行政院所屬各機關因公出國人員出國報告書

(出國類別：研習)

「研發添加劑開發與應用研習」出國報告

服務機關：中國石油公司煉製研究所

出國人職稱姓名：專案經理　孔慶宸

出國地點：美國

出國期間：中華民國 89 年 11 月 20 日

至 89 年 12 月 3 日

報告日期：中華民國 90 年 1 月 18 日

G87/c0890753

「研發添加劑開發與應用研習」

出國報告

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「研發添加劑開發與應用研習」出國報告

一、 出國目的：

本公司各類油品已面臨強大之競爭壓力，就提昇本公司油品之競爭力，並與對手進行市場區隔之目的而言，各式添加劑之靈活運用，可謂相當重要之工作。由於選擇合適之添加劑為一相當複雜之工作，全球各大油公司與添加劑公司均投入相當高比例之人力與物力進行此產品之研發與應用之研究。

以本公司之立場而言，投入全新產品之研究將耗費相當大之研究人力與經費，更可能耗時過長而喪失商機；因此，如何引進最適合本公司使用之添加劑應為現階段之工作重點。目前，以本公司煉製研究所之人力與設備，進行各種添加劑方案之評估，以及各種同類添加劑之優劣比較，引進最適合本公司油品使用之添加劑，是最可行之作法。

由於添加劑之發展技術與引擎測試技術發展速度十分快速，若須以最合適之方法篩選出最適合之添加劑，就必須隨時更新資料、更新設備與更新方法來達成。因此，本次職奉派赴美國西南研究所（ Southwest Research Institute)研習最新之引擎與車輛測試技術與發展趨勢，赴知名添加劑公司德士古公司與雪弗龍公司之研究中心研習最新之添加劑發展趨勢及測試技術，就是為瞭解添加劑之最新發展趨勢與測試方法之最新進展狀況，作為研究方向與內容之參考。

二、 出國行程：

職於 89 年 11 月 20 日自台北出發，前往各研習地點，並於 89 年 12 月 3 日返國，共計 14 日，其主要行程及工作內容如下：

日期	地點	工作內容
89／11／20	台北－舊金山－丹佛－聖安東尼	啓程
89／11／21	聖安東尼	赴西南研究所研習引擎測試技術
89／11／22	聖安東尼－芝加哥－紐約	
89／11／23~11／28	紐約	赴德士古公司研習添加劑及引擎測試技術
89／11／29	紐約－舊金山	
89／11／29~12／01	舊金山	赴雪弗龍公司研習添加劑及引擎測試技術
89／12／02~12／03	舊金山－台北	返程

三、 工作內容及心得：

1. 於西南研究所研習內容及心得：

目前本公司汽油清淨添加劑之採購規範中，均指定西南研究所作為公正之第三實驗室，所有投標樣品均需經過該研究所之測試，達到指定之性能要求，才能成為合格投標樣品；此關係已維持近十年，雙方配合相當良好。

本次赴西南研究所研習，除討論未來是否具有更大之合作空間外，尚對於目前所執行中之添加劑採購測試程序之細節進行討論，並實地學習該研究所之實車試驗與引擎試驗之處理流程及重點要求。

i. 清淨添加劑採購測試相關問題研討

目前，本公司所指定之測試方法為 BMW 318I 實車試驗，作為判定清淨添加劑保持進氣閥清淨性功能優劣之工具。此方法之試驗所需時間較長，重現性並非十分良好，且較難加以模仿；但由於是實車長時間測試，因此，代表性較佳，國外添加劑公司仍會以此試驗作為重要之測試項目。但由於前述缺點，國外以發展出以 Ford 2.3L 引擎作為測試添加劑保持進氣閥清淨性功能優劣之工具，其具有所需時間較短，再現性較佳之優點，西南研究所亦可提供該項測試，代號為 ASTM D6201，本公司可考慮採用。

ii. 燃燒室積污測試方法研討

另於燃燒室積污（Combustion Chamber Deposit, CCD）部份，至目前為止，國外尚無公認之標準測試方法可供評估之用。然西南研究所無論使用 BMW 318 I 實車測試或 Ford 2.3L 引擎測試，均可同時進行 CCD 之評估，雖然非標準方法，但可同時提供數據供參考。美國加州之汽油清淨劑規範亦已採用 Ford 2.3L 引擎測試時所同時測得之 CCD 數值作為規範標準（不得高於 1300mg 或高於基準油料 140%）。因此，本方法可考慮未來採購添加劑時加以運用，並同時規範 IVD 及 CCD 之上限值。

iii. 實驗設備研習心得

此外，於該專業之引擎試驗研究所中，除各種引擎台測試及時車測試單元外，尚搭配寬敞之空間作為引擎拆裝、評估之工作室，如此，引擎在上架前之準備工作及測試達到某一階段須進行評估或完成測試須進行整理等工作，均可獨立於此工作室進行，而同時，引擎台單元可進行另外一組測試工作，不會干擾，也較易操作；值得借鏡。

2. 於德士古公司研習內容及心得：

德士古公司為知名之國際添加劑公司，其發展出之清淨添加劑技術於業界評價甚高；該公司所生產之添加劑亦實際應用於該公司所供應之汽柴油產品中。

i. 清淨添加劑

目前使用於該公司所供應之汽油中之清淨添加劑類型並非該公司最高級之產品，而是針對該公司之需求所開發出之配方，主要以 PIBA （poly-iso-butylene amine）+ PEA（polyether amine）作為 detergent，以 polyether（PE）作為 carrier fluid，以符合美國環保署對清淨性之要求。

