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PRIMJER NOVOGA PRISTUPA RAZVOJU GORIVA U GRUPACIJI MOL

Sažetak

Danas smo svjedoci iznimna ubrzanja djelatnosti istraživanja i razvoja u svim granama znanosti. To vrijedi za zaštitu okoliša, automobilsku industriju, a također i za naftnu industriju. Naš rad predstavlja jedan novi primjer kada se taj postupak usredotoči na usklađivanje nastojanja navedenih industrija u nekom određenom području. MOL Plc. je razvio proizvodnju motornog goriva jedinstvene kakvoće koje udovoljava svim zahtjevima zaštite okoliša, motornih vozila, a također i očekivanjima kupaca. Međutim, postizanje navedenih zahtjeva ovisi o nekoliko čimbenika, kao što su odgovarajuća konstrukcija motora, katalizator i formulacija motornoga goriva. Ovo potonje zadatak je naftne industrije koja mora postići ekonomičnu proizvodnju odgovarajućih goriva. Naša inovacija smjera ka razvijanju novog koncepta goriva koje će udovoljavati i najsloženijim zahtjevima. Osim konvencionalnih koraka razvoja goriva, uspostavili smo i proveli i nova laboratorijska i primjenska ispitivanja kako bismo poboljšali i optimizirali sastav goriva.

Uspjeli smo razviti 99-oktanski, nesumporni, visoko izoparafinski reformulirani benzin. Zahvaljujući svojem naročitom sastavu i sadržaju aditiva, MOL TEMPO 99 EVO osigurava izvrsnu vozivost i snagu, dugotrajnu stabilnost pohrane, čistije izgaranje, te nižu emisiju CO, CH i NOx. Štiti motor, te posjeduje odlična svojstva održavanja čistoće, čišćenja, zaštite od korozije i podmazivanja.

Uvod

Jednu od glavnih pokretačkih sila u razvijanju motornih goriva i vozila predstavlja očekivanje vlade i svekolike zajednice u vidu osiguravanja čistijeg i zdravijeg okoliša. Radi toga specifikacije goriva moraju udovoljiti očekivanjima kupaca

jednako kao i potrebama novih i starih konstrukcija vozila, ne dovodeći pritom u pitanje sigurnost opskrbe.

Istovremeno, postojeći standardi goriva (EN 228 i EN 590) teško da uključuju specifikacije koje bi udovoljile potrebama vozača za boljom vozivošću, jamčeći istovremeno dug životni vijek i zaštitu motora vozila i njihovih sustava dovoda goriva. Da bi osigurale sve to, udruge proizvođača vozila i motora Europe, Azije i Sjeverne Amerike (ACEA, JAMA, AAM, EMA) zajednički su objavile Svjetsku povelju o gorivima (izvorno: World Wide Fuel Charter, WWFC). Prvo je izdanje objavljeno 1998. kako bi omogućilo razumijevanje zahtjeva motora vozila za gorivom te uskladilo kakvoću goriva i potrebe vozila diljem svijeta [1].

Na navedenim kontinentima specifikacije emisija vozila, koje uz štetne tvari obuhvaćaju i zahtjev smanjenja emisije ugljičnog dioksida, a samim time i potrošnje, postaju sve strože. Radi navedenih ciljeva, proizvođači automobila kažu kako uz poboljšanje brojnih svojstava goriva jednu od najvažnijih promjena predstavlja smanjenje sadržaja sumpora u njemu. Time će se omogućiti korištenje brojnih sustava čišćenja ispušnih plinova iznimno osjetljivih na sumpor (npr. hvatača NO_x) i novih konstrukcija vozila (npr. izravno ubrizgavanje benzina, tzv. GDFI – gasoline direct fuel injection - kod benzinskih motora), uz čiju se uporabu emisije štetnih tvari i ugljičnog dioksida koji izazivaju učinak staklenika mogu znatno smanjiti [2-5].

Motorna goriva kategorije 4 Povelje WWFC su nesumporna goriva namijenjena najnovijim konstrukcijama motora, uključujući brojne specifikacije kakvoće, koje nisu utvrđene niti u postojećim niti u planiranim europskim ili američkim standardima goriva. Od posebne su važnosti za dug životni vijek vozila ispitivanja motora koja se nalaze na kraju kategorije. Naglašavamo pritom kako se svojim budućim normama za goriva i Europa i Amerika približavaju tim specifikacijama. Tablica 1 sažima europska svojstva, kao i svojstva Povelje, koja se odnose na premium benzine [1, 5-7].

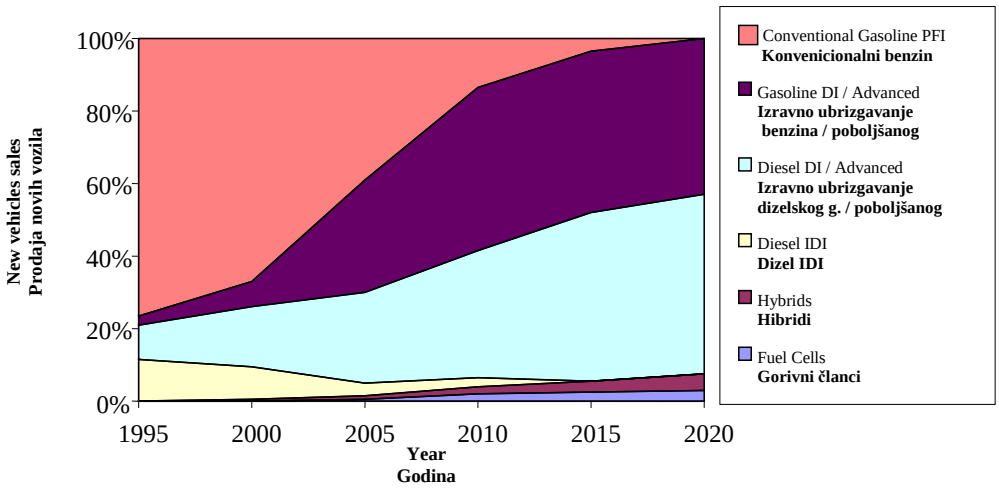
Prema tvorcima Povelje primjenom će se ovih preporuka:

- smanjiti utjecaj motornih vozila na okoliš putem njihove smanjene emisije;
- dosljedno udovoljiti očekivanjima kupaca glede performanci; te
- smanjiti na minimum problemi vezani uz opremu vozila, uz pomoć optimiziranih goriva za svaku kategoriju nadzora emisije, čime će se smanjiti troškovi kupaca (kod same kupnje, kao i oni operativni) a povećati razina njihova zadovoljstva [1].

