F. Ahlgren, M. E. Mondejar, M. Genrup and M. Thern 2016 Waste Heat Recovery in a Cruise Vessel in the Baltic Sea by Using an Organic Rankine Cycle: A Case Study Journal of Engineering for Gas Turbines and Power-Transactions of the Asme 138
1
Jan Waste Heat Recovery in a Cruise Vessel in the Baltic Sea by Using an Organic Rankine Cycle: A Case Study
0742-4795
011702
WOS:000371127900008 Maritime transportation is a significant contributor to SOx, NOx, and particle matter (PM) emissions, and to a lesser extent, of CO2. Recently, new regulations are being enforced in special geographical areas to limit the amount of emissions from the ships. This fact, together with the high fuel prices, is driving the marine industry toward the improvement of the energy efficiency of ships. Although more sophisticated and complex engine designs can improve significantly of the energy systems on ships, waste heat recovery arises as the most effective technique for the reduction of the energy consumption. In this sense, it is estimated that around 50% of the total energy from the fuel consumed in a ship is wasted and rejected through liquid and gas streams. The primary heat sources for waste heat recovery are the engine exhaust and coolant. In this work, we present a study on the integration of an organic Rankine cycle (ORC) in an existing ship, for the recovery of the main and auxiliary engines (AE) exhaust heat. Experimental data from the engines on the cruise ship M/S Birka Stockholm were logged during a port-toport cruise from Stockholm to Mariehamn, over a period of 4 weeks. The ship has four main engines (ME) Wartsila 5850 kW for propulsion, and four AE 2760 kW which are used for electrical generation. Six engine load conditions were identified depending on the ship's speed. The speed range from 12 to 14 kn was considered as the design condition for the ORC, as it was present during more than 34% of the time. In this study, the average values of the engines exhaust temperatures and mass flow rates, for each load case, were used as inputs for a model of an ORC. The main parameters of the ORC, including working fluid and turbine configuration, were optimized based on the criteria of maximum net power output and compactness of the installation components. Results from the study showed that an ORC with internal regeneration using benzene as working fluid would yield the greatest average net power output over the operating time. For this situation, the power production of the ORC would represent about 22% of the total electricity consumption on board. These data confirmed the ORC as a feasible and promising technology for the reduction of fuel consumption and CO2 emissions of existing ships. Times Cited: 1Ahlgren, Fredrik Mondejar, Maria E. Genrup, Magnus Thern, Marcus Montagud, Maria E. Mondejar/0000-0001-8734-6757; Thern, Marcus/0000-0003-3913-0796
1
1528-8919

V. Andersson, P. A. Franck and T. Berntsson 2016 Techno-economic analysis of excess heat driven post-combustion CCS at an oil refinery International Journal of Greenhouse Gas Control 45 130-138 Feb Techno-economic analysis of excess heat driven post-combustion CCS at an oil refinery 1750-5836

WOS:000370097000013 Carbon capture and storage may, as a bridging technology, rapidly decrease CO2 emissions in the industrial sector. In this paper, a techno-economic study of a future MEA carbon capture plant implemented at a case study oil refinery is presented. Costs are calculated for six setups of carbon capture at the refinery. Excess heat from the refinery processes is used in the capture plant for regeneration of the absorption fluid, and the stripper reboiler temperature is varied to increase the extractable of excess heat. Supplementary heating is carried out with a heat pump. The number of chimneys to be included in the capture process is also varied, resulting in different CO2 concentrations and amounts of CO2 at the inlet of the capture plant. Results show that the specific cost for carbon capture increases as the amount of captured carbon increases due to the need for heat pumps. The costs are in the range of 41-57(sic)/t for the low-temperature cases (T-Reb =90 degrees C) and 39-44(sic)/t for the high-temperature cases (T-Reb = 120 degrees C). (C) 2015 Elsevier Ltd. All rights reserved. Andersson, Viktor Franck, Per-Ake Berntsson, Thore 1878-0148 <Go to ISI>://WOS:000370097000013

O. P. Arsenyeva, L. Cucek, L. L. Tovazhnyanskyy, P. O. Kapustenko, Y. A. Savchenko, S. K. Kusakov and O. I. Matsegora 2016 Utilisation of waste heat from exhaust gases of drying process Frontiers of Chemical Science and Engineering 10
1 131-138
Mar Utilisation of waste heat from exhaust gases of drying process 2095-0179

WOS:000371615000011

Nowadays a lot of low-grade heat is wasted from the industry through the off- and flue-gasses with different compositions. These gases provide the sensitive heat with utilisation potential and latent heat with the components for condensation. In this paper, process integration methodology has been applied to the partly condensed streams. A hot composite curve that represents the gas mixture cooling according to equation of state for real gases was drawn to account the gas-liquid equilibrium. According to the pinch analysis methodology, the pinch point was specified and optimal minimal temperature difference was determined. The location of the point where gas and liquid phases can be split for better recuperation of heat energy within heat exchangers is estimated using the developed methodology. The industrial case study of tobacco drying process off-gasses is analysed for heat recovery. The mathematical model was developed by using MathCad software to minimise the total annualised cost using compact plate heat exchangers for waste heat utilisation. The obtained payback period for the required investments is less than six months. The presented method was validated by comparison with industrial test data. Times Cited: 7
Arsenyeva, Olga P. Cucek, Lidija Tovazhnyanskyy, Leonid L. Kapustenko, Petro O. Savchenko, Yana A. Kusakov, Sergey K. Matsegora, Oleksandr I.
Arsenyeva, Olga/A-2979-2017; Cucek, Lidija/P-1225-2015; Tovazhnyanskyy, Leonid/Q-2100-2017
Cucek, Lidija/0000-0003-4754-2758; Tovazhnyanskyy, Leonid/0000-0002-9000-3824
7
2095-0187

Y. M. Barzi, M. Assadi and K. Parham 2018 A waste heat recovery system development and analysis using ORC for the energy efficiency improvement in aluminium electrolysis cells
International Journal of Energy Research
42 4 1511-1523
Mar A waste heat recovery system development and analysis using ORC for the energy efficiency improvement in aluminium electrolysis cells 0363-907X

WOS:000427120300008
The present work investigates an active waste heat recovery system for the side walls of the aluminium electrolysis cells, enabling utilization of the extracted heat in power generation. This will potentially lead to energy efficiency improvement in the primary aluminium production industry and an enhanced aluminium production rate. An experimentally validated loop thermosyphon heat pipe model was used for heat extraction from the cell side wall. Boosting system thermal efficiency through waste heat recovery, by means of a heat utilization system, and increasing the level of control, as well as thermal equilibrium, stand as the main addressed objectives of the current study, which consequently result in an increased aluminium production rate. An organic Rankine cycle is incorporated into the system, and its performance is evaluated, taking into consideration the operating situations in terms of available temperature and thermal power range.
Times Cited: 0
Barzi, Yaser Mollaei Assadi, Mohsen Parham, Kiyan
0
1099-114x

S. Bellocchi, G. L. Guizzi, M. Manno, M. Pentimalli, M. Salvatori and A. Zaccagnini 2017 Adsorbent materials for low-grade waste heat recovery: Application to industrial pasta drying processes
Energy 140
729-745 Dec
Adsorbent materials for low-grade waste heat recovery: Application to industrial pasta drying processes
0360-5442

WOS:000415394200065 Energy intensive industries face strong challenges due to rising electricity costs and environmental limitations, therefore, developing methods for energy efficiency improvement is becoming an increasingly important issue. With an estimated 30% of industrial energy input being lost as waste heat, its recovery represents an interesting energy efficiency solution potentially providing for a zero-emission, low cost and abundant resource. This study presents an innovative technology for low-grade waste heat recovery based on advanced adsorbent materials, specifically applied to the drying process of alimentary pasta. Warm and humid air flow resulting from the drying process represents a high-enthalpy waste heat source that, if recovered, can significantly improve the process efficiency. This can be achieved by means of high specific surface materials among which Metal Organic Framework (MOF) compounds represent a promising solution. In this work, the industrial pasta production process has been studied and possible plant design options identified, including an innovative adsorption cycle to recover waste heat from the drying process. The thermodynamic processes involved in pasta drying plants have been quantitatively analysed to assess the energy savings that can be achieved by using adsorbent materials such as MOFs. Results point to thermal energy savings in the range 40-50%. (C) 2017 Elsevier Ltd. All rights reserved. Times Cited: 0
Bellocchi, Sara Guizzi, Giuseppe Leo Manno, Michele Pentimalli, Marzia Salvatori, Marco Zaccagnini, Alessandro
Manno, Michele/0000-0001-9239-4817
0
1873-6785
1 <Go to ISI>://WOS:000415394200065

S. Boldyryev, H. Mikulcic, G. Krajacic and N. Duic 2016 Waste heat utilisation of Croatian cement industry accounting Total Site demands
Z. Kravanja and M. Bogataj 26th European Symposium on Computer Aided Process Engineering 38B
2223-2228 Computer Aided Chemical Engineering Waste heat utilisation of Croatian cement industry accounting Total Site demands
978-0-444-63873-1

WOS:000406968900168 The cement industry sector as an energy intensive industrial sector, where energy cost represents approximately 40% of the total production cost per one ton of cement, and one of the highest greenhouse gases - GHG emitting industrial sectors, accounts for around 5% of global anthropogenic GHG emissions as reported (Mikulcic et al, 2015). Considering that, the cement is the most widely used material for construction needs, this paper analyses the potential of energy efficiency improvement of the cement production for a particular cement plant in Croatia. The heat recovery potential was determined and an amount of waste heat available for utilisation accounting site wide demands are identified with use of Process Integration technique. The results show huge potential for energy saving of cement production. Different scenarios for utilization of low potential heat are proposed accounting different site demands and energy prices. Implementation of paper results helps to the cement plant's profitability and reduces environmental impact of the cement industry.
Times Cited: 0

Boldyryev, S. Mikulcic, H. Krajacic, G. Duic, N.
Escape
26th European Symposium on Computer Aided Process Engineering (ESCAPE)
Jun 12-15, 2016
Portoroz, SLOVENIA
Boldyryev, Stanislav/O-8465-2016
Boldyryev, Stanislav/0000-0002-2866-3995
1570-7946 <Go to ISI>://WOS:000406968900168

T. Bornemann 2017 Industrial Waste Heat Utilization Kassel, Univ., Diss. 2017 kassel university press 220 Industrial Waste Heat Utilization 978-3-7376-0402-4

Für Unternehmen der produzierenden Automobilindustrie stellt Energieeffizienzsteigerung ein elementares Instrument zur Verbesserung der Wettbewerbsfähigkeit dar. Der Fokus dieser Dissertation wird auf die Nutzung von Abwärme industrieller Produktionsprozesse gerichtet. Um die Ressource Abwärme quantifizieren zu können, wird eine Abwärmeanalyse im Untersuchungsobjekt durchgeführt. Zur Bewertung der möglichen Abwärmenutzungspfade werden sämtliche thermische sowie elektrische Bedarfe durch Vermessung der energetisch relevanten Prozesse ermittelt. Letztendlich wird die direkte thermische Nutzung von Abwärme durch Einspeisung in werksinterne Wärmeversorgungsnetze als zweckmäßige Nutzungsvariante herausgearbeitet.

Wird die zur Verfügung stehende Abwärmemenge neben Kraft-Wärme-Kopplungsanlagen in die Energieversorgung eines Produktionsstandortes integriert, resultiert ein Spannungsfeld. Primäres Ziel dieser Dissertation besteht in dessen Erforschung und der Analyse der Vorteilhaftigkeit bezüglich der hierarchischen Priorisierung der Ressource Abwärme innerhalb von dezentralen Energiesystemen.

German

S. Bruckner, S. L. Liu, L. Miro, M. Radspieler, L. F. Cabeza and E. Lavemanna 2015 Industrial waste heat recovery technologies: An economic analysis of heat transformation technologies
Applied Energy 151
157-167 Aug
Industrial waste heat recovery technologies: An economic analysis of heat transformation technologies
0306-2619

WOS:000356198700016 In this paper, the potential of industrial waste heat for heating and cooling applications is investigated. Therefore, heat transformation technologies are presented and their technical and economic potential are discussed. First, different industrial processes and their operating temperatures are presented as possible waste heat sources as well as low temperature processes, which can be supplied with waste heat. Then, a general economic analysis is performed for three different cases of waste heat use: an absorption chiller producing cold and heat production with a compression and an absorption heat pump. The maximum acceptable investment cost for each technology is estimated and compared with the current investment cost depending on the operating hours of the system. For this, three different consumer types, Enthusiast, Real Estate and Industry, are defined to represent different expectations in interest rate, payback period and the resulting annuity factor. Instead of judging if a technology is profitable or not, it is calculated how much the system is allowed to cost in order to be competitive for certain operating hours. Combined with present day cost of the technology, this serves as a rough judgment of the market deployment process. Finally, a sensitivity analysis of the initial assumptions for the economic analysis is performed, revealing a strong influence of the annuity factor. For the present day technology cost, absorption chillers were found to be profitable for two of the three consumer types when operated for at least 2500 h per year. Electric heat pumps are profitable for all consumer types when exceeding 4000 operating hours per year while absorption heat pumps start at 3000 h of operation per year to be profitable for all consumer types. (C) 2015 Elsevier Ltd. All rights reserved. Times Cited: 51
Brueckner, Sarah Liu, Selina Miro, Laia Radspieler, Michael Cabeza, Luisa F. Laevemanna, Eberhard
Cabeza, Luisa F./B-4587-2013
Cabeza, Luisa F./0000-0001-5086-872X
51
1872-9118 <Go to ISI>://WOS:000356198700016

S. Brueckner, R. Arbter, M. Pehnt and E. Laevemann 2017 Industrial waste heat potential in Germany–a bottom–up analysis
Energy Efficiency 10
2 513–525
Apr Industrial waste heat potential in Germany–a bottom–up analysis 1570–646X

WOS:000398999800015

Industrial waste heat may be one of the answers to future energy demands. Depending on the temperature, industrial waste heat may be used to produce electricity or meet cooling or heating demands at different temperature levels. However, in order to estimate the influence the waste heat may have in future energy systems, the magnitude of the industrial waste heat in the different countries need to be estimated. For Germany, so far, only top–down analyses of the waste heat potential exist, using key figures derived from other studies in other countries. In this paper, the first bottom–up approach for estimating the industrial waste heat potential in Germany is presented. For this approach, an algorithm to evaluate and test the mandatory emission report data from German production companies was developed. In a second step, round about 81,000 data sets have been evaluated to calculate a conservative and lower boundary value for the industrial waste heat. As this conservative, lower boundary based on the collected data from the German industry, the waste heat volume was evaluated as 127 PJ/a or 13 % of the industrial fuel consumption. Results were used to derive key figures with which the missing share of the data was approximated. Times Cited: 1
Brueckner, Sarah Arbter, Rene Pehnt, Martin Laevemann, Eberhard
1
1570–6478 <Go to ISI>://WOS:000398999800015

F. Buhler, S. Petrovic, K. Karlsson and B. Elmegaard 2017
Industrial excess heat for district heating in Denmark
Applied Energy 205
991-1001 Nov
Industrial excess heat for district heating in Denmark 0306-2619