該公司最高級之清淨添加劑，為以 PEA 作為 detergent，搭配 polyether（PE）作為 carrier fluid，使用高劑量時，可有效清除化油器、噴油嘴、燃燒室積污，達成降低辛烷值需求、省油、降低排氣污染等功效。此添加劑並不直接添加於該公司之汽油中，而是製作成小包裝型式販賣，以獲取更高利潤，並提昇公司品牌形象。

ii. 摩耗改善劑

該公司近兩年間發展出另一非清淨添加劑類型之汽油添加劑，稱為 Friction Modifier，此添加劑直接添加於汽油中，其有效成份將提供活塞頭頂端在與汽缸壁摩擦時充分之潤滑，並隨活塞之上下往復運動時，進入潤滑油系統中，略微改變潤滑油之性質，提供更佳之潤滑效果。因此，使用此添加劑後，將可獲得立即性之省油效果，該公司並提供豐富之測試結果供本公司參考。

iii. 柴油潤滑性添加劑

在柴油添加劑方面，該公司在歐洲亦發展出潤滑性添加劑供該公司之柴油使用，狀況相當良好，並無發生任何與添加劑有關之問題。而對於未來柴油往超低硫之方向發展，該公司認為在潤滑性添加劑本身之技術尚並無問題，在硫含量僅30 ppmw之柴油中，仍可使用與目前使用同類型之添加劑克服潤滑性不足之問題，僅需將劑量調整至較高之劑量即可。此建議及見解，職將以實際之試驗加以印證。若為確實，則將降低未來潤滑性添加劑之採購及操作複雜性。

iv. 柴油消泡劑

另在柴油消泡劑方面，該公司之專家提出數點須值得特別注意之要項工本公司進行研究時作參考：

a. 消泡劑之測試方法具有很大之變異度，若在操作時不夠仔細，就有可能與其他實驗室所得到之結果產生相當大之差異。而必須特別注意之事項包括：
   I. 容器及試驗器材之徹底清洗
   II. 溫度控制
   III. 柴油含水量
b. 消泡劑之評估必須選用本公司典型之柴油，愈接近實際狀況愈好；亦即，在其他國家或其他地區使用效果甚佳之消泡劑不見得會對本公司之柴油發揮同樣良好之作用。
c. 消泡劑具有溶解性不夠好之特性，在實際添加時，有許多細節必須掌握，才能發揮最佳功能。例如，組成配方時所用之助溶劑、添加方式、混合方式等，均會影響使用結果。此點意謂在實驗室篩選出來效果不錯之添加劑在實際應用

時若方式不恰當，則可能不能達成預期功效。

雖然消泡劑之選用及應用較為困難，但該公司仍認為在柴油添加劑中為除了潤滑性添加劑外，最值得投資添加之添加劑。其理由甚多，簡言之，減少泡沫產生，可獲致保持加油站清潔、提高輸油速率、減少顧客加油時間與提高每車次加油量等成果，建議本公司考慮添加。

v. 引擎測試

該研發中心之引擎測試設備相當完備，具有各式引擎供測試之用，並擁有多具車體動力計供車輛測試使用。其中數量最多之測試設備即為本田發電機，用途為供初篩，所有引擎測試均由本田發電機之測試開始。而由於每次拆裝後必須確保引擎之狀況與前次相同，因此必須有完整之 QC 步驟，該測試乃使用排氣分析儀作為其 QC 之用，即經拆裝後重新組裝之引擎，於運轉初期先行將排氣取樣分析，若在可接受之範圍內，表示本次組裝無失誤，可進行下一步實驗；否則，須重新拆解、重組。

3. 於雪弗龍公司研習內容及心得：

雪弗龍公司亦為知名之油公司，擁有美國西岸最大之煉油廠，其旗下之國際添加劑公司稱為 Oronite，其發展出之清淨添加劑技術於業界亦評價甚高；該公司所生產之添加劑亦實際應用於該公司所供應之汽柴油產品中。

i. 清淨添加劑

目前使用於該公司所供應之汽油中之清淨添加劑類型與前

述之德士古公司相同，亦非該公司最高級之產品，而是針對該公司之需求所開發出之配方，以符合美國環保署對清淨性之要求為設計基準。

該公司亦已發展出以PEA作為detergent，搭配polyether(PE)作為carrier fluid，具有有效清除化油器、噴油嘴、燃燒室積污，達成降低辛烷值需求、省油、降低排氣污染等功效之添加劑。該公司人員認為本公司欲發展小包裝具有清除積污效果之添加劑上市販售，在現在台灣油品市場出現第二家競爭者之情況下，應相當有賣點，且時機恰當，應具有相當高之成功機會。

於此次赴舊金山研習期間，雪弗龍公司分別指定Oronite公司及雪弗龍公司之研究人員參與討論，以雪弗龍公司之立場，其所選用之添加劑並非絕對要使用Oronite公司之產品，仍可與其他公司採購或合作，以降低成本。但實際狀況顯示，雪弗龍公司所選用之添加劑仍幾乎全為Oronite公司之產品，其理由為Oronite公司對於雪弗龍公司之油品特性與煉製現況最為瞭解，其提出之各種解決方案最能切中問題中心，且能獲得最多之後續服務，因此，雖然其收費較其他公司高，但雪弗龍公司仍樂意採用 Oronite 公司之產品。此關係值得本公司作為借鏡，煉研所可扮演 Oronite 公司之角色，對於中油公司之煉油廠、油庫、行銷部門提供各種收費服務，爭取雙贏。

ii. 識別劑

另在識別劑方面，雪弗龍公司所採用之產品亦為Oronite公司之產品，為一種生物科技，其具有相當高之獨特性，絕無冒用或仿製之可能。其定量方式經職實際操作後，

認為操作人員之操作必須經過訓練，同時，必須準備相當多種類之試劑或溶劑，因此，適合於實驗室中執行定量檢測。此外，由於該添加劑已經實際使用於該公司之汽油中，經過各種測試與監控，該公司提供了相當多之資料供本公司參考。其資料內容包括該添加劑之生產與品管、添加之位置與方法、於油庫應用時之實況資料、在加油站抽檢之品管資料、實車使用之資料、委託西南研究所所進行之檢測結果以及檢測準確性之資料等。

iii. 引擎測試

該研發中心之引擎測試設備相當完備，具有各式引擎供測試之用，並擁有多具車體動力計供車輛測試使用。值得注意之處為該中心亦擁有多具本田發電機供初篩之用，其理由與德士古公司相同，由於本田發電機所具有之輕巧、簡易與普遍性均甚高，因此，幾乎所有引擎測試均由本田發電機之測試開始。

四、 結論

1. 本次研習，職共赴三處研究機構或中心研習引擎測試技術，實地實習其設備及運作之方式，得到以下之心得：三處之引擎測試部門除引擎測試單元與實車車體動力計之設備外，均搭配寬敞之空間作為引擎拆裝、評估之工作室，如此，引擎在上架前之準備工作及測試達到某一階段須進行評估或完成測試須進行整理等工作，均可獨立於此工作室進行，而同時，引擎台單元可進行另外一組測試工作，不會干擾，也較易操作；值得借鏡。

