Universitatea Tehnică a Moldovei

ANALIZA POSIBILITĂȚII UTILIZĂRII PEROXIDULUI DE HIDROGEN ÎN CALITATE DE COMBUSTIBIL LA AUTOVEHICULE

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Proiect de master

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Rezumat

În lucrarea dată este descrisă posibilitatea de utilizare a peroxidului de hidrogen în calitate de combustbil pentru autovehicule, care sunt motivate de proprietățile fizice și chimice a elementului dat și de necesitatea de a găsi o sursă de energie mai ecologică decât combustibilii tradiționali. Astfel, în primul capitol este descrisă istoria, domeniile de utlizare, metodele de obținere, proprietățile fizice și chimice ale peroxidului de hidrogen. Deasemenea avem descrise tendințele cotidiene în domeniul auto și alternativele prezentate la moment ca alternativă a combustibilor convenționali, printre care avem: motorul pe hidrogen, pe pile de combustie, hybrid, electrice, biodiesel, și gaz natural sau petrolier lichefiat. Studierea peroxidului de hidrogen conduce spre ideia ca el nu poate fi folosit într-un motor clasic cu adrede internă fara a face careva schimbări sau modernizări constructive majore, din cauza proprietăților lui odixante și destul de agresive pentru anumite materiale, de exemplu utilizate la sistemul de alimentare și inejcție. La fel, elementul dat nu poate arde nemijlocit ca de exemplu motorina sau benzina. Acesta necesită tranportarea în cilindru în forma de abur, sau poate fi transportat și ca lichid în cazul în care avem un sistem cu doi combustibili. Astfel peroxidul de hidrogen îndeplinește rolul de oxidant, ceia ce mărește perfomanța și caracteristicile ecologice ale motorului.

În al doilea capitol avem descris cercetările actuale legate de utilizarea peroxidului de hidrogen în diferite motoare și condiții. Acestea descriu ideile teoretice legate de untilizarea peroxidului de hidrogen în motor și respectiv partea practică cu rezultate și concluzii. Cercetările arată creșterea eficienței termice în mediu cu 10%, scăderea emisiilor de CO și HC, a opacității gazelor de eșapament și posibilitatea de al folosi în proporțile de până la 30% în motorul MAC și 10% în MAS. Aceasta se datorează în mare parte emisiei de oxidgen care se întâmplă la descompunerea peroxidului de hidrogen, ceia ce serveste ca o sursa de oxigen curată lipsită de azot și derivații sai care provin din aer. Aplicarea injecției directe de H2O2 are potențialul de a anula unele dintre dificultățile asociate cu controlul evenimentului de ardere și de a extinde gama de regimuri de ardere la care funcționează aprinderea prin compresie cu sarcină omogene. Manipularea concentrației de H2O2 și SOI oferă două instrumente care pot fi utilizate pentru a obține timpul de ardere dorit într-o gamă largă de condiții de admisie. Deși rezultatele acestui experiment sunt promițătoare, extinderea modelului de calcul la mai multe zone pentru a surprinde natura neomogenă a injecției de H2O2 va oferi o perspectivă suplimentară asupra comportamentului strategiei de control al arderii duble a combustibilului. În plus, trebuie abordat efectul presiunilor mai mari de admisie asupra viabilității adăugării de H2O2, deoarece multe motoare HCCI încorporează acum condiții de funcționare îmbunătățite pentru a crește densitatea de putere a motorului.

În al treilea capitol, cel practic am efectuat calcule legate de efectele peroxidului de hidrogen asupra motorului cu ardere internă, și anume căldura specifică, energia specifică, densitatea amestecului, coeficientul de transfer de căldură, cuplul. În special, adăugarea de peroxid de hidrogen a dus la o presiune medie efectivă, putere și cuplu semnificativ mai mari, în principal datorită creșterii densității energetice a amestecului. Eficiența termică a prezentat o creștere mult mai mică, dar deloc neglijabilă. S-a constatat, de asemenea, că emisiile de NOx au scăzut enorm. În condiții de încărcare constantă, abordarea de adăugare a peroxidului de hidrogen a condus la o scădere de 9 ori a NOx. Cu toate acestea, valorile de emisie de NOx obținute erau încă ridicate, sugerând astfel necesitatea utilizării unei tehnologii suplimentare pentru tratarea acestora. introducerea peroxidului de hidrogen duce la un proces de aprindere în două etape. Prima etapă de aprindere este esențială în controlul întregului proces de aprindere, deoarece sa constatat că este întârziată odată cu creșterea adiției de peroxid de hidrogen, în timp ce a doua etapă de aprindere a fost avansată. Aceasta a condus la o scădere rapidă a unghiului de ardere rapidă și un răspuns nemonoton al unghiului manivelei de aprindere la adăugarea de peroxid de hidrogen.