WOS:000414817100080 Excess heat is available from various sources and its utilisation could reduce the primary energy use. The accessibility of this heat is however dependent amongst others on the source and sink temperature, amount and potential users in its vicinity. In this work a new method is developed whith analyses excess heat sources from the industrial sector and how they could be used for district heating. This method first allocates excess heat to single production units by introducing and validating a new approach. Spatial analysis of the heat sources and consumers are then performed to evaluate the potential for using them for district heating. In this way the theoretical potential of using the excess heat for covering the heating demand of buildings is determined. Through the use of industry specific temperature profiles the heat usable directly or via heat pumps is further found. A sensitivity analysis investigates the impact of future energy efficiency measures in the industry, buildings and the district heating grid on the national potential. The results show that for the case study of Denmark, 1.36 TWh of district heat could be provided annually with industrial excess heat from thermal processes which equals 5.1% of the current demand. More than half of this heat was found to be usable directly, without the need for a heat pump.Buhler, Fabian Petrovic, Stefan Karlsson, Kenneth Elmegaard, Brian Elmegaard, Brian/J-6662-2014
Elmegaard, Brian/0000-0002-0503-6286; Petrovic, Stefan/0000-0002-1869-8908
1872-9118 <Go to ISI>://WOS:000414817100080

F. Bühler, S. Petrović, K. Karlsson and B. Elmegaard 2017
Industrial excess heat for district heating in Denmark
Applied Energy 205
991 - 1001
Industrial excess heat for district heating in Denmark 0306-2619

BUHLER2017991 Excess heat, Industry, District heating, Heat pump, Spatial analysis, GIS Abstract
Excess heat is available from various sources and its utilisation could reduce the primary energy use. The accessibility of this heat is however dependent amongst others on the source and sink temperature, amount and potential users in its vicinity. In this work a new method is developed which analyses excess heat sources from the industrial sector and how they could be used for district heating. This method first allocates excess heat to single production units by introducing and validating a new approach. Spatial analysis of the heat sources and consumers are then performed to evaluate the potential for using them for district heating. In this way the theoretical potential of using the excess heat for covering the heating demand of buildings is determined. Through the use of industry specific temperature profiles the heat usable directly or via heat pumps is further found. A sensitivity analysis investigates the impact of future energy efficiency measures in the industry, buildings and the district heating grid on the national potential. The results show that for the case study of Denmark, 1.36TWh of district heat could be provided annually with industrial excess heat from thermal processes which equals 5.1% of the current demand. More than half of this heat was found to be usable directly, without the need for a heat pump.
http://www.sciencedirect.com/science/article/pii/S0306261917310449

F. Bühler, S. Petrovic, T. S. Ommen, F. M. Holm and B. Elmegaard
2017 Identification of Excess Heat Utilisation Potential using GIS: Analysis of Case Studies for Denmark Proceedings of ECOS 2017: 30th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems
San Diego, California, USA

Identification of Excess Heat Utilisation Potential using GIS: Analysis of Case Studies for Denmark

U. Chiarotti, V. Moroli, F. Menchetti, R. Piancaldini, L. Bianco, A. Viotto, G. Baracchini, D. Gaspardo, F. Nazzi, M. Curti and M. Gabriele
2017 Development of a Small Thermoelectric Generators Prototype for Energy Harvesting from Low Temperature Waste Heat at Industrial Plant Journal of Nanoscience and Nanotechnology 17 3 1586-1591 Mar Development of a Small Thermoelectric Generators Prototype for Energy Harvesting from Low Temperature Waste Heat at Industrial Plant 1533-4880

WOS:000397126500007

A 39-W thermoelectric generator prototype has been realized and then installed in industrial plant for on-line trials. The prototype was developed as an energy harvesting demonstrator using low temperature cooling water waste heat as energy source. The objective of the research program is to measure the actual performances of this kind of device working with industrial water below 90 degrees C, as hot source, and fresh water at a temperature of about 15 degrees C, as cold sink. The article shows the first results of the research program. It was verified, under the tested operative conditions, that the produced electric power exceeds the energy required to pump the water from the hot source and cold sink to the thermoelectric generator unit if they are located at a distance not exceeding 50 m and the electric energy conversion efficiency is 0.33%. It was calculated that increasing the distance of the hot source and cold sink to the thermoelectric generator unit to 100 m the produced electric energy equals the energy required for water pumping, while reducing the distance of the hot source and cold sink to zero meters the developed unit produces an electric energy conversion efficiency of 0.61%.Times Cited: 1
Chiarotti, Ugo Moroli, Valerio Menchetti, Fernando Piancaldini, Roberto Bianco, Loris Viotto, Alberto Baracchini, Giulia Gaspardo, Daniele Nazzi, Fabio Curti, Maurizio Gabriele, Massimiliano
1
1533-4899 <Go to ISI>://WOS:000397126500007

J. N. Chiu, J. Castro Flores, V. Martina and B. Lacarrière 2016
Industrial surplus heat transportation for use in district heating Energy 110
139 - 147
Industrial surplus heat transportation for use in district heating 0360-5442

CHIU2016139 Mobile thermal energy storage (M-TES), Industrial surplus heat, Low temperature district heating (LTDH), Environomic evaluation, Techno-economic analysis
Abstract M-TES (Mobile Thermal Energy Storage) technology is explored in this paper for transportation of industrial surplus heat for use in LTDH (low temperature district heating network). LTDH has promising potential in utilizing low grade heat, on the other hand, 20%-50% of industry generated surplus heat is often released to the ambient environment. M-TES is used to match thermal energy supply and demand that occur at different locations and that are shifted in time. In this paper, design of M-TES is conducted, optimization in operating strategies is performed, sensitivity analysis on levelized cost is studied, and environmental impact of CO2 emissions due to transportation is evaluated. The results of the study show an array of transportation means and storage operating strategies under which M-TES is technically, economically and environmentally sound for transportation of industrial surplus heat for use in LTDH network. Special issue on Smart Energy Systems and 4th Generation District Heating
http://www.sciencedirect.com/science/article/pii/S0360544216305539

J. N. W. Chiu and V. Martin 2015 Industrial Surplus Heat Storage in Smart Cities ASME 2015 9th International Conference on Energy Sustainability
collocated with the ASME 2015 Power Conference, the ASME 2015 13th International Conference on Fuel Cell Science, Engineering and Technology, and the ASME 2015 Nuclear Forum
56857 C2 - Energy Sustainability
V002T13A008-C1 - Volume 2: Photovoltaics; Renewable-Non-Renewable Hybrid Power System; Smart Grid, Micro-Grid Concepts; Energy Storage; Solar Chemistry; Solar Heating and Cooling; Sustainable Cities and Communities, Transportation; Symposium on Integrated/Sustainable Building Equipment and Systems; Thermofluid Analysis of Energy Systems Including Exergy and Thermoeconomics; Wind Energy Systems and Technologies

Industrial Surplus Heat Storage in Smart Cities

Surplus heat generated from industrial sectors amounts to between 20% and 50% of the total industrial energy input. Smart reuse of surplus heat resulted from industrial sectors and power generation companies is an opportunity to improve the overall energy efficiency through more efficient use the primary energy sources. A potential solution to tackle this issue is through use of thermal energy storage (TES) to match user demand to that of the generated surplus heat. A mobile TES (M-TES) concept of transportation of industrial surplus heat from production sites to end customers has shown promising results. One commissioned demonstration project using industrial heat for swimming pool water temperature regulation in Dortmund, Germany proved the interest and attention given to this concept.In this paper, a techno-economic case study in Sweden of transportation of surplus thermal energy to district heating in smart cities is presented. The application consists of heat storage at 110°C-130°C through the use of phase change materials (PCM) based TES, notably with use of Erythritol (90 kWh/ton) for the considered temperature range, to remote district heating network located at 48 km from the thermal energy generation site. The advantages of using latent heat based PCM are the high enthalpy density per unit volume and per unit mass, as well as the quasi-constant temperature during charging and releasing of heat. The M-TES in this study has a total storage capacity of 2.1 MWh, the optimization of charge/discharge time to the amount of stored/released energy and to that of energy transportation rate is presented in this paper. Contrary to logical thinking, it is shown through this work that under certain conditions, it is more cost-effective to operate at partial load of storage units albeit the increased number of transport trips and charge/discharge cycles. 10.1115/ES2015-49535
doi: 10.1115/ES2015-49535
http://dx.doi.org/10.1115/ES2015-49535

F. Dal Magro, S. Savino, A. Meneghetti and G. Nardin 2017
Coupling waste heat extraction by phase change materials with superheated steam generation in the steel industry Energy
137 1107-1118
Oct Coupling waste heat extraction by phase change materials with superheated steam generation in the steel industry 0360-5442

WOS:000414879400097

To allow a better exergy exploitation than the current state-of-the-art waste heat to power solutions in the steel industry, a new type of energy recovery system based on Phase Change Materials is proposed. In particular, the use of high temperature PCMs evolves from simply smoothing off gas temperature, as in the most recent studies for energy recovery from electric arc furnaces, to generating constant superheated steam able to feed the downstream turbine nearly at nominal load. This result is achieved by introducing an auxiliary section between the PCM Section and the steam generation one, which provides the auxiliary heat needed to level the thermal content of off gas. The auxiliary heat is extracted from the PCM units by a heat transfer fluid flowing across the inner tube of each PCM container. Different models to properly size and simulate the operations of the proposed energy recovery system have been developed and integrated. Results show how the size of the steam generator and the turbine can be reduced of about 41% with respect to traditional solutions, while increasing electric power production by 22% thanks to the reduced fluctuation in steam parameters at the turbine inlet, which leads to a greater overall efficiency. (C) 2017 Elsevier Ltd. All rights reserved.
Dal Magro, Fabio Savino, Stefano Meneghetti, Antonella Nardin, Gioacchino
11th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES)
Sep 04-09, 2016
Lisbon, PORTUGAL
Dal Magro, Fabio/0000-0002-8866-5618; Meneghetti, Antonella/0000-0002-9475-0763
1
1873-6785 <Go to ISI>://WOS:000414879400097

B. Delpech, B. Axcell and H. Jouhara 2017 A review on waste heat recovery from exhaust in the ceramics industry B. Kaamierczak, M. Kutylowska, K. Piekarska, H. Jouhara and J. Danielewicz
International Conference on Advances in Energy Systems and Environmental Engineering 22
E3S Web of Conferences
A review on waste heat recovery from exhaust in the ceramics industry

WOS:000417352100034

Following the energy crisis in 1980, many saving technologies have been investigated with attempts to implement them into various industries, one of them is the field of ceramic production. In order to comply with energy saving trends and environmental issues, the European ceramic industry sector has developed energy efficient systems which reduced significantly production time and costs and reduced total energy consumption. The last achievement is of great importance as the energy consumption of the ceramic process accounts for a significant percentage of the total production costs. More precisely, the firing stage consumes the highest amount of energy during the whole ceramic production process. The use of roller kilns, fired by natural gas, involves a loss of 50% of the input energy via the flue gas and the cooling gas exhausts. This review paper briefly describes the production process of the different ceramic products, with a focus on the ceramic sector in Europe. Due to the limited on waste heat recovery in the ceramic industry, other high temperature waste heat recovery applications are considered in the paper, such as in concrete and steel production, which could have a potential use in the ceramic industry. The state of the art technologies used in the ceramics industry are reviewed with a special interest in waste heat recovery from the ceramic process exhaust stacks and energy saving technologies. Times Cited: 0
Delpech, Bertrand Axcell, Brian Jouhara, Hussam
Asee17
International Conference on Advances in Energy Systems and Environmental Engineering (ASEE)
Jul 02-05, 2017
Wroclaw, POLAND
2267-1242
Unsp 00034 <Go to ISI>://WOS:000417352100034

J. Dieckmann, C. Smutzer and J. Sinha 2017 Waste Heat-to-Power Using Scroll Expander for Organic Rankine Bottoming Cycle; TIAX LLC, Lexington, MA (United States) Medium: ED; Size: 38 p.
Waste Heat-to-Power Using Scroll Expander for Organic Rankine Bottoming Cycle DE-EE0005767; Other: D0659 United States 10.2172/1360148 Other: D0659 GFO English

D0659 32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION, 42 ENGINEERING, Waste heat recovery, low-grade, moderate temperature, scroll expander, organic Rankine cycle, energy harvesting The objective of this program was to develop a novel, scalable scroll expander for conversion of waste heat to power; this was accomplished and demonstrated in both a bench-scale system as well as a full-scale system. The expander is a key component in Organic Rankine Cycle (ORC) waste heat recovery systems which are used to convert medium-grade waste heat to electric power in a wide range of industries. These types of waste heat recovery systems allow for the capture of energy that would otherwise just be exhausted to the atmosphere. A scroll expander has the benefit over other technologies of having high efficiency over a broad range of operating conditions. The speed range of the TIAX expander (1,200 to 3,600 RPM) enables the shaft power output to directly drive an electric generator and produce 60 Hz electric power without incurring the equipment costs or losses of electronic power conversion. This greatly simplifies integration with the plant electric infrastructure. The TIAX scroll expander will reduce the size, cost, and complexity of a small-scale waste heat recovery system, while increasing the system efficiency compared to the prevailing ORC technologies at similar scale. During this project, TIAX demonstrated the scroll expander in a bench-scale test setup to have isentropic efficiency of 70-75% and operated it successfully for ~200 hours with minimal wear. This same expander was then installed in a complete ORC system driven by a medium grade waste heat source to generate 5-7 kW of electrical power. Due to funding constraints, TIAX was unable to complete this phase of testing, although the initial results were promising and demonstrated the potential of the technology. (United States)
[TIAX LLC, Lexington, MA]
http://www.osti.gov/scitech/servlets/purl/1360148

K. Ebrahimi, G. F. Jones and S. Fleischer 2015 Thermo-economic analysis of steady state waste heat recovery in data centers using absorption refrigeration Applied Energy 139 384-397 Feb Thermo-economic analysis of steady state waste heat recovery in data centers using absorption refrigeration 0306-2619

WOS:000349063000034

This paper addresses the technical and economic issues associated with waste heat recovery in data centers through the use of absorption cooling machines. The theoretical possibility of utilizing the heat dissipated by a server, or a number of servers, to power an absorption system, which in turn produces cooling for other servers in the data center, is investigated. For this purpose, a steady-state thermodynamic model is developed to perform energy balance and exergy analyses for a novel configuration of an on-chip two-phase cooling system and an absorption refrigeration system. This combination is created by replacing the condenser in the on-chip cooling circuit with the generator of an absorption refrigeration cycle. The performance of the developed model in simulating both LiBr-water and water-ammonia absorption cooling systems is examined through verification of the model results against the reference data available in the literature. The verification indicates the superiority of LiBr-water absorption system for data center/server operating conditions. Therefore, a LiBr-water absorption refrigeration system is modeled in the novel combined heat recovery system. For these systems it is shown that the traditional definition for the coefficient of performance (COP) is not appropriate to evaluate the performance and, in its place, introduce a new figure of merit. Through a sensitivity analysis, the effects of server waste heat quality, server coolant type, solution peak concentration, solution heat exchanger effectiveness, evaporator temperature, and operating pressures on the performance of the novel system are investigated. Finally, using the thermodynamic model and cost information provided by the absorption refrigeration industry, an economic analysis is carried out to calculate the payback period when this technology is used for data center waste heat recovery. Times Cited: 23
Ebrahimi, Khosrow Jones, Gerard F. Fleischer, S.
24
1872-9118 <Go to ISI>://WOS:000349063000034

A. Elson, R. Tidball and A. Hampson 2015 Waste Heat to Power Market Assessment; Oak Ridge National Lab. (ORNL), Oak Ridge, TN (United States). Building Technologies Research and Integration Center (BTRIC) Medium: ED; Size: 86 p.