2. 本次赴德士古公司及雪弗龍公司研習添加劑引擎測試技術，兩處研發中心之共通點為均配置數量頗多之本田發電機，作為測試添加劑之用，所有引擎測試均由本田發電機之測試開始。而德士古公司更為確保每次拆裝後必須確保引擎之狀況與前次相同，因此使用排氣分析儀作為其 QC 之用，即經拆裝後重新組裝之引擎，於運轉初期先行將排氣取樣分析，若在可接受之範圍內，表示本次組裝無失誤，可進行下一步實驗；否則，須重新拆解、重組。值得本公司參考。

3. 本次赴德士古公司及雪弗龍公司研習並討論添加劑之各種產品，兩家公司均鼓勵本公司生產小包裝清淨添加劑販售，並認為目前時機恰當。同時，對於以馬力提昇作為訴求重點認為是很好之構想。

4. 德士古公司提出之新型汽油添加劑，Friction Modifier，可提供更佳之潤滑效果，使用後，將可獲得立即性之省油效果，該公司並提供豐富之測試結果供本公司參考。由於目前油品市場競爭激烈，因此，此種可有明確訴求之添加劑，建議可慎重列入本公司選用汽油添加劑時之考慮。

5. 柴油消泡劑之使用，可獲得甚多效益，大致包括減少泡沫產生，可獲致保持加油站清潔、提高輸油速率、減少顧客加油時間與提高每車次加油量等；雖然消泡劑之選用及應用較為困難，但仍相當值得考慮。

6. 雪弗龍公司所採用之識別劑為 Oronite 公司之產品，為一種生物科技，其具有相當高之獨特性，絕無冒用或仿製之可能。該添加劑在實際使用時，所需注意及可能遭遇之問題，雪弗龍公司提供了相當多之資料供本公司參考。而此識別劑系統

檢測方式經職實際操作後，認為操作人員之操作必須經過訓練，同時，必須準備相當多種類之試劑或溶劑，因此，適合於實驗室中執行定量檢測。而其優劣點及與其他系統之比較建議應儘速進行。

Fuels and Lubricants Research Department
Fuel Evaluations

- BMW Intake Valve Deposit Test
- Combustion Chamber Deposit Evaluations
- Intake Valve Sticking Test
- Port Fuel Injector Deposit Testing
- Truck Fuel Economy Improvements
- Vehicle Driveability Testing
- Vehicle Octane Requirement Determinations and Octane Requirement Increase (ORI) Evaluations

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- Cummins L-10 Injector Depositing
- Exhaust Valve Seat Recession
- Ford 2.3-L Intake Valve Deposit Test
- Intake System and Combustion Chamber Deposits Screening
- Octane Requirement Test
- Sequence VI (Modified)

Topic:	BMW INTAKE VALVE DEPOSIT TEST
Point of Contact:	Kevin Brunner Phone: (210) 522-3579 Fax: (210) 681-5344
Test Objective:	The objective of this test is to evaluate fuels' ability to control deposits on intake valves.
Vehicle:	For this test, a 1985 BMW 318i, four-cylinder, four-stroke, 1.8-L vehicle with an automatic transmission is used.
Test Procedure:	1. The vehicle is run 10,000 test miles with daily mileage accumulation of 800 miles. 2. A fixed route is run, consisting of: • 10 percent city • 20 percent secondary road • 70 percent highway 3. Intake valves are weighed.
Fuel Requirement:	The fuel requirement for this test is 500 gallons of fuel.
Duration:	The duration of this test is 4 weeks.
Test Results:	(PASS/FAIL) The test is a PASS if the average intake valve deposit weight is less than 100 milligrams per valve for EPA requirement and less than 50 milligrams per valve for CARB requirement. CARB also requires a combustion chamber deposit (CCD) weight determination in conjunction with the BMW IVD Test.
Note:	A 5,000-mile test option is available. This test is run as a CARB procedure and as an EPA procedure following ASTM Method D-5500.

Topic:	COMBUSTION CHAMBER DEPOSIT EVALUATIONS
Point of Contact:	Kevin Brunner Phone: (210) 522-3579 Fax: (210) 681-5344
Test Objective:	The objective of this test is to evaluate the capability of a test fuel or fuel additive to prevent CCD growth or to clean CCDs previously formed.
Vehicle:	Various vehicles may be used for this test procedure.
Test Procedure:	For CCD Thickness Measurements: Use a Fisher Permascope® thickness measurement device linked to a computer for data storage. Plexiglass templates are used to improve test accuracy and precision. For CCD Weight Measurements: Deposits are manually scraped into specially designed envelopes. Deposits are then weighed to the nearest 0.1 mg.
Fuel Requirement:	Various amounts of fuel may be used for this procedure.
Duration:	This test procedure usually requires 10,000 to 20,000 miles for deposit stabilization. The driving route should include a mix of city, suburban, and highway driving with a soak period.
Test Results:	CCD thickness and weight measurements for the piston top and combustion chamber regions of each cylinder are determined.
Note:	CCD evaluations are usually incorporated into a fleet program that also includes intake valve deposit (IVD) and octane requirement increase (ORI) evaluations.

Topic:	INTAKE VALVE STICKING TEST
Point of Contact:	Frank Lu Phone: (210) 522-6986 Fax: (210) 681-5344
Test Objective:	The objective of this test is to determine a fuel's performance in regard to the prevention of intake valve sticking at low temperature.
Vehicle:	The vehicle used in this test is a 1991 Volkswagen Vanagon vehicle with 2.1-L four-cylinder engine and four-speed transmission.
Test Procedure:	1. This 13-cycle dynamometer test consists of 6 minutes at 1,500 rpm, 5 minutes at 1,700 rpm, followed with a 10-minute hot soak for each cycle. 2. This is followed by 16 hours of cold soak at 0°F. 3. Cylinder pressures are measured during three cold cranks at cold temperature. 4. Steps 1-3 are repeated during the next two days.
Fuel Requirement:	The fuel requirement for this test is 25 gallons.
Duration:	Duration is 2 weeks.
Test Results:	(PASS/FAIL) A fuel passes the test if the cranking compression of each cylinder is over 100 psi following the three-day evaluation.
Note:	