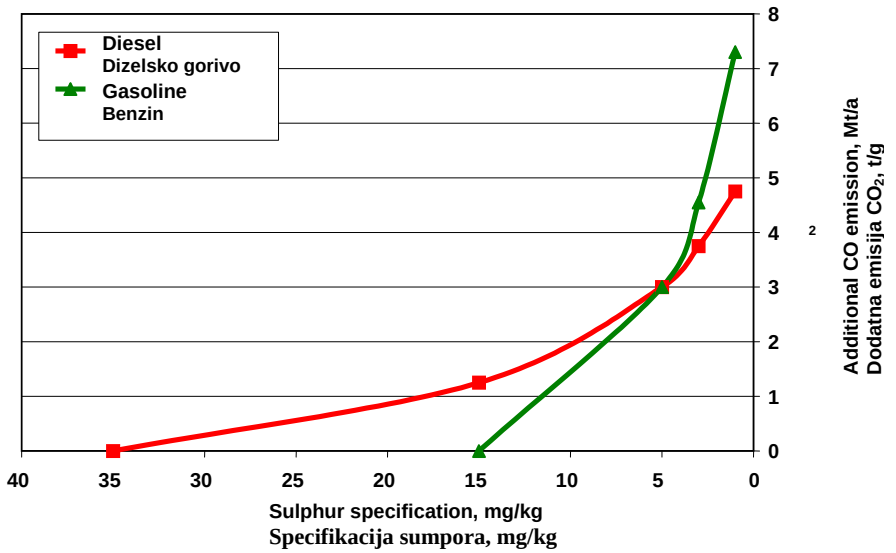
Djelatnici naftne industrije ne slažu se u potpunosti sa sve strožim ograničenjima kakvoće budući da to od njih zahtijeva značajne napore te su brojne studije pokazale kako nove konstrukcije motora u brojnim slučajevima ne zadovoljavaju postavljena očekivanja. Smanjenje sadržaja sumpora pridonosi smanjenju emisija sumpornog dioksida (SO_2), ugljikovodika (HC) i ugljikovog monoksida (CO). Svaka daljnja izmjena u sastavu (primjerice, niža razina olefina i aromata), međutim, ne bi donijela nikakvo značajno poboljšanje. Na širenje benzinskih motora s izravnim ubrizgavanjem (slika 1) što ga zagovaraju brojni proizvođači automobila još valja pričekati, dok je “dizelska revolucija” već započela, barem u Europi. Rezultat općih nastojanja u pravcu smanjenja sadržaja sumpora u gorivima, kao i ograničenja

kakvoće koja zahtijevaju daljnju hidroobradbu izazivaju povećanu emisiju CO_2 iz rafinerija (slika 2) [5,8-10].

Slika 1: Predviđena prodaja novih vozila (Izvor: EUCAR)
Figure 1: Prognostic new vehicle sales (Source: EUCAR)



Slika 2: Utjecaj sumpora na emisiju CO_2 iz rafinerija (Izvor: CONCAWE)
Figure 2: Sulphur specification effect for CO_2 emission of refin. (Source:CONCAWE)



Tablica 1: Specifikacije/preporuke motornih benzina – premium kategorija

		EN 228:1999[a]	EN 228:2004[a]	WWFC Cat. 4
Svojstva benzina	Metoda			
Istraživački oktanski broj (IOB)	EN 25164	min. 98	min. 98	min. 98
Motorni oktanski broj (MOB)	EN 25163	min. 88	min. 88	min. 88
Sadržaj olova, mg/l	EN 237	maks. 5	maks. 5	trag
Sadržaj fosfora, mg/l	ASTM D 3231	-	-	trag
Sadržaj mangana, g/l	ASTM D 3831	-	-	trag
Sadržaj silikona, mg/kg	ICP-AES	-	-	trag
Gustoća (pri 15°C), kg/m^3	EN ISO 3675	720-775	720-775	715-770
Sadržaj sumpora, mg/kg	EN ISO 14596	maks. 150	maks. 10[b]	maks. 10
Oksidacijska stabilnost, minuta	EN ISO 7536	min. 360	min. 360	min. 480
Smola nakon ekstrakcije, mg/100 ml	EN ISO 6246	maks. 5	maks. 5	maks. 5
Smola prije ekstrakcije, mg/100 ml	EN ISO 6246	-	-	maks. 30
Korozivnost (Cu, 3h, 50˚C)	EN ISO 2160	min. 1b	min. 1b	min. 1b
Izgled		bistar, proziran	bistar, proziran	bistar, proziran
Sadržaj olefina, % v/v	ASTM D 1319	maks. 18.0	maks. 18.0	maks. 10.0
Sadržaj aromata, % v/v	ASTM D 1319	maks. 42.0	maks. 35.0	maks. 35.0
Sadržaj benzena, % v/v	EN 12177	maks. 1.0	maks. 1.0	maks. 1.0
Oksigenati, % v/v	EN 1601			
MTBE		maks. 15	maks. 15	-
Ostali spojevi kisika		maks. 3-15[c]	maks. 3-15[c]	-
Količina kisika, %	EN 1601	maks. 2.7	maks. 2.7	maks. 2.7
Tlak para, kPa (ljeto, Mađarska)	EN 13016-1	45-60	45-60	45-60
Destilacija	EN ISO 3405			
T10, °C		-	-	maks. 65
T50, °C		-	-	77-100
T90, °C		-	-	130-175
E70, % v/v		20-48	20-48	20-45
E100, % v/v		46-71	46-71	50-65
E150, % v/v		min. 75	min. 75	-
E180, % v/v		-	-	min. 90
Kraj, °C		maks. 210	maks. 210	maks. 195
Ostatak, % v/v		maks. 2	maks. 2	-
Indeks vozivosti[d] ljeto		-	-	maks. 570
Čistoća brizgaljke, % gubitka protoka	ASTM D 5598	-	-	maks. 5
Zaljepljenost usisnog ventila, zadovoljava/nezadovoljava	CEC F-16-T96	-	-	zadovoljava
Čistoća usisnog ventila[e], mg/ventil	ASTM D 6201	-	-	50
Talozi komore izgaranja[e], % temeljnog goriva	ASTM D 6201	-	-	140

[a] *Bezolovni benzin Super plus*
[b] *Specifikacija djelomice iz 2005. a obvezatna od 2009.*
[c] *Ovisno o vrsti spoja s kisikom, vidi normu*
[d] *DI = (1,5×T10) + (3×T50) + (T90) + (11×sadržaj kisika %)*
[e] *Postoje i druge metode*

Međutim, multinacionalne naftne tvrtke sa solidnim kapitalom i dalje lansiraju jedan zaštićeni proizvod sa smanjenim sadržajem sumpora i aromata za drugim, kako bi povećale udio na tržištu i okoristile se sve češćim poreznim olakšicama. Konkurencija na tržištu motornih benzina je jaka, dok su motorni benzini bez sumpora (<10 mg/kg) ili pak s pozitivnim svojstvima koja nadmašuju standarde uvedeni također i u Europu i Mađarsku, uz objašnjenje ekološkim razlozima i potrebama novih konstrukcija motora u nekim slučajevima, uz također i posebno "odabrane" sastave i aditive u cilju postizanja više snage.

