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How legislation and customer needs drive innovation

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Engine innovations in the large engine sector are no longer only driven by customer requirements such as reliability and operating costs. While in the past, the emission legislations could be met with relatively straight forward engine modifications, this has changed significantly with the recent emission legislation. The emission standards have become more stringent and the cadence of reduction steps has increased considerably. Thus, today the main focus of the engine development aims on compliance with the emission targets.
Major engine applications for large engines are the marine and the stationary sector. For marine applications, the International Maritime Organization (IMO) established an international convention for the prevention of air pollution by ships. Emission legislations for stationary power plant applications are defined by the World Bank Guidelines or the Technische Anleitung zur Reinhaltung der Luft. These strict legislations along with the customer requirements require the application of new technologies.
Regarding the thermodynamic process, exhaust gas recirculation, multi-stage turbocharging, extreme Miller cycle, and water injection still offer major opportunities. Control systems in combination with a dual fuel combustion system provide the flexibility to switch from heavy fuel oil to gaseous fuel. Selective catalytic reduction, particulate filters, and scrubber systems are options for exhaust gas aftertreatment. FEV has investigated different possible solutions to address these challenges. Mechanical and combustion simulation methods as well as experimental single cylinder engine research were used to evaluate different technologies.
The increase in fuel consumption limits the application of extreme Miller valve timings. The most promising approach to reduce NO_x-emissions without exhaust gas aftertreatment and no or just a small increase in fuel consumption is an optimized combination of a moderate Miller cycle, cooled exhaust gas recirculation and two stage turbocharging. However, typically this approach will increase the particulate emissions. In the future, it will no longer be possible to meet the most stringent emission limitations with thermodynamic solutions alone. A preferred solution will be a combination of thermodynamic measures and selective catalytic NO_x reduction as exhaust gas aftertreatment to achieve lowest NO_x- and particulate emissions as well as low fuel consumption simultaneously. Another option is the usage alternative fuels like compressed natural gas, methanol, or dimethyl ether. However, any new fuel has to comply with the boundary conditions of the corresponding engine application and of course with the supply infrastructure.

Application of momentum theory to combustion study of fuel spray and gas jet
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The author presented at the first (2010), second (2012) and third Tagung (2014), on the visual studies of high aromatic fuel like LCO (Light Cycle Oil) combustion using a visual test engine and a large-sized RCEM (Rapid Compression and Expansion Machine).
An aim of the author's research work has been to find how to improve the air-fuel mixture formation and diffusive combustion of liquid fuel spray. The famous momentum theory of fuel spray proposed by Prof. Wakuri about 60 years ago is still useful to study and explain such the phenomena.
Moreover, in the gas engine area, what we call, GI (Gas Injection) combustion is a diffusive combustion of high pressure gas jet and that theory can be applied to estimate the air-fuel ratio in gas jet.
At the present fourth Tagung, the author will present some clear image of improvement of diffusive combustion of both liquid and gas fuel, applying the momentum theory. As examples, the following experimental data by using the RCEM are introduced and the process of improvement of combustion is explained through the momentum theory.

1. Large amount of water emulsion

   In this test, large amounts of water, even more than fuel (LCO) itself is mixed and ignited by a pilot injection. About twice the volume of emulsified fuel is injected from larger nozzle hole than the normal pure fuel case to obtain the same heat. This method is effective, not only to reduce NO_x drastically to even clear the IMO Tier3 regulation (-80 %) but also to promote spray combustion to achieve shorter after-burning. The reason for improvement of spray combustion is examined according to the momentum theory.

2. Methanol

   As an alternative fuel, the combustion characteristics of methanol are investigated. Methanol spray combustion displays extremely short after-burning which can be explained in the same way as for the water-emulsion technology.

3. Natural gas GI (high pressure Gas Injection) combustion

   Image of air-fuel mixture formation by high pressure natural gas jet is fundamentally near to that of liquid spray. Effect of gas injection pressure on GI combustion is investigated by raising it from the conventional 30 MPa level, and improvement of air entrainment that leads to faster diffusive combustion is studied.

