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UVOĐENJE BIODIZELSKOG GORIVA U REPUBLIKU HRVATSKU

Sažetak

Biodizel je motorno gorivo koje se proizvodi esterifikacijom repičinog ulja s metanolom. Može se koristiti u smjesi s mineralnim dizelom. Biogoriva a posebno biodizel su danas najvrjedniji izvori obnovljive energije. Nacionalne ekonomije povezuju tako poljoprivrednu proizvodnju i proizvodnju energije.

U Hrvatskoj nema još proizvodnje biodizela. Zbog povoljnih klimatskih uvjeta Hrvatska ima značajni potencijal proizvodnje biodizela iz repičinog ulja. Pod utjecajem kretanja u razvijenim europskim zemljama te na osnovi 18-mjesečnog rada na nacionalnom energetskom programu BIOEN (program korištenja energije iz biomase i otpada), te radi stimulativnih mjera hrvatske vlade može se očekivati povećanje nasada pod uljaricama, a posebno uljane repice. Energetske potrebe hrvatske poljoprivrede iznose 105000 t goriva godišnje (bez procesiranja). U slučaju korištenja biodizela trebalo bi za proizvodnju ekvivalentne količine repičinog ulja koristiti 120000 ha obradivog zemljišta. Ukupne obradive površine u Hrvatskoj iznose 1632750 ha. U 1993. u Hrvatskoj su uvedene nove visokokvalitetne sorte uljane repice, tzv. "00"-kultivari. S novim "00"-sortama prinosi su u prosjeku porasli sa 2,2 t/ha na 3,2 t/ha. Potencijalna potrošnja biodizela u Hrvatskoj procjenjuje se približno na najmanje 30000 t/god. metilnog estera repičinog ulja.

Očekivane ekonomske, socijalne i ekološke koristi na nacionalnoj razini treba dostići kroz stvaranje domaće proizvodnje biodizela i kroz podupiranje široke upotrebe

biodizela. Prvi korak je na razini testova, tako da je u planiranju više regionalnih projekata proizvodnje repičinog ulja kao i eksperimentalno postrojenje za esterifikaciju. Korištenje biodizela ispitat će se u realnim eksploatacijskim uvjetima. Hrvatska vlada treba uspostaviti porezne i zakonske uvjete koji podupiru proizvodnju i korištenje biodizela. Isto tako treba formirati hrvatski standard za biodizelsko gorivo u skladu s europskim standardima i direktivama.

1. Uvod

Biodizel je motorno gorivo, koje se dobiva iz repičinog ulja, te drugih biljnih ulja esterifikacijom s metanolom, a kod toga nastaje gorivo, koje ima svojstva potpuno usporediva s dizelom iz mineralnog ulja. Može se koristiti i kao smjesa s mineralnim dizelskim gorivom. Koristi se i kod modernih dizelovih motora s katalizatorom, te se proizvodi i u zimskoj kvaliteti do -20°C.

Prvo vozilo na biljno ulje predstavljeno je pred više od stotinu godina. Davne 1900. godine na Svjetskoj izložbi u Parizu Rudolf Diesel je izložio motor na ulje iz kikirikija. Prvi suvremeni pokusi i ispitivanja mogućnosti korištenja biljnog ulja za pokretanje motornih vozila potaknuta su 1973. godine u doba prve naftne krize. Odmah je pokazano da se biljna ulja mogu uspješno koristiti u dizelovim motorima, no postojale su i određene poteškoće. Glavni uzrok problema, visoka viskoznost ulja, ubrzo je otkriven i riješen od kemičara, koji su ulje prilagodili jednostavnom esterifikacijom. U reakciji ulja i alkohola zamjenjuje se glicerol, komponenta svake prirodne masnoće s metanolom.

Danas se u Njemačkoj uljarice za biodizel uzgajaju na preko 300.000 ha, u 1997. godini je proizvedeno preko 400.000 tona, a biodizel se toči na 1271 benzinskih postaja. Vozači taksija koriste biodizel u više od 40.000 vozila. Francuska naftna kompanija Elf proizvodi i koristi preko 1 milijun hektolitara biodizela svake godine (oko 100000 t). Proizvodnja i korištenje biodizela nije rijetkost ni u zemljama u tranziciji (Češka, Slovačka, Poljska). Tako je u Češkoj još 1991. godine pokrenut "Oleoprogramme", odnosno projekt korištenja uljane repice za proizvodnju biodizela. Glavni cilj projekta je korištenje viška obradivih površina u industrijske svrhe u skladu s postojećom poljoprivrednom politikom, a projektom se očekuje postizanje udjela biodizela od 5% u svim dizelovim motorima u odnosu na 1991.

Italija, Mađarska i Slovenija ubrzano rade na podizanju novih postrojenja, kako bi nadoknadile zaostajanje prema drugima. Možda i najveća prednost korištenja biodizela pred klasičnim dizelskim gorivom leži u smanjenoj emisiji tzv. stakleničkih plinova i štetnih tvari. Izgaranjem i proizvodnjom 1 kg klasičnog dizelskog goriva emitira se 4,01 kg CO_{2ekv}, a za proizvodnju 1 kg biodizela to iznosi 0,916 kg CO_{2ekv}, zahvaljujući apsorbiranju CO_2 iz zraka tijekom rasta biljke. Korištenje 100%-tnog biodizela (B100) smanjuje emisiju NO_x za 13%, dok se pri korištenju mješavine 20%-tne mješavine ukupna emisija NO_x smanjuje za 2,67%. Nadalje, korištenje B100 značajno smanjuje emisiju čestica (32%), ugljičnog monoksida (35%), te ako gledamo samo emisiju ispušnih plinova iz vozila, potpuno se eliminira SO_x. Ugljikovodici (HC) su s B100 manji za 37%. Pored toga, proizvodnjom iz uljane repice dodatno se dobiva kvalitetna stočna hrana i glicerol interesantan kemijskoj industriji.