S obzirom na svoju vodeću tržišnu ulogu i ekološku svijest, MOL je pokrenuo razvijanje motornog benzina premium razine, koji sada svojim poboljšanim sastavom i aditivima, kao i vjerodostojnim tehničkim parametrima, može stati uz bok svakom srodnom proizvodu. Udovoljava zahtjevima kupaca s obzirom na snagu i ekologiju, jednako kao i onima ne samo postojeće populacije vozila, već i budućih konstrukcija, te specifikacijama EU 2005. i 2009., nudeći iskustvo za cjelovitu proizvodnju i plasman nesumpornih goriva.

Eksperimentalni dio

Za vrijeme djelatnosti razvijanja uvedena su i nova ispitivanja, uz uobičajene analitičke i primjenske metode za motorne benzine. Važan korak u postupku razvoja bilo je razvijanje metoda prikladnih za ispitivanje očekivane snage, za što smo kanili upotrijebiti ne samo ispitivanje snage na dinamometru, već također i mjerenje sposobnosti ubrzanja vozila, maksimalne brzine i startnosti. Razvijena je mjerodavna metoda ispitivanja kako bi se izmjerilo ubrzanje vozila unutar različitih raspona brzine, tako da jedini ljudski čimbenik predstavlja pokret vozača kojim postiže najveću snagu.

Slika 3: Ispitivanje vozila na dinamometru
Figure 3: Vehicle testing on chassis dynamometer

Uvjeti
Tlak, temperatura i vlažnost zraka

Praćenje
Temperature goriva, vanjske dobavne crpke, cestovnog opterećenja, vjetra

Očitavanje
Vremena ubrzanja, maksimalne brzine, snage, brzine, brzine vrtnje, potrošnje goriva, temperature ulja, parametara stanja vozila

Slična je metoda razvijena kako bi se utvrdila maksimalna brzina postignuta pod različitim opterećenjem (slika 3), kao i da bi se odredila sposobnost goriva za hladni start. Učinak sastava goriva na vozivost provjeren je na dinamometru tipa SCHENCK E 364/230. Parametri vozila praćeni su uz pomoć GUTMANN MEGA MACS 55 i BOSCH FSA 560 opreme za dijagnostiku motora. Za mjerenja kilometraže korišten je FLOWTRONIC 206-208 mjerač potrošnje goriva. Nekoliko je tipova vozila korišteno za ispitivanja ubrzanja i druga ispitivanja: Opel Astra 1.4i ECOTEC-1.6i, Suzuki Swift 1.0-1.3, Mitsubishi Carisma 1.8 GDI, itd.

Svojstva benzina utvrđena su u skladu s odgovarajućim metodama prikazanima u tablici 1 utvrđenima normom EN 228 i kategorijom 4 Povelje (WWFC). Od novih smo ispitivanja uveli utvrđivanje svojstva trošenja materijala (modificirani ISO 12156) i svojstva sprječavanja korozije (ASTM D 665A) pri uporabi motornih benzina.

Rezultati i rasprava

Za vrijeme postupka razvijanja ispitnih metoda pojačano smo proučavali literaturu vezanu uz premium benzine i uspostavili redovnu funkciju za potrebe usporedne raščlambe s kakvoćom proizvoda domaće konkurencije. Kasnije smo to proširili na ispitivanje uzoraka sa zapadnoeuropskih crpki, što je sve skupa potvrdilo naše pretpostavke. Kao što je detaljno prikazano u tablici 2, smola prije ekstrakcije («neisprana smola») zaštićenih motornih benzina se razlikuje, te se može pronaći sve od tragova do značajnih predoziranja aditiva. Uz iznimku dvaju uzoraka, smola nakon ekstrakcije («isprana smola») odgovara specifikaciji.

Sadržaj je sumpora uglavnom bio ispod 50 mg/kg, ali je i kod domaćih i kod stranih uzoraka pronađen također i uzorak bez sumpora. Uz jednu iznimku, sadržaj je olefina bio ispod 10 % v/v, dok je, što se tiče sadržaja aromata, pronađen i uzorak sa tek standardnim ograničenjem. Pojavu novog svojstva, malog trošenja dijelova motora, niske vrijednosti traga trošenja pri ispitivanju HFRR, pri čemu valja istaći, da je u jednom stranom uzorku promjer traga trošenja bio 317 μm umjesto očitanja od 7 do 900. To upućuje da se tvrtka koja ga plasira koristi aditivima protiv trošenja kako bi zaštitila dijelove vozila i poboljšala podmazivanje motora.

Kako bismo našim kupcima podastrli vjerodostojna svojstva, pregledali smo međunarodne norme za goriva, razvijene uglavnom kako bi se naglasila primjenska svojstva goriva, a ne samo njihova normirana svojstva. Stoga smo proučili sustav kriterija francuskog UTAC-a, engleskog AA SEAL of Approvala, još jednog francuskog DHYCA, EPA u SAD, njemačkog Top Tiera, zajedno s ispitivanjem mogućeg udovoljavanja kategorijama benzina Povelje (WWFC). Iako navedeni sustavi nisu još uopće postali službenom specifikacijom, a Povelja (WWFC) to još nije, navedene su se međunarodne specifikacije pokazale vrlo korisnima za dublje promišljanje problematike goriva. Tako smo se počeli koristiti prednostima novih termina koji nisu odveć poznati u domaćoj tehnologiji, kao što su vozivost, mazivost benzina, itd.

Tablica 2: Glavne karakteristike domaćih (H) i EU (K) uzoraka benzina Super i Super plus-zima 2001

Oznaka uzorka	H-1	H-2	H-3	H-5	H-6	H-7	K-1	K-2	K-3
IOB	99.5	95.8	95.7	96.6	95.8	95.8	99.7	95.4	99.2
MOB	89.1	84.7	85.1	85.2	85.0	85.4	89.6	85.4	88.9
Gustoća, pri 15° C kg/m³	760.4	750.4	756.1	748.6	748.5	747.6	752.8	736.0	749.5
Smola prije ekstrakcije, mg/100ml	84.0	63.2	4.2	20.7	5.7	19.4	82.1	37.6	25.2
Smola nakon ekstrakcije, mg/100ml	5.4	6.0	0.8	0.5	0.4	0.6	2.0	2.0	1.2
Sumpor, mg/kg	1.3	34.1	5.6	28.1	37.4	33.4	3.1	21.3	1.3
Olefini, % v/v	1.43	9.51	6.44	9.86	5.45	9.69	2.72	10.78	3.09
Aromati, % v/v	42.41	33.78	36.6	33.56	36.12	33.72	41.68	29.57	40.71
MTBE, % v/v	10.31	1.45	2.68	1.47	3.38	1.42	8.02	2.41	7.83
Benzen, % v/v	0.53	0.50	0.53	0.50	0.62	0.48	0.63	0.79	0.60
Kisik, %	1.92	0.27	0.47	0.27	0.61	0.26	1.49	0.45	1.37
Tlak para (suha metoda), kPa	66.9	65.2	58.7	63.7	73.5	66.0	71.7	84.5	78.3
E70, %	37	29	30	27	31	29	41	34	39
E100, %	58	47	48	47	48	50	58	53	56
E150, %	91	81	77	81	78	84	89	82	87
E180, %	99	94	93	94	93	95	97	93	97
Ostatak destilacije, % v/v	0.5	0.9	1.1	0.5	0.9	0.8	0.4	0.4	0.4
Mazivost benzina HFRR, µm	-						837	317	816

Niti jedno od goriva koje se dosad nalazilo na mađarskome tržištu nije odgovaralo najstrožoj kakvoći benzina kategorije 4 Povelje WWFC. (iako sadržaj MOL-ovih benzina grupacije Tempo udovoljava primjenskim kriterijima kategorije 4, to nije slučaj s obzirom na neke druge uvjete, poput primjerice sadržaja sumpora).