Topic:	**PORT FUEL INJECTOR DEPOSIT TESTING**
Point of Contact:	Kevin Brunner Phone: (210) 522-3579 Fax: (210) 681-5344
Test Objective:	The objective of this test is to evaluate the tendency of a gasoline to clean up or keep the port fuel injectors clean.
Vehicle:	A 1985-87 Chrysler 2.2-L turbocharged engine with an automatic transmission is used for this test.
Test Procedure:	The procedure for this test is as follows: 1. PFI "keep-clean" and "clean-up" driving cycle: ● 55 mph for 15 minutes ● Engine-off soak for 45 minutes 2a. Keep-clean procedure: Flow test every 1,000 miles for 10,000 miles 2b. Dirty-up/Cleanup procedure: For dirty-up phase, run 15/45 cycle, and flow test until at least one injector is fouled to greater than 10 percent 3. For clean-up phase, run 15/45 cycle, and flow test every 1,000 miles until the previously dirtied injector fouling is 5 percent or less
Fuel Requirement:	The fuel requirement for this test is 500 gallons.
Duration:	The duration of this test is 40 days for PFI keep-clean test and usually 30 days for clean-up test.
Test Results:	(PASS/FAIL) Keep-Clean is a PASS if the fouling of all injectors remains 5 percent or less for the entire 10,000-mile test. Clean-up is a PASS when the fouling of all four injectors becomes 5 percent or less for the duration of the test.
Note:	This test is run following ASTM Method D-5598
Topic:	**TRUCK FUEL ECONOMY**

	IMPROVEMENTS
Point of Contact:	Larry Eckhardt Phone: (210) 522-2980 Fax: (210) 681-5344
Test Objective:	The objective of this test is to evaluate fuel economy benefits associated with various fuel additives, oil additive component, or devices
Vehicle:	Class-8 trucks and busses are used for this test.
Test Procedure:	Test procedures used include: ● SAE and TMC Joint Test Procedure (J1321 Fuel Consumption Test Procedure - Type II)
Fuel Requirement:	The amount of diesel fuel required for this test depends on the test plan used.
Duration:	The duration of the test is 6 to 8 weeks.
Test Results:	Fuel consumption is recorded (procedure accuracy ±1 percent).
Note:	

Topic:	VEHICLE DRIVEABILITY TESTING
Point of Contact:	Kevin Brunner Phone: (210) 522-3579 Fax: (210) 681-5344
Test Objective:	The objective of this test is to evaluate effects of fuel or fuel additive on vehicle operation as related to deposit formation or fuel volatility/driveability index.
Vehicle:	Various vehicles may be used for this procedure.
Test Procedure:	This test procedure may include: 1. CRC cold start and warm-up driveability procedure 2. BMW driveability procedure 3. SAE procedure
Fuel Requirement:	The fuel requirement is dependent upon test objective and procedure (10 gallons per evaluation).
Duration:	Duration of this test is dependent upon test objective and procedure (24 hours per evaluation).
Test Results:	Total of weighted demerits is recorded at the end of the test.

Topic:	**VEHICLE OCTANE REQUIREMENT DETERMINATIONS AND OCTANE REQUIREMENT INCREASE (ORI) EVALUATIONS**
Point of Contact:	Kevin Brunner Phone: (210) 522-3579 Fax: (210) 681-5344
Test Objective:	The objective of this test is to determine the lowest octane level fuel at which a vehicle can be operated without audible knock being detected by a trained rater. For ORI, the test objective is to determine the amount of increase in octane requirement of a vehicle as it accumulates miles.
Vehicle:	Various vehicles may be used for this test procedure.
Test Procedure:	• For individual vehicle octane requirement determinations, CRC designation E-15 procedure is used. • For ORI evaluations, multiple determinations are conducted at various test mileage points with ORI being the difference in start and end determinations.
Fuel Requirement:	CRC-specified octane reference fuel is used for this test procedure.
Duration:	During determinations, approximately 35 miles are accumulated. For ORI evaluations, the final determination is conducted after octane requirement has stabilized, which requires approximately 20,000 miles.
Test Results:	Test results reported include: • Vehicle octane requirement • Vehicle ORI
Note:	ORI evaluations are usually incorporated into a fleet program that also includes intake valve deposit (IVD) and combustion chamber deposit (CCD) evaluations.

Topic:	**CUMMINS L-10 INJECTOR DEPOSITING**
Point of Contact:	Jim Brown Phone: (210) 522-3313 Fax: (210) 681-5344
Test Objective:	The objective of this test is to determine the effect of diesel fuel and/or diesel fuel additives on the generation, prevention, and clean up of deposits inside open-nozzle unit injectors.
Apparatus:	For this test, a 1988-1989 Cummins L-10, six-cylinder, in-line, turbo-charged and after-cooled, direct injection diesel engine is used.
Test Procedure:	The engine is operated at 2,300 rpm for 125 hours, cycling every 15 seconds, from producing ~55 to 65 bhp to being motored by another power source.
Fuel Requirement:	For this test, 370 gallons of diesel fuel are required.
Duration:	The duration of this test is 125 hours.
Test Results:	The following are noted at the end of this test: ● Fuel injector flow change ● Fuel injector plunger deposits (PASS/FAIL) Superior neat fuels or fuels with additives will demonstrate 6.0 percent or less average flow loss and 10.0 or less average deposit rating.
Note:	For additional information, see Cummins Material Specification 60032.

Topic:	**EXHAUST VALVE SEAT RECESSION**
Point of Contact:	Al Brunett Phone: (210) 522-2892 Fax: (210) 684-7530
Test Objective:	The objective of this test is to determine the effects of gasoline additives and/or lead (Pb) content in reducting or eliminating exhaust valve seat recession in an engine designed to run on regular leaded gasoline.
Apparatus:	For this test, a 134 CID Ford industrial engine on a dynamometer test stand is used.
Test Procedure:	Normally, 8-hour segments of 2,100 rpm at wide open throttle are required for this test procedure.
Fuel Requirement:	The fuel requirement for this test varies with test time; however, approximately 4 gallons of fuel per hour are required.
Duration:	Test duration is 40 hours for 0.075 in. recession (unleaded, nonadditized fuel).
Test Results:	At end of test, exhaust valve seat recession is noted.
Note:	

Topic:	**FORD 2.3-L INTAKE VALVE DEPOSIT TEST**
Point of Contact:	Jim Brwon Phone: (210) 522-3313 Fax: (210) 681-5344
Test Objective:	The objective of this test is to determine intake valve deposit-forming tendency of unleaded gasoline, and/or gasoline additives.
Apparatus:	For this test, a 1994 Ford 2.3-L dual spark plug engine on a dynamometer test stand is used.
Test Procedure:	1. The test cycle consists of: ● 2,000 rpm and 230 mm Hg manifold absolute pressure for 4 minutes ● 30-second ramp to 2,800 rpm ● 2,800 rpm and 540 mm Hg manifold absolute pressure for 8 minutes ● 30 second ramp to 2000 rpm 2. The cycle is repeated for 100 hours.
Fuel Requirement:	The fuel requirement for this test is approximately 250 gallons.
Duration:	The duration of this test is 100 hours.
Test Results:	Test results for this test are reported in two ways: PRIMARY: Intake valve deposit ratings and weights SECONDARY: Combustion chamber deposit ratings, weights, and thickness
Note:	Test is run following ASTM Method D 6201.

