITY 2018: World Engineering Science & Technology Congress (ESTCON) (
7. Investigating the effect of multi-variable interactions in modelling high speed reactive spray break up injected in high pressure elevated temperature environment. Nisikane, D et al. Conference: Conference on Thermo-and Fluid Dynamic Processes in Direct Injection Engines (THIESEL)
8. Towards zero emission engines through the adoption of combustion lead engine design realised through a split cycle topology Morgan, R et. alConference: Conference on Thermo-and Fluid Dynamic Processes in Direct Injection Engines (THIESEL)

9. A Late Injection Combustion Strategy Using a Novel Ramped Combustion System Robert E. Morgan, Morgan Heikal, Emily Pike-Wilson. SAE ICE Conference (2017) SAE2017-24-0090.

10. Two hidden layers are usually better than one. Alan J. Thomas, Miltos Petridis, Simon Walters, S Malekshahi Gheytassi & Robert Morgan. Chapter Engineering Applications of Neural Networks 2017 CCIS vol. 744.
11. The 60% efficiency reciprocating engine: A modular alternative to large scale combined cycle power. Gurr, A. Atkins & R. Morgan. CIMAC 2016 Congress June 2016 .
12. On the optimal node ratio between hidden layers: A probabilistic study. Alan J. Thomas, Miltos Petridis, Simon Walters, S Malekshahi Gheytassi & Robert Morgan. GPU Technical Conference (2016). DOI: 10.18178/ijmlc.2016.6.5.605.
13. Accelerated optimal topology search for two hidden layer feed forward neural networks. Alan J. Thomas, Miltos Petridis, Simon Walters, S Malekshahi Gheytassi & Robert Morgan. Engineering Applications of Neural Networks (2016)
14. Conceptual design and preliminary testing of an Organic Rankin Cycle Thermal Architecture. A Panesar, R. Morgan, D. Kennaird, E. Pike-Wilson, R Sansome & M. Heikal. International Heat Transfer Symposium Nottingham June 2016
15. On predicting the optimal number of hidden nodes. A Thomas, M. Petridis, S Walters, S Malekshahi Gheytassi & R. Morgan. CSCI Las Vegas 7-9th December 2015. http://doi.ieeecomputersociety.org/10.1109/CSCI.2015.33
16. Results from the testing of a heavy duty diesel engine with hydrogen fumigation. R. E. Morgan, M. R Heikal, A. F. Atkins and P. Atkins.
IMechE ICE conference. 2015
17. Effect of Hydrogen Fumigation in a Dual Fuelled Heavy Duty Engine. RE Morgan, MR Heikal, C Lenartowicz, P Atkins, A Atkins. Accepted for publication at the 2015 ICE conference, September 2015
18. The benefits of high injection pressure on future heavy duty engine performance. RE Morgan, MR Heikal, C Lenartowicz, A Banks, A Aude. 2015 ICE conference,
19. Measurement and simulation of low temperature packed bed regenerators. E. Pike-Wilson, T Gardhouse, R. Morgan & M Heikal. 14th UK Heat Transfer Conference. Edinburgh September 2015
20. A novel Rankin cycle system for heavy duty Diesel engines. A Panasar, M Heikal & R Morgan. Sustainable thermal energy management conference, 7&8th July 2015 University of Newcastle
21. Cryogenic Thermal Energy Storage Systems. E. Pike-Wilson, R.E. Morgan & A.B. Cundy. ASME-ATI-UIT 2015 Conference on Thermal Energy Systems: Production, Storage, Utilization and the Environment. 17-20th May 2015, Napoli, Italy
22. The split cycle engine and its impact on the vehicle cooling system. R E Morgan, G Dong,and M R Heikal. IMechE VTMS Conference, 11th -13th May 2015
23. A novel working fluid for Organic Rankine Cycle (ORC). A Panasar, R Morgan and M Heikal. IMechE VTMS Conference, 11th -13th May 2015
24. An Alternative Thermodynamic Cycle for Reciprocating Piston Engines. N. Jackson, A. Atkins, J. Eatwell, & R. Morgan. Vienna motor symposium May 2015
25. A design of experiments (DOE) approach to optimise temperature measurements accuracy in Solid Oxide Fuel Cell (SOFC). Barari, F. Morgan, R. and Barnard, P. 32nd UIT Heat Transfer Conference, Pisa 2014
26. A novel organic Rankin cycle system with improved thermal stability and low global warming fluids. Panesar, Angad S., Morgan, Robert, Miche, Nick and Heikal, Morgan. DOI 10 1051/matecconf/2014 1306002
27. Facture mechanics of carbon fibre composite flywheels. J Lenz, BRK Blackman, AC Taylor, R Morgan and C Crua. 16th European Conference on Composite Materials, Seville, Spain 22-26th June 2014