U suštini iskaz proizvođača automobila s obzirom na taj niz odlika tvori normu, apsolutno vjerodostojan sustav kriterija kojima svakako želimo udovoljiti putem naše formule za motorni benzin. Kao okončanje prve faze rada, uspjeli smo uspostaviti sustav tehničkih odlika na temelju kojega je uprava MOL-a ocijenila opravdanim dalje istraživati razvijenu koncepciju benzina.

Tehnička provedba

Iako stoji kako proizvođači automobila uglavnom razvijaju svoje benzinske motore za korištenje benzina s IOB 95, u nekim se slučajevima ipak zahtijeva i viši oktanski broj:

- postoje vozila čija konstrukcija zahtijeva viši oktanski broj,
- talozi u komori izgaranja povećavaju traženi oktanski broj motora,
- vozila opremljena oktanskim senzorom naročito su pogodna za korištenje viška oktana, nudeći tako mogućnost dinamičnije vožnje.

Međutim, previsoki oktanski broj može imati negativan učinak budući da je brzina izgaranja nekih visokooktanskih komponenti slabija od prosjeka, što dovodi do nižeg tlaka, a samim time i slabije snage te ubrzanja vozila. Ispitavši brojne recepte i dizajne kako bismo to razjasnili, odlučili smo se za istraživački oktanski broj 99.

Vodili smo česte i intenzivne tehničke rasprave s međunarodnim proizvođačima aditiva glede kupnje i ispitivanja novih aditiva za naše potrebe. Budući da smo tražili novi aditiv, nismo mogli izbjeći pitanje razvijanja ispitne metode. Tako je stvorena mogućnost mjerenja svojstva trošenja, vrijednost HFRR za benzine. Dobro poznata kod dizelskih goriva, ova je ispitna metoda (na preporuku proizvođača vozila) uvedena nakon pojave visoko hidroobrađenih plinskih ulja. Iako su kod benzinskih motora dijelovi izloženi manjem opterećenju, sustav ubrizgavanja od 100 do 150 bara novih GDFI motora i korištenje motornih benzina bez sumpora može zahtijevati korištenje aditiva mazivosti. Kao alternativa, smanjenje trenja u cilindru može povećati snagu i osigurati uštedu goriva.

Nadalje, motori s izravnim ubrizgavanjem osjetljiviji su na taloge (aditiv plus komponente goriva). Za razliku od motora s tradicionalnim načinom ubrizgavanja goriva, talozi se mogu pojaviti u većoj mjeri, pa čak i na novim mjestima i dijelovima [11-14]:

- ulazni dio: povišena recirkulacija ispušnih plinova (EGR) i stupnjevi čišćenja spremnika povećavaju stvaranje taloga,
- ventil za deaktivaciju: putem EGR-a i pozitivne ventilacije kartera (PCV) povećava se stvaranje taloga, te se mogu promijeniti uvjeti protoka, što dovodi do snažna pogoršanja stvaranja smjese,
- ulazni ventil: učinak hlađenja i ispiranja benzina tipičan za tradicionalne motore ovdje nije prisutan, pa se tvari iz EGR-a i PCV-a lako talože,
- izravni sustav ubrizgavanja: okoliš se odlikuje višom temperaturom budući da se brizgaljka nalazi na vrućem cilindru a ne u hlađenoj usisnoj cijevi,
- komora izgaranja: benzin dolazi u izravan doticaj s vrućim cilindrom i klipom,
- EGR ventil: visok stupanj protoka koji sadrži više taložnih materijala.

Ispitavši brojne aditive i koncentracije, razvili smo smjesu aditiva MOL Tempo 99 EVO, u suradnji s jednim od vodećih svjetskih proizvođača aditiva, namijenjenu vozilima jednako s izravnim kao i s neizravnim ubrizgavanjem. Rezultat su odlični učinci čišćenja i održavanja čistoće, uz smanjenje taloga u komori izgaranja.

Tablica 3: Neki učinci aditiva MOL TEMPO 99 EVO

Vrsta goriva	Vrsta ispitivanja	Metoda	Vrijednost
Osnovni benzin	Korozija	ASTM D 665A modific.	Hrđa
EVO	Korozija	ASTM D 665A modific.	Nema hrđe
Osnovni benzin	Mazivost, HFRR	ISO 12156-1 modific.	789 µm
EVO	Mazivost, HFRR	ISO 12156-1 modific.	418 µm
Temeljni benzin	Talog na usisnom ventilu	CEC F-04A-87	68.1 mg/ventilu
EVO	Talog na usisnom ventilu	CEC F-04A-87	5.7 mg/ventilu

Posljedice toga su odlična antikorozijska svojstva za bakrene i željezne dijelove, što uvelike ide u prilog također i odvajanju vode kao nečistoće. Koncentracija aditiva podešena je tako da udovoljava sadržaju od 30 mg/100 cm^3 smola nakon ekstrakcije utvrđenu za kategoriju 4 Povelje. Neki od učinaka ovog aditiva prikazani su u tablici 3.

Tijekom djelatnosti istraživanja i razvoja postalo je očigledno kako Dunavska rafinerija ne može proizvesti takvo gorivo bez sumpora pod uvjetima koji su tada vladali, te je bilo potrebno unaprjeđenje procesa. Ono je već djelomice bilo u tijeku u sklopu projekta poboljšanja učinkovitosti, tako da bi uvjeti za proizvodnu nesumpornog goriva u Dunavskoj rafineriji mogli biti osigurani vrlo brzo.

U međuvremenu smo na ispitivanjima ubrzanja utvrdili također i kako bi formula zahtijevala korištenje nove komponente za namješavanje benzina. Smatrali smo kako smo pronašli upravo to u komponenti bogatoj C_6 parafinima te napose u vrijednim cikloparafinima postrojenja za izomerizaciju lakog primarnog benzina. Putem razgovora s rukovodstvom postrojenja, kao i na temelju naših redovitih analiza, utvrdili smo kako bi savršena komponenta za namješavanje benzina sastava koji upravo odgovara našim potrebama mogla biti proizvedena nakon potrebnog unaprjeđenja postrojenja. Nastavili smo sustavno posjećivati ključna procesna postrojenja, što smo ih mogli smatrati proizvodnim postrojenjima komponente za namješavanje, te s osobljem razmatrati parametre što su ih oni smatrali bitnima jedan po jedan, utvrđujući istovremeno realne granice ostvarive proizvodnje.