Waste Heat to Power Market Assessment ORNL/TM-2014/620; Other: ED2001000; CEED210 United States 10.2172/1185773 Other: ED2001000; CEED210 ORNL English

ED2001000; CEED210 CHP, Combined Heat and Power, Waste Heat to Power Waste heat to power (WHP) is the process of capturing heat discarded by an existing process and using that heat to generate electricity. In the industrial sector, waste heat streams are generated by kilns, furnaces, ovens, turbines, engines, and other equipment. In addition to processes at industrial plants, waste heat streams suitable for WHP are generated at field locations, including landfills, compressor stations, and mining sites. Waste heat streams are also produced in the residential and commercial sectors, but compared to industrial sites these waste heat streams typically have lower temperatures and much lower volumetric flow rates. The economic feasibility for WHP declines as the temperature and flow rate decline, and most WHP technologies are therefore applied in industrial markets where waste heat stream characteristics are more favorable. This report provides an assessment of the potential market for WHP in the industrial sector in the United States. (United States)
[ICF International, Fairfax, VA]
http://www.osti.gov/scitech/servlets/purl/1185773

L. Eriksson, M. Morandin and S. Harvey 2018 A feasibility study of improved heat recovery and excess heat export at a Swedish chemical complex site International Journal of Energy Research 42 4 1580-1593 Mar A feasibility study of improved heat recovery and excess heat export at a Swedish chemical complex site 0363-907X

WOS:000427120300013

New ambitious targets for reduced greenhouse gas emissions and increased energy efficiency in industry and in the stationary energy sector provide incentives for industrial plants to investigate opportunities for substantially increasing recovery and use of excess heat from their operations. This work investigates the economic feasibility of recovering industrial excess heat at a Swedish chemical complex site for increased site internal heat recovery or export to a regional district heating (DH) network. The work is based on investment cost data estimated in previous work by the authors. A site-wide heat collection and distribution system based on circulating hot water was envisioned, which is also connected to a regional DH network. With the help of multiobjective optimization, the optimal heat contributions from the individual plant sites were identified that minimize the total system cost for a large range of options involving different quantities of internally recovered heat and heat export to the DH system. A payback period analysis was conducted together with a risk assessment to take into account uncertainty regarding utility steam production cost and heat sale price. The results of the study indicate that a payback period of around 3years can be achieved for a number of cases in which 30% to 50% of the total excess heat produced by the site plants is recovered. Although it seems more profitable to recover heat at the site rather than exporting heat to the DH system only, profitability appears to be maximized by hybrid solutions that allow a share of the excess heat to be sold to the DH system and some heat to be recovered at the site simultaneously. In this work, the options of excess heat export and improved internal heat recovery at a Swedish chemical complex site are considered simultaneously. A large set of configurations of a site-wide hot water network are compared and their profitability estimated. The profitability analysis is accompanied by a risk assessment that takes into account possible variations of natural gas prices and heat sale prices. Eriksson, Lina Morandin, Matteo Harvey, Simon 1099-114x <Go to ISI>://WOS:000427120300013

C. Forman, I. K. Muritala, R. Pardemann and B. Meyer 2016
Estimating the global waste heat potential
Renewable & Sustainable Energy Reviews
57 1568-1579
May Estimating the global waste heat potential 1364-0321

WOS:000370456000114 The process chain of energy conversion from primary energy carriers to final energy use is subject to several losses. Especially in end use, vast amounts of converted energy occur as waste heat, which is often released to the environment. In terms of raising energy efficiency and reducing the energy consumption, such waste heat needs to be used. To date, some studies or investigations about industrial waste heat of selected countries have been carried out, but other sectors like commerce were not considered. Therefore, this work presents a novel top-down approach for the estimation of waste heat potential of the most common sectors of end use (transportation, industrial, commercial and residential) including electricity generation on a global scale. It also deals with the temperature distribution of this unused energy. The evaluation reveals that 72% of the global primary energy consumption is lost after conversion. In further detail, 63% of the considered waste heat streams arise at a temperature below 100 degrees C in which electricity generation has the largest share followed by transportation and industry. Times Cited: 27
Forman, Clemens Muritala, Ibrahim Kolawole Pardemann, Robert Meyer, Bernd
27

Z. Hampikian 2017 Urban Structuring of a Heat Network and Waste Heat: Proximity as a Dynamic Variable Flux 109-110 3 9-22

Urban Structuring of a Heat Network and Waste Heat: Proximity as a Dynamic Variable

The development of district heating, which is part of French energy transition public policies, is promoted in particular as a way to recover waste heat that would otherwise be lost in the urban environment. The integration of these energy sources involves an important role for geographic and organisational proximity in the making of the energy provision service. Indeed, the system is based on the existence of a close and coordinated relationship between an urban energy system and activities that produce heat even though they are not linked to the energy provision service. Therefore, the situation relies on spatial and organisational coordination between traditionally separate activities.Building on work in industrial ecology and on the notions developed by the French school of proximity, this article analyses the role of proximity in urban structuring of heat networks supplied by waste heat in Marne-la-Vallée and Dunkirk in France. From this empirical analysis, it is demonstrated that, even though proximity is necessary to initiate the heat exchange, it cannot explain in itself the evolution of the network. In particular, the uncertainties that the activities are facing and local territorial dynamics play an important part in the decisions taken by the actors involved in the networked system, the latter appearing less stable in time than conventional energy networks.

B. Hu, H. Liu, R. Z. Wang, H. B. Li, Z. P. Zhang and S. Wang 2017
A high-efficient centrifugal heat pump with industrial waste heat recovery for district heating Applied Thermal Engineering 125
359-365 Oct
A high-efficient centrifugal heat pump with industrial waste heat recovery for district heating 1359-4311

WOS:000410011200033

The urban construction area and heating energy consumption in northern China have been increasing greatly in recent years. At the same time, a large amount of low-grade industrial waste heat is released directly to the environment in most industrial plants. To meet the district heating demands and recover the industrial waste heat simultaneously, high-efficiency centrifugal heat pumps are applied for district heating and heat recovery. A permanent-magnetic synchronous frequency-convertible (PSF) centrifugal heat pump is developed which has a much higher COP in comparison with that of conventional heat pumps. In a district heating project with waste heat recovery from industry, testing results have shown that COP of a 500RT PSF centrifugal heat pump could reach 7.1, and the total system COP of the district heating system reaches 4.8. The operating cost for one heating season is just 40.3% of gas-fired boiler heating system. The emission of Carbon Dioxide is reduced by 60.6% and 563% when compared with coal-fired boiler and gas-fired boiler heating system, respectively. This shows that application of PSF centrifugal heat pumps to recover the low-grade industrial waste heat for district heating are quite attractive in the north of China cities.
 Times Cited: 0
Hu, Bin Liu, Hua Wang, R. Z. Li, Hongbo Zhang, Zhiping Wang, Sheng Wang, R.Z./0000-0003-3586-5728
0

B. Hunter, A. Ray and Ieee 2016 Cement Plant Waste Heat Recovery Heat-to-Horsepower 2016 Ieee-Ias/Pca Cement Industry Technical Conference

IEEE-IAS PCA Cement Industry Technical Conference Cement Plant Waste Heat Recovery Heat-to-Horsepower 978-1-4673-8619-7

WOS:000390114300006

Many waste heat recovery systems in cement plants have been implemented in Asia, but few are in operation today in the Western hemisphere. Barriers here include low energy prices, high payback criteria, no regulatory requirement and little local industry experience. New drivers are emerging locally, including: increasing energy prices, improving financial instruments, carbon and water reduction requirements, and new system designs that meet utility and industry objectives. This presentation demonstrates how waste heat recovery can be combined with steam turbine mechanical drives to offset electrical energy consumption that meets utility energy efficiency incentive requirements and reduces overall project capital costs. Sensible cooling can replace evaporative cooling to reduce water consumption and ID Fan power consumption, not only from the waste heat to steam recovery but also by lowering the volumetric flowrate to achieve the same mass flowrate. Monitoring energy reduction can be used as a basis for 3rd party financing, and options for three-year payback buyouts will be discussed. Times Cited: 0

Hunter, Bill Ray, Allen

IEEE-IAS/PCA Cement Industry Technical Conference

May 13-20, 2016

Grapevine, TX

2155-9139 <Go to ISI>://WOS:000390114300006

H. Jouhara, S. Almahmoud, A. Chauhan, B. Delpech, G. Bianchi, S. A. Tassou, R. Llera, F. Lago and J. J. Arribas 2017
Experimental and theoretical investigation of a flat heat pipe heat exchanger for waste heat recovery in the steel industry
Energy 141
1928-1939 Dec
Experimental and theoretical investigation of a flat heat pipe heat exchanger for waste heat recovery in the steel industry
0360-5442

WOS:000423249200049 Most of the energy demand in the steel industry is used for heating purposes. The recovery of residual heat contributes to significant reductions in both production costs and greenhouse gas emissions. In this paper, the design, manufacture and testing of an innovative heat recovery system based on a Flat Heat Pipe heat exchanger (FHP) is described. The FHP system consists of stainless steel heat pipes linked by a bottom header and a shell and tube top header. The thermal performance of the FHP was investigated both in the laboratory and on an industrial plant and the energy recovered and the working temperatures of the FHP are reported. A theoretical modelling tool has been built to predict the performance of the device in the laboratory. Reasonable agreement has been obtained between experimental and theoretical results. It is concluded from the results that the HIP is an innovative high efficiency technology for waste heat recovery from such industrial applications. (C) 2017 The Authors. Published by Elsevier Ltd. Times Cited: 0
Jouhara, Hussam Almahmoud, Sulaiman Chauhan, Amisha Delpech, Bertrand Bianchi, Giuseppe Tassou, Sawas A. Llera, Rocio Lago, Francisco Jose Arribas, Juan
Bianchi, Giuseppe/J-5661-2013
Bianchi, Giuseppe/0000-0002-5779-1427; Jouhara, Hussam/0000-0002-6910-6116
0
1873-6785 <Go to ISI>://WOS:000423249200049

V. Jovovic 2015 Thermoelectric Waste Heat Recovery Program for Passenger Vehicles; Gentherm Incorporated, Azusa, CA (United States) Medium: ED; Size: 102 p.

Thermoelectric Waste Heat Recovery Program for Passenger Vehicles

33 ADVANCED PROPULSION SYSTEMS Gentherm began work in October 2011 to develop a Thermoelectric Waste Energy Recovery System for passenger vehicle applications. Partners in this program were BMW and Tenneco. Tenneco, in the role of TIER 1 supplier, developed the system-level packaging of the thermoelectric power generator. As the OEM, BMW Group demonstrated the TEG system in their vehicle in the final program phase. Gentherm demonstrated the performance of the TEG in medium duty and heavy duty vehicles. Technology developed and demonstrated in this program showed potential to reduce fuel consumption in medium and heavy duty vehicles. In light duty vehicles it showed more modest potential. (United States)
[Gentherm Incorporated, Azusa, CA]
http://www.osti.gov/scitech/servlets/purl/1337561

M. Karvonen, R. Kapoor, A. Uusitalo and V. Ojanen 2016 Technology competition in the internal combustion engine waste heat recovery: a patent landscape analysis Journal of Cleaner Production 112 3735-3743 Jan Technology competition in the internal combustion engine waste heat recovery: a patent landscape analysis 0959-6526

WOS:000368207500013

Fuel prices and tightening emission standards have challenged the dominance of internal combustion engines. As a response to this changed business context, the automotive industry has shown active interest in waste heat recovery technologies, which have seen rapid development in recent years. This paper uses a literature review and patent landscape analysis to study key emerging technologies in the field, namely, thermoelectric generators, and Rankine cycle and organic Rankine cycle systems. The state-of-the-art review highlights the challenges, advantages and future prospects of the selected technologies. The patent analysis reveals the leading countries, principal technological development indicators and most important actors active in the field. The results indicate a growing trend of patenting in all selected technologies. The United States and Japan are by far the most dominant countries in the waste heat recovery area, although their relative share of patent applications is declining. By applying a patent landscape approach, the study offers a quantitative perspective on current developments in waste heat recovery technology, provides indicators of future trends, and contributes to debate about technological competition in the automotive industry. Based on the conducted analyses, thermoelectric generators seems to be the most developed of the alternatives and closest to commercial application. Rankine cycle-based technologies, although less well developed, potentially offer greater environmental gains and better efficiency than thermoelectric generators. The study provides valuable information for stake-holders interested in waste heat recovery technologies and gives policymakers perspectives regarding different technological options in development of cleaner engine solutions. (C) 2015 Elsevier Ltd. All rights reserved. Times Cited: 10
Karvonen, Matti Kapoor, Rahul Uusitalo, Antti Ojanen, Ville
Karvonen, Matti/0000-0001-6538-8382
10
1879-1786
5 <Go to ISI>://WOS:000368207500013

M. Kofinger, R. R. Schmidt, D. Basciotti, O. Terreros, I. Baldvinsson, J. Mayrhofer, S. Moser, R. Tichler and H. Pauli 2018 Simulation based evaluation of large scale waste heat utilization in urban district heating networks: Optimized integration and operation of a seasonal storage Energy 159
1161-1174 Sep
Simulation based evaluation of large scale waste heat utilization in urban district heating networks: Optimized integration and operation of a seasonal storage 0360-5442

WOS:000442973300099
The integration of renewable heat sources and industrial waste heat in urban district heating (DH) networks is essential for a sustainable and low-carbon heat supply and therefore a key element for a future prove energy system. Achieving this integration requires the investigation of different technical and infrastructural options, as well as economic analyses for improved implementation. In the city of Linz (Austria), the existing industry exhibits significant unused waste heat potentials which could be integrated into the existing urban OH system, however, a seasonal storage is required due to the competition with an existing waste incineration plant. This paper shows, that a strategic operation of the seasonal storage could increase the number of charging cycles and thereby increase significantly the revenues of the system. This is mainly due to the combined utilization of the storage in a seasonal approach to shift the waste heat from summer to the winter period and as a short term buffer. Thus, the profits from actively participating on the electricity market with the existing combined heat and power (CHP) plants are increased. Koefinger, M. Schmidt, R. R. Basciotti, D. Terreros, O. Baldvinsson, I. Mayrhofer, J. Moser, S. Tichler, R. Pauli, H.
3rd International Conference on Smart Energy Systems and 4th Generation District Heating (SES4DH)
Sep 12-13, 2017
Copenhagen, DENMARK
1873-6785 <Go to ISI>://WOS:000442973300099

D. Konovsek, M. Fuzir, M. Slatinek, T. Sepul, K. Plesnik and S. Lecnik
2017 Process of Optimization of District Heat Production by Utilizing Waste Energy from Metallurgical Processes A. Trnik, J. Avsec and I. Medved 22nd International Meeting of Thermophysics 2017 and 4th Meeting of Enre 2017
1866
AIP Conference Proceedings
Process of Optimization of District Heat Production by Utilizing Waste Energy from Metallurgical Processes 978-0-7354-1546-1

WOS:000426600400052

In a consortium with SIJ (Slovenian Steel Group), Metal Rayne, the local community of Ravne na Koroskem and the public research Institut Jozef Stefan, with its registered office in Slovenia, Petrol Energetika, d.o.o. set up a technical and technological platform of an innovative energy case for a transition of steel industry into circular economy with a complete energy solution called)Utilization of Waste Heat from Metallurgical Processes for District heating of Ravne na Koroskem. This is the first such project designed for a useful utilization of waste heat in steel industry which uses modern technology and innovative system solutions for an integration of a smart, efficient and sustainable heating and cooling system and which shows a growth potential. This will allow the industry and cities to make energy savings, to improve the quality of air and to increase the benefits for the society we live in. On the basis of circular economy, we designed a target-oriented co-operation of economy, local community and public research institute to produce new business models where end consumers are put into the centre. This innovation opens the door for steel industry and local community to a joint aim that is a transition into efficient low-carbon energy systems which are based on involvement of natural local conditions, renewable energy sources, the use of waste heat and with respect for the principles of sustainable development. Times Cited: 0
Konovsek, Damjan Fuzir, Miran Slatinek, Matic Sepul, Tanja Plesnik, Kristijan Lecnik, Samo
Thermophysics 2017
22nd International Meeting of Thermophysics (Thermophysics) / 4th Meeting of the Energy and Responsibility (EnRe)
Sep 12-14, 2017
Terchova, SLOVAKIA
0094-243x
Unsp 050003-1