Radna grupa sastavljena od stručnjaka iz različitih institucija, fakulteta i INE, pripremila je za Vladu RH prijedlog projekta kojim se ostvaruju uvjeti za pokretanje proizvodnje, te potiče razvoj tržišta za biodizelsko gorivo.

2. Razlozi za pokretanje projekta i ciljevi

2.1. Očekivani učinci u Hrvatskoj

Uspješna provedba projekta imala bi višestruke pozitivne učinke na gospodarstvo, poljoprivredu i zaštitu okoliša u Hrvatskoj, kao što je to uočeno u drugim europskim zemljama. Kao najvažniji očekivani učinci uvođenja biodizela u gospodarstvo Hrvatske mogu se istaknuti:

- Nadomještavanje dijela fosilnih goriva koja se uvoze obnovljivim gorivom, zadržavanje stranih sredstava plaćanja u zemlji, te veća sigurnost opskrbe.
- Efekt boljeg gospodarenja fosilnim gorivima; na uloženih 100 energetskih jedinica mineralnog energenta u proizvodnom lancu biodizela dobije se u konačnici 320 jedinica energije uključujući biljno ulje, dok se za 100 ulaznih energetskih jedinica u procesu nastajanja mineralnog dizelskog goriva u konačnici dobiju 83 jedinice.
- Za Hrvatsku je važno angažiranje zapuštenih obradivih poljoprivrednih površina (400000 ha).
- Uvođenje "treće kulture" (osim pšenice i kukuruza), kojom bi se osigurao dodatni i sigurniji prihod poljoprivrednim proizvođačima u

Hrvatskoj, omogućilo bolje iskorištavanje mehanizacije, te povećala rentabilnost poljoprivredne proizvodnje.

- Makroekonomski (izvozno) je za Hrvatsku proizvodnja uljane repice mnogo povoljnija od pšenice (pogotovo nakon ulaska u WTO), a prisutne su i objektivne klimatske i pedološke prednosti za tu proizvodnju.
- Provođenje programa smanjenja emisije CO_2 prihvaćenog potpisivanjem sporazuma iz Kyota (biodizel je "CO_2-neutralno" gorivo).
- Smanjenje zagađenja zraka radi manje štetne emisije pri izgaranju goriva u motoru, a time pozitivan utjecaj na kvalitetu življenja stanovništva i na javno zdravlje.
- Smanjenje rizika zagađivanja voda korištenjem biološki razgradljivog energenta.

U odnosu na mineralno dizelsko gorivo biodizel je pored navedenih društvenih koristi pokazao u primjeni i neke tehničke prednosti:

- Ne predstavlja opasnost za temeljne vode prilikom transporta, skladištenja i korištenja.
- Kod transporta ne klasificira se kao opasna tvar, jer nije lako zapaljiv.
- Biodizel poboljšava podmazivanja u motoru, te tako doprinosi trajnosti motora.
- Biodizel pokazuje bolja svojstva izgaranja i mirniji rad motora, povećava cetanski broj.
- Ispušni plinovi nemaju neugodan miris karakterističan za dizelove motore s mineralnim gorivom.

Novi materijal zahtijeva istraživanja ne samo tehničke prirode, nego i upoznavanje efekata na gospodarstvo i življenje stanovništva, tako da su istraživanja i razvojne aktivnosti u razvijenim zemljama na ukupnom proizvodnom lancu biodizela koncentrirana na:

- Širenje palete mogućih sirovina na ulazu u proizvodnju, a ne samo repičino i sojino ulje, tako da se poboljša kvaliteta proizvoda i pojeftini proizvodnja, jer je proizvodnja biodizela skuplja od proizvodnje mineralnog dizela.
- Razvoj proizvodnih jedinica za esterifikaciju visoke fleksibilnosti u korištenju različitih sirovina.
- Pozicioniranje biodizela u tržišne segmente u kojima je biodizel jedino ili superiorno rješenje, tako da se postiže viša prodajna cijena (primjer!).

- Razvoj sorti i postupaka uzgoja uljane repice koji poboljšavaju energetsku efikasnost i ekološku prihvatljivost ukupnog proizvodnog lanca.
- Razumijevanje efekata poboljšanja koje taj proizvodni lanac donosi kroz utjecaj na zdravlje stanovništva i kroz čuvanje radnih mjesta u poljoprivredi, kako bi se potaklo uvođenja biodizela u gospodarstvo.
- Poboljšavanje konstrukcija motora, kako bi se moglo za posebne namjene koristiti i neesterificirano biljno ulje.