Tablica 4: Startnost s različitim benzinima po hladnom vremenu na Suzuki Swift 1.0

Vrsta goriva	Temperatura ulja, °C	Temperatura zraka, °C	Vrijeme startanja, sekunde
MOL TEMPO 95*	0	0	2.74
MOL TEMPO 99 EVO*	0	0	1.70

*isti DVPE

Tablica 5. Maksimalna brzina vozila Opel Astra 1.4i ECOTEC s različitim benzinima na dinamometru (putno opterećenje, umjereno povećanje)

Vrsta goriva	Prosječna maksimalna brzina, km/h
MOL TEMPO 91	130.0
MOL TEMPO 95	131.6
MOL TEMPO 98	134.3
MOL TEMPO 99 EVO	135.6
Konkurencija A – gradacija premium	135.5

Nakon brojnih istraživanja i ispitivanja brojnih recepata putem već spomenutih testova ubrzanja, stavljajući veliki naglasak na prisutnost odgovarajućih lakih

komponenti, njihov visok oktanski broj, ravnomjeran raspored oktana, osiguravanje komponenti s visokim stupnjem izgaranja i potpunim izgaranjem, te uklonivši komponente s visokim vrelištem koje uzrokuju štetnu emisiju i povišen talog, napokon je razvijen jedinstveni recept. Zahvaljujući tome, EVO posjeduje odlične destilacijske odlike (umjeren DVPE, dobar E70 i E100, nizak FBP, itd.) i stabilnost skladištenja (nizak sadržaj olefina). Sažetak njegove dobre startnosti i rezultata ispitivanja maksimalne brzine nalazi se u tablicama 4 i 5.

Prilikom razvijanja velik je naglasak stavljen na što je moguće šire udovoljavanje ekološkim zahtjevima. Tako smo uspjeli razviti proizvod koji premašuje specifikacije trenutačno primjenjive mađarske norme MSZ EN 228, udovoljava specifikacijama što će biti uvedene u EU u razdoblju 2005.-2009., te odgovara preporukama Povelje za kategoriju 4.

Iznimna ekološka svojstva proizvoda MOL Tempo 99 EVO su slijedeća:

- Sadržaj sumpora ispod 10 mg/kg, što omogućava uvođenje najnovijih konstrukcija vozila i njihovih katalizatora s naročitim potrebama (Euro 3 i 4 emisijske specifikacije – vidi tablicu 6). Smanjenje emisija ne samo štetnih tvari (HC, CO, NOx) već – preko niže potrošnje tih konstrukcija – također i ugljičnog dioksida, koji izaziva učinak staklenika.
- Sadržaj aromata ispod 35 % v/v a benzena ispod 0.4 % v/v – čime se značajno smanjuju emisije benzena i ostalih aromatskih ugljikovodika štetnih za zdravlje ljudi.
- Sadržaj olefina ispod 5 % v/v (trećina prosjeka tržišta) – značajno smanjujući emisiju isparivih organskih spojeva, pri čemu olefini uvelike pridonose zagađenju zraka velikih gradova, kao i stvaranju ozona i smoga blizu površine tla.
- Sadržaj parafina od min. 48 % v/v – povećali smo omjer najmanje štetnih, potpuno izgarajućih komponenti za namješavanje visokog oktanskog broja.
- Sadržaj kisika od min. 2 % - čime se poboljšava ukupno izgaranje i smanjuju emisije neizgorenih ugljikovodika i ugljičnog monoksida.

Tablica 6: EURO 3 i 4 specifikacije emisija za benzinske automobile (EU Direktiva 98/69/EC)

	Emisija, g/km		
	NOx	CH	CO
Euro 3-2000	0.15	0.20	2.30
Smanjenje (1996.), %	40	40	30
Euro 4-2005	0.08	0.10	1.00
Smanjenje (1996.), %	68	70	70

Uz korištenje proizvoda MOL Tempo 99 EVO, emisije se ugljičnog monoksida i ugljikovodika mogu smanjiti za 35-12 % odnosno 8-1 %, u usporedbi s tradicijskim benzinskim gradacijama IOB-a 95. Količina ispuštenih dušičnih oksida može se nadalje smanjiti na razinu utvrđenu specifikacijama Euro 4 uz korištenje DE-NOx katalizatora, koji zahtijevaju nove motorne benzine bez sumpora.

Evo kako je razvijen MOL TEMPO 99 EVO, novi član obitelji TEMPO (slika 4).

Slika 4: Podrijetlo goriva MOL TEMPO 99 EVO
Figure 4: Origin of MOL TEMPO 99 EVO

MOL Tempo ≡ zadržava dobra svojstva svih MOL-ovih motornih benzina, član obitelji.

99 ≡ minimalni IOB 99

EVO ≡ (evolucija) razvoj, koji predstavlja odgovor na potražnju za unapređenjem goriva, razvoj konstrukcije vozila, te izazov ekološke svijesti.

Zaključak

Uspjeli smo razviti 99-oktanski, nesumporni, visoko izoparafinski reformulirani benzin. Na temelju svoga naročita sastava, optimalne raspodjele oktana i sadržaja aditiva, MOL Tempo 99 EVO osigurava izvrsnu vozivost i snagu, čistije izgaranje, te nižu emisiju CO, CH i NOx. Štiti motor odličnim učincima održavanja čistoće, čišćenja, zaštite od korozije i podmazivanja. Prikladan je također i za motore PFI i GDFI. Mađarske nagrade za inovaciju i kakvoću 2001. i 2002. zajedno s kupcima potvrdile su nov pristup i ispunjenje složenih zahtjeva. MOL Tempo 99 EVO predstavlja idući korak u evoluciji goriva, jedinstvenu i vjerodostojnu vrijednost na europskom tržištu goriva.

A NEW APPROACH TO FUEL DEVELOPMENT AT MOL GROUP – AN EXAMPLE

Abstract

Nowadays we are witnessing an extraordinary acceleration of research and development activity in all branches of science. This is the situation in environmental protection, automotive industry and oil industry, too. Our paper introduces a new example when this process is focused on harmonisation of attempts of these industries in a specific field. MOL Plc. has designed the manufacture of a unique quality motor fuel that satisfies all needs of environmental protection, motor vehicles

and customers' expectation, too. However, the attainment of these requirements depends on several factors such as proper motor construction, after-treatment catalyst and the formulation of the motor fuel, too. The latter is the task of the oil industry producing the appropriate fuels economically. In our innovation we aimed at developing a new fuel concept meeting the most complex requirements. Beside the conventional steps of fuel development we established and applied new laboratory and application tests to improve and optimise fuel composition.

We succeeded in developing a 99 octane, sulphur-free, high isoparaffin reformulated gasoline. Based on its special composition and additive content MOL TEMPO 99 EVO provides excellent driveability and power, long storage stability, cleaner burning, lower CO, CH, NOx emissions. It protects engines with excellent keep clean, clean up, anticorrosion and lubricating effects.

Introduction

One of the major driving forces in the development of motor fuels and vehicles is the expectation by both the government and the community to ensure a cleaner and healthier environment. Therefore the fuel specifications must satisfy the expectations by customers as well as the needs of both new and old engine designs in a way that the safety of supply is not endangered.