D. Kurle, C. Schulze, C. Herrmann and S. Thiede 2016 Unlocking waste heat potentials in manufacturing G. Seliger and J. Kruger
23rd Cirp Conference on Life Cycle Engineering
48 289-294
Procedia CIRP
Unlocking waste heat potentials in manufacturing

WOS:000385400300049

Industry releases vast amounts of heat energy as dissipative waste heat to the atmosphere. It is therefore necessary to acquire a better understanding of the waste heat potentials in manufacturing. The paper presents an integrated approach for identifying and quantifying waste heat potentials of different production processes. The identification is based on an estimation procedure followed by a simulative assessment of production processes to quantify and allocate waste heat over time. The approach further elaborates on a potential source and demand matching of heat streams. A case study from the automotive industry demonstrates the applicability of the approach.
 Times Cited: 0
Kurle, Denis Schulze, Christine Herrmann, Christoph Thiede, Sebastian
23rd CIRP Conference on Life Cycle Engineering
May 22-24, 2016
Berlin, GERMANY
2212-8271 <Go to ISI>://WOS:000385400300049

R. Law, A. Harvey and D. Reay 2016 A knowledge-based system for low-grade waste heat recovery in the process industries
Applied Thermal Engineering 94
590-599
Feb A knowledge-based system for low-grade waste heat recovery in the process industries
1359-4311

WOS:000370770300060 The rising cost of energy, combined with increasingly stringent legislation to reduce greenhouse gas emissions is driving the UK process industries towards increasing energy efficiency. Significant gains can be made in this sector by recovering low-grade waste heat as up to 14 TWh per annum (4% of total energy use) of the UK process industries' energy consumption is lost as recoverable waste heat. Substantial recovery of this would have economic benefits of the order of 100s pound of million/year and environmental benefits of 100s of thousands of tonnes of carbon dioxide equivalent per year. A similar situation is envisaged in other industrialised countries. This paper describes the development of a knowledge-based system for the selection and preliminary design of equipment for low-grade waste heat recovery in the process industries. The system processes commonly available plant data to select the most appropriate technology for waste heat recovery from a range of programmed options. Case-study testing shows that the system can successfully select and design viable solutions for waste heat recovery from a range of options, producing designs which are economically, environmentally and technically feasible. (C) 2015 Elsevier Ltd. All rights reserved.
Times Cited: 8
Law, Richard Harvey, Adam Reay, David
9 <Go to ISI>://WOS:000370770300060

S. Lecompte, H. Huisseune, M. van den Broek, B. Vanslambrouck and M. De Paepe 2015 Review of organic Rankine cycle (ORC) architectures for waste heat recovery Renewable & Sustainable Energy Reviews 47 448–461 Jul

Review of organic Rankine cycle (ORC) architectures for waste heat recovery 1364–0321

WOS:000353755100039 The organic Rankine cycle (ORC) is commonly accepted as a viable technology to convert low temperature heat into electricity, Furthermore, ORCs are designed for unmanned operation with little maintenance. Because of these excellent characteristics, several ORC waste heat recovery plants are already in operation. Although the basic ORC is gradually adopted into industry, the need of increased cost–effectiveness persists. Therefore, a next logical step is the development of new ORC architectures. Even though there has been a strong renaissance towards ORC research in the last decade, ORC architectures have received relatively little attention. Several barriers can be listed. First, there is the difficulty in assessing the additional complexity of the system. While several advanced cycle designs appear promising from a thermodynamic viewpoint, it is not clear that these represent viable economic solutions. Secondly, there is a lack of experimental data from open literature. Additionally, there is the challenge of coping with various boundary conditions from literature, which makes an objective comparison difficult. In this article an overview is presented of ORC architectures. The performance evaluation criteria and boundary conditions are clearly stated. As well, an overview of the available experimental data is given. (C) 2015 Elsevier Ltd. All rights reserved. Times Cited: 121
Lecompte, Steven Huisseune, Henk van den Broek, Martijn Vanslambrouck, Bruno De Paepe, Michel
Lecompte, Steven/0000-0002-1447-7526
124 <Go to ISI>://WOS:000353755100039

S. Lemmens and S. Lecompte 2017 Case study of an organic Rankine cycle applied for excess heat recovery: Technical, economic and policy matters Energy Conversion and Management 138 670 - 685 Case study of an organic Rankine cycle applied for excess heat recovery: Technical, economic and policy matters 0196-8904

LEMMENS2017670 Organic Rankine cycle (ORC), Heat recovery, Case study, Financial analysis, Public policy Abstract Many industrial processes inevitably produce excess heat as by-product. Recovering this heat is a matter of waste management and provides opportunities to improve the energy use efficiency. The excess heat can be used for heating purposes (e.g., in processes, or delivered to district heating systems or buildings) or to generate electricity. An increasingly applied technology for industrial excess heat recovery is the organic Rankine cycle (ORC), suitable to recover low-grade heat from 90°C onwards. Although ORCs are studied intensively, few studies have examined the economics of commissioned ORC systems. This paper investigates a 375kWgross ORC system employed for flue gas heat recovery from an industrial kiln in Flanders, Belgium. The purpose of the study is twofold: providing insight into a practical ORC case; and evaluating the financial feasibility while taking the specific policy circumstances into account. The financial appraisal takes account of the specific technical setup, the diverse costs of the system, the external economic parameters, and the policy circumstances in Europe, Belgium and Flanders. A sensitivity analysis illustrates the influence of each parameter on the results. The analysis demonstrates the dominance of the investment costs (4217€2013/kWgross) in the expenses. Under the valid conditions the investment has a positive financial return, but the financial support from the government is indispensable. Finally, the sensitivity analysis reveals the importance of attaining sufficient load hours and the influence of electricity prices on the financial feasibility of ORC projects. The results suggest that ORC systems are suitable for industrial excess heat electricity production under certain conditions, but financial support remains necessary. Reducing the investment costs of the ORC itself could alleviate these conditions.

http://www.sciencedirect.com/science/article/pii/S0196890417300936

Y. Li, J. Xia, H. Fang, Y. Su and Y. Jiang 2016 Case study on industrial surplus heat of steel plants for district heating in Northern China Energy 102 397 - 405 Case study on industrial surplus heat of steel plants for district heating in Northern China 0360-5442

LI2016397

District heating, Industrial surplus heat, Heat recovery, Steel plant Abstract In China, district heating systems are facing a dilemma between rapid growth in demand owing to urbanization and environmental problems related to coal-fired boilers. The utilization of industrial surplus heat has great potential on improving the power of heating systems and reducing coal consumption of boilers. However, few industrial systems are constructed under the consideration of district heating. Some features of the surplus heat, such as the position, grade, and production schedule, are significantly different to traditional heat sources. To recover the surplus heat, retrofits of district heating systems are necessary. In this paper, according to the current situations and the future developments, a scheme is proposed to integrate the surplus heat of two steel plants into a large-scale district heating network. Three sources of surplus heat are involved: slag-flushing water, cooling water, and low-pressure steam. The scheme has been partly applied in a corresponding demonstration project. The actual performance proves the feasibility of the integrated system and implies significant benefits in terms of economic cost, CO2 emission and pollutant emissions. Furthermore, the potential to extend the scheme in Northern China is also evaluated.

http://www.sciencedirect.com/science/article/pii/S0360544216301670

Y. Li, J. Xia, Y. Su and Y. Jiang 2017 Systematic optimization for the utilization of low-temperature industrial excess heat for district heating Energy
144 984 - 991
Systematic optimization for the utilization of low-temperature industrial excess heat for district heating 0360-5442

LI2018984 District heating, Heat pump, Industrial excess heat Abstract Because of extensive heat shortage and serious air pollution, industrial excess heat (IEH) has attracted much attention in the district heating (DH) markets of Northern China, as it has great potential for recycling and satisfying the large demand. Most of the available IEH is released at low temperature by steel plants, chemical plants, etc., which are located far away from the heat users. The energy consumption and pipe investment for heat transportation should be optimized to improve the comprehensive efficiency. This study will use systematic models to make optimization to primary-network temperatures and corresponding connecting forms. Several suggestions will be proposed to help improving the energy efficiency. Furthermore, based on a real case study, two new schemes are proposed and compared with the existing scheme. The connecting form of the optimized scheme is different to conventional heat pump systems using sources such as sewage and ambient water. The rated COP is estimated to be 6.16, and the annual electricity consumption is 40.78 kWh/GJ. The system has significant advantages in terms of energy savings and reductions in pollution emissions in comparison to conventional source systems, implying that it can be worth exploiting IEH even at low temperatures and long distances.

http://www.sciencedirect.com/science/article/pii/S0360544217320819

C. W. R. Lin, Y. J. M. Parng and Y. L. Chen 2018 Profit optimization of sustainable low-to-medium temperature waste heat recovering management Industrial Management & Data Systems 118 2 330-348

Profit optimization of sustainable low-to-medium temperature waste heat recovering management 0263-5577

WOS:000426531500002

Purpose Responding to natural resource depletion and carbon dioxide (CO2) emission problems, and also the stricter government's energy regulations, the purpose of this paper is to develop a sustainable waste heat recovery optimal-profit-oriented management model especially targeting on the easily forgotten low- and medium-temperature waste heat in the industry. In the paper, a system is constructed to facilitate converting the low- and medium-grade waste heat in factories into electricity, and yields optimal profit. Design/methodology/approach This paper integrates an efficient Organic Rankine Cycle (ORC) system from both sustainable energy reservation and cost effectiveness approaches with an optimization model that adopts particle swarm optimization (PSO) algorithm to determine proper installation locations and feasible generator sets. The system is constructed to facilitate converting the low- and medium-grade waste heat in factories into electricity, and yields optimal profit. The model considers the environmental factors: temperature, heat amount, equipment configuration of the number of ORC sets, and detailed investment cost constraints. Findings The results show that annual investment return rate, annual increase in electricity, power generation efficiency, and annual CO2 emission reduction are all highly improved, and investment recovery period is shortened. Also, the larger scale of the waste heat emission, the better the performance is achieved. Finally, the study also completes a sensitivity test under dynamic conditions of electricity price, generator sales price and factory budget constraints, and the results are consistently robust. More valuably, this paper demonstrates applications on two different manufacturing industries with various waste heat emission scales to prove the accountability. Originality/value The main contributions are in three aspects. First, it proves that applying PSO to a nonlinear mathematical model can help determine the optimal number and style configuration of generators for waste heat sources. Second, different from the prior research works focusing on power generation, this paper also deliberates the cost factors, cost of generators, costs of numerous peripheral components and future maintenance costs to ensure the factories not conflict with the financial limitations. Third, it is not only successfully applied in two industries with different scales, but also robust with various economic tests, electricity price change, generator sales price change, and investment budget adjustments. Times Cited: 0

Lin, Chun-Wei R. Parng, Yuh-Jiuan Melody Chen, Yu-Lin

0

1758-5783

Si <Go to ISI>://WOS:000426531500002

W. Lin, L. Nilsson and R. Malutta 2017 Waste Heat Recovery by Organic Rankine Cycle (ORC) for Moist Exhaust Gases From Paper Industry
58417 C2 - ASME International Mechanical Engineering Congress and Exposition V006T08A012-C1 - Volume 6: Energy

Waste Heat Recovery by Organic Rankine Cycle (ORC) for Moist Exhaust Gases From Paper Industry

Large potential exists in recovering waste heat from paper industry processes and machinery. If the overall energy efficiency would be increased, it could lead to significant fuel savings and greenhouse gas emission reduction. The organic Rankine cycle (ORC) system is a very strong candidate for converting low-grade waste heat into power. However, there is a lot of water vapor containing latent heat in the exhaust gases from the drying process in the paper industry. Thus, the aim of this research work is to increase the efficiency of the ORC system by recovering not only the sensible heat but also the latent heat from the exhaust gases in the paper drying process. In order to recover the latent heat from the moist exhaust gases, one idea of this article is to introduce a direct contact condensing unit into the ORC system. The performance of ORC system with the direct contact condensing unit was analyzed by using the CHEMCAD software. A case study was conducted based on data of the exhaust gases from a tissue production / drying machine. Latent heat will be recovered when the evaporating temperature of the ORC working fluid is lower than the dew point of the water vapor in the exhaust gases. The results showed that the available heat load was increased when the evaporating temperature was reduced. Furthermore, a performance comparison of the ORC systems with and without the direct contact condensing unit was carried out in the case study as well. The results showed that the ORC system with the direct contact condensing unit not only could recover latent heat from the water vapor in the exhaust gases but also could have a small size and small volume evaporator in the ORC system.

10.1115/IMECE2017-71326
doi: 10.1115/IMECE2017-71326
http://dx.doi.org/10.1115/IMECE2017-71326

H. Z. Liu 2017 Research on Industrial Waste Heat Utilization Technology X. Chu Proceedings of the 2017 4th International Conference on Education, Management and Computing Technology
101 1239-1243
Advances in Social Science Education and Humanities Research
Research on Industrial Waste Heat Utilization Technology 978-94-6252-323-4

WOS:000426716000266

With the increasingly tense energy situation, energy saving and emission reduction has become an important issue in the current industrial sector. China's industrial waste heat resources are abundant, but the utilization rate of waste heat is low. This paper summarizes the present situation of industrial waste heat utilization resources, and discusses the development of industrial waste heat utilization technology. Corresponding to different industries, this paper focuses on the analysis of several waste heat utilization. Times Cited: 0

Liu, Huazhen
Icemct 2017
4th International Conference on Education, Management and Computing Technology (ICEMCT)
Apr 15-16, 2017
Hangzhou, PEOPLES R CHINA
2352-5398 <Go to ISI>://WOS:000426716000266

H. Y. Lu, L. Price and Q. Zhang2016 Capturing the invisible resource: Analysis of waste heat potential in Chinese industry
Applied Energy 161
497-511 Jan
Capturing the invisible resource: Analysis of waste heat potential in Chinese industry 0306-2619

WOS:000366063100042

Waste heat recovery and utilization represents a missed opportunity to reduce China's total energy use, decrease carbon dioxide emissions, and improve air quality. Currently, China does not have a standardized or transparent methodology to quantify the waste heat potential in the industrial sector, which accounts for more than two thirds of China's primary energy consumption. This paper presents the results of thermal energy modeling to quantify the technical maximum waste heat potential in three energy-intensive industrial sectors: cement, iron and steel, and glass. In addition, this paper identifies the practical potential for producing electricity from waste heat in these sectors. The analysis finds that the glass sector has the highest waste heat to power generation potential per unit of production basis among the studied sectors. This paper provides key principles for managing waste heat in the industrial sector and key sector characteristics for implementing waste heat to power generation technologies. Times Cited: 14
Lu, Hongyou Price, Lynn Zhang, Qi
Lu, Hongyou/0000-0003-1399-1977
15
1872-9118 <Go to ISI>://WOS:000366063100042

H. Lu 2015 Capturing the Invisible Resource. Analysis of Waste Heat Potential in Chinese Industry and Policy Options for Waste Heat to Power Generation; Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States) Medium: ED; Size: 95 p.