4. Low calorie gas

   Since air entrainment into a gas jet depends on the injected gas momentum according to the momentum theory, adding even inert gas thus increases the momentum and could improve the diffusive combustion. It is the same theory as for the above-mentioned water emulsion. The admixture of natural gas and inert gas, equivalent to a low calorie gas shows a rather higher combustion rate during the injection than pure methane does. This is a unique feature of GI combustion, which is not seen in the lean-burn type engine.

Performance of 2200 bar LE CR injector for the fulfillment of EPA Tier 4 and Euro 5 emissions which complies also with DF requirements

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Robert Bosch investigated together with the institute of piston- and internal combustion engines at the University Rostock the potential of a modern 2200 bar CR injector on a single cylinder engine with a bore of 140 mm. Engine internal measures and exhaust after treatment strategies were evaluated for EPA Tier 4 and Euro 5 LE emission limits. Strategies for best fuel economy and best total cost of ownership were derived from the engine results. These results will be presented in a separate paper "combustion strategies to fulfill future off-highway emission legislation of the displacement category of 2.5 l/Cyl"during the "4. Rostocker Großmotorentagung". To enable a correlation between engine results and the mixture preparation and metering quality of the injector, the injector was characterized in detail. This paper shows the performance of the injector CRIN-LE-22 which is already widely used in EPA Tier 4 applications together with the other MCRS-22 (high and low pressure pump, pressure limiting valve and pressure sensor) components in the field. The MCRS-22 is presented in an overview. The spray, injection quantity and -rate were analyzed at idle, part and full load condition. These results are brought in correlation to the injector lay out and simulation results. Beyond the verification of the injector performance for Diesel EPA Tier 4 and Euro 5 applications also the capability for DF applications was analyzed. Measurements show the limits on minimum injection quantities and spray performance. The DF capabilities of the injector was not verified on the single cylinder engine, but the CRIN-LE-22 performance was verified on other modern 2 nd gen. DF engines. That is brought in correlation to the injector which was used for this study. Finally an outlook for further injector development is given.

Concept for Prediction of Fuel Consumption and Emissions in Ship Manoeuvres by means of Fast-Time Simulation

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Actions and measures to reduce fuel consumption and emissions can be classified according to several aspects. For instance, legal frameworks can be seen as indirect and rather global and generic measures contributing to more environmentally-friendly maritime transportation by developing and establishing rules and regulations. Those indirect measures also may include training and education in sustainable shipping by learning how to apply procedures, methods and technologies in a smooth and optimized manner.
Direct measures are usually those actions and measures that are directly related to transportation and concrete navigation processes and are mainly technical and operational. Technical measures are those that contribute to sustainable shipping and reduction of greenhouse gas (GHG) emissions and are related to ship design, development and installation of technical systems as e.g. for propulsion, engines and using alternative fuels or cleaning exhaust gases etc. Operational measures are related to the processes of planning and executing voyages time- and energy-efficiently and taking into account the reduction of GHG emissions through sophisticated operation of the ship under the different environmental conditions and ship status.Mainly the operational measures will be discussed in this paper taking into account the educational and training aspects.
By means of Fast-Time-Simulation (FTS) Technology the ship's motion can be calculated for more than 20 minutes ahead within only one second. This prediction is based on a highly non-linear system of equations of motion as used in Ship Handling Simulators. An online FTS-Monitoring module provides predictions that show the immediate reaction of the vessel. In the offline FTS-Planning module various manoeuvring strategies can be tried out and discussed beforehand. The navigational officer is enabled to take into account manoeuvre technique, safety and economic aspects as well as time consumption. The propulsion units of the ship models concern the calculation of the engine torque and thus propeller revolutions and thrust. Presently, in order to enhance this simplified engine model and to meet the challenge of considering the combustion process as detailed as possible keeping the ability of the FTS likewise, an enhanced model is under development to predict also fuel consumption and emissions. Studies had been carried out to estimate the benefit of a detailed, but therefore more time-consuming process-calculation for transient engine operation. Several data coming from laboratory test bed as well as from engines installed on a real RoPax-ferry form the basis of the on-going research work. Such a comprehensive prediction covering also engine processes will give an additional and more profound basis for decision-making to the navigational officer and can additionally be applied in teachings and advanced training.