2.2. Ciljevi projekta

Ukupan cilj projekta je pokretanje proizvodnje te poticaj razvitka tržišta za biodizelsko gorivo u Republici Hrvatskoj. Za ostvarenje ukupnog cilja potrebno je slijedeće:

- donošenje političke odluke o opravdanosti uvođenja biodizelskog goriva,
- provedba demonstracijskog projekta kojim bi se pokazale osobitosti namjenskog uzgoja i prerade uljane repice te proizvodnje biodizelskog goriva u Hrvatskoj,
- izbor modela korištenja biodizelskog goriva u Hrvatskoj (mješavina bio- i klasičnog dizela u svim vozilima, čisti biodizel za posebna vozila, proizvodnja i korištenje u seoskim zadrugama,...),
- uspostava hrvatskog standarda za biodizelsko gorivo,
- donošenje odgovarajućih poticajnih mjera za namjenski uzgoj uljarica,
- zakonska regulativa za korištenje biogoriva u Hrvatskoj.

3. Provedba projekta

3.1 Proizvodnja i tržište za biodizel u Hrvatskoj

Procjenjuje se da je potencijal tržišta Hrvatske oko 30000 t/god. metilnog estera (5% dodatka u mineralni dizel), što bi uz prosječne prinose repice i iskorištenja u daljoj preradi zahtijevalo oko 25000 ha površina pod uljanom repicom. Prema projekcijama poljoprivrednih stručnjaka, koji razmišljaju o samoproizvodnji energije za potrebe poljoprivrede u RH, potrebno je imati oko 12% površina pod uljanom repicom (austrijski model), što čini 110000 ha, te daje 125000 t/god. metilnog estera u zreloj fazi razvoja tržišta tog proizvoda.

U slučaju da se ester repičinog ulja koristi samo kao aditiv za poboljšanje mazivosti niskosumpornih dizela (3% dodatka) nezavisno od njegove šire potrošnje kao motornog goriva, potrebno je osigurati 20000 t/god..

Dosadašnja iskustva pokazuju da je regionalni pristup proizvodnji sirovog repičinog ulja primjereniji od centraliziranog radi uštede transportnih troškova za repicu i bliske veze s proizvodnjom stočne hrane zbog korištenja uljane sačme. Projektom predviđene regionalne proizvodnje sirovog ulja davale bi oko 15000 t/god. ulja svaka, a u demonstracijskoj fazi oko 1000 - 2000 t/god.

Proizvodnja metilnog estera repičinog ulja i miješanje s mineralnim dizelom u tržišni proizvod čine prirodnu cjelinu za koju je povoljnije da iz ekonomskih razloga i radi jamstva ujednačene kvalitete izlaznog proizvoda, bude što većeg kapaciteta. Za Hrvatsku to znači da bi moglo postojati samo jedno postrojenje za esterifikaciju. U demonstracijskoj fazi to bi bilo postrojenje od 2000 - 4000 t/god. estera, a kasnije od 30000 - 50000 t/god.

3.2 Neposredni zadaci

Za ostvarenje ukupnog cilja, a to je pokretanje proizvodnje, te poticaj razvitka tržišta za biodizelsko gorivo u Hrvatskoj treba učiniti slijedeće:

- Donošenje političke odluke (Vlada, ministarstva, Sabor) o opravdanosti realizacije proizvodnje biodizelskog goriva.
- Formiranje konzorcija - interesne udruge za provedbu projekta biodizela.
- Provedba demonstracijskih regionalnih projekata kojima bi se utvrdile osobitosti namjenskog uzgoja i prerade uljane repice, kao i korištenja biodizela.
- Izgradnja centralnog postrojenja za proizvodnju biodizelskog goriva kapaciteta prilagođenog regionalnim demonstracijskim projektima (kod Ine postoji iskoristiva oprema).
- Izbor tehničkog modela korištenja biodizela u Hrvatskoj (mješavina bio- i klasičnog dizela u svim vozilima, čisti biodizel za posebna vozila, proizvodnja i korištenje u lokalnim zajednicama i drugo).
- Uspostava hrvatskog standarda za biodizelsko gorivo usklađenog s europskim.
- Donošenje odgovarajućih poticajnih mjera za namjenski uzgoj uljarica za industrijsko korištenje, po uzoru na europske, te model povezivanja interesa u proizvodnom lancu od polja do benzinske crpke.
- Uspostava zakonske regulative relevantne za korištenje biogoriva u Hrvatskoj, po uzoru na europsku.

3.3. Struktura operativnih aktivnosti

Proizvodni lanac biodizela obuhvaća niz problemskih i stručnih cjelina, kao i zaokruženih grupa zadataka, za koje se mogu identificirati potencijalni kompetentni izvođači koji bi sudjelovali u okviru konzorcija za realizaciju te proizvodnje u Hrvatskoj. To su prije svega: Agronomski fakultet, Energetski institut "Hrvoje Požar" i INA d.d.

Prvi zadatak je izrada studije podobnosti za potrebe Vlade Republike Hrvatske za stratešku odluku o načinu uvođenja i poticanja proizvodnje i korištenja biodizelskog goriva. Pored toga treba pripremiti demonstracijsku-namjensku proizvodnju uljane repice, preradu u sirovo repičino ulje, proizvodnju estera repičinog ulja, te ispitivanje korištenja smjese estera repičinog ulja u smjesi s dizelskim gorivom iz rafinerija INE. Kod toga je potreban koordinirani rad na projektima i cjelovito sagledavanje i provedba zadataka. Regionalni partneri na projektu surađivat će s konzorcijem.