Topic:	INTAKE SYSTEM AND COMBUSTION CHAMBER DEPOSITS SCREENING
Point of Contact:	Kevin Brunner Phone: (210) 522-3579 Fax: (210) 681-5344
Test Objective:	The objective of this test is to screen gasoline additives for effects on intake valve sticking (IVS), and intake system and combustion chamber deposits.
Apparatus:	For this test, a two-cylinders, 6,500-watt Honda generator, fluid-cooled, modern 4-cycle engine is used.
Test Procedure:	1. Engine operating modes are alternated every two hours between a 1,500-watt step and a 2,500-watt step. 2. For intake valve sticking measurements, the cylinder head is cold soaked for 12 hours at -20°C.
Fuel Requirement:	For this test, 45 gallons of 86 octane ((R+M)/2) fuel are required.
Duration:	The duration of this test is 80 hours.
Test Results:	The following test results are noted: - Intake valve sticking - force required to open intake valve - Combustion chamber deposits - rating and deposits weights - Intake valve deposit - rating and deposits weights
Note:	For additional information, see SAE Papers No. 892121 and 940347.

Topic:	OCTANE REQUIREMENT TEST
Point of Contact:	Jim Brown Phone: (210) 522-3313 Fax: (210) 681-5344
Test Objective:	The objective of this test is to determine the response of a given engine to various fuels/additives in terms of the change in engine octane requirement over time.
Apparatus:	For this test, a test stand consisting of engine, automatic transmission, dynamometer, and inertia flywheels is used. Current configuration simulating 1993 Oldsmobile Achieva with automatic transmission is used.
Test Procedure:	The test procedure is as follows: 1. Simulate commuter-type driving 2. Cycle among idle, 35 mph, and 65 mph 3. Electronically determining octane requirement every 24 hours under conditions simulating severe acceleration in a vehicle Various procedures to fit the octane requirement increase, octane requirement reduction, or octane requirement increase control objective may be used.
Fuel Requirement:	Approximately 1.5 gallons of fuel per test hour will be required.
Duration:	Typically, a test duration of 250 hours is necessary to achieve octane requirement equilibrium.
Test Results:	Test results are as follows: PRIMARY: Engine octane requirement trend over time. SECONDARY: Intake valve and combustion chamber deposit ratings, weights, and combustion chamber deposit thickness
Note:	The Stand configuration for this test is outlined in SAE Paper No. 950744.

Topic:	**SEQUENCE VI (MODIFIED) Fuel Economy Test**
Point of Contact:	Jim Brown Phone: (210) 522-3313 Fax: (210) 681-5344
Test Objective:	The purpose of this test is to evaluate fuel economy associated with fuels/additives.
Apparatus:	A 1982 Buick 3.8-L V-6 engine with two-barrel carburetor is used for this test.
Test Procedure:	For this procedure, a modified ASTM Sequence VI (Fuel Efficient Engine Oil) test procedure is used. This procedure compares fuel consumption of test fuel/additive to that of a baseline fuel at 150°F and 275°F oil temperature.
Fuel Requirement:	The fuel requirement for this test is 100 gallons.
Duration:	The duration of this test is 64 hours.
Test Results:	Percent fuel economy improvement is noted at the end of this test.
Note:	This test is a modified version of the Fuel Efficient Engine Oil Test, Sequence VI.

TEXACO

TFA-5004C Performance Claims

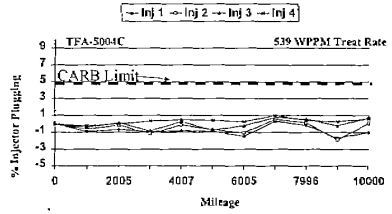
Keeps Clean and Cleans Up

- Carburetors
- Port Fuel Injectors
- Intake Valve
- Combustion Chambers
- Exhaust Valves
- Reduces NOx Emissions

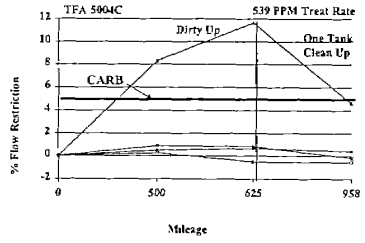
TFA-5004C Consumer Benefits

- Restores Lost Power
- Improves Acceleration
- Smoothes Out Rough Idling
- Increase Fuel Economy
- Eliminates Tough Starts
- Eliminates Intake Valve and Exhaust Valve Sticking
- One Tank Intake Valve Clean Up