Simplified L'Orange fuel injection system for DUAL Fuel applications

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In den letzten Jahren hat der Anteil der Gasmotoren im Markt stark zugenommen und wird auch weiter steigen. Dual Fuel Motoren ermöglichen dabei sowohl eine hohe Flexibilität und Betriebssicherheit als auch einen uneingeschränkten Motorbetrieb, beispielsweise bei Unterbrechung der Gasversorgung. Des Weiteren zeigt, der bei DUAL Fuel Motoren übliche Gasbetrieb mit Piloteinspritzung Vorteile gegenüber dem Betrieb mit Zündkerze, u.a. durch eine erhöhte Standfestigkeit.

Als Weltmarktführer für Dual Fuel-Einspritzsysteme hat L'Orange mehr als 20 Jahre Erfahrung in der Entwicklung und Fertigung von Einspritzsystemen, sowohl für Motoren mit homogener Verbrennung (Niederdruckgas) als auch für solche mit heterogener Verbrennung (Hochdruckgas). Die entsprechenden Motoren von Wärtsilä überzeugen seit vielen Jahren am Markt.

Neben vielen Vorteilen liegt der Nachteil der aktuellen Dual Fuel Einspritzsysteme in ihrer hohen Komplexität, was den Umgang damit aufwendig macht, insbesondere hinsichtlich des Baumraumbedarfs. In der Regel haben die Einspritzsysteme zwei getrennte Kraftstoffkreise, einen für die Piloteinspritzung im Gasbetrieb und einen für den reinen Betrieb mit Flüssigkraftstoff. Dies erfordert bislang mehrere Pumpen zu Druckerzeugung, einen Doppelnadelinjektor mit einer Common Rail- und einer Pump Line Nozzle-Seite bzw. zwei separate Injektoren pro Zylinder.

Aktuell entwickelt L'Orange ein neues, deutlich vereinfachtes Einspritzsystem. Es besteht nur noch aus einem Kraftstoffkreis mit einer Hochdruckpumpe, sowie einem Injektor pro Motorzylinder. Der Injektor hat eine Ein-Nadel-Düse, über die die Pilotmenge und die Volllastmenge im Flüssigkraftstoffbetrieb eingespritzt werden.

Die Tatsache, dass mit einer Düse sowohl die Volllastmenge, als auch eine stabile Kleinstmenge bei gleichzeitig ausreichend guter Kraftstoffzerstäubung dargestellt werden muss, bedarf einer im gesamten Einspritzverlauf optimierten Düse, was sowohl an die Entwicklung als auch an die Fertigung große Herausforderungen stellt. Um die geforderte Motorperformance und Emission zu gewährleisten, muss die Einspritzmenge über die gesamte Lebensdauer stabil bleiben, was einen geschlossenen Regelkreis zur Driftkompensation erfordert. Des Weiteren werden Design-Maßnahmen zu Sicherstellung des Wärmehaushalts der Hochdruckpumpe und der Düse im Gasbetrieb erforderlich.

Nach umfangreichen Simulationen und Konstruktionsanpassungen, konnten Versuche am Komponenten - Prüfstand und am Strahlbild-Prüfstand in Hause L'Orange sowie an Motoren sehr gute Ergebnisse aufzeigen, so dass erste Serienanwendungen in Kürze zu erwarten sind.

Robust and fuel flexible Tier III solutions for two-stroke marine engines

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Focus within NO_x emission reductions is naturally increasing, especially on the various aspects concerned with first costs and IMO NO_x compliance. MAN Diesel & Turbo has evaluated several potential NO_x reduction technologies and chosen to focus development and specification efforts on two very different technologies: Exhaust Gas Recirculation (EGR) and Selective Catalytic Reduction (SCR). Through this work, MDT has been developing full IMO Tier III compliant solutions for a large variety of fuels and for the full two-stroke marine engine programme.