Capturing the Invisible Resource. Analysis of Waste Heat Potential in Chinese Industry and Policy Options for Waste Heat to Power Generation LBNL-179618; Other: ir:179618 United States 10.2172/1236444 Other: ir:179618 LBNL English

ir:179618 32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION, 54 ENVIRONMENTAL SCIENCES

This study analyzed the theoretical maximum potential and practical potential of waste heat in the cement, iron, and steel, and glass sectors in China, based on thermal energy modeling, expert interviews, and literature reviews. (LBNL) (United States) [Lawrence Berkeley National Lab. , Berkeley, CA]

http://www.osti.gov/scitech/servlets/purl/1236444

A. Luo, H. Fang, J. J. Xia, B. R. Lin and Y. Jiang 2017 Mapping potentials of low-grade industrial waste heat in Northern China
Resources Conservation and Recycling
125 335-348
Oct Mapping potentials of low-grade industrial waste heat in Northern China 0921-3449

WOS:000408299800031

Low-grade industrial waste heat has drawn great attention in China. A new regulation concerning low-grade industrial waste heat (IWH) use has been issued by the NDRC (National Development and Reform Commission) and the Ministry of Housing and Urban-Rural Development. Among the four major tasks mentioned, the most important is investigating IWH. However, there is little official data on the amount of waste heat in China. This paper presents a three-level method of IWH investigation. Meanwhile, the information needed at each level is summed up and heating area in northern China is taken as a case. A series of means are adopted, such as official statistics analysis, literature investigation, field test and so on. Results reveal the drastic situation of energy waste, and the great potential for energy conservation through the use of IWH. Approximately, 100 Mtce (2.93 EJ) potential of waste heat in industry can be recovered during heating season in whole northern China with 3.04 billion m(3) of water saving.. Questionnaire inquiry covers 11 cities in Hebei, a typical industrial province. The feasibility and benefit of waste heat to district heating (DH) were verified in a case in Qianxi county. But usually waste heat doesn't distribute according to residential heat demand, as details are necessary when we regard it as potential heat source in any level. Moreover, it is recommended that policy makers should attach importance to data statistics, technology evaluation and stimulating market mechanism for proposed aim on waste heat. Times Cited: 1
Luo, Ao Fang, Hao Xia, Jianjun Lin, Borong Jiang, Yi
1
1879-0658 <Go to ISI>://WOS:000408299800031

S. Maharaj, P. Govender and Ieee 2016 Identification and Recovery of Waste Heat Proceedings of the 13th Conference on the Industrial and Commerical Use of Energy 214-220 Identification and Recovery of Waste Heat 978-0-9946-7591-0

WOS:000386657000032

South Africa heavily depends on its vast quantities of cheap coal resources to fire its power stations. These power stations supply electricity to a large industrial sector made up of oil refineries, mines, smelters, mills (paper, food, textile), motor, and various farming and manufacturing industries. The increasing number of consumers has lead to a high demand on the electricity grid unfortunately this has resulted in the electricity utility implementing load-shedding during peak consumption periods. An increase in electricity generation would result in an increase of CO2 emissions by coal fired power stations supplying its national grid. The current energy drive by the government is to promote renewable energy in the industrial sector while reducing greenhouse gases (GHG) in the process. South Africa is blessed with an abundant supply of renewable energy such as solar and wind, while modern technologies such as thermoelectricity is being introduced as a viable renewable alternative. Most industries emit waste heat during their processes. This energy can be recovered and reused. This paper identifies potential sources of wasted heat and also proposes a simple thermo-electric device to convert the heat energy into electricity. Times Cited: 0

Maharaj, S. Govender, P.

Icue

13th Conference on the Industrial and Commercial Use of Energy (ICUE) Aug 16-17, 2016

Cape Town, SOUTH AFRICA <Go to ISI>://WOS:000386657000032

M. B., Z. S. and Z. L.E. 2017 An Integrated Supply Chain Model with Excess Heat Recovery IFIP International Conference on Advances in Production Management Systems: The Path to Intelligent, Collaborative and Sustainable Manufacturing
IFIPAICT, volume 514 479-487

An Integrated Supply Chain Model with Excess Heat Recovery

S. Mazzoni, M. Jimenez-Arreola and A. Romangoli 2017 Innovative Organic Rankine arrangements for Water Savings in Waste Heat Recovery Applications Energy Procedia
143 361 - 366
Innovative Organic Rankine arrangements for Water Savings in Waste Heat Recovery Applications 1876-6102

MAZZONI2017361 ORC, Water Saving, Waste Heat Recovery Abstract Water is a natural resource of vital importance in the Singaporean context because of its high cost and scarcity. Indeed, 430mil gallons a day are consumed by the Singapore end-users, 45% domestic and 55% industry, with the latter expected to increase in the years to come by more than 60%. A significant amount of water is used for cooling towers which, in a hot and humid environment like that of the South-East Asian countries, have to operate extremely hard to reject heat from waste heat sources. While economics often limits the feasibility of low temperature Waste Heat Recovery (WHR) (40°C - 200°C), the large amount of waste heat available represents a huge opportunity for energy savings; indeed, the gaps remain such as maximise energy output, cooling loop in the condenser, smaller and compact size waste heat recovery systems, stabilising waste heat source and quality of waste heat. One valid alternative to reduce the cooling load in cooling towers (i.e. less water consumption) is represented by Organic Rankine Cycles (ORCs), which are mainly used to maximize the electricity output from a waste heat source. The operating principle of ORCs is the same as that of steam power plants and the main advantages of ORCs are simple and compact system structure and widely used heat sources and availability in recovering low temperature heat energy. In small scale, ORCs have not been commercialised due to techno-economic factors (i.e. low efficiency and payback period) and therefore there is a significant drive to find suitable solutions for electric power output between 10kWe and 100kWe. The paper deals with the development of key enabling components for small ORCs systems aimed to minimize water consumption from cooling towers by means of innovative ORC plant arrangements based on Turbo-Expander (TE) pumping system and internal regeneration processes. By means of this novel arrangement, improvement in global ORC performance are observed, reducing at the same time the cooling load at the condenser. The plant arrangement is described into details and results for different low temperatures WHR are presented, highlighting the benefit in terms of m3 of saved water when Toluene and R245FA Working Fluid (WF) are adopted.
Leveraging Energy Technologies and Policy Options for Low Carbon Cities
http://www.sciencedirect.com/science/article/pii/S1876102117364615

L. Miro, S. Bruckner and L. E. Cabeza 2015 Innovative Organic Rankine arrangements for Water Savings in Waste Heat Recovery Applications Renewable & Sustainable Energy Reviews 51 847-855 Nov Mapping and discussing Industrial Waste Heat (IWH) potentials for different countries 1364-0321

WOS:000371000900060 In accordance to the current worldwide trend of reducing CO2 emissions and to make the industry more competitive incrementing its efficiency, some countries are starting to quantify their quantity of Industrial Waste Heat. In fact, to be able to recover and reuse this waste heat from industrial processes as a source for other processes or activities, the availability of reliable data of the Industrial Waste Heat potential found in a region is a key point. For that, after an exhaustive literature research, this article shows Industrial Waste Heat data from 33 countries and 6 subregions of different countries. Their feasibility is assessed in the discussion part as it is expected and shown in most of the cases that the amount of Industrial Waste Heat is proportional to some parameters regarding the country and its industry like: the Energy Consumed by the Country, the Energy Consumed by the Industry and the amount of Industrial Waste Heat Intensive Industry in the country. Country scale has been chosen and it is shown that at other scales these parameters are not always available. Nevertheless, some of the studied cases found show data not fitting into this pattern (approximately 1/6 of the data found). That can be explained taking into account that in most of the studies the methodology to account the quantity of Industrial Waste Heat is not explained. Factors like the reference year of the data, the boundaries of the analysis, the type of waste heat considered, etc. affect to the report of quantity of Industrial Waste Heat. Therefore, the authors provide a set of parameters and recommend checking these in order to confirm the reliability of data referring to Industrial Waste Heat quantities. Times Cited: 16
Miro, Laia Brueckner, Sarah Cabeza, Luisa E.
Cabeza, Luisa F./B-4587-2013
Cabeza, Luisa F./0000-0001-5086-872X
16 <Go to ISI>://WOS:000371000900060

L. Miro, S. Brueckner, R. McKenna and L. F. Cabeza 2016
Methodologies to estimate industrial waste heat potential by transferring key figures: A case study for Spain Applied Energy 169 866-873
May
Methodologies to estimate industrial waste heat potential by transferring key figures: A case study for Spain 0306-2619

WOS:000374196200069

In the current European energy context, the use of recovered industrial waste heat provides an attractive opportunity to substitute primary energy consumption by a low-emission and low-cost energy carrier. In the case of industrial waste heat, this potential is currently not only largely untapped, but also unaccounted for. In order to achieve a widespread use of recovered industrial waste heat, assessments with a large scope and high spatial resolution are needed. Three methods published in the period 20022010 have been found in the literature, which are potentially transferable to other regions. These three methods are based on either the energy consumption of each manufacturing sector or the individual site CO2 emissions. The scope of this analysis is, first, to investigate in how far a transfer of the figures to different countries or regions is sensible in comparison to former studies in the literature. In the process, some uncertainties when transferring methods were identified (different definitions of industry, different standard industrial activities classifications or no standard at all, etc.). The second goal is, once the methodology is accepted, to apply it to a case study, in this case the industrial sector in Spain and two of its counties (Catalonia and the Basque Country) for the years 2001, 2009, 2010 and 2013. In this period, and based on the different approaches employed, the Spanish annual industrial waste heat potential ranges from 54.3 to 151.1 PJ, Catalonia from 8.6 to 29.7 PJ, and from 7.2 to 11.9 PJ for the Basque Country. The methods are considered highly transferable but uncertainties inevitably arise in the case that the source and destination industrial sectors are very different. Times Cited: 5
Miro, Laia Brueckner, Sarah McKenna, Russell Cabeza, Luisa F.
Cabeza, Luisa F./B-4587-2013
Cabeza, Luisa F./0000-0001-5086-872X
5
1872-9118 <Go to ISI>://WOS:000374196200069

L. Miro, J. Gasia and L. F. Cabeza 2016 Thermal energy storage (TES) for industrial waste heat (IWH) recovery: A review
Applied Energy 179
284-301 Oct
Thermal energy storage (TES) for industrial waste heat (IWH) recovery: A review 0306-2619

WOS:000383291800025

Industrial activities have a huge potential for waste heat recovery. In spite of its high potential, industrial waste heat (IWH) is currently underutilized. This may be due, on one hand, to the technical and economic difficulties in applying conventional heat recovery methods and, on the other, the temporary or geographical mismatch between the energy released and its heat demand. Thermal energy storage (TES) is a technology which can solve the existing mismatch by recovering the IWH and storing it for a later use. Moreover, the use of recovered IWH leads to a decrease of CO2 emissions and to economic and energy savings. Depending on the distance between the IWH source and the heat demand, TES systems can be placed on-site or the IWH can be transported by means of mobile TES systems, to an off-site heat demand. Around 50 industry case studies, in which both on-site and off-site recovery systems are considered are here reviewed and discussed taking into account the characteristics of the heat source, the heat, the TES system, and the economic, environmental and energy savings. Besides, the trends and the maturity of the cases reviewed have been considered. On-site TES systems in the basic metals manufacturing are the technology and industrial sector which has focused the most attention among the researchers, respectively. Moreover, water (or steam), erythritol and zeolite are the TES materials used in most industries and space comfort and electricity generation are the most recurrent applications. Times Cited: 32
Miro, Laia Gasia, Jaurne Cabeza, Luisa F.
Cabeza, Luisa F./B-4587-2013
Cabeza, Luisa F./0000-0001-5086-872X; Gasia, Jaume/0000-0001-9280-9306
32
1872-9118 <Go to ISI>://WOS:000383291800025

L. Miro, R. McKenna, T. Jager and L. F. Cabeza 2018 Estimating the industrial waste heat recovery potential based on CO2 emissions in the European non-metallic mineral industry Energy Efficiency 11 2 427-443 Feb

Estimating the industrial waste heat recovery potential based on CO2 emissions in the European non-metallic mineral industry

1570-646X

WOS:000422803500008 Industrial waste heat (IWH) is a key strategy to improve energy efficiency and reduce CO2 emissions in the industry. But its potential for different countries remains unclear due to a non-existent or inconsistent data basis. The objective of this paper is to assess the IWH potential of the European non-metallic mineral industry, using databases which comprise CO2 emissions of more than 400 industrial sites as well as country- and sector-specific parameters. This sector is selected because of its homogenous nature, meaning that most sites carry out similar or the same processes, which facilitates site-level modelling with subsector-level assumptions. The bottom-up approach is employed to derive the IWH potential for this industry over the period 2007-2012. Average results in this period show an IWH potential per site of 0.33 PJ/a and a potential for the whole sector of 134 PJ/a. The countries with the largest IWH potentials are Germany, Italy, France and Spain with yearly average potentials of 23, 19, 17 and 16 PJ, respectively. The subsector with the most IWH potential is cement. Further work should focus on the improvement of methodologies to assess the IWH potential, in particular through a techno-economic assessment of links between IWH sources and potential sinks. Times Cited: 0
Miro, Laia McKenna, Russell Jaeger, Tobias Cabeza, Luisa F.
Cabeza, luisa f./0000-0001-5086-872x
0
1570-6478 <Go to ISI>://WOS:000422803500008

S. Moser, J. Mayrhofer, R. R. Schmidt and R. Tichler 2018
Socioeconomic cost-benefit-analysis of seasonal heat storages in district heating systems with industrial waste heat integration
Energy 160
868-874 Oct
Socioeconomic cost-benefit-analysis of seasonal heat storages in district heating systems with industrial waste heat integration 0360-5442

WOS:000445985300071 Industrial waste heat is primarily available in summer months while district heating demand is greater in winter months. In order to shift heat potentials from summer to winter and thereby make the feed-in of industrial waste heat economically more attractive, the paper explores the use of waste heat with large-scale (seasonal) heat storage. This paper focuses on the case study of the industrial city of Linz (Austria), and demonstrates the advantages and disadvantages of seasonal heat storage. The interaction between the storage system with optimal cogeneration plant dispatch and industrial waste heat integration is explained. Furthermore, the most important parameters of the heat storage in order to achieve economic feasibility are highlighted. One main finding is that the number of annual cycles is crucial for a seasonal heat storage. The amortization period is computed to be about 20 years, and is shown to be extremely sensitive to changes in electricity, gas and CO2 prices. (C) 2018 Elsevier Ltd. All rights reserved. Moser, Simon Mayrhofer, Julia Schmidt, Ralf-Roman Tichler, Robert
12th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES)
Oct 04-08, 2017
Dubrovnik, CROATIA
1873-6785 <Go to ISI>://WOS:000445985300071

K. O'Rielly and J. Jeswiet 2015 IMPROVING INDUSTRIAL ENERGY EFFICIENCY THROUGH THE IMPLEMENTATION OF WASTE HEAT RECOVERY SYSTEMS Transactions of the Canadian Society for Mechanical Engineering 39 1 125-136

IMPROVING INDUSTRIAL ENERGY EFFICIENCY THROUGH THE IMPLEMENTATION OF WASTE HEAT RECOVERY SYSTEMS 0315-8977

WOS:000352167100010

Improving the energy efficiency of industrial processes and the facilities in which they are carried out is often considered to be one of the most promising ways to begin reducing global greenhouse gas emissions. One of the best ways for organizations to reduce their energy consumption without having to carry out extensive equipment and facility overhauls is waste heat recovery or energy recycling. Waste heat recovery involves tapping into previously discarded thermal energy streams and reusing it for various purposes within a facility (space heating or cooling) or within the process itself (pre-heating air and boiler makeup water). Despite the numerous social and economic benefits that are available through waste heat recovery, several economic and technical barriers still exist to its wide-scale implementation. This paper provides an overview of the current state of waste heat recovery systems available in industry, offers a discussion of the major barriers to their wide-spread implementation, and lastly concludes with new data with several new case studies from Canadian manufacturers which have successfully harnessed waste heat within their facilities. Times Cited: 0