28. The potential of bottoming cycle applied to a high exhaust gas recirculation engine for maximum fuel consumption improvement. Panesar, Angad S., Morgan, Robert, Miche, Nick and Heikal, Morgan. 2nd International Workshop on Heat Transfer Advances for Energy Conservation and Pollution Control. October 18-21 2013 Xi'an China
29. An investigation of bottoming cycle fluid selection on the potential efficiency improvements of a Euro 6 heavy duty diesel engine. Panesar, Angad S., Morgan, Robert, Miche, Nick and Heikal, Morgan. VTMS 11 2013 C1365/021/2013 IMechE
30. Micro CHP – a mass market opportunity. R.E. Morgan, B. Flint & J. Devriendt. Sustainability & Microgeneration Conference. University of Brighton. June 2006
31. A novel internal combustion engine with simultaneous injection of fuel and pre-compressed pre-heated air . Coney, M.W., Linnemann, C, Morgan, R.E. Bandcroft, T.G, & Sammut, R.M . Fall Technical Conference of the Internal Combustion Engine Division of the ASME. New Orleans, Louisiana. ICEF2002-485 pp. 67-77. September 2002
32. Engineering aspects of a novel high efficiency reciprocating internal combustion engine Coney, M.W.; Linnermann, C, Cross, A.M.; Morgan, R.E.; & Wilson, B. . ASME International Joint Power Generation Conference, Phoenix USA. IJPG2002-26047 pp. 935-943. June 2002
33. Development of a reciprocating compressor using water injection to achieve quasi isothermal compression. Coney, M.W.; Stephenson, P.; Malmgren, A. Linnermann; C. Morgan, R.E.; Richards, R.A.; Huxley, R.; Abdullah, H.;Proceedings of the 16th International Compressor Engineering Conference at Purdue, July 20
34. Characterisation of a high pressure diesel fuel spray at elevated pressures, R.E. Morgan; D. Kennaird; M.R. Heikal & F. Bar. THESAL 2001, Valencia
35. A study of the formation and break-up of a diesel spray for HSDI diesel engine combustion system R Morgan; M Gold; J Wray; S Whelan.
The Fifth International Symposium on Diagnostics and Modelling of Combustion in Internal Combustion Engines - COMODIA 2001, Nagoya, Japan, 1-4 Jul 2001, JSME, Paper No. 1-23.
36. Air-fuel mixing in a homogeneous charge di gasoline engine. Martin Gold; John Stokes; Robert Morgan; Morgan Heikal; Guillaume de Sercey; Steve Begg.
SAE 2001-01-0968, 2001
37. The influence of injector parameters on the formation and break-up of a diesel spray. R Morgan; J Wray; D A Kennaird; C Crua; M R Heikal.
SAE 2001-01-0529, 2001
38. A new high-pressure diesel spray research facility. D Kennaird; C Crua; M Heikal; R Morgan; F Bar; S Sapsford
Computational and Experimental Methods in Reciprocating Engines, London, Nov 2000, I.Mech.E, Paper C587/040/2000.
39. CFD simulation of di diesel truck engine combustion using VECTIS. Gang Li; Steve M Sapsford; Robert E Morgan.
SAE 2000-01-2940, 10pp. 2000
40. A heavy duty engine concept for ultra-low emissions. S Edwards; R E Morgan; C H Such; I J Penny. International Congress - What Challenges for the Diesel Engine of the Year 2000 and Beyond?, Ecully, May 2000, SIA, Paper No. SIA 2000/03/19.
41. A premium heavy duty engine concept for 2005 and beyond .R E Morgan; S P Edwards; A J Nicol; I D Johnstone; J R Needham.
SAE 1999-01-0831, 1999, 16pp.
42. Thermal management of the high performance engine N J Owen; R E Morgan; S R Streater. ATA conference on High Performance Spark Ignition Engines for Passenger Cars, Como, Nov 1997, Paper 97A4009, pp87-96.
43. Measurements and prediction of coolant velocity in internal combustion engine cooling systems, R E Morgan; N J Owen; M R Heikal; S G Cox.
I.Chem.E., 5th UK conference on Heat Transfer, London, 17-18 Sep 1997, Vol.2.