The two NO_x reducing technologies differs in their type of reduction methodology, control systems, MDT scope of supply and naturally also in advantages and drawbacks. MDT has no preference for one or the other technology, but aim at collecting, investigating and document experience to guide users in making the best choice between the two technologies. Issues to consider when choosing technology includes scope of supply for engine designer, engine manufacturer and ship yard, costs (CAPEX and OPEX), service & maintenance of engine related components, choice of sub-suppliers for auxiliary components, certification issues, control systems, compliance including methods for proving compliance for ship owners, limitations to NO_x reducing running conditions, engine performance and fuel oil consumption along with installations of engine and auxiliary components and naturally influences from fuels and lubrications.

Both the EGR and HP SCR technologies has been evaluated through both modelling, component testing, test beds and extensive service experience testing. In total, MDT two-stroke engines have several thousand hours of Tier III compliant service, giving valuable insight into the advantages and drawbacks. This extensive work has proven the NO_x reduction potential of the two technologies, and the focus has been changed towards issues related to e.g. fuel flexibility and use on the various B&W engine platforms, control strategies and alternative solutions for ensuring Tier III compliance for future engines.

Combustion strategies to fulfill future off-highway emission

Mathias Fenner, Dr. Barba Christian; Robert Bosch GmbH

The engine category of 2.5 l/Cyl. is characterized by a wide range of different applications such as marine, locomotive and non-road mobile machinery. Highest demands regarding fuel consumption, robustness, total costs of ownership (TCO) and specific power have to be combined with a multitude of different emission legislations. Besides EPA Tier 4, the proposed EU Stage 5 regulation will continue the limitation of pollutants, especially for the power category of more the 560 kW.
For an assessment of different combustion strategies and the fuel injection equipment (FIE), a modern single cylinder research engine was taken into service. The methodology of design of experiments (DoE) was applied to investigate all different boundary conditions in this segment. This allows to cover a wide range of parameters influencing the combustion. On the one hand the air path (boost pressure level, demand of cooling, EGR) and on the other hand the fuel path with injection pressure as well as different injection pattern.
Furthermore studies with a high pressure high density (HP-/HD) spray chamber enables a characterization of injection behavior in detail. Cold and hot conditions allow the analysis of penetration, cone angle and evaporation of the diesel jets, which serves as validation of the engine measurements.
The focus of this study is a prediction of different requirements for future off-highway large engine concepts to fulfill actual and future emission limits. For this purpose a consideration of EGR and non EGR concepts was done. Thus, it is possible to define requirements regarding the air path, FIE and exhaust gas treatment with respect to emissions as well as an assessment of the total costs of ownership (TCO).