Demonstracijska faza projekta sastoji se od sljedećih cjelina zadataka:

- Proizvodnja uljane repice u okviru regionalnih projekata.
- Proizvodnja sirovog repičinog ulja u okviru regionalnih projekata.
- Proizvodnja estera repičinog ulja u centralnom postrojenju.
- Proizvodnja i distribucija komercijalnog motornog goriva u kontroliranom krugu potrošača.
- Praćenje korištenja novog motornog goriva - testovi na vozilima u okviru regionalnih projekata, potencijalne tržišne niše.
- Valorizacija rezultata demonstracijske faze projekta i prijedlozi za dalju realizaciju.

4. Sudionici provedbe projekta

4.1. Poljoprivredni sektor

Uljana repica je vrlo važna kultura u plodoredu. Posebna vrijednost kao predkulture pokazuje se visokim povratkom hranjivih tvari tlu, visokom aktivnošću mikroorganizama, uskim C/N odnosom žetvenih ostataka i popravljanjem svojstva tla u dubljim slojevima, zbog dubokog rasta rastresitog korijena. Dobra je pretkultura žitaricama, mahunarkama, krmnim i drugim kulturama. Najpovoljnije je uljanu repicu uzgajati na istoj površini svake četvrte do pete godine.

Stvaranje i uvođenje u proizvodnju novih “00” kultivara uljane repice, poboljšane kakvoće ulja i sačme omogućilo je brzo širenje ove kulture osobito

u Europi, gdje je postala najvažnija uljarica. Za Republiku Hrvatsku je posebno zanimljivo da bi navedena kultura mogla potaknuti proizvodnju na danas neobrađenim površinama, koje iznose čak preko 200.000 ha obradivog poljoprivrednog zemljišta.

Klimatski uvjeti u Hrvatskoj su vrlo pogodni za proizvodnju biljnih ulja, odnosno uzgajanje uljarica. Prema podacima Državnog zavoda za statistiku u Hrvatskoj je 1998. godine zasijano 1.056.649 ha, a 401.351 ha (27,5%) obradivih površina oranica i vrtova je ostalo nezasijano. U strukturi sjetve najviše su zastupljene žitarice (65,8%). Industrijskim biljem je zasijano 112.240 ha (10,6%), a uljarice su zastupljene s 6,8%. Sva ekstenzivnost naše ratarske proizvodnje vidljiva je iz pregleda strukture sjetve na obiteljskim poljoprivrednim gospodarstvima. Na 82,1% oraničnih površina obiteljskih poljoprivrednih gospodarstava zasijano je 6,3% industrijskih kultura, a uljarica svega 3,3%. Posebno je zapostavljena uljana repica, koja je na obiteljskim poljoprivrednim gospodarstvima zasijana na samo 803 ha. Međutim, makroekonomski je za Hrvatsku proizvodnja uljane repice povoljnija od pšenice (poglavito nakon ulaska u WTO), uz sve navedene objektivne klimatske i pedološke prednosti za tu proizvodnju.

4.2. Naftna industrija

INA d.d. kao dominantna naftna tvrtka u Hrvatskoj zainteresirana je za suradnju u dijelu svojih kompetencija i interesa. U slučaju da projekt uvođenja biodizelskog goriva u Hrvatsku uspješno krene u realizaciju, INA bi bila zainteresirana za proizvodnju metilnog estera repičinog ulja, te za proizvodnju komercijalnog goriva kao smjese mineralnog dizela i biljnog estera, kao i za distribuciju tog goriva. Proizvodno postrojenje za esterifikaciju u slučaju realizacije bilo bi na lokaciji Zagreb.

Poseban interes INE bio bi okrenut mogućem korištenju estera repičinog ulja kao komponente za poboljšanje primjenskih karakteristika dizelskih goriva (poboljšanje mazivosti niskosumpornih dizela, poboljšanje cetanskog broja i dr.).

Za nastup prema Vladi Republike Hrvatske i drugim partnerima u konzorciju INA ističe svoje prednosti:

1. Centralna pozicija lokacije Zagreb u odnosu na regionalne proizvođače sirovog ulja, te u odnosu na tržište.

2. Proizvodnja estera repičinog ulja može se realizirati na lokaciji Zagreb uz investicijska ulaganja upola niža nego drugdje u Hrvatskoj radi raspoložive prisutne opreme i infrastrukture.
3. Tržište komercijalnog biodizelskog goriva, uključujući i proizvodnju za potrošače s posebnim zahtjevima traži jamstvo kvalitete i kompetenciju u području motornih goriva.
4. Osigurana je dobra veza s distribucijskom mrežom.
5. INA koristi repičino ulje i njegov ester kao modernu biorazgradivu sirovinu za razne nove proizvode i za supstituciju postojećih proizvoda u području maziva, te je na lokaciji Zagreb prisutan razvojni sinergizam, a time i bolji ekonomski efekt te proizvodnje.

4.3. Energetski sektor i državna uprava

Projekt uvođenja biodizelskog goriva u Hrvatsku dio je Nacionalnog energetskog programa BIOEN, kojeg je Vlada Republike Hrvatske utvrdila za jedan od prioritetnih strateških zadataka radi restrukturiranja gospodarstva i razvitka energetskog sektora prema potrebama Republike Hrvatske. Proizvodnja i korištenje biodizela zbog svojih već opisanih pozitivnih učinaka od posebnog je značaja za Hrvatsku, a u nacrtu Strategije razvitka energetskog sektora Republike Hrvatske, koju je Energetski institut "Hrvoje Požar" izradio za Vladu Republike Hrvatske predviđa se u 2030. godini udio biogoriva u prometu između 4 i 8%.