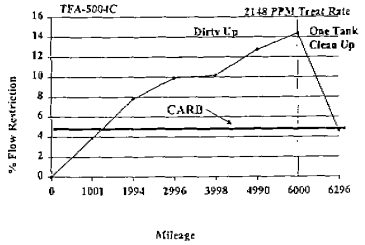
2.2L Chrysler PFI Keep Clean

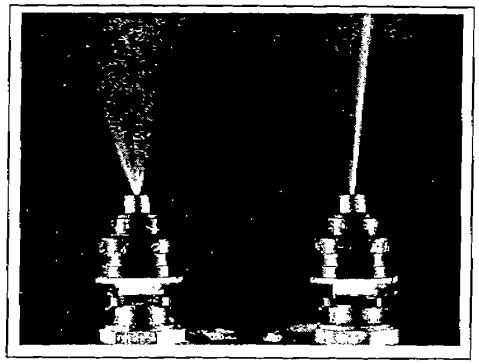


2.2L Chrysler
Port Fuel Injection Clean Up

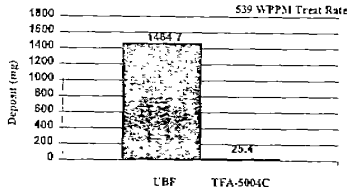


2.2L Chrysler
Port Fuel Injection Clean Up

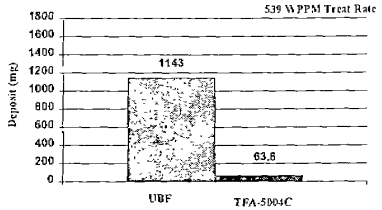




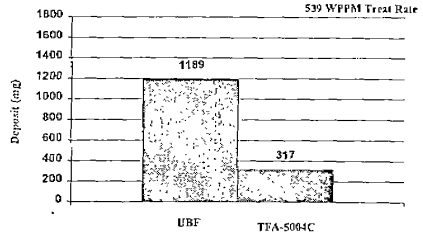
GM 2.0L Intake Valve Keep Clean



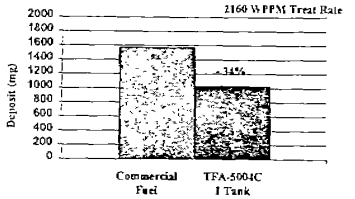
Ford 2.3L Intake Valve Keep Clean



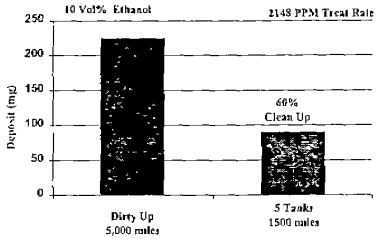
GM 3.1L Intake Valve Keep Clean



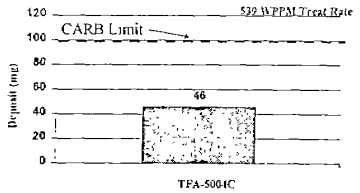
GM 3.1L Intake Valve Clean Up



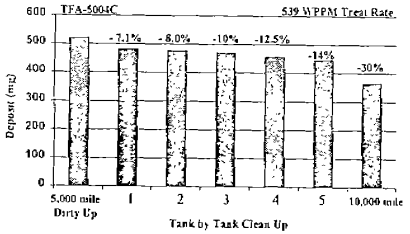
BMW Intake Valve Clean Up



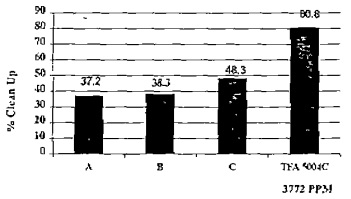
BMW 318i Intake Valve Keep Clean

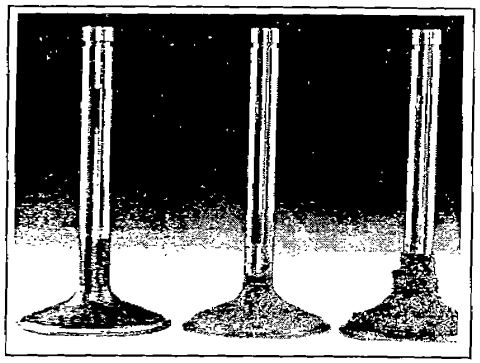


BMW 318i Intake Valve Clean Up

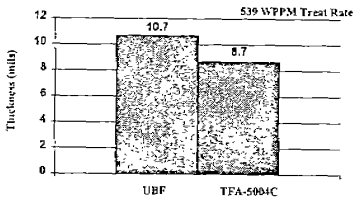


Aftermarket Comparison Tests
Intake Valve Clean Up

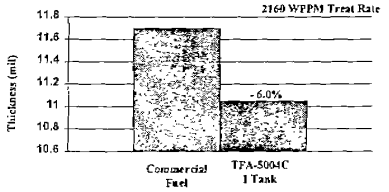




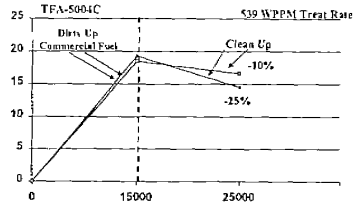
GM 3.1L
Combustion Chamber Keep Clean

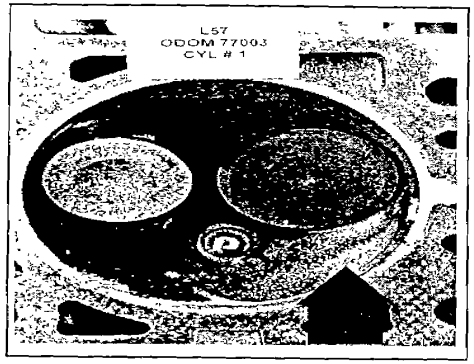


GM 3.1L
Combustion Chamber Clean Up



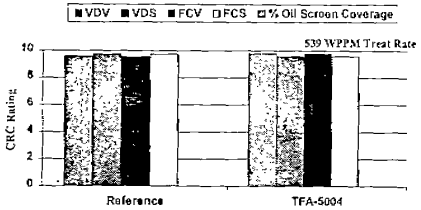
3.3L Chrysler
Combustion Chamber Clean Up



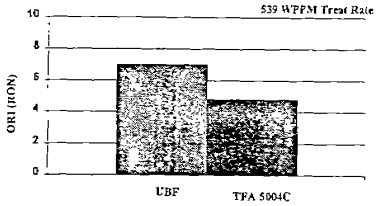


Combustion Chamber Squish Region

Ford 4.6L
Crankcase Performance



GM 2.0L
Octane Requirement Increase



Aftermarket Concerns

Package Stability
- Low Temperature
- Ambient Temperature
- High Temperature

Flashpoint
- Insurance Fire Code

Product Compatibility

Container Compatibility
- Solvent

Bottle Compatibility

Container Types:

Increasing Cost

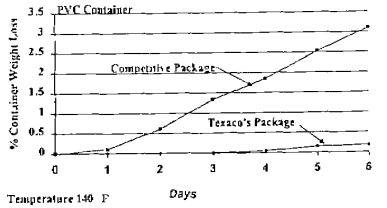
- High Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)
- Fluorinated HDPE (Levels 1-5)
- Polyethylene Terephthalate (PET)
- Barrex
- Metal

Bottle Compatibility

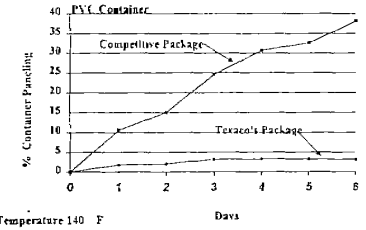
Thermal Testing:

- Six Week Period
- 140 F
- % Weight Loss
- % Paneling

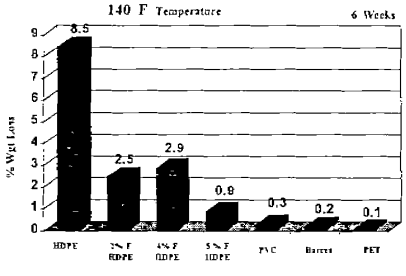
Container Compatibility



Container Compatibility



Package Compatibility



Label Compatibility

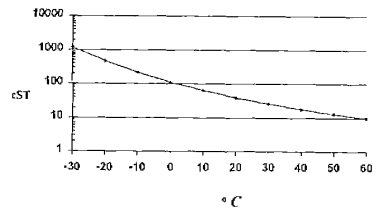
Product::
- doesn't run label print
- doesn't release label from container