Methods to Reduce Test Bed Work for Large Engine Combustion Development
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Die ständig steigenden Anforderungen an Großmotoren zwingen den Ingenieur von heute neue Wege zu gehen. Speziell beim Dieselmotor ist der experimentelle Anteil am Entwicklungsprozess im Vergleich zum Gasmotorensektor, wo schon über 40 % der Optimierung mit Simulationswerkzeugen durchgeführt werden, immer noch sehr hoch. Eine Reduzierung der Prüfstandsarbeit kann einerseits durch Weiterentwicklung der 3D-CFD Rechnung hinsichtlich der Beschreibung von Energieumsatz und Schadstoffbildung erfolgen, und andererseits durch Einsatz von Design of Experiments (DoE) zur Versuchsplanoptimierung beziehungsweise zur Erstellung von Modellen aus experimentell ermittelten Daten.
In diesem Zusammenhang wurde ein schnelllaufender Einzylinder-Großdieselmotor mit unterschiedlichen Einlassdrallniveaus am Großmotoren-Kompetenzzentrum LEC in Graz untersucht. Beide Konfigurationen wurden mit optischen Zugängen versehen, mit dem Ziel die Simulation besser auf den realen Prozess abstimmen zu können. Durch Brennraumaufnahmen vom Einspritzstrahl bei unterschiedlichen Ladungsbewegungen und anschließender Kalibrierung der relevanten Modellparameter konnten sehr gute Simulationsergebnisse hinsichtlich Brennverlauf und Stickoxidemissionen für beide Konzepte erzielt werden. Eine zuverlässige Berechnung der Partikel- bzw. Rußemissionen war trotz sehr großem Aufwand und Anwendung unterschiedlicher Rußmodelle nicht möglich. Eine Erklärung für den Umstand, dass sich die Rußemissionen einer genauen Vorausberechnung entziehen, liegt in der starken Schwankung der Brennraumbedingungen von Zyklus zu Zyklus. Der Blick in den Brennraum mit einer Hochgeschwindigkeitskamera und die Auswertung der Aufnahmen zeigen von Zyklus zu Zyklus stark fluktuierende Rußkonzentrationsverläufe.
Für komplexe Untersuchungen am Prüfstand kann die Entwicklungszeit durch Anwendung von Design of Experiments reduziert werden. Anhand zweier möglicher Routen zur Stickoxidemissionserfüllung einer Marineapplikation, einerseits durch gekühlte Abgasrückführung und andererseits mit selektiver katalytischer Reduktionstechnologie, wird gezeigt, dass bei gleichbleibender Aussagekraft relativ zu einer vollfaktoriellen Untersuchung der Messaufwand drastisch verringerbar ist. Zur Anwendung kam am Prüfstand eine erweiterte Form von DoE, bei der die nächsten Einstellpunkte jeweils aus einem DoE Plan stammten, welcher durch vorangegangene Messergebnisse und verfeinerte Modellgenerierung ständig adaptiert wurde. Im Falle der SCR-Route wurde zunächst für die Versuche vereinfachend eine konstante Konvertierungsrate angenommen. Zur Bestimmung der tatsächlich erreichbaren Konvertierungsraten wurde ein Modell eingesetzt, das aus Messdaten mit Hilfe von DoE-Funktionalen für eine bestimmte Beschichtung und den Parametern Abgastemperatur, Katalysatorvolumen und Abgasmassenstrom generiert wurde. Mit diesem Ansatz kann der Kraftstoff- und Harnstoffverbrauch im Kennfeld bestimmt werden, wodurch die Voraussetzungen für eine Optimierung und einen fairen Vergleich mit der Abgasrückführungs-strategie geschaffen wurden.
Die angeführten Beispiele machen deutlich, dass die Anwendung statistischer Methoden und verfeinerter Simulationstechniken wirkungsvolle Werkzeuge zur Verringerung von Versuchszeit am Prüfstand, zur Erhöhung der Vorhersagesicherheit und für die Durchführung von Optimierungsaufgaben sind.

Options for Efficiency and Emission Optimization of 4-Stroke Medium Speed Engines

Dr. Alexander Knafl, Prof. Dr. Gunnar Stiesch; MAN Diesel & Turbo SE

Entwicklungsaktivitäten an mittelschnelllaufenden Großmotoren sind weiterhin getrieben von Forderungen zur Verbrauchs- sowie Emissionsreduzierung; Zuverlässigkeit und Lebensdauer werden selbstverständlich vorausgesetzt. Während Verbrauchsreduzierung bzw. Wirkungsgradsteigerung direkten Kundennutzen und somit Wettbewerbsvorteile generieren, werden emissionsreduzierende Maßnahmen in erster Linie von Seiten der Regularien gefordert und kontinuierlich vorangetrieben. Mitunter stellen wirkungsgradsteigernde und emissionssenkende Maßnahmen einen Zielkonflikt dar.

Im Rahmen dieser Arbeit werden Möglichkeiten zur Verbrauchs- und Emissionssenkung anhand der Produktpalette von mittelschnelllaufenden 4-Takt Motoren aus dem Hause MAN Diesel & Turbo SE dargestellt. Das Produktportfolio umfasst einen Leistungsbereich von 0.5 – 20 MW als Diesel-, Gas- sowie Dual-Fuel-Motoren. Die Anwendungsgebiete reichen von Propulsionsmotoren und Nebenaggregaten in der Schifffahrt über Notstrom-Aggregate hin zu Spitzenlast- und Grundlastanlagen im stationären Energieerzeugungssektor.