Zbog karaktera projekta u njegovoj provedbi sudjeluje više ministarstava Vlade Republike Hrvatske i to kako slijedi:

- Ministarstvo poljoprivrede i šumarstva nositelj je Programa i odgovorno je Vladi Republike Hrvatske za njegovu realizaciju sukladno djelokrugu poslova i zadataka Ministarstva;
- Ministarstvo gospodarstva posebno je odgovorno za strateški razvitak RH, zapošljavanje, brži razvitak nerazvijenih krajeva, koordinaciju suradnje s razvojno orijentiranim agencijama UN i EU;
- Ministarstvo zaštite okoliša i prostornog uređenja odgovorno je za sustav zaštite okoliša i racionalno korištenje energije;

Za realizaciju projekta koristit će se stručna pomoć i financijska sredstva međunarodnih fondova ili fondova pojedinih zemalja namijenjenih za pomoć zemljama srednje i istočne Europe, a projekt će izvan granica Republike Hrvatske predstavljati:

- Ministarstvo poljoprivrede i šumarstva u svim vladinim i međudržavnim institucijama,

- Ministarstvo zaštite okoliša i prostornog planiranja u vladinim i međunarodnim institucijama koje skrbe o zaštiti okoliša,
- Agronomski fakultet i INA, d.d. u svim institucijama koje se bave proizvodnjom, transportom i prodajom uljane repice i biodizelskog goriva,
- Energetski institut "Hrvoje Požar" u kontaktima s institutima i agencijama, te međunarodnim i međudržavnim organizacijama koje skrbe o energetskoj efikasnosti i primjeni obnovljivih izvora energije.

5. Zaključak

Dosadašnje aktivnosti i dogovori u Hrvatskoj ujednačile su opća stajališta o tom energentu, koja se mogu sažeti na:

- Hrvatska mora formulirati svoju politiku razvoja na tom energentu u skladu sa svojim specifičnostima, vezano na politiku prema vlastitoj poljoprivredi, turizmu i zaštiti okoliša.
- Treba odmah snimiti (identificirati) sve ekonomske, političke i socijalne efekte (cost benefit) u proizvodnom lancu biodizela, od poljoprivrede do benzinske crpke s posebnim naglaskom na segmentaciju tržišta i na sirovinsku osnovu.
- Projekt biodizela je oformljen temeljem odluka Ministarstva poljoprivrede i šumarstva, uz podršku Ministarstva zaštite okoliša, Ministarstva gospodarstva i Poglavarstva Grada Zagreba, te INA d.d. i realizirat će se u početnoj fazi kao regionalni demonstracijski projekt u konzorcijalnoj formi.

INTRODUCING BIODIESEL FUEL INTO THE REPUBLIC OF CROATIA

Summary

Biodiesel is an engine fuel that is produced from rapeseedoil by esterification with methanol having the properties that are comparable to petroleum diesel fuel. It can be used as blend with mineral diesel fuel.

Biofuels and especially biodiesel today represent the most valuable form of renewable energy sources. In majority of European countries biodiesel has privileged tax treatment. National economies are connecting agricultural production with energy production.

In Croatia, at present, there is no biodiesel production. Due to its favourable climate conditions, Croatia has significant potential for biodiesel production from rapeseedoil. Under the influence of modern movements in developed European countries and also based on the 18-month work in the frame of the National Energy Programme BIOEN (Programme of using energy from biomass and waste), and due to stimulative measures of the Croatian government, we could expect an increase of oilseed plants, especially rapeseed. Total demands of Croatian agricultural production on energy are 105.000 t of fuel without processing losses. In the case of using biodiesel as fuel, for the production of rapeseedoil of an equivalent amount one would need 120.000 hectares of arable land. The entire Croatian arable area is 1.632.750 hectares. In 1993, in Croatia were introduced new high-quality varieties of rapseed, the so called "00"-cultivars. With new "00"-varieties, yield was in average increased from 2.2 t/ha to 3.2 t/ha. The rough estimate of the potential demand on biodiesel in Croatia is at least 30000 t/y of rapeseedoil methylester.

Expected economic, social end ecological benefits on national level registered in other european countries should be achieved by establishing of domestic biodiesel production and by promoting the broad use of biodiesel. The first step will be on the test level, so that several regional projects for rapeseedoil production are in preparation, as well as an experimental plant for esterification. The use of biodiesel will be examined under real test run conditions. The Croatian government should establish fiscal and legal conditions which promote the production and use of rapeseedoil and biodiesel. Also a Croatian fuel quality standard for biodiesel should be established in accordance with European standards and directives.

1. Introduction

Biodiesel is a motor fuel obtained from rapeseed oil, as well as from other vegetable oils, through esterification with methanol, yielding fuel the properties of which are comparable with the diesel fuel obtained from mineral oil. It may also be used as blend with mineral diesel fuel. It is also used with modern catalyzed diesel engines, being produced also in the winter quality of down to -20^0C.