UV Stable

TFA-5004C

Package	A	B
Solvent	Aviet A	N40HT
Specific Gravity @ 60 F	0 89	0 92
Flashpoint PMCC F	135 min	190 min
TBN	25	25
Kin Vis 40 C cST	18 2	35 9

Kinematic Viscosity



TFA-5004C
Types of Application

- One-shot - combined treatment through vacuum and fuel system
- Standard - used every day
- Premium - complete protection for 5,000 km
- Premium Plus - complete protection for 8,000 km

Summary

- Additive Performance
  - Port Fuel Injector Deposit Control
  - Intake Valve Deposit Control
  - Combustion Chamber Deposit Control
  - Exhaust Valve Deposit Control
- Package Compatibility
  - Compatible With The Lease Expensive Packaging
- Can Provide Turn Key Service
- Discussion

ORONITE D-TECT Markers can . .

- **Protect Brand Equity**
- **Add "Teeth" to Audit Programs**
- **Provide Liability Insurance**
- **Provide Opportunities for Product Differentiation**
- **Offer Quality Control Assurance**
- **Offer Market Intelligence**

=ADD VALUE TO THE BOTTOM LINE!

CONFIDENTIAL

ORONITE

MARKER TECHNOLOGY RECOMMENDATIONS FOR CPC - TAIWAN MARKER SPECIFICATIONS

- Marker Supplied in Additive Package (as discussed earlier)
- Stable in Additive and Finished Fuel
- No performance problems, including cosmetic
  - » Proven Field Performance
- Covert and Secure
  - » PPB Treat Levels
  - » Control of Availability of Marker
  - » Specific Measurement Equipment and/or Procedure
- Field and Lab Testing Capability
  - » Precise and Accurate
  - » Selective Measurement outside Matrix
  - » Eliminate background influences

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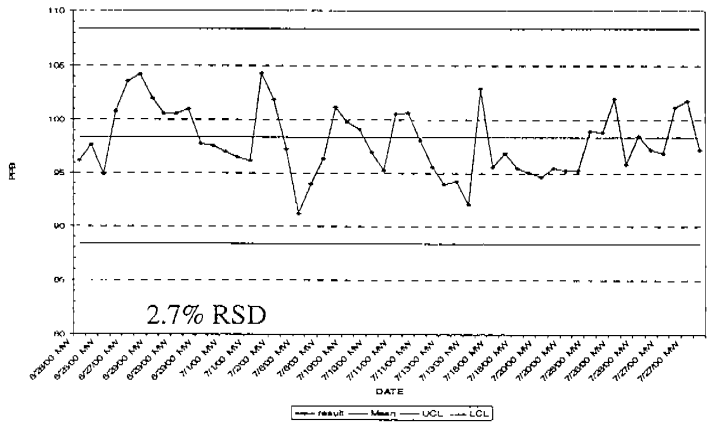
ORONITE

ORONITE D-TECT MARKERS:
HPLC Control Chart - Marker 2



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ORONITE D-TECT Markers:
Summary

- Low treat rates
- Cost-effective
- Stable, soluble, and compatible
- Quantitative & Qualitative analyses (field & lab)
- Easy, repeatable & reproducible analyses
- Easy to blend into finished products
- Customer-unique marker system
- Secure
- Covert
- FIELD PROVEN!

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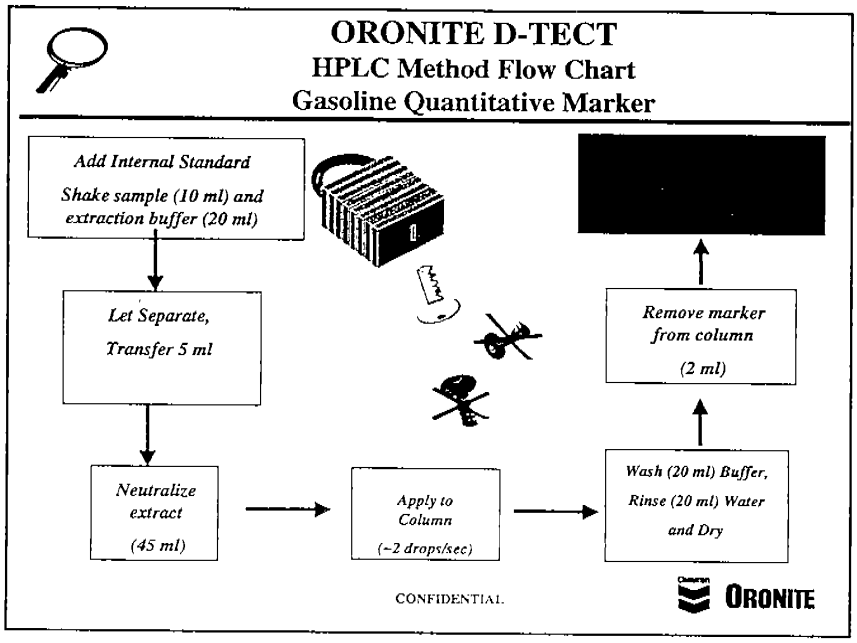
ORONITE