Als Schlüssel-Technologien zur Wirkungsgradsteigerung stehen die Abgasturboaufladung — speziell 2-stufige Aufladung — sowie die Brennverfahrensentwicklung und die damit einhergehenden Möglichkeiten zur Verbesserung der thermodynamischen Prozessführung im Mittelpunkt. Weiterentwicklungen in der Aufladung sowie dem Brennverfahren erlauben es, gleichzeitig das Emissionsniveau, speziell Stickoxid und Ruß, aber auch unverbrannte oder teilverbrannte Kohlenwasserstoffverbindungen zu reduzieren. In Verbindung mit geschlossenen Regelkreisen wie der zylinderdruckbasierten Verbrennungsregelung wird gezeigt wie ein wirkungsgrad- und emissionsoptimierter Motorbetrieb unabhängig von Kraftstoff- und Umgebungseinflüssen sichergestellt wird.

Über die innermotorischen Möglichkeiten zur Emissionsreduzierung hinaus werden Entwicklungen in der Abgasnachbehandlung anhand der NOx-SCR-Technologie dargestellt. Spezielles Augenmerk liegt auf dem Zusammenspiel zwischen Motor und Abgasnachbehandlungssystem und den damit verbundenen Herausforderungen und Potentialen.

Application of large-sized RCEM to a study on combustion in dual fuel gas engine operation

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The term „dual fuel“ in this paper means not only the operation that pilot diesel spray ignites gas-air pre-mixture but also that more quantity of diesel fuel than the image of „pilot“ is injected in the gas-air mixture, which is considered as a need for marine gas engines. Some phenomena remain unclear in this combustion style, for example, ignition of diesel spray itself would show some different feature from normal diesel engines as it is surrounded by not air but gas-air mixture.
After the diesel spray ignition, gas flame starts to propagate in the pre-mixture from it. In other words, both diffusive combustion and pre-mixed flame propagation exist at the same time and would affect each other in a combustion chamber. It would be a complicated combustion mechanism to be simulated by a CFD.
In this study, a world-largest class RCEM (Rapid Compression and Expansion Machine, 240 mm bore, 330 rpm) is applied to obtain some hint concerning such a combustion mechanism. Visual data through a glass window, RHR (Rate of Heat Release) and emissions can be obtained by one combustion cycle in the RCEM. To recover the weak point of RCEM that it is difficult to simulate the cycle-to-cycle variation, five times experiments are carried out in each condition. The following experiments are conducted changing the factors like lambda (excess air ratio), gas composition, diesel fuel mass and compression temperature at pilot injection.

1. Change in ignition delay of pilot diesel spray by the above-mentioned factors
2. Change in total combustion including gas flame propagation by the factors
3. Change in emissions by them
4. Change in combustion by applying swirling air flow

Furthermore, the „knocking“ phenomena that occur in the RCEM over the critical condition are examined. Additionally, change in combustion by adding hydrogen to natural gas will be introduced. Through the above-mentioned experiments, it is concluded that the RCEM is a useful tool to obtain some clear image on such the complicated combustion phenomena.

ORC-Modul zur Abgaswärmenutzung am mittelschnelllaufenden 4-Takt Diesel- und Dual-Fuel Motor in maritimer Anwendung

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The increase in efficiency along with a reduction in emissions is the main task in the development of modern marine propulsion systems. This improvement can be achieved directly by the engine itself or by a combined cycle for waste heat recovery. This paper presents a method where an ORC-Process (Organic-Rankine-Cycle) is arranged downstream of the engine for generating electric power.
An ORC-Process is different from the Water-Steam-Cycle actually by using an organic working fluid. Due to the high number of potential work fluids they can be optimally adapted to the existing heat source and cooling system. In order maximize the efficiency; the temperature difference of the ORC-Process should be as large as possible. This can generally be reached by utilizing the exhaust heat directly or by the steam system.
The analyzed ORC module is an independent unit with a rated electrical output of 309 kW and an efficiency of 13.9 %. The full power of the ORC module is already provided at 65 % load of 8 M 46 DF engine. Due to the early achievement of the maximum output a high average utilization of the ORC-Module is ensured. The feasible ORC-Output is up to 8 % of the engine power. This value corresponds directly to an efficiency improvement.
In addition to the rated output the average load of the ORC-Module is defined through the connection to the exhaust system of the engine. Therefore the ORC module is integrated in the standard steam system of the vessel and acts upstream the dumping condenser to control the steam pressure. Accordingly, the pressure control strategy is extended by a further level. Due to this configuration the operation of the ORC-Module is independent of the uptime of the individual engine in a multi-engine system and provides electrical power once excess steam is available. Studies considering characteristic load profiles of multi-engine vessels showed a payback time of 2 . . . 4 years. The payback period is affected by the average ORC-Output and the cost of fuel.
Due to the special design and integration of the ORC-Module, a significant increase in efficiency and a decrease in specific emissions are achieved.