Abstract

In the given paper is described the possibility of using hydrogen peroxide as a fuel for motor vehicles, which are motivated by the physical and chemical properties of the given element and the need to find a more environmentally friendly energy source than traditional fuels.

Thus, the first chapter describes the history, fields of utilization, methods of production, physical and chemical properties of hydrogen peroxide. We also describe the everyday trends in the automotive field and the alternatives currently presented as an alternative to conventional fuels, among which we have: hydrogen, fuel cell, hybrid, electric, biodiesel, and natural gas or liquefied petroleum gas. The study of hydrogen peroxide leads to the idea that it cannot be used in a conventional internal combustion engine without making any major constructive changes or modernizations, because of its oxidizing and rather aggressive properties for certain materials, for example used in the fuel system and fuel injection. Likewise, the given element cannot burn directly like diesel or gasoline. It requires transportation in the cylinder in the form of vapor, or it can also be transported as a liquid if we have a dual fuel system. In this way hydrogen peroxide acts as an oxidizer, which increases the performance and environmental characteristics of the engine

In the second chapter we have described the current research related to the utilization of hydrogen peroxide in different engines and conditions. They describe the theoretical ideas related to the untilization of hydrogen peroxide in the engine and the practical part with results and conclusions. The research shows an increase in thermal efficiency in the environment by 10%, a decrease in CO and HC emissions, a decrease in exhaust gas opacity and the possibility of using it in up to 30% in MAC engines and 10% in MAS. This is largely due to the emission of oxidgen that occurs in the decomposition of hydrogen peroxide, which serves as a clean oxygen source free of nitrogen and its derivatives from the air. The application of direct injection of H2O2 has the potential to negate some of the difficulties associated with controlling the combustion event and to extend the range of combustion regimes at which homogeneous charge compression ignition works. Manipulation of H2O2 concentration and SOI provide two tools that can be used to achieve the desired combustion timing over a wide range of inlet conditions. While the results of this experiment are promising, extending the computational model to more areas to capture the inhomogeneous nature of H2O2 injection will provide additional insight into the behavior of the dual fuel combustion control strategy. In addition, the effect of higher intake pressures on the viability of H2O2 addition needs to be addressed, as many HCCI engines now incorporate enhanced operating conditions to increase engine power density.

In the third chapter, the practical one, we performed calculations related to the effects of hydrogen peroxide on the internal combustion engine, namely specific heat, specific energy, mixture density, heat transfer coefficient, torque. In particular, the addition of hydrogen peroxide resulted in significantly higher mean effective pressure, power and torque, mainly due to the increase in the energy density of the mixture. The thermal efficiency showed a much smaller but not negligible increase. It was also found that NOx emissions decreased enormously. Under constant load conditions, the hydrogen peroxide addition approach led to a 9-fold decrease in NOx. However, the NOx emission values obtained were still high, thus suggesting the need for additional technology to treat the NOx. The introduction of hydrogen peroxide leads to a two-stage ignition process. The first ignition stage is crucial in controlling the whole ignition process, as it was found to be delayed with increasing hydrogen peroxide addition, while the second ignition stage was advanced. This led to a rapid decrease in the rapid firing angle and a nonmonotonic response of the ignition crank angle to hydrogen peroxide addition.