At the same time the current fuel standards (EN 228 and EN 590) hardly include specifications, which would satisfy the needs of motorists for a better driveability, and also guarantee the long service life and no harm features of the vehicle engines and their fuel supply systems. In order to provide all that the associations uniting the car and motor manufacturers in Europe, Asia and North America (ACEA, JAMA, AAM, EMA) have called into life their joint publication, World Wide Fuel Charter (WWFC). The first edition was published in 1998 in order to both allow understanding the fuel requirements of vehicle engines, and harmonise the fuel quality and the needs of vehicle all over the world [1].

In the continents mentioned above the vehicle emission specifications, which in addition to the harmful substances include the requirement of reducing carbon-dioxide emission and hence consumption are getting ever more severe. Due to these objectives automobile manufacturers say that in addition to improving numerous fuel properties one of the most important changes is a reduction in their sulphur content. This will allow the use of many extremely sulphur-sensitive exhaust gas after-treating devices (e.g. NO_x traps) and new engine designs (e.g. gasoline direct fuel injection - GDFI - spark ignition engines), using which the emissions of harmful substances and carbon dioxide causing the greenhouse effect can be reduced significantly [2-5].

The WWFC Category 4 motor fuels are the sulphur-free fuels for the most recent engine designs, including many quality specifications, which are not specified either in the current or planned EU, or US fuel standards. For the long vehicle service life the motor tests found at the end of the category are especially important. It is noted here that both EU and US are approaching this specifications with their future fuel standards. Table 1 summarises the EU and WWFC properties relating to premium gasolines [1, 5-7].

According to the creators of WWFC the implementation of the recommendations will:

- Reduce the impact of motor vehicles on environment through reduced vehicle fleet emissions;
- Consistently satisfy customer performance expectations; and
- Minimise vehicle equipment complexities with optimised fuels for each emission control category, which will reduce customer costs (purchase and operation) and increase satisfaction [1].

Players in the oil industry not fully agree to the ever more stringent quality constraints since this requires significant efforts from them, and many studies have pointed out that the new motor designs have in many cases not met the hopes set on them. Reduction in sulphur content contributes to the reduction in sulphur-dioxide, hydrocarbon and CO emissions, too. Any further changes in composition (such as lower olefins and aromatics), however, would not result in any significant benefit. The spread of direct injection gasoline engines (Figure 1) favoured by many automobile manufacturers is still to be waited for, and a “Diesel revolution” has started in Europe at least. A disadvantageous property of both the reduction in sulphur content, and the quality constraints resulting in additional hydrotreating, is the increased CO_2 emissions from refineries (Figure 2) [5,8-10].

However, the multinational oil companies of a solid capital keep launching branded products with reduced sulphur and aromatics contents after the other in order to increase their market share and to make use of the tax allowances more and more common. The competition in the motor gasoline market is close and motor gasolines (free of sulphur (<10 mg/kg) or with beneficial properties in excess of the standards, have also been introduced in Europe and Hungary, the marketing of which has been explained by environmental reasons and the needs of new engine designs in some cases, and by special “selected” compositions and additives aiming at a higher power in others.

Assuming its market leader role and environment awareness MOL launched the development of a motor gasoline with a premium level, which now can be a competitor to any other products based on both its advanced composition and additives, and authentic technical parameters. It responds to the power and environmental expectation by customers, meets the requirements of not only the current vehicle pool but also the future constructions, and satisfies the EU 2005 and 2009 specifications, offering experience for the full scale production and logistical marketing of the sulphur-free fuels.

Table 1: Motor gasoline specifications/recommendations-premium category

		EN 228:1999[a]	EN 228:2004[a]	WWFC Cat. 4
Gasoline characteristic	Method			
Research Octane Number (RON)	EN 25164	min. 98	min. 98	min. 98
Motor Octane Number (MON)	EN 25163	min. 88	min. 88	min. 88
Lead content, mg/l	EN 237	max. 5	max. 5	Non-detectable
Phosphorus content, mg/l	ASTM D 3231	-	-	Non-detectable
Manganese content, g/l	ASTM D 3831	-	-	Non-detectable
Silicon content, mg/kg	ICP-AES	-	-	Non-detectable
Density (at 15°C), kg/m^3	EN ISO 3675	720-775	720-775	715-770
Sulphur content, mg/kg	EN ISO 14596	max. 150	max. 10[b]	max. 10
Oxidation stability, minutes	EN ISO 7536	min. 360	min. 360	min. 480
Washed gums, mg/100 cm^3	EN ISO 6246	max. 5	max. 5	max. 5
Unwashed gums, mg/100 cm^3	EN ISO 6246	-	-	max. 30
Copper corrosion	EN ISO 2160	min. 1b	min. 1b	min. 1b
Appearance		Clear, bright	Clear, bright	Clear, bright
Olefins content, % v/v	ASTM D 1319	max. 18.0	max. 18.0	max. 10.0
Aromatics content, % v/v	ASTM D 1319	max. 42.0	max. 35.0	max. 35.0
Benzene content, % v/v	EN 12177	max. 1.0	max. 1.0	max. 1.0
Oxygenates, % v/v	EN 1601			
MTBE		max. 15	max. 15	-
Other oxygen compounds		max. 3-15[c]	max. 3-15[c]	-
Oxygen content, %	EN 1601	max. 2.7	max. 2.7	max. 2.7
Vapour pressure, kPa (summer, Hungary)	EN 13016-1	45-60	45-60	45-60
Distillation	EN ISO 3405			
T10, °C		-	-	max. 65
T50, °C		-	-	77-100
T90, °C		-	-	130-175
E70, % v/v		20-48	20-48	20-45
E100, % v/v		46-71	46-71	50-65
E150, % v/v		min. 75	min. 75	-
E180, % v/v		-	-	min. 90
FBP, °C		max. 210	max. 210	max. 195
Distillation residue, % v/v		max. 2	max. 2	-
Driveability Index[d] summer		-	-	max. 570
Injector cleanliness, % flow loss	ASTM D 5598	-	-	max. 5
Intake valve sticking, pass/fail	CEC F-16-T96	-	-	Pass
Intake valve cleanliness[e], mg/valve	ASTM D 6201	-	-	50
Combustion chamber deposits[e], % of base fuel	ASTM D 6201	-	-	140

[a] *Unleaded super plus gasoline*
[b] *Specification partially from 2005 and mandatory from 2009*
[c] *Chemical-dependent, see standard*
[d] *DI = (1,5×T10) + (3×T50) + (T90) + (11×oxygen content %)*
[e] *There are another methods, too*

Experimental

During the development activity new tests were introduced in addition to the usual analytical and application methods of motor gasolines. An important step in the development process has been the development of methods suitable to examine the power promises, for which we intended to use not only the power test on chassis dyno, but also the measurement of vehicle acceleration ability, maximum speed and star-up capability. A testing method of a suitable level of significance has been developed to measure the acceleration shown by the vehicles within the various speed ranges so that the only humane interference is the movement by the driver to push down to full power.