Use of diesel particulate filter technology in the field of large engines
Lukas Cavegn; Hugengineering

Die gesteigerte Sensibilität bezüglich Umweltthemen und die weit fortgeschrittene Umwelttechnik in Bereichen der individuellen Mobilität und dem landgebundenen Transportwesen, lässt den Fokus der Gesetzgebung auf weitere motorische Anwendungen mit kleineren Stückzahlen schwenken. Neben den NOx- und SOx-Emissionen sollen auch Russpartikel eliminiert werden. Die Definition des Partikelausstosses über die Anzahl anstelle des Gewichtes ist der einzige Sinnvolle Ansatz um das Schädigungspotenzial der Russemissionen wirkungsvoll zu minimieren. Aus diesem Grund kommen langfristig lediglich geschlossene Filtersysteme zur Russ Abscheidung in Betracht. Neben ihren hervorragenden Eigenschaften als Russfilter stellen uns diese Dieselpartikelfilter jedoch auch vor grosse Herausforderungen speziell im Bereich der Grossmotoren. Hier sind neben den zum Teil sehr tiefen Abgastemperaturen, welche im Zusammenhang mit den grossen Abgasmassenströmen sehr hohe Regenerationsleistungen erfordern, vor allem die Treib- und Schmierstoffqualitäten speziell zu betrachtende Parameter, die neue Lösungen erfordern.
Die Firma Hug Engineering AG ist seit vielen Jahren ein Pionier der Partikelfiltertechnik im Segment non Automotive. Als Entwickler und Hersteller von komplett Systemen sind alle relevanten Kompetenzen von der Filtertechnologie über die Regenerationstechnik bis zur Systemintegration unter einem Dach vereint. Dieses Know-how erlaubt uns gerade bei sehr herausfordernden Fragestellungen immer die optimale Lösung für den Kunden zu finden.
Der von der Hug Engineering AG entwickelte Schwerölfilter befindet sich noch in einem sehr frühen Funktionsmuster-stadium. Nichtsdestotrotz sind erste Laborergebnisse sehr vielversprechend ausgefallen. Über Langzeitversuche mit hochaschigem Abgas konnte dargestellt werden, dass sich das Serviceintervall durch geeignete Massnahmen von unpraktikablen 100 Betriebsstunden auf über 3500 Betriebsstunden verlängern lässt. Dies soll in nächster Zeit durch einen Versuchsträger in realem HFO-Betrieb verifiziert werden.

A regulatory outlook for PM / BC emissions for shipping
Torsten Mundt; DNV GL

Recent studies on the effects of Particulate Matter (PM) and international initiatives to reduce emissions to air has prompted a growing interest in particulate emissions and the role they play in accelerating climate change. Recent studies which looked at PM's effects on human health and how the shipping industry may be contributing to PM emissions have lead international organisations to question the suitability of the current legal framework on ship emissions.
Black carbon (BC) is one of the main points of discussion in this debate. BC is a light absorbing component of particulate matter and is said to have a detrimental effect on climate forcing. The overall impact of shipping on PM / BC is presumably limited, but it may have a significant impact on a regional level as ships may operate close to arctic areas and the number of these operations is expected to increase in the future.
The effects of PM on human health are not related to black carbon alone, they are dependent on the size distribution (ultrafine fraction of PM emissions) as well as the chemical composition of particles. Health implications have already been recognized and addressed in regulations for land-based (transport) sectors. However, they are still being discussed for the shipping industry. This study provides further background on particulate matter and black carbon, their effects on the environment and human health as well as the current status of shipping's contribution to the overall anthropogenic impact. The paper also discusses potential ways to measure PM and BC, their origin and possible abatement technologies/ strategies.