The first vehicle powered by vegetable oil was presented over a hundred years ago. Back in 1900, at the World Expo in Paris, Rudolf Diesel exhibited a motor driven by peanut oil. The first contemporary tests of the possibility of using vegetable oil for the powering of motor vehicles were launched in 1973, during the first oil crisis. It has shown right away that vegetable oils may be successfully used in diesel engines, but there were also certain difficulties. The main source of the problem – high oil viscosity – was soon detected and resolved on the part of the chemists, who adapted the oil through simple esterification. In the reaction between oil and alcohol, glycerol– a component of any natural fat - is being replaced by methanol.

Today, in Germany, oilseed plants for biodiesel are being cultivated on over 300,000 ha. In 1997, over 400,000 tons were produced, while biodiesel is being offerred at 1,271 gasoline stations. Taxi drivers use biodiesel in over 40,000 vehicles. The French oil corporation Elf is both producing and consuming over 1 million hectolitres of biodiesel each year. The production and use of biodiesel is no rarity even in transition countries (Czech Republic, Slovak Republic, Poland). In the Czech Republic, for instance, a project entitled "oleoprogramme" was launched back in 1991, being a project of using rapeseed oil for biodiesel production. The main purpose of the project is the use of excess arable land for industrial purposes. The expected results of the project are the achievement of 5% of biodiesel in all diesel engines with regard to 1991.

Italy, Hungary and Slovenia are speeding up the construction of new plants in order to make up for the lost time with regard to others. Maybe the greatest advantage of using biodiesel over the classical diesel fuel lies in reduced emission of the so called greenhouse gases and hazardous substances. The combustion and production of 1 kg of classical diesel fuel causes the emission of 4.01 kg of CO_{2equiv}, while the amount for the production of 1 kg of biodiesel is 0.916 kg of CO_{2equiv}, owing to CO_2 absorption from the air during the plant's growth.

The use of a 100% biodiesel (B 100) reduces NO_x emission by 13%, while, during the use of a 20% blend, total NO_x emission is reduced by 2.67%. Furtherly, the use of B100 considerably reduces particulate (32%) and carbon monoxide (35%) emission. If we look only at the vehicle exhaust emission, SO_x is completely eliminated. Hydrocarbons (HC) are lower by 37% with B100. Apart from that, production from rapeseed oil enables additional volumes of high quality cattle food, as well as glycerol – which is of interest for the chemical industry.

The task force consisting of experts from various institutions, faculties, and INA, has prepared for the Government of the Republic of Croatia a draft proposal of the project, realizing conditions for production initiation and encouraging biodiesel fuel market development.

2. Reasons for the Launching of the Project and its Goals

2.1 Expected Effects in Croatia

Successful implementation of the project would have multiple positive effects on the economy, agriculture and environmental protection in Croatia, as has been the experience of other European countries. As the most important expected effects of introducing biodiesel into Croatia's economy, we may point out the following:

- Making up for a part of the imported fossil fuels by renewable fuel, keeping foreign currency within the country, and increased supply safety.
- The effect of better managing fossil fuels; per each 100 energy units of the mineral energent invested into the biodiesel production chain, one ultimately obtains 320 energy units including vegetable oil, while 100 energy units in the process of mineral diesel fuel production ultimately generate 83 units.
- For Croatia, of importance is also the engagement of the formerly neglected arable land (400,000 ha).
- The introduction of a "third crop" (apart from wheat and corn), ensuring an additional and safer income for agricultural manufacturers in Croatia, enabling better machinery use, and increasing the agricultural production cost effectiveness.
- In macroeconomic (export) terms, the production of rapeseed oil is much more favourable than that of wheat (especially after the joining of the WTO), while there are also objective climatic and pedological advantages for the said production.

- Implementation of the CO_2 emission reduction programme adopted by the signing of the Kyoto Protocol (biodiesel is a "CO_2-neutral" fuel).
- Air pollution reduction due to less harmful emission at combustion in the engine, and hence positive impact on the population's quality of life and public health.
- Reducing the risk of water pollution through the use of a biodegradable energent.

With regard to mineral diesel fuel, biodiesel has, apart from the above social benefits, also shown some technical advantages in application:

- It does not pose threat to water during transportation, storage or use.
- It is not classified as hazardous substance during transportation, because it is not inflammable.
- Biodiesel improves lubrication in the engine, thus contributing to its durability.
- Biodiesel shows better combustion properties and calmer engine operation, while at the same time increasing the cetane number.
- Exhaust gases do not have a bad odour otherwise proper to diesel engines using mineral fuel.

The new material requires tests not only of technical nature, but also introduction into the effects on economy and population's life, so that R&D activities in developed countries concerning the entire biodiesel production line have been concentrated on the following:

- Expanding the scope of possible feeds at production input, apart from rapeseed and soya oil, so that product quality be improved and production costs reduced, since biodiesel production is more expensive than that of mineral diesel.
- Development of esterification production units showing high flexibility in the use of various feeds.
- Placing of biodiesel within those segments of the market where it would appear as the sole or at least a superior solution, so that higher selling price may be achieved (an example!).
- The development of the types and kinds of rapeseed oil cultivation improving energy efficiency and environmental tolerability of the entire production chain.
- Understanding the imporovement effects brought about by that production chain through the impact on the population's health and the preservation of workplaces in agriculture, in order to encourage the introduction of biodiesel into the economy.