A similar method has been developed both to define the maximum speed achieved at various loads (Figure 3), and to measure the cold starting potential of the fuels. The effect of fuel composition on driveability has been performed on SCHENCK E 364/230-type chassis dyno. Vehicle parameters have been monitored using GUTMANN MEGA MACS 55 and BOSCH FSA 560 motor diagnostic equipment. For mileage measurements FLOWTRONIC 206-208 fuel consumption meter was used. Several type of vehicle were used for acceleration and other tests: Opel Astra 1.4i ECOTEC-1.6i, Suzuki Swift 1.0-1.3, Mitsubishi Carisma 1.8 GDI, etc.

Gasoline properties were determined according to the appropriate methods given in Table 1 specified by EN 228 standard and WWFC 4th Category. As a new tests we have also introduced the definition of wear property (modified ISO 12156) and rust preventing characteristics (ASTM D 665A) of the motor gasolines.

Figure 3: Vehicle testing on chassis dyno

Conditions
Air pressure, air temperature, air humidity

Controls
Fuel temperature tempering, external supply pump, road load, wind

Readings
Acceleration time, maximum speed, power, speed, revolutions per minutes, fuel consumption, oil temperature, vehicle condition parameters

Results and discussions

During the development process of the testing methods we increased studying the literature of the premium gasolines, and established it a regular function to make comparative analysis with the product quality of the domestic competitors. This was later extended to include the survey of samples from West-European filling stations, which we later found out successfully confirmed some of our assumptions. As shown in the details in Table 2 the unwashed gums of the branded motor gasolines varies, anything can be found from trace amounts to significant additive over-dosages. With the exception of two samples the washed gums met the specification. Sulphur content was below 50 mg/kg in general, but in case of domestic and foreign samples sulphur-free product was also found. With the exception of one case the olefin content was below 10 % by volume, and as regards aromatics content a sample with just the standard limit was also encountered. The appearance of a new property, the gasoline wear reduction, a low HFRR value can be highlighted since in one of the foreign samples the diameter of wear scare diameter was 317 μm instead of a 7 to 900 reading. This implies that the marketing company uses antiwear additive to protect the engine parts providing better engine lubricity.

Table 2: Major characteristics of domestic (H) and EU (K) Super and Super Plus gasoline samples - winter 2001

Gasoline No.	H-1	H-2	H-3	H-5	H-6	H-7	K-1	K-2	K-3
RON	99.5	95.8	95.7	96.6	95.8	95.8	99.7	95.4	99.2
MON	89.1	84.7	85.1	85.2	85.0	85.4	89.6	85.4	88.9
Density, at 15°C kg/m^3	760.4	750.4	756.1	748.6	748.5	747.6	752.8	736.0	749.5
Unwashed gums, mg/100cm^3	84.0	63.2	4.2	20.7	5.7	19.4	82.1	37.6	25.2
Washed gums, mg/100cm^3	5.4	6.0	0.8	0.5	0.4	0.6	2.0	2.0	1.2
Sulphur, mg/kg	1.3	34.1	5.6	28.1	37.4	33.4	3.1	21.3	1.3
Olefins, % v/v	1.43	9.51	6.44	9.86	5.45	9.69	2.72	10.78	3.09
Aromatics, % v/v	42.41	33.78	36.6	33.56	36.12	33.72	41.68	29.57	40.71
MTBE, % v/v	10.31	1.45	2.68	1.47	3.38	1.42	8.02	2.41	7.83
Benzene, % v/v	0.53	0.50	0.53	0.50	0.62	0.48	0.63	0.79	0.60
Oxygen, %	1.92	0.27	0.47	0.27	0.61	0.26	1.49	0.45	1.37
DVPE, kPa	66.9	65.2	58.7	63.7	73.5	66.0	71.7	84.5	78.3
E70, %	37	29	30	27	31	29	41	34	39
E100, %	58	47	48	47	48	50	58	53	56
E150, %	91	81	77	81	78	84	89	82	87
E180, %	99	94	93	94	93	95	97	93	97
Distillation residue, % v/v	0.5	0.9	1.1	0.5	0.9	0.8	0.4	0.4	0.4
Gasoline HFRR, m	-						837	317	816

In order to face our customers with an authentic set of properties we reviewed the international fuel standards, which had been developed basically to highlight the application properties of fuels in addition to their standard characteristics. This way we studied the system of criteria from the French UTAC, the English AA SEAL of Approval, an other French DHYCA, the EPA in the US, the German Top Tier, along with the examination of the possible compliance with the WWFC fuel categories. Although the systems mentioned above have not, while the WWFC has not yet, become official specifications, to disclose the deeper thoughts about fuels these international specifications were very useful. We started utilising the benefits of new terms not too well known in the domestic engineering life such as driveability, gasoline lubricity etc.

None of the fuels marketed to date in Hungary met the most severe high quality gasoline quality Category 4 of WWFC. (Although members in MOL's Tempo gasoline family satisfied the application criteria of Category 4, however, they did not in terms of some other conditions such as sulphur content).

Basically the position statement given by the automotive constructors within this set of properties represents a standard, absolutely authentic system of criteria that we want to comply with through our motor gasoline formula in any case. As a close-out of the first work stage we succeeded in establishing a technical property system, based on which MOL's senior management deemed it worthwhile to further investigate the gasoline concept developed.

Technical implementation

Although it is true that the automotive constructors generally design their spark ignited engines for products of RON 95, however, in some cases a higher octane is required:

- there exist vehicles designed for higher octane,
- combustion chamber deposits increase the octane required by the engine,
- and vehicles fitted with an octane sensor are especially suitable for utilising the excess octane, offering the adventure of a more dynamic driving.

However, a too high octane may have a negative effect since the combustion speed of some high octane components is worse than average, resulting in lower induced pressure and hence lower power and worse vehicle acceleration. Having tested many receipts and many constructions to clarify all that we have decided for 99 research octane.

We initiated frequent and intense technical discussions with international additive manufacturers in respect of purchasing and testing novelty additives for our concept. Since we were looking for a novelty additive we could not avoid the issue of testing method development. This way a possibility was created to measure the wear properties, the value of HFRR for gasolines. Well known for the diesel fuels this testing method was introduced (on a recommendation by car manufacturers) after the appearance of deeply hydrogenated gas oils. For motor gasolines although the

parts are exposed to lower load, however, the 100 to 150 bar injection system of the new GDFI engines and the use of sulphur-free motor gasolines may require the use of lubricity additives. Otherwise, friction reduction in the cylinder can increase power and fuel economy.

An other aspect is that the direct injection engines are more sensitive to deposits (additive plus fuel components). In comparison to traditional port fuel injected engines deposits may occur in an increased fashion, or even at new place or on new parts [11-14]:

- inlet manifold: higher exhaust gas recirculation (EGR) and Canister purge rates increase the rate of deposit formations,
- port deactivation valve: through EGR and the positive crankcase ventilation (PCV) deposit formation is increased, flow conditions may change resulting in strong deterioration in the mixture formation,
- inlet valve: gasoline cooling and washing effect typical of the traditional engines is not present, substances from EGR and PCV may deposit easily,
- direct injection system: environment with a higher temperature since the injector is located in the hotter cylinder and not in the cooled intake pipe,
- combustion chamber: gasoline contacts the hot cylinder and piston directly,
- EGR valve: high flow rates carrying more deposit materials.