44. Ductile-brittle transitions in pipe grade polyethylene. R.E. Morgan & P.S. Leevers 9th International Conference on Deformation, Yield & Fracture Cambridge April 1994
45. Rapid crack propagation along pressurised plastic pipe. P.S. Leevers; G.S. Venizelos & R.E. Morgan. Buried plastic Pipe Technology: ASTM STP 1222 1994
46. Strategies for avoiding rcp in gas-pressurised pipe. P.S. Leevers; G.S. Venizelos & R.E. Morgan. Conf. Proc. 13th Plastic Fuel Gas Pipe symposium, San Antonio, USA 1993

Other Publications (Patents)

1. Cool combustion. In PCT. 2017
2. Injector family. In PCT 2017
3. LN2 management family In PCT. 2017
4. Temperature Measurement in Fuel Cells. In PTC 2017
5. Method and apparatus for power storage
   Robert Morgan, Stuart Nelmes, Nicola Castellucci & Gareth Brett. WO2013034908 A3
6. Integration of an energy storage device with a spate thermal process
   Robert Morgan & Gareth Brett. WO2012020234 A3
7. Electricity generation device and methods
   Robert Morgan, Daniel Harris & Gareth Brett. WO2013104904 A1
8. Electricity generation device and method. Robert Morgan & Gareth Brett WO2012095636 A3
9. Method and apparatus for storing thermal energy
   Robert Morgan & Michael Dearman. WO2012020233A2
10. A Boiler Unit
    J Devriendt, C Evans, R Morgan, P Barnard & B Girvan. GB0821700.2
11. Fuel Cell Stack Flow Hood
    M Harrington, P Barnard, R Leah & R E Morgan. PTC/GB08/00645
12. SOFC Stack System Assembly with Thermal Enclosure
    J Devriendt, R Leah & R Morgan. PTC/GB2007/000990
13. Fuel Cell Stack Assembly
    R E Morgan, R Leah & B Girvan. GB0706319.1
14. Gas Compressor.
    M W Coney, R A Huxley & R E Morgan. F04 B039/04

Invited Speeches

1. Future Powertrain 2019
2. SIG Combustion Meeting 2018
3. British Science Festival. Future of Transport. 8/9/2017
4. APC Spoke Network. Low Carbon Vehicle Show Panel Member 6/9/2017
5. Preparing for the Grand Challenge. Royal Institution, 25/4/2017. Invited Speaker.
6. Pathways to the ultra-efficient powertrain – towards 60% efficiency. Future Powertrain Conference 2017. Speaker.
7. Rest in Peace – ICE. Royal Institution, 14/11/2016. Invited Speaker.
8. Cheltham Science Festival - The future of the car. 10/6/2016 Invited Speaker & Member of Panel.
9. APC Spoke Network. Low Carbon Vehicle Show 2016. Panel Discussion
10. What's next for the Internal Combustion Engine Low Carbon Vehicle Show 2014. Invited Speaker.
11. Liquid air energy storage for bulk energy management. 13th UK Heat Transfer Conference, Imperial College 2-3rd September 2013. Keynote Speech.
12. Liquid Air Energy Storage for Grid Applications. Liquid Air Conference, Royal Academy of Engineering 26th March 2013. Keynote Speaker.
13. Liquid air energy storage. A cost effective utility scale power storage solution. Thermo Fluid Section, Institute of Mechanical Engineers 2nd February 2012. Invited Speaker.

14. Stand Up For Start Ups. Institute of Physics 8th November2011. Invited Speaker.
15. Modelling of Large Scale Thermal Stores Using Flowmaster. Flowmaster International Users Conference 14th November 2011. Invited Speaker.