- Improving engine design, so that even the non-esterified vegetable oil could be used for special purposes.

2.2 The Project Goals

The overall goal of the project is to initiate the production and encourage the development of a market for biodiesel fuel in the Republic of Croatia. The realization of this overall goal requires the following:

- making of a political decision on the justification of introducing biodiesel fuel,
- implementation of a pilot project showing the specific properties of a targeted cultivation and treatment of rapeseed oil and biodiesel fuel production in Croatia,
- the choice of a model of using biodiesel fuel in Croatia (a mixture of bio- and classical diesel in all vehicles; pure biodiesel for special vehicles, production and use in rural cooperatives,..),
- establishment of a Croatian biodiesel fuel standard,
- passing of the appropriate incentives for the targeted cultivation of oilseed plants,
- legal regulations for biofuel use in Croatia.

3. The Project's Implementation

3.1 Biodiesel Production and Market in Croatia

It is estimated that the Croatian market potentials amount to around 30,000 t/y of methyl ester (5% of addition into the mineral fuel), which would require – given the average rapeseed yield and its use in further processing – around 25,000 ha of land growing rapeseed.

According to the estimates of agricultural experts, thinking about energy self-production for agricultural needs in Croatia, one should have around 12% of the land under rapeseed (the Austrian model), which makes 110,000 ha and yields 125,000 t/y of methyl ester in the mature phase of the said product's market development.

In cases where rapeseed oil ester is used solely as an additive for improving the lubricity of low-sulphur diesel fuels (3% of additive), regardless of its wider consumption as motor fuel, one must ensure 20,000 t/y.

The so far experience has shown that regional approach to the production of raw rapeseed oil is more appropriate than the centralized one in order to

save transportation costs for the rapeseed and due to a close relationship with the cattle feed production resulting from the use of oil pellets.

Regional raw oil production envisaged by the project would yield around 15,000 t/y of oil each, and – in the test phase – around 1,000-2,000 t/y.

The production of rapeseed oil methyl ester and its blending with the mineral diesel into a market product constitutes a natural whole. For economic purposes, as well as in view of an even quality of the output product, it is more favourable that its capacity be as large as possible. For Croatia, this means that there could be only one esterification plant. In the test phase, that would be a 2,000-4,000 t/y of ester plant, followed by that of 30,000-50,000 t/y.

3.2 Immediate Tasks

In order to achieve the overall objective – being that of production initiation – as well as to encourage the development of a biodiesel fuel market in Croatia, the following should be done:

- make a political decision (Government, the ministries, the Parliament) on the justification of implementing biodiesel fuel production.
- Establish a consortium – an interest association for implementing the biodiesel project.
- Implement test regional projects in order to identify the peculiarities of a targeted rapeseed cultivation and processing, as well as biodiesel use.
- Construct a central plant for biodiesel fuel production with the capacity adapted to regional pilot projects (INA already has at its disposal some equipment that could be used for the purpose).
- Choose a technical model of biodiesel use in Croatia (a mixture of bio- and classical diesel in all vehicles; pure biodiesel for special vehicles, production and use in local communities, and so on).
- Establish a Croatian biodiesel fuel standard co-ordinated with that European.
- Passing of appropriate incentives for a targeted cultivation of oilseed plants for industrial use, according to European model, as well as a model of connecting interests in the production chain from the field to the gasoline station.
- Establishment of legal regulations relevant for the use of biofuel in Croatia, according to European model.

3.3 Structure of Operational Activities

The biodiesel production chain encompasses a series of problem areas and expert complexes, as well as rounded up task groups for which potential competent contractors may be identified that would take part in the consortium established for the realization of the said production in Croatia. They are first of all the Faculty of Agronomy, the "Hrvoje Požar" Energy Institute, and "INA" d.d.

The first task is to elaborate a feasibility study for the needs of the Government of the Republic of Croatia, for a strategic decision on the manner of introducing and encouraging the production and use of biodiesel fuel.

Apart from that, pilot/targeted production of rapeseed, processing into raw rapeseed oil, production of rapeseed oil ester, and testing of the blend of rapeseed oil ester blended with diesel fuel from Ina's refineries, all need to be prepared.

Co-ordinated work on the projects is also necessary, as well as a wholesome consideration and implementation of the tasks. Regional partners on the project shall be co-operating with the consortium.

The pilot project phase consists of the following task groups:

- Rapeseed production in the scope of regional projects.
- Raw rapeseed oil production in the scope of regional projects.
- Rapeseed oil ester production at the central plant.
- Production and distribution of commercial motor fuel within a controlled circle of consumers.
- Monitoring the use of the new motor fuel – vehicle (field) tests within regional projects, possible market niches.
- The pilot project phase results evaluation and proposals for a further realization.

4. The Project Implementation Participants

4.1 The Agricultural Sector

Rapeseed is an extremely important crop in crop sequence. Its particular value as a preliminary crop is shown through a high return of the nutrients to the ground, a high microorganism activity, a narrow C/N ratio of the harvest remains, and improving properties in the deeper layers, due to a deep growth of the expanded root. It constitutes a good forecrop for the

cereals, leguminous plants, forage and other crops. It is best if rapeseed is being cultivated on the same field each fourth to fifth year.