O'Rielly, Kristine Jeswiet, Jack

0 <Go to ISI>://WOS:000352167100010

G. Oluleye, N. Jiang, R. Smith and M. Jobson 2017 A novel screening framework for waste heat utilization technologies
Energy 125
367-381 Apr
A novel screening framework for waste heat utilization technologies 0360-5442

WOS:000401202300032

Waste heat exploitation improves the energy efficiency of process sites, ensuring lower costs and lower CO2 emissions. Technologies such as organic Rankine cycles, absorption chillers, mechanical heat pumps, absorption heat transformers and absorption heat pumps exist to utilize waste heat. Though these technologies make waste heat re-use technically feasible, selection of technologies based on different heat source temperatures still needs to be addressed. In this work, a novel screening approach is proposed to compare technologies considering the waste heat source quality. A methodology is also presented to select technologies for a process site based on the screening results. Since multiple energy form interactions occur, the screening criterion considers the deviation of the actual performance from the ideal performance of technology options, taking into account irreversibilities as a result of finite temperature heat transfer. The tool is applied to screen and select technologies for waste heat sources below 265 degrees C. Results identify the temperature ranges where technologies have minimum exergy degradation. The framework systematically matches heat source temperatures with technology options compared to a trial and error approach. The framework was applied to an industrial case study to recover 45,660 kW of useful energy from the available waste heat. (C) 2017 Elsevier Ltd. All rights reserved. Times Cited: 0
Oluleye, Gbemi Jiang, Ning Smith, Robin Jobson, Megan
0
1873-6785 <Go to ISI>://WOS:000401202300032

G. Oluleye, M. Jobson and R. Smith 2015 A hierarchical approach for evaluating and selecting waste heat utilization opportunities Energy 90 5-23 Oct A hierarchical approach for evaluating and selecting waste heat utilization opportunities 0360-5442

WOS:000364248100002 This paper presents a ranking criterion for evaluating opportunities that utilize recovered energy from the available waste heat in process sites. The ranking criterion takes into account the energy performance of waste heat recovery technologies associated with each opportunity, their potential to reduce greenhouse gas emissions (namely CO2) and the economics (costs and benefits). Mathematical modelling of the opportunities using the ranking criterion is developed to allow for systematic evaluation of opportunities, for example within an optimization framework. A methodology using the ranking criterion to design site waste heat recovery systems is also proposed. The methodology is applied to a case study of a petroleum refinery. Hierarchy and performance of waste heat utilization opportunities depends on the temperature of the heat available, amongst other factors. The site operating cost and CO2 emissions reduce by 26% and 18% respectively when opportunities to use the recovered energy from waste heat within and outside the process site boundaries are explored. Sensitivity of the ranking to energy prices is studied, to explore the outlook for waste heat utilization in the future. The methodology can be applied to the process industries and other facilities producing waste heat. (C) 2015 Elsevier Ltd. All rights reserved. Times Cited: 7
Oluleye, Gbemi Jobson, Megan Smith, Robin
Smith, Robin/P-3019-2016
Smith, Robin/0000-0003-1832-8592; Jobson, Megan/0000-0001-9626-5879
7
1873-6785
1

G. Oluleye, R. Smith and M. Jobson 2016 Modelling and screening heat pump options for the exploitation of low grade waste heat in process sites Applied Energy
169 267–286
May Modelling and screening heat pump options for the exploitation of low grade waste heat in process sites 0306–2619

WOS:000374196200023 The need for high efficiency energy systems is of vital importance, due to depleting reserves of fossil fuels and increasing environmental problems. Industrial operations commonly feature the problem of rejecting large quantities of low-grade waste heat to the environment. The aim of this work is to develop methods for the conceptual screening and incorporation of low-temperature heat upgrading technologies in process sites. The screening process involves determination of the best technology to upgrade waste heat in process sites, and the combination of waste heat source and sink temperatures for a technology. Novel simplified models of mechanical heat pumps, absorption heat pumps and absorption heat transformers are proposed to support this analysis. These models predict the ratio of the real performance to the ideal performance in a more accurate way, than previous simplified models, taking into account the effect of changing operating temperatures, working fluids non-ideal behaviour and the system component inefficiencies. A novel, systems-oriented criterion is also proposed for conceptual screening and selection of heat pumps in process sites. The criterion (i.e. the primary fuel recovery ratio) measures the savings in primary fuel from heat upgraded, taking into account power required to drive mechanical heat pumps and missed opportunities for steam generation when absorption systems are used. A graphical based methodology is also developed for applying the PRR in process sites and applied to a medium scale petroleum refinery. Results show that applying the PRR yields 9.2% additional savings in primary fuel compared to using the coefficient of performance to screen and incorporate heat pumps. Times Cited: 10
Oluleye, Gbemi Smith, Robin Jobson, Megan
Smith, Robin/P-3019-2016
Smith, Robin/0000-0003-1832-8592
10
1872-9118 <Go to ISI>://WOS:000374196200023

E. Oro, R. Allepuz, I. Martorell and J. Salom 2018 Design and economic analysis of liquid cooled data centres for waste heat recovery: A case study for an indoor swimming pool Sustainable Cities and Society 36
185-203 Jan
Design and economic analysis of liquid cooled data centres for waste heat recovery: A case study for an indoor swimming pool
2210-6707

WOS:000415900000018 A vast amount of waste heat is produced in urban areas from a range of local sources such as metros, large buildings and urban waste. Data centres are another rapidly growing sector generating heat that could potentially be recovered and reused for heating and cooling. The integration of heat reuse solutions in the data centre industry will decrease the operational expenses by reducing the cooling demand and will create new business models by selling the excess heat to nearby heat demand applications. On one hand, the manuscript demonstrates how liquid cooled data centres can reduce the overall data centre consumption up to 30% in comparison with state-of-the-art air cooled data centres. On the other hand, the liquid cooling configuration of on-chip servers is evaluated numerically for a case study of an indoor swimming pool. For the best favourable solution, the data centre operator reduces its operational expenses and generates additional incomes by selling the excess heat, achieving a net present value after 15 years of 330,000 (sic). Moreover, the indoor swimming pool operator reduces its operational expenses 18%. Finally, the results of the case study are extrapolated to study the impact of heat reuse usage in Barcelona. Times Cited: 0
Oro, Eduard Allepuz, Ricard Martorell, Ingrid Salom, Jaume
Salom, Jaume/0000-0001-7035-3248
0
2210-6715 <Go to ISI>://WOS:000415900000018

S. Paivarinne, O. Hjelm and S. Gustafsson 2015 Excess heat supply collaborations within the district heating sector: Drivers and barriers
Journal of Renewable and Sustainable Energy
7 3
May Excess heat supply collaborations within the district heating sector: Drivers and barriers
1941-7012
033117
WOS:000357684800018 This article combines the theoretical field of Industrial Symbiosis (IS) with a business model perspective to increase the knowledge about drivers and barriers behind the emergence of excess heat supply collaborations between district heating companies and industrial firms. The increased knowledge is gained by identifying and examining drivers and barriers associated with collaborative efforts to funnel excess heat produced by industrial firms into district heating grids in Sweden. An increased recovery of excess heat has the potential to reduce the primary energy demands of district heating systems. This study examines both existing and potential developments of industrial collaborations of excess heat-based district heating systems. The focus of the study consists of two Swedish cases of existing collaboration between district heating companies and pulp and paper industries as well as 16 industrial firms that all produce unused excess heat as a by-product. Confirming earlier research results, this study shows that financial issues are both the main drivers and the main barriers behind the emergence and development of inter-organisational collaborations. In addition, this study confirms earlier research that found the trust, joint problem solving, and fine-grained information transfer are important elements of successful collaboration. This study complements and clarifies these three features by including honesty and shared visions on common goals as important qualities needed for well-functioning collaborations. Combining the IS and the business model perspective has made it possible to examine more factors related to collaboration. The business model perspective has contributed with knowledge about central components of the business agreement between the collaborating parties, and the IS-perspective has contributed knowledge of the important organisational factors behind the emergence and development of long-term sustainable business agreements between firms. (C) 2015 AIP Publishing LLC. Paivarinne, Sofia Hjelm, Olof Gustafsson, Sara <Go to ISI>://WOS:000357684800018

S. Päivärinne 2017 Utilisation of Excess Heat Towards a Circular Economy: Implications of interorganisational collaborations and strategic planning Linköpings universitet, Institutionen för ekonomisk och industriell utveckling, Industriell miljöteknik. Linköpings universitet, Tekniska fakulteten. Linköpings Universitet PhD

Utilisation of Excess Heat Towards a Circular Economy: Implications of interorganisational collaborations and strategic planning

0345-7524
9789176854594

In order to significantly lower the environmental impact from human activities, numerous efforts and approaches related to the transformation of human activities have developed during the last decades. Examples of such efforts are policies and strategies at different levels, some with a top-down approach focusing on extensive institutional changes, and some with a bottom-up approach focusing on industrial actors and industry-led activities. One essential aspect of these efforts concerns the energy used producing the products and services provided within our society. This includes, for example, improved efficiency of processes in order to minimise the amount of energy used, or optimisation of efficiency by using energy with the lowest possible exergy value. It can also be about re-use of energy, which is the focus of this thesis. Heat, which is the main by-product of all energy systems, can be utilised for heating purposes to lower the primary energy demand for heating. Increased utilisation of excess heat, however, requires collaboration between normally unrelated actors, those with a supply of and those demanding excess heat. In Sweden, which is a Northern European country with high demand for heat, the tradition of large energy-intensive manufacturing industries generating large amounts of excess heat, in combination with well-established district heating distribution systems, constitute good conditions for excess heat utilisation. Despite the fact that Sweden is among the world leaders in utilising excess heat, there is however, still a large unutilised potential.
From this background, the objective of this thesis is to identify challenges behind excess heat utilisation for heating purposes, and to propose practical suggestions to facilitate expanded excess heat utilisation. The overall objective is analysed with a focus on drivers and barriers behind interorganisational collaborations on excess heat utilisation, important components of interorganisational business models and how the technical conditions regarding supply and demand could be facilitated by strategic municipal spatial planning processes. The research is largely based on interviews conducted with societal actors with different perspectives on excess heat utilisation; energy companies, industries generating high-grade excess heat, facilities generating low-grade excess heat, facilities demanding low-grade excess heat, experts of utilisation of low-grade excess heat, branch organisations, municipal spatial planners, energy- and climate advisors, and developers. Document studies have been conducted in order to collect case specific knowledge. The research questions are explored based on literature studies on the principles of industrial symbiosis, business model perspective and strategic planning. Further, they are examined in a Swedish context.
It is concluded that the three perspectives complement each other by providing a system perspective on increased

utilisation of excess heat as they seek to contribute both environmental and financial benefits at both a company and societal level. In order to facilitate further utilisation of excess heat it is important to focus on the organisational factors of humility, honesty, transparency, trust, fine-grained information transfer, joint problem solving, and shared visions of common goals, which are important conditions behind development of functional and long-term durable collaborations. Business models for collaboration could contribute to the creation of these organisationally important conditions. Such business models could also provide knowledge on how to create and capture joint values. For some collaborations involving actors lacking the technical knowledge related to the capturing and distribution of excess heat, a third-party providing services related to the technical knowledge required could be beneficial. Collaborations in which one of the actors consists of an energy company often entail the technical knowledge required. This implies that different collaborations involving different types of actors and under different prevailing financial, technical and organisational conditions require customised and flexible business solutions. Local authorities could, through their overall function, initiate interorganisational collaborations on excess heat within the framework of municipal spatial planning. The results do however show that the investigated planning processes could develop more extensive stakeholder participation to include further societal actors related to excess heat. More extensive stakeholder participation, have the potential to initiate new development of collaborations on excess heat between normally unrelated actors, both with and without involvements of third-party knowledge brokers. A broader participation is also expected to result in increased knowledge on how to plan to further facilitate the condition of excess heat utilisation.

G. P. Panayiotou, G. Bianchi, G. Georgiou, L. Aresti, M. Argyrou, R. Agathokleous, K. M. Tsamos, S. A. Tassou, G. Florides, S. Kalogirou and P. Christodoulides 2017 Preliminary assessment of waste heat potential in major European industries S. A. Tassou and G. Bianchi
Proceedings of 1st International Conference on Sustainable Energy and Resource Use in Food Chains 123
335-345 Energy Procedia
Preliminary assessment of waste heat potential in major European industries

WOS:000426327700043
Industrial processes are currently responsible for almost 26% of European primary energy consumptions (275 Mtoe/yr). Furthermore, most of the energy sources that drive the industrial sector are fossil fuel based. Every industrial process is characterised by a multitude of waste heat streams at different temperature levels whose recovery would undoubtedly contribute to the enhancement of the sustainability of the industrial sites and their products. Waste heat recovery systems can offer significant energy savings and substantial greenhouse gas emission reductions. For the latter to materialise technological improvements and innovations aimed at improving the energy efficiency of heat recovery equipment and reducing installation costs should take place. This paper outlines the opportunities and the potential for industrial heat recovery in the European Union by identifying and quantifying primary energy consumption in the major industrial sectors and their related waste streams and temperature levels. Through a systematic analysis considering waste heat and Carnot's potential estimation, detailed results are given for all industrial sectors, temperature ranges and EU countries. The 'big picture' is rather promising with regards to the estimated total waste heat potential. (C) 2017 The Authors. Published by Elsevier Ltd. Times Cited: 1
Panayiotou, Gregoris P. Bianchi, Giuseppe Georgiou, Giorgos Aresti, Lazaros Argyrou, Maria Agathokleous, Rafaela Tsamos, Konstantinos M. Tassou, Savvas A. Florides, Georgios Kalogirou, Soteris Christodoulides, Paul
Icfes 2017
1st International Conference on Sustainable Energy and Resource Use in Food Chains (ICFES) / Symposium on Heat Recovery and Efficient Conversion and Utilisation of Waste Heat
Apr 19-20, 2017
Windsor, ENGLAND
Bianchi, Giuseppe/J-5661-2013
Bianchi, Giuseppe/0000-0002-5779-1427; Argyrou, Maria/0000-0001-9296-4453; Aresti, Lazaros/0000-0002-9426-7114
1876-6102 <Go to ISI>://WOS:000426327700043

T. Parker and A. Kiessling 2016 Low-grade heat recycling for system synergies between waste heat and food production, a case study at the European Spallation Source Energy Science & Engineering 4 2 153-165 Mar Low-grade heat recycling for system synergies between waste heat and food production, a case study at the European Spallation Source 2050-0505

WOS:000374441700004 At present food production depends almost exclusively on direct use of stored energy sources, may perhaps they be nuclear-, petroleum-, or biobased. Arable land, artificial fertilizers, and fresh water resources are the base for our present food systems, but are limited. At the same time, energy resources in the form of waste heat are available in ample quantities. The European Spallation Source (ESS) will require approximately 270 GWh of power per year to operate, power that ultimately is converted to heat. This multidisciplinary case study details an alternative food production cooling chain, using low-grade surplus heat, and involving fermentation, aquaculture, nutrient recapture, and greenhouse horticulture including both use of low-grade surplus heat and recycling of society's organic waste that is converted to animal feed and fertilizer. The study indicates that by combining the use of surplus energy with harvest of society's organic side flows, for example, food waste and aquatic-based cash crops, sustainable food systems are possible at a level of significance also for global food security. The effects of the proposed heat reuse model are discussed in a system perspective and in the context of the UNSCD indicator framework. The potential sustainability benefits of such an effort are shown to be substantial and multifaceted.