Cuprins

Introducere

Căutarea unor surse de energie durabile și ecologice a devenit din ce în ce mai urgentă în fața schimbărilor climatice și a epuizării combustibililor fosili. Întrucât sectorul transporturilor rămâne unul dintre cei mai mari contributori la emisiile de gaze cu efect de seră, explorarea combustibililor alternativi este esențială pentru atingerea obiectivelor globale de sustenabilitate. Printre diferiții candidați pentru energie curată, peroxidul de hidrogen (H_2O_2) a apărut ca o opțiune promițătoare pentru aplicațiile auto. Recunoscut în mod tradițional pentru utilizarea sa ca agent dezinfectant și de albire, peroxidul de hidrogen posedă proprietăți unice care îl fac un candidat atractiv pentru combustibil, în special în contextul motoarelor cu ardere internă și al celulelor de combustibil. Această teză își propune să investigheze viabilitatea peroxidului de hidrogen ca combustibil pentru automobile, concentrându-se pe caracteristicile sale de producție, depozitare și ardere. Examinând proprietățile chimice ale peroxidului de hidrogen, avantajele sale potențiale față de combustibilii convenționali și provocările asociate cu implementarea sa în tehnologia auto, această cercetare încearcă să contribuie la corpul tot mai mare de cunoștințe despre combustibilii alternativi.

Prima secțiune a acestei teze va oferi o imagine de ansamblu cuprinzătoare a utilizărilor istorice și contemporane ale peroxidului de hidrogen, evidențiind rolul său în producția de energie și potențialul său ca combustibil curat. Capitolele ulterioare vor aprofunda aspectele tehnice ale utilizării peroxidului de hidrogen în aplicațiile auto, inclusiv densitatea energetică, eficiența arderii și profilul de emisii. În plus, această cercetare va aborda provocările infrastructurale și de reglementare care trebuie abordate pentru a facilita adoptarea pe scară largă a peroxidului de hidrogen ca combustibil pentru automobile. În cele din urmă, aceast proiect presupune că peroxidul de hidrogen, cu conținutul său ridicat de energie și impactul redus asupra mediului, ar putea juca un rol crucial în tranziția către un viitor de transport mai durabil. Prin analiza riguroasă și explorarea aplicațiilor inovatoare, această cercetare își propune să lumineze calea de urmat pentru peroxidul de hidrogen ca opțiune de combustibil viabilă pentru următoarea generație de automobile.

Industria auto globală se află într-un moment remarcabil, se confruntă cu o presiune crescândă pentru tranziția de la combustibilii fosili tradiționali la surse de energie mai curate și mai durabile. Având în vedere că transportul reprezintă aproximativ 14% din emisiile globale de gaze cu efect de seră, nevoia de soluții inovatoare pentru a reduce acest impact nu a fost niciodată mai critică. Pe măsură ce țările se străduiesc să atingă obiective ambițioase de neutralitate a emisiilor de carbon, explorarea combustibililor alternativi a câștigat avânt. Printre numeroasele opțiuni disponibile, peroxidul de hidrogen (H_2O_2) se remarcă ca un candidat convingător, oferind o combinație unică de densitate energetică, beneficii pentru mediu și versatilitate. Peroxidul de hidrogen, o moleculă simplă, dar puternică, a fost de mult recunoscută pentru aplicațiile sale în diverse domenii, inclusiv în medicină, agricultură și procese industriale. Cu toate acestea, potențialul său ca sursă de combustibil nu a fost pe deplin realizat. Spre deosebire de combustibilii fosili convenționali, peroxidul de hidrogen se descompune în apă și oxigen, eliberând energie în proces și producând poluanți minimi. Această caracteristică îl poziționează ca o alternativă prietenoasă cu mediul care ar putea atenua semnificativ amprenta ecologică a sectorului auto.

Mai mult, această lucrare va aborda problemele practice asociate cu adoptarea peroxidului de hidrogen ca combustibil pentru automobile. Aceste provocări includ dezvoltarea unor metode de depozitare sigure și eficiente, stabilirea unui lanț de aprovizionare fiabil și cadrele de reglementare necesare pentru a sprijini integrarea acestuia în infrastructura auto existentă. Prin examinarea studiilor de caz și a proiectelor pilot, această cercetare va oferi informații despre starea actuală a tehnologiei combustibililor cu peroxid de hidrogen și potențialul său de scalabilitate. Astfel, putem afirma că peroxidul de hidrogen reprezintă o cale viabilă către un viitor auto mai sustenabil. Prin valorificarea proprietăților sale unice și abordând provocările implementării, peroxidul de hidrogen ar putea juca un rol transformator în reducerea amprentei de carbon a transportului. Pe măsură ce ne aflăm în pragul unei revoluții energetice, această cercetare urmărește să contribuie la dialogul privind combustibilii alternativi și să inspire

explorarea în continuare a potențialului neexploatat al peroxidului de hidrogen ca combustibil curat și eficient pentru următoarea generație de vehicule.

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