The creation and introduction into production of the new "00" rapeseed cultivars with improved oil and pellet quality has enabled a fast spread of this crop, particularly in Europe, where it has become the most important oilseed plant. For Croatia, it is of particular interest that the said crop could start production on the yet uncultivated areas, today constituting over 200,000 ha of arable agricultural land.

Climatic conditions in Croatia are very apt for the production of vegetable oils i.e. oilseed plant cultivation. According to the data of the State Office of Statistics, in 1998, the amount of planted arable land was 1056,649 ha, while 401,351 ha (27.5%) of arable land remained unplanted. In the harvest strusture, the highest share is that of cereals (65.8%). Industrial plants cover 112,240 ha (10.6%), while oilseed plants are represented with 6.8%. All the extension of our agricultural production may be seen from the review of the harvest structure on family-owned farms. On 82.1% of the farmland, 6.3% of industrial cultures has been planted, while the share of oilseed plants is only 3.3%. Rapeseed is particularly neglected, planted on family farms on only 803 ha. However, in macroeconomic terms, for Croatia, rapeseed production is more favourable than that of wheat (especially after the joining of WTO), with all the aforementioned objective climatic and pedological advantages for the said production.

5. The petroleum industry

INA d.d., as a dominant oil corporation in Croatia, is interested in co-operation in a part of its competences and interests. Should the project of introducing biodiesel fuel in Croatia be successfully implemented, INA would be interested into the production of rapeseed oil methyl ester, as well as for the production of commercial fuel as a blend of mineral diesel and vegetable ester, as well as for the distribution of the said fuel. The esterification production plant would – in the case of its implementation – be located in Zagreb.

Special INA's interest would be turned towards a possible use of rapeseed oil ester as a component for the improvement of diesel fuel performances (low-sulphur diesel lubricity improvement, cetane number improvement, etc.)

As for its appearance towards the Government of the Republic of Croatia and other partners in the consortium, INA would like to point out its advantages:

1. The central position of the Zagreb location with regard to regional raw oil producers, as well as with regard to the market.
2. Production of the rapeseed oil ester may be realized on Zagreb location with investments being half lower than elsewhere in Croatia, due to the available equipment and infrastructure.
3. The commercial biodiesel fuel market, including production for consumers with special requests, requires guaranteed quality and competence in the area of motor fuels.
4. Good linkage with the distributional network has already been ensured.
5. INA is using rapeseed oil and its ester as a modern biodegradable feed for various new products, as well as for the replacement of the existing products in the area of lubricants, which means that there is a certain development synergy present on Zagreb location, and hence also better economic effects of the said production.

5.1 The Energy Sector and State Administration

The project of introducing biodiesel fuel into Croatia is a part of the BIOEN National Energy Programme, set by the Government of the Republic of Croatia as one of the priority strategic tasks, in view of economic restructuring and energy sector development according to the needs of the Republic of Croatia. The production and use of biodiesel, due to its already described positive effects, is of particular significance for Croatia. In the draft of the Energy Sector Development Strategy for the Republic of Croatia elaborated for the Government of the Republic of Croatia by the "Hrvoje Požar" energy institute, the share of biofuel in traffic by 2030 is envisaged to be 4-8%.

Due to the project's character, it involves the participation of several ministries of the Government of the Republic of Croatia, as follows:

- The Ministry of Agriculture and Forestry is the bearer of the project, answering to the Government of the Republic of Croatia for its implementation, in compliance with its specific tasks and competences;
- The Ministry of Economy is particularly responsible for Croatia's strategic development, employment, faster development of underdeveloped regions, and co-operation co-ordination with development-oriented UN and EU agencies;

- The Ministry of Environmental Protection and Development Planning is responsible for the environmental protection system and rational energy use.

The project implementation shall make use of the expert assistance and financial means of the international funds or individual countries' funds intended for helping Central and Eastern European countries, while the project shall beyond Croatia's limits be represented by:

- The Ministry of Agriculture and Forestry in all governmental and interstate institutions,
- The Ministry of Environmental Protection and Development Planning in governmental and international institutions taking care of environmental protection,
- The Faculty of Agronomy and INA d.d. in all institutions engaged in the production, transportation and sale of rapeseed oil and biodiesel fuel,
- The "Hrvoje Požar" energy institute in contacts with institutes and agencies, as well as with international and interstate organizations taking care of energy efficiency and application of renewable energy sources.

6. Conclusion

The so far activities and agreements in Croatia have set general attitudes on the said energent, which may be summarized as follows:

- Croatia must formulate its development policy on the said energent in compliance with its specific properties, and associated with its policy towards its own agriculture, tourism, and environmental protection.
- All economic, political and social effects (cost-benefit) must be identified immediately in the biodiesel production chain, from agriculture to the gasoline stations, with a particular stress on market segmentation and the feed basis.
- The biodiesel project has been established based on the resolutions by the Ministry of Agriculture and Forestry, supported by The Ministry of Environmental Protection and Development Planning, The Ministry of Economy, and The Authorities of the City of Zagreb, and by INA d.d., and shall in the initial phase be implemented as a regional pilot project in consortial form.

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665.334.94 repičino ulje	rapeseed oil
665.334.94.062.6 metilni ester repičinog ulja	rapeseedoil methylester
621.436 dizelov motor	diesel engine
621.43.018 učinak motora	engine efficiency
621.43.019.9 emisija ispušnih plinova i čestica	exhaust gas and particulate emission

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