Times Cited: 1

Parker, Thomas Kiessling, Anders

1 <Go to ISI>://WOS:000374441700004

K. Pettersson 2016 Pilot Project Study for Industrial Surplus Heat Transportation KTH School of Industrial Engineering and Management (ITM), Energy Technology KTH Royal Institute of Technology M. Eng.

Pilot Project Study for Industrial Surplus Heat Transportation

http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1074779 Primary energy use in Sweden today can to a large extent be traced to manufacturing industries. In parallel, improved energy efficiency is a goal set out by Swedish authorities and the EU. One way to improve efficiency in the industry is to harvest the excess energy in form of heat that is currently going to waste in the various processes. This thesis has investigated the feasibility of employing a mobile thermal energy storage (M-TES), developed at KTH, as a method of transporting excess heat from a steel plant in Sandviken to a local hotel and conference centre. The M-TES performance had previously been determined on a small scale prototype, and the effects on performance and cost of up-scaling the M-TES for real use was studied theoretically. An estimation of the cost for up scaling the M-TES from its current laboratory scale to the intended large scale was obtained. The study concludes that the construction cost can be affected mainly by two parameters: the number of tubes and tube diameter inside the M-TES. Changes to the performance parameters of the M-TES, caused by varying these parameters, were investigated using theoretical correlations. It was found that performance of the M-TES can drastically change with changes to the design parameters. The exact changes in construction costs were not obtained, however, a cost effective design uses as few tubes as possible, meaning the tube diameter has to be increased. Using the theoretically based performance values, an M-TES operation was mapped towards two scenarios; one scenario where a greenhouse is supplied with heat, with comparatively low heating demand to the other scenario, where the greenhouse and hotel are both supplied. In the hotel-scenario, the M-TES complements the boiler that is already in place and provides heat for the hotel today. It was found that increased heating demand and number of heat deliveries significantly improved the economic performance of the M-TES system. The levelized cost of transported energy (LCOTE) was used as parameter for measuring this performance and LCOTE:s of 470 and 1380 SEK per MWh were found in the high and low demand scenarios, respectively. A sensitivity analysis showed that the M-TES itself is among the most influential parameters on the LCOTE, while also being deemed as the most uncertain in terms of cost and performance. It is recommended for future work that the MTES is investigated extensively with regard to design choice, performance and costs. http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1074779

R. Pili, A. Romagnoli, H. Spliethoff and C. Wieland 2017 Techno-Economic Analysis of Waste Heat Recovery with ORC from Fluctuating Industrial Sources V. Dossena, A. Guardone and M. Astolfi 4th International Seminar on Orc Power Systems
129 503-510
Energy Procedia
Techno-Economic Analysis of Waste Heat Recovery with ORC from Fluctuating Industrial Sources

WOS:000411758800065

A significant portion of the consumed energy by the industrial sector is rejected as waste heat in the medium temperature range. Organic Rankine Cycles (ORC) are a valuable technology to recover the available waste heat at medium temperatures, and produce electricity or combined heat and power (CHP). A trade-off has to be found between the reduced environmental impact of an industrial site and investment costs for waste heat recovery (WHR). Very challenging for the WHR are the large fluctuations in temperature and/or mass flow rate. In the present work, the economic feasibility of industrial WHR with ORC is analyzed for different applications, with and without heat storage: hot air from clinker cooling (fluctuating heat source temperature), exhaust gas from rolling mill reheating furnace (fluctuating heat source mass flow rate) and a case of exhaust gas from electric arc furnace (both fluctuating heat source temperature and mass flow rate). The different configurations are developed and simulated by combining MATLAB (R) and EBSILON (R) Professional. A latent heat buffer with LiNO3 appeared to be the best option for WHR from cement clinker cooling. In case of rolling mill reheating furnace, a design for the minimum mass flow rate and bypass of any exceeding fluctuation appeared the most economical solution, whereas the best environmental performance was achieved for lower bypass of the heat source. In case of electric arc furnace, the best economic solution appeared to be without storage, even though the latent buffer could guarantee the highest CO2-savings. The described design and analysis method should help investors, designers and decision makers take better choices to increase the efficiency and improve the economy of industrial sites with ORC technology. (C) 2017 The Authors. Published by Elsevier Ltd. Times Cited: 1
Pili, Roberto Romagnoli, Alessandro Spliethoff, Hartmut Wieland, Christoph
4th International Seminar on ORC Power Systems (ORC)
Sep 13-15, 2017
Politecnico Milano Bovisa Campus, MILANO, ITALY
Romagnoli, Alessandro/N-1975-2014
Romagnoli, Alessandro/0000-0003-1271-5479
1876-6102 <Go to ISI>://WOS:000411758800065

M. Preissinger and D. Bruggemann 2017 Thermoeconomic Evaluation of Modular Organic Rankine Cycles for Waste Heat Recovery over a Broad Range of Heat Source Temperatures and Capacities
Energies 10 3
Mar
Thermoeconomic Evaluation of Modular Organic Rankine Cycles for Waste Heat Recovery over a Broad Range of Heat Source Temperatures and Capacities 1996-1073
269
WOS:000398736700009 Industrial waste heat recovery by means of an Organic Rankine Cycle (ORC) can contribute to the reduction of CO2 emissions from industries. Before market penetration, high efficiency modular concepts have to be developed to achieve appropriate economic value for industrial decision makers. This paper aims to investigate modularly designed ORC systems from a thermoeconomic point of view. The main goal is a recommendation for a suitable chemical class of working fluids, preferable ORC design and a range of heat source temperatures and thermal capacities in which modular ORCs can be economically feasible. For this purpose, a thermoeconomic model has been developed which is based on size and complexity parameters of the ORC components. Special emphasis has been laid on the turbine model. The paper reveals that alkylbenzenes lead to higher exergetic efficiencies compared to alkanes and siloxanes. However, based on the thermoeconomic model, the payback periods of the chemical classes are almost identical. With the ORC design, the developed model and the boundary conditions of this study, hexamethyldisiloxane is a suitable working fluid and leads to a payback period of less than 5 years for a heat source temperature of 400 to 600 degrees C and a mass flow rate of the gaseous waste heat stream of more than 4 kg/s. Times Cited: 2
Preissinger, Markus Brueggemann, Dieter
Preissinger, Markus/0000-0001-5701-9595
2 <Go to ISI>://WOS:000398736700009

R. EA and M. S 2018 Energetic and exergetic optimized Rankine cycle for waste heat recovery in a cement factory Applied Thermal Engineering 132
410 - 422
Energetic and exergetic optimized Rankine cycle for waste heat recovery in a cement factory 1359-4311

AMIRIRAD2018410

Cement production, Steam cycle, Waste heat power generation, Energy and exergy analyses Abstract The cement industry is one of the largest industries with regard to energy consumption. In the current study, the waste heat from the chimneys of Sabzevar cement factory was used to generate power with the use of the steam cycle in order to improve the energy efficiency. The results revealed that the increase in the boiler pressure decreased the total amount of the recovered energy due to the increase in the final temperature of the exhaust gases. But, the steam cycle efficiency was increased. Therefore, there would be an optimum pressure for the recovery boiler based on the energy and exergy analyses. Accordingly, the maximum exergy absorption from the waste heat of the chimneys of Sabzevar cement factory occurred at the pressure of 891.8 kPa. Considering the work consumption of air-cooled condenser fans, the maximum net power occurred at the recovery boiler pressure of 1398 kPa. The highest overall energy and exergy efficiencies also occurred at this pressure. Moreover, the effects of the important operating parameters, including the maximum cycle temperature, environmental temperature and condenser pressure on the optimum pressure were investigated. Results indicated that the boiler optimum pressure was independent from the operating parameters and remained constant, when these parameters changed.

http://www.sciencedirect.com/science/article/pii/S1359431117361045

M. Ramirez, M. Epelde, M. G. de Arteche, A. Panizza, A. Hammerschmid, M. Baresi and N. Monti 2017 Performance evaluation of an ORC unit integrated to a waste heat recovery system in a steel mill V. Dossena, A. Guardone and M. Astolfi 4th International Seminar on Orc Power Systems 129 535-542

Energy Procedia

Performance evaluation of an ORC unit integrated to a waste heat recovery system in a steel mill

WOS:000411758800069

Waste heat revalorization creates interesting opportunities to energy intensive industries. In the present project, a large-scale ORC pilot plant along with a waste heat recovery unit (WHRU) in a steel mill has been designed, commissioned and operated. The plant is part of the European Commission funded PITAGORAS project and it has been installed at ORI MARTIN in Brescia (Italy). Waste heat is recovered from the fumes of the Electric Arc Furnace (EAF) to produce saturated steam which is then delivered to a district heating (DH) network during heating season and to the ORC for electricity generation during the rest of the year. The main challenge was the integration of these systems in a single plant since the heat source is highly unstable and steady heat load is preferable for the DH and ORC for their safe operation. A steam accumulator of 150m(3) volume was implemented between the WHRU and the ORC/DH systems to maintain a steady discharge pressure, to reduce the fast transients and to extend the supply over longer periods. The ORC has a nominal power output of 1,8MW and the preliminary results of the first weeks of operation of the ORC unit resulted in a net efficiency of 21.7%. Currently the plant is undergoing monitoring campaign which will provide additional data to further evaluate and optimize the system. (C) 2017 The Authors. Published by Elsevier Ltd. Times Cited: 1

Ramirez, M. Epelde, M. de Arteche, M. Gomez Panizza, A. Hammerschmid, A. Baresi, M. Monti, N.

4th International Seminar on ORC Power Systems (ORC)

Sep 13-15, 2017

Politecnico Milano Bovisa Campus, MILANO, ITALY

1876-6102 <Go to ISI>://WOS:000411758800069

L. Reinholdt, B. Horntvedt, S. R. Nordtvedt, B. Elmegaard, J. K. Jensen, T. L. Lemminger and R. Int Inst2016 HIGH TEMPERATURE ABSORPTION COMPRESSION HEAT PUMP FOR INDUSTRIAL WASTE HEAT 12th Iir Gustav Lorentzen Natural Working Fluids Conference
1038-1045
Refrigeration Science and Technology
HIGH TEMPERATURE ABSORPTION COMPRESSION HEAT PUMP FOR INDUSTRIAL WASTE HEAT 978-2-36215-018-0

WOS:000402544400127

Heat pumps are currently receiving extensive interest because they may be able to support the integration of large shares of fluctuating electricity production based on renewable sources, and they have the potential for the utilization of low temperature waste heat from industry. In most industries, the needed temperature levels often range from 100 degrees C and up, but until now, it has been quite difficult to find heat pump technologies that reach this level, and thereby opening up the large-scale heat recovery in the industry. Absorption compression heat pumps can reach temperatures above 100 degrees C, and they have proved themselves a very efficient and reliable technology for applications that have large temperature changes on the heat sink and/or heat source. The concept of Carnot and Lorenz efficiency and its use in the analysis of system integration is shown. A 1.25 MW system having a Carnot efficiency higher than 82% by the better temperature match of the process to the heat sink and source is reported. Another major benefit of using ammonia and water as working pair is the possibility of reaching quite high temperatures at a significantly lower operating pressure, which makes it possible to reach a temperature of 108 degrees C using standard industrial refrigeration equipment as described in the three included realized systems. Times Cited: 0
Reinholdt, L. Horntvedt, B. Nordtvedt, S. R. Elmegaard, B. Jensen, J. K. Lemminger, Thor L.
12th IIR Gustav Lorentzen Natural Working Fluids Conference
Aug 21-24, 2016
Heriot Watt Univ, Edinburgh, SCOTLAND
Elmegaard, Brian/J-6662-2014
Elmegaard, Brian/0000-0002-0503-6286; Jensen, Jonas Kjaer/0000-0003-2955-1001
0151-1637 <Go to ISI>://WOS:000402544400127

F. Riaz, S. P. Lee, S. K. Chou, C. S. Tay and T. Soe 2017 Analysis of Low-Grade Waste Heat Driven Systems for Cooling and Power for Tropical Climate Energy Procedia 143 389 - 395 Analysis of Low-Grade Waste Heat Driven Systems for Cooling and Power for Tropical Climate 1876-6102 RIAZ2017389 Heat Recovery, Energy Efficiency, Ejector Cooling, ORC, Hybrid System Leveraging Energy Technologies and Policy Options for Low Carbon Cities http://www.sciencedirect.com/science/article/pii/S1876102117364652

A. F. Sandvall, E. O. Ahlgren and T. Ekvall 2016 System profitability of excess heat utilisation - A case-based modelling analysis Energy 97
424-434 Feb
System profitability of excess heat utilisation - A case-based modelling analysis 0360-5442

WOS:000371841100036

The use of EH (excess heat) in DH (district heating) may contribute to increased sustainability through reduced use of primary energy. In Sweden, while biomass has become the most important DH fuel during the last decades, there is a significant amount of industrial EH that could be utilised in the DH systems if it could be shown to be an economically viable alternative. This study addresses the long-term system profitability of a large heat network between a cluster of chemical industries and two DH systems that enables an increased use of EH. An assessment is carried out by scenario and sensitivity analyses and by applying the optimising energy systems model MARKAL_WS, in which the DH systems of the Vastra Gotaland region of Sweden are represented individually. The results show heat network profitability under most assumptions, and that the profitability increases with biomass competition, phase-out of natural gas use and higher CO2 charges, whereas it decreases with the availability of other EH sources in the base load of the DH systems. (C) 2015 The Authors. Published by Elsevier Ltd.

Sandvall, Akram Fakhri Ahlgren, Erik O. Ekvall, Tomas Ahlgren, Erik O./0000-0002-1164-0850
1873-6785 <Go to ISI>://WOS:000371841100036

A. Simeone, Y. Luo, E. Woolley, S. Rahimifard and C. Boer 2016 A decision support system for waste heat recovery in manufacturing Cirp Annals-Manufacturing Technology 65 1 21-24 A decision support system for waste heat recovery in manufacturing 0007-8506

WOS:000380603200006 One third of energy consumption is attributable to the industrial sector, with as much as half ultimately wasted as heat. Consequently, research has focused on technologies for harvesting this waste heat energy, however, the adoption of such technologies can be costly with long payback time. A decision support tool is presented which computes the compatibility of waste heat source(s) and sink(s), namely the exergy balance and temporal availability, along with economic and environmental benefits of available heat exchanger technologies to propose a streamlined and optimised heat recovery strategy. Substantial improvement in plant energy efficiency together with reduction in the payback time for heat recovery has been demonstrated in the included case study. (C) 2016 The Author. Times Cited: 1
Simeone, Alessandro Luo, Yang Woolley, Elliot Rahimifard, Shahin Boer, Claudio
Woolley, Elliot/0000-0002-5445-4687; Simeone, Alessandro/0000-0002-8617-2721
1
1726-0604 <Go to ISI>://WOS:000380603200006

A. Thekdi and S. U. Nimbalkar 2015 Industrial Waste Heat Recovery - Potential Applications, Available Technologies and Crosscutting R&D Opportunities; Oak Ridge National Lab. (ORNL), Oak Ridge, TN (United States) Medium: ED; Size: 82 p.