Having tested many additives and concentrations we developed the additive composition of MOL TEMPO 99 EVO in a joint effort with one of the world leading additive manufacturer for direct and indirect injection vehicles. This has excellent clean up and keep clean effects, but causes reduced combustion chamber deposits. This has outstanding anticorrosion property on both copper and iron parts and highly supports the separation of contaminating water, too. The additive concentration has been set so that it meets the 30 mg/100 cm^3 washed gums content specified for WWFC Category 4. Some effect of the additive is shown in Table 3.

Table 3: Some effects of the additive of MOL TEMPO 99 EVO

Fuel type	Test type	Method	Value
Base gasoline	Corrosion	ASTM D 665A modified	Rusted
EVO	Corrosion	ASTM D 665A modified	Free of rust
Base gasoline	HFRR	ISO 12156-1 modified	789 μm
EVO	HFRR	ISO 12156-1 modified	418 μm
Base gasoline	Intake valve deposits	CEC F-04A-87	68.1 mg/valve
EVO	Intake valve deposits	CEC F-04A-87	5.7 mg/valve

It became evident in the R&D activity that Danube Refinery could not produce such a sulphur free fuel under the conditions of that time so an upgrade in the processes should have been made also. This was already in progress partly under the efficiency improvement project, so the solution that established the conditions for producing sulphur-free motor gasoline could be developed quickly in Refinery.

In the meantime we also found out in the acceleration tests that the use of a new gasoline-blending component would be required for the formula. We thought we had identified just that in a stream rich in C_6 paraffins and especially in valuable cycloparaffins in the Light Naptha Isomerisation Unit. During both discussions with the unit management, and our analyses made on a regular basis it was demonstrated that a gasoline-blending component of a perfect composition suitable exactly for our purposes could be produced after the proper upgrades performed by the unit personnel. We went on visiting the key process units in a methodical manner, which we could count on as blending component production units, and discussed with the operating staff the parameters deemed important by them one by one, and also defined the realistic limits of manufacture achievable.

Following many experiments and having tested many receipts in the acceleration tests already mentioned, placing great emphasis on the presence of the proper light components, on their high octane, on the even distribution of octane, on providing components with high combustion rate and complete combustion, and by removing the high boiling point components causing harmful emission and increased deposit the unique receipt was developed eventually. As a result EVO has excellent distillation characteristic (moderate DVPE, good E70 and E100, low FBP, etc.) and storage stability (low olefins content). Its good cold weather startability and the results of maximal speed tests are summarised in Table 4 and 5, respectively.

Table 4: Cold weather startability of different gasolines on Suzuki Swift 1.0

Fuel type	Oil temperature, °C	Air temperature, °C	Starting time, second
MOL TEMPO 95*	0	0	2.74
MOL TEMPO 99 EVO*	0	0	1.70

*same DVPE

Table 5: Maximal speed of Opel Astra 1.4i ECOTEC with different gasolines on chassis dyno (road load, moderate rise)

Type of Fuel	Average maximal speed, km/h
MOL TEMPO 91	130.0
MOL TEMPO 95	131.6
MOL TEMPO 98	134.3
MOL TEMPO 99 EVO	135.6
Competitor A – premium grade	135.5

In the development a great emphasis was placed on as wide a compliance with the environmental expectations as possible. This way we have succeeded in developing a product, which exceeds the specifications of the currently applicable Hungarian Standard MSZ EN 228, meets the specifications to be introduced by EU in 2005-2009, and satisfies the recommendations of WWFC Category 4.

Outstanding environmental properties of MOL TEMPO 99 EVO are:

- Sulphur content below 10 mg/kg, which allows the introduction of the newest engine designs and their after-treating catalysts of special needs (Euro 3 and 4 emission specifications – see Table 6). Reducing the emissions of not only the harmful substances (HC, CO, NOx) but through the lower consumption of these designs, also that of carbon dioxide, which causes greenhouse effect.
- Aromatics content below 35 % v/v and benzene content below 0.4 % v/v – significantly reducing the emissions of benzene and other aromatic hydrocarbons harmful to human health.
- Olefins content below 5 % v/v (which is one third of the market average) – dramatically reducing the emission of volatile organic compounds, out of which the olefins greatly contribute to the air pollution in large cities, and to ozone and smog formation near ground level.
- Paraffin content min 48 % v/v – we have increased the proportion of least harmful, completely combusting blending components of high octane.
- Oxygen content min 2 % - improving the complete combustion and reducing the emissions of unburned hydrocarbons and carbon monoxide.

Table 6: EURO 3 and 4 emission specif. for gasoline fuelled cars (EU Dir. 98/69/EC)

	Emission, g/km		
	NOx	CH	CO
Euro 3-2000	0.15	0.20	2.30
Reduction (1996), %	40	40	30
Euro 4-2005	0.08	0.10	1.00
Reduction (1996), %	68	70	70

If MOL TEMPO 99 EVO is used the emissions of carbon monoxide and hydrocarbons can be reduced by 35-12 % and 8-1 %, respectively, compared to the traditional RON 95 gasoline grades. While the quantity of nitrogen oxides emitted can be reduced to the level set in Euro 4 specifications using the DE-NOx catalysts, which require the new sulphur free motor gasoline. This is how MOL TEMPO 99 EVO, the new member of the TEMPO Family has been created (Figure 4).

Figure 4: Origin of MOL TEMPO 99 EVO

MOL Tempo ≡ keeping the good properties of all MOL motor gasolines, a member of the Family.
99 ≡ minimum 99 RON
EVO ≡ (evolution) the development, which is an answer to the fuel upgrading demand, to the vehicle construction developments, and to the challenge of the self-conscious environment protecting human.

Conclusions

We succeeded in developing a 99 octane, sulphur-free, high isoparaffins containing reformulated gasoline. Based on its special composition, octane distribution and additive content MOL TEMPO 99 EVO provides excellent driveability and power, cleaner burning, lower CO, CH, NOx emissions. It protects engines with excellent keep clean, clean up, anticorrosion and lubricating effects. It is suitable for PFI and GDFI engines, too. Hungarian innovation and quality awards in 2001 and 2002, and our customers acknowledged the new approach and fulfilment of the complex requirements. MOL Tempo 99 EVO represents the next step of fuel evolution, unique and authentic quality values in the fuel market of Europe.

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665.733.5.035.3	motorni benzin IOB 99, MOL TEMPO 99 EVO	C
665.733.5.082	reformulirani motorni benzin	reformulated gasoline RFG
.002.61	gledište sastava, formulacije i namješavanja	constituents, formulation and blending viewpoint
.001.53	istraživanje i razvoja produkata	product research and development
351.777 (4)	EU program za čišće motorno gorivo 1990-2009	EU programme for clean motor fuel 1990-2009 y.
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