Industrial Waste Heat Recovery - Potential Applications, Available Technologies and Crosscutting R&D Opportunities
ORNL/TM-2014/622; Other: ED2701000; CEED063 United States 10.2172/1185778 Other: ED2701000; CEED063 ORNL English

ED2701000; CEED063
Waste Heat Recovery, Waste Heat Management, Energy Efficiency
The purpose of this report was to explore key areas and characteristics of industrial waste heat and its generation, barriers to waste heat recovery and use, and potential research and development (R&D) opportunities. The report also provides an overview of technologies and systems currently available for waste heat recovery and discusses the issues or barriers for each. Also included is information on emerging technologies under development or at various stages of demonstrations, and R&D opportunities cross-walked by various temperature ranges, technology areas, and energy-intensive process industries. (United States)
[E3M Inc, North Potomac, MD]
(ORNL)
[Oak Ridge National Lab. , Oak Ridge, TN]
http://www.osti.gov/scitech/servlets/purl/1185778

Y. Thomas, L. Wang and A. Denzer 2017 Energy Savings Analysis of a Greenhouse Heated by Waste Heat 15th IBPSA Conference, Building Simulation 2017 San Francisco, CA, USA 2512-2517

Energy Savings Analysis of a Greenhouse Heated by Waste Heat

A. Ustaoglu, M. Alptekin and M. E. Akay 2017 Thermal and exergetic approach to wet type rotary kiln process and evaluation of waste heat powered ORC (Organic Rankine Cycle) Applied Thermal Engineering 112
281-295 Feb
Thermal and exergetic approach to wet type rotary kiln process and evaluation of waste heat powered ORC (Organic Rankine Cycle) 1359-4311

WOS:000394831500029 In this study, the energetic and exergetic performance analysis of a rotary kiln and cooling section in a cement factory using wet method was carried out based on the actual operational data. The energy and exergy efficiencies of the wet type rotary kiln are about 46% and 35%, respectively. The results showed that a great amount of heat energy of 30.5 MW is exhausted from the chimney of rotary kiln. In order to evaluate recovery capacity of exhausted gas, Organic Rankine Cycle (ORC) was considered and its energetic and exergetic performance were evaluated for isentropic and dry type fluids for different conditions. Isentropic fluid, R245fa shows the best performance while the dry fluid, R600a has the lowest performance. For condensation temperature of 303 K and evaporation pressure of 1500 kPa, the thermal and exergy efficiencies of R600a are 9.8% and 21.7% while the thermal and exergy efficiencies of R245fa are 13% and 29%, respectively. Isentropic fluids, R245fa, R142b can be used at high evaporator pressures and low condenser temperatures as R600 and R600a are not appropriate after a certain pressure since the efficiency remain stable. The exergy destruction rates in heat exchanger and evaporator are about 80% of the total exergy destruction. (C) 2016 Elsevier Ltd. All rights reserved. Times Cited: 2
Ustaoglu, Abid Alptekin, Mustafa Akay, Mehmet Emin
2 <Go to ISI>://WOS:000394831500029

Z. a. Ö. B. S. Utlu 2018 Thermodynamic analysis of thermophotovoltaic systems used in waste heat recovery systems: an application International Journal of Low-Carbon Technologies

Thermodynamic analysis of thermophotovoltaic systems used in waste heat recovery systems: an application

doi:10.1093/ijlct/ctx019

Thermodynamic analysis of the thermophotovoltaic (TPV) system was carried out in our research and the results are presented. First, the TPV system was analyzed in three different regions. In the analysis, each part of the system is taken separately, while the whole system is handled separately. Within the thermodynamic analysis of each region, energy and exergy analysis were carried out and the system was analyzed from part to part. As a result of this method, a general energy and exergy efficiency of the whole TPV system is determined. Our results are supported by formulas. The In0.2Ga0.8As0.18Sb0.82 cell has a higher efficiency compared to the GaSb cell at the same source temperature. This is because the reverse saturation current and the energy band gap are low and the short-circuit current is high.

If TPV systems are applied for waste heat energy potential in the Turkish iron and steel industry, the energy efficiency of GaSb cell systems is 66 192 MJ per year with energy efficiency of 2.04%, the energy efficiency of In0.2Ga0.8As0.18Sb0.82 cell systems is 7.31% with annual energy efficiency of 189 971 MJ can be recovered. It is aimed that the work done will be an alternative to the existing electricity generation and will form a resource for future works.

B. H. Vagle 2016 Utilization of surplus heat from snow producing machines Institutt for energi og prosessteknikk NTNU, the Norwegian University of Science and Technology 120 M. Eng. Utilization of surplus heat from snow producing machines

http://hdl.handle.net/11250/2402913

D. M. van de Bor, C. A. I. Ferreira and A. A. Kiss 2015 Low grade waste heat recovery using heat pumps and power cycles Energy 89 864-873 Sep Low grade waste heat recovery using heat pumps and power cycles 0360-5442

WOS:000361252500077 Thermal energy represents a large part of the global energy usage and about 43% of this energy is used for industrial applications. Large amounts are lost via exhaust gases, liquid streams and cooling water while the share of low temperature waste heat is the largest. Heat pumps upgrading waste heat to process heat and cooling and power cycles converting waste heat to electricity can make a strong impact in the related industries. The potential of several alternative technologies, either for the upgrading of low temperature waste heat such as compression-resorption, vapor compression and trans-critical heat pumps, or for the conversion of this waste heat by using organic Rankine, Kalina and trilateral cycle engines, are investigated with regards to energetic and economic performance by making use of thermodynamic models. This study focuses on temperature levels of 45-60 degrees C as at this temperature range large amounts of heat are rejected to the environment but also investigates the temperature levels for which power cycles become competitive. The heat pumps deliver 2.5-11 times more energy value than the power cycles in this low temperature range at equal waste heat input. Heat engines become competitive with heat pumps at waste heat temperatures at 100 degrees C and above. Times Cited: 16
van de Bor, D. M. Ferreira, C. A. Infante Kiss, Anton A. Kiss, Anton/J-2918-2015
Kiss, Anton/0000-0001-5099-606X; Infante Ferreira, Carlos A./0000-0002-8810-7309
16
1873-6785 <Go to ISI>://WOS:000361252500077

R. Vescovo and F. Campana 2015 Surplus Heat: Free Fuel for Efficiency Improvement in the Oil & Gas Industry Offshore Mediterranean Conference Ravenna, Italy

Surplus Heat: Free Fuel for Efficiency Improvement in the Oil & Gas Industry

OMC-2015-327
0788894043648 C1 - OMC

S. B. Viklund 2015 Energy efficiency through industrial excess heat recovery-policy impacts Energy Efficiency 8 1 19-35 Feb Energy efficiency through industrial excess heat recovery-policy impacts 1570-646X

WOS:000347554100002 The EU target on energy efficiency implies a 20 % reduction in the use of primary energy by implementation of energy efficiency measures. Not all potential cost-effective measures for improved energy efficiency are implemented. This energy efficiency gap is explained by market barriers. Policy instruments can be used to overcome these barriers. The target could, for example, be obtained through industrial excess heat recovery; but there is a knowledge gap on factors affecting excess heat utilization. In this study, interviews were carried out with energy managers in order to study excess heat utilization from industry's perspective. The study seeks to present how excess heat recovery can be promoted or discouraged through policy instruments, and several factors are raised in the paper. The interviews revealed that excess heat recovery is generally referred to in terms of heat deliveries to the district heating network. One may need to look for innovative recovery solutions, and policies are needed to bring these solutions into action. Due to inefficient conversion for heat-driven electricity generation, a system favoring this implementation could favor an inefficient system. Beyond external instruments, internal goals, visions, and the importance of energy as a priority were shown to be important in the work with improved energy management. Viklund, Sarah Broberg 1570-6478 <Go to ISI>://WOS:000347554100002

S. B. Viklund and E. Lindkvist 2015 Biogas production supported by excess heat - A systems analysis within the food industry
Energy Conversion and Management
91 249-258
Feb Biogas production supported by excess heat - A systems analysis within the food industry
0196-8904

WOS:000348887000025 The aim of this paper was to study the effects on greenhouse gases and economics when a change is made in the use of industrial organic waste from external production and use of biogas (A) to internal production and use (B). The two different system solutions are studied through a systems analysis based on an industrial case. The baseline system (A) and a modified system (B) were compared and analysed. Studies show that industrial processes considered as integrated systems, including the exchange of resources between industries, can result in competitive advantages. This study focuses on the integration of internally produced biogas from food industry waste produced by a food company and the use of excess heat. Two alternative scenarios were studied: (1) the use of available excess heat to heat the biogas digester and (2) the use of a part of the biogas produced to heat the biogas digester. This study showed that the system solution, whereby excess heat rather than biogas is used to heat the biogas digester, was both environmentally and economically advantageous. However, the valuation of biomass affects the magnitude of the emissions reduction. Implementing this synergistic concept will contribute to the reaching of European Union climate targets. (C) 2014 Elsevier Ltd. All rights reserved. Viklund, Sarah Broberg Lindkvist, Emma
1879-2227 <Go to ISI>://WOS:000348887000025

D. Wang 2016 Simultaneous Waste Heat and Water Recovery from Power Plant Flue Gases for Advanced Energy Systems; Gas Technology Institute, Des Plaines, IL (United States)
Medium: ED
Simultaneous Waste Heat and Water Recovery from Power Plant Flue Gases for Advanced Energy Systems DE-GTI-FE0024092 United States 10.2172/1347684 NETL English

20 FOSSIL-FUELED POWER PLANTS This final report presents the results of a two-year technology development project carried out by a team of participants sponsored by the Department of Energy (DOE). The objective of this project is to develop a membrane-based technology to recover both water and low grade heat from power plant flue gases. Part of the recovered high-purity water and energy can be used directly to replace plant boiler makeup water as well as improving its efficiency, and the remaining part of the recovered water can be used for Flue Gas Desulfurization (FGD), cooling tower water makeup or other plant uses. This advanced version Transport Membrane Condenser (TMC) with lower capital and operating costs can be applied to existing plants economically and can maximize waste heat and water recovery from future Advanced Energy System flue gases with CO₂ capture in consideration, which will have higher moisture content that favors the TMC to achieve higher efficiency.
(United States)
[Gas Technology Inst., Des Plaines, IL]
http://www.osti.gov/scitech/servlets/purl/1347684

G. Weinberger, S. Amiri and B. Moshfegh 2017 On the benefit of integration of a district heating system with industrial excess heat: An economic and environmental analysis Applied Energy 191 454-468 Apr On the benefit of integration of a district heating system with industrial excess heat: An economic and environmental analysis 0306-2619

WOS:000395963500036

Energy-related cooperation using industrial excess heat (IEH) in district heating (DH) networks shows economic and environmental benefits. A rarely investigated approach is the energy cooperation which incorporates a jointly operated CHP plant also producing process steam for nearby industry. The present study aims to evaluate economic and environmental effects on the Hofors DH system with jointly operated CHP plant when the nearby steel mill extends the supply of recovered IEH. Various IEH supply opportunities with different capacities of hot water and steam were designed and compared with existing IEH utilization, plant heat and electricity production and DH system performance. The energy system model MODEST is used for cost-optimization. A parametric study is used to analyze influences of increasing IEH cost and fluctuating electricity prices. The results show advantages for the DH system to utilize IEH for deliveries of DH and process steam and the cogeneration of electricity. Economic and environmental benefits are decreased total system cost (-1.67 MEUR/a), less use of fuels and electricity, and reduced CO2 emissions with a maximal reachable amount of 28,200 ton/a when the use of biofuel is assumed as limited resource and the substituted marginal electricity production is based on coal condensing power plants. The results also show that industrial steam is a preferred heat supply source as long as the steam cost is below the alternative heat production cost, irrespective of the electricity price. While the cost-effective utilization of industrial hot water for DH is more sensitive and affected by a beneficial CHP production based on higher electricity price segments, it is also shown that utilization of continuously supplied industrial hot water is limited during seasons of low DH demand. Weinberger, Gottfried Amiri, Shahnaz Moshfegh, Bahram
Weinberger, Gottfried/0000-0001-5574-8372
1872-9118 <Go to ISI>://WOS:000395963500036

Z. Y. Xu and R. Z. Wang 2017 Absorption heat pump for waste heat reuse: current states and future development Frontiers in Energy 11 4 414-436 Dec

Absorption heat pump for waste heat reuse: current states and future development 2095-1701

WOS:000419367300002 Absorption heat pump attracts increasing attention due to its advantages in low grade thermal energy utilization. It can be applied for waste heat reuse to save energy consumption, reduce environment pollution, and bring considerable economic benefit. In this paper, three important aspects for absorption heat pump for waste heat reuse are reviewed. In the first part, different absorption heat pump cycles are classified and introduced. Absorption heat pumps for heat amplification and absorption heat transformer for temperature upgrading are included. Both basic single effect cycles and advanced cycles for better performance are introduced. In the second part, different working pairs, including the water based working pairs, ammonia based working pairs, alcohol based working pairs, and halogenated hydrocarbon based working pairs, for absorption heat pump are classified based on the refrigerant. In the third part, the applications of the absorption heat pump and absorption heat transformer for waste heat reuse in different industries are introduced. Based on the reviews in the three aspects, essential summary and future perspective are presented at last. Times Cited: 0
Xu, Zhenyuan Wang, Ruzhu
Wang, R.Z./0000-0003-3586-5728
0
2095-1698
Si <Go to ISI>://WOS:000419367300002

C. Zhang, A. Romagnoli, J. Y. Kim, A. A. M. Azli, S. Rajoo and A. Lindsay
2017 Implementation of industrial waste heat to power in Southeast Asia: an outlook from the perspective of market potentials, opportunities and success catalysts Energy Policy
106 525-535
Jul
Implementation of industrial waste heat to power in Southeast Asia: an outlook from the perspective of market potentials, opportunities and success catalysts 0301-4215

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As an important way to increase industrial energy efficiency, Waste Heat to Power (WHP) technologies have been gaining popularity in recent years. In order to appraise the market potential of WHP technologies in Southeast Asia, a techno-economic assessment for WHP technologies is conducted in this paper. The technical and economic market potential of WHP in Southeast Asia is estimated to be 1788 MW and 1188 MW respectively. The main market drivers and barriers for WHP market expansion in Southeast Asia are also analyzed. Given the fact that WHP is a far cheaper power generation technology as compared with traditional and renewable power generation, the WHP market is expected to increase fast in the coming years. Mounting electricity price from grid, government emissions regulations and subsidies, the integration of WHP products with original equipment manufacturer, capital cost reduction induced by technology development are identified as the key drivers for the market growth. The above arguments are proofed through the analysis of a power plant WHP project in Southeast Asia. Times Cited: 1
Zhang, Chuan Romagnoli, Alessandro Kim, Je Young Azli, Anis Athirah Mohd Rajoo, Srithar Lindsay, Andrew
Rajoo, Srithar/R-2171-2017; Romagnoli, Alessandro/N-1975-2014
Rajoo, Srithar/0000-0002-9488-7786; Romagnoli, Alessandro/0000-0003-1271-5479
1
1873-6777 <Go to ISI>://WOS:000402343600050

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Proceedings of the 2017 7th International Conference on Mechatronics, Computer and Education Informationization
75 855-859
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Energy is an important issue in the development of economical economy in China. In shipbuilding industry, the waste heat utilization of diesel engine is an important technology. This article briefly introduces the definition of waste heat and analyzes the waste heat of hip diesel engine exhaust gas through the six s50me - C8 type diesel engine waste heat utilization system, and then elaborates on the prospect for the development of the main application of this technology and its application in the future. Times Cited: 0
Zhao, Zhiqiang Zhai, Wei
Mcei 2017
7th International Conference on Mechatronics, Computer and Education Informationization (MCEI)
Nov 03-05, 2017
Shenyang, PEOPLES R CHINA
2352-538x <Go to ISI>://WOS:000426646000183