ORONITE D-TECT
HPLC Method Flow Chart
Gasoline Quantitative Marker
Add Internal Standard
Shake sample (10 ml) and extraction buffer (20 ml)
Let Separate,
Transfer 5 ml
Neutralize extract
(45 ml)
Apply to Column
(~2 drops/sec)
Wash (20 ml) Buffer, Rinse (20 ml) Water and Dry
Remove marker from column
(2 ml)
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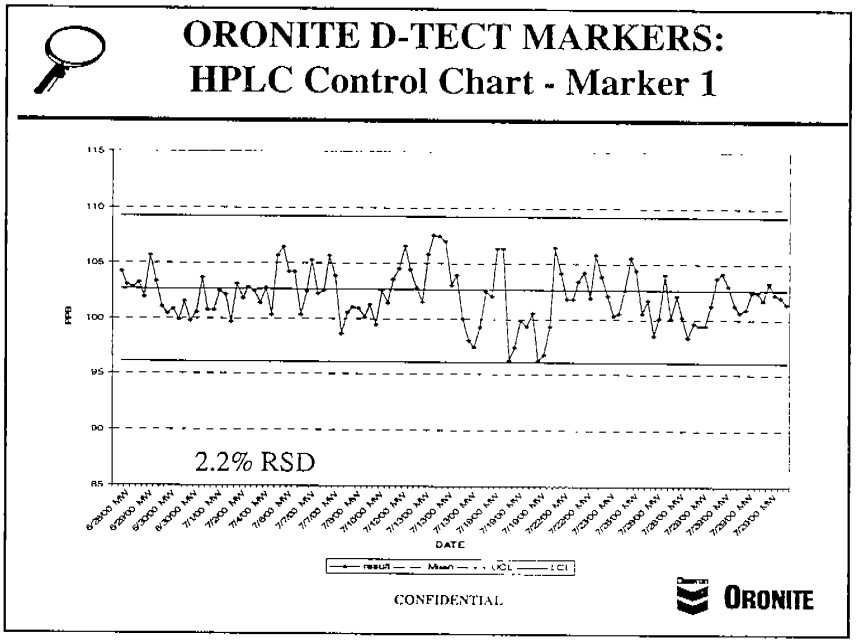
ORONITE D-TECT MARKERS:
HPLC Control Chart - Marker 1
2.2% RSD
DATE
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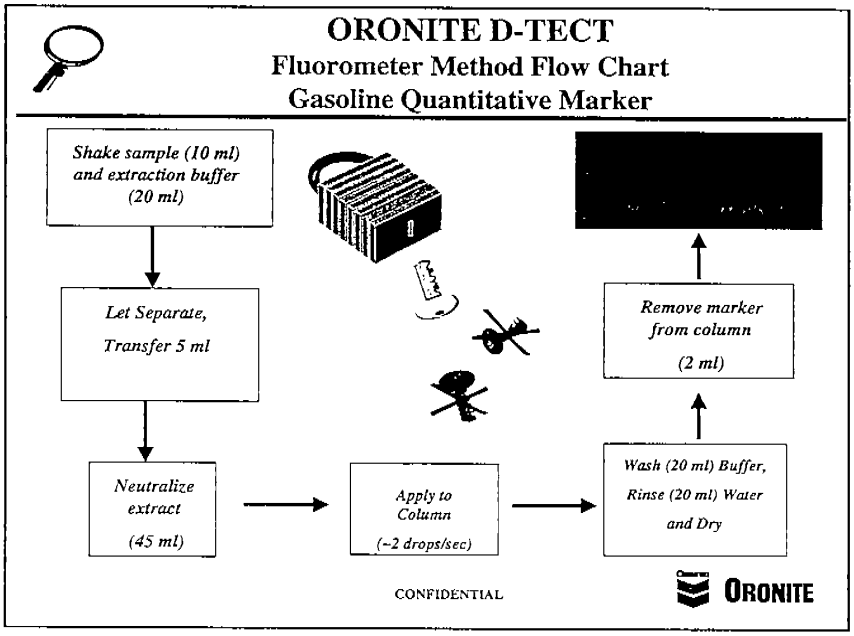
ORONITE D-TECT
Fluorometer Method Flow Chart
Gasoline Quantitative Marker
Shake sample (10 ml) and extraction buffer (20 ml)
Let Separate, Transfer 5 ml
Neutralize extract (45 ml)
Apply to Column (~2 drops/sec)
Wash (20 ml) Buffer, Rinse (20 ml) Water and Dry
Remove marker from column (2 ml)
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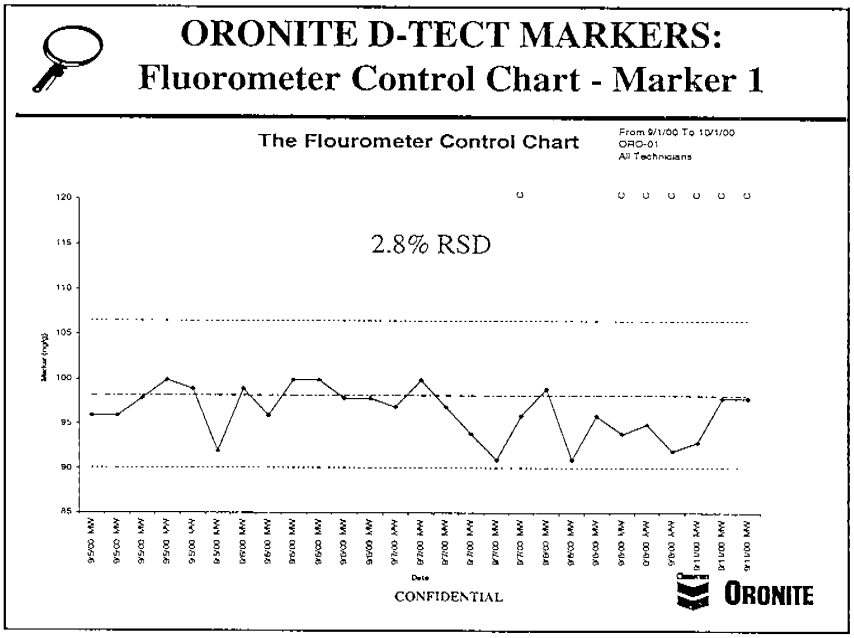
ORONITE D-TECT MARKERS:
Fluorometer Control Chart - Marker 1
The Flourometer Control Chart
From 9/1/00 To 10/1/00
ORO-01
All Technicians
2.8% RSD
120
115
110
105
100
95
90
85
Date
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Technical Recommendation

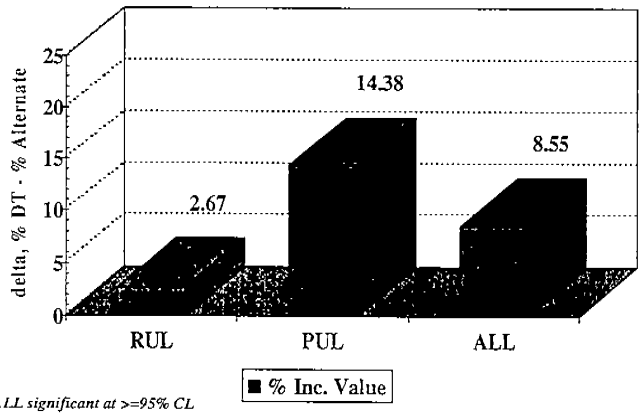
- The Alternate test was good at detecting if gasoline additive had been put in at the terminal. However, the test did not work well detecting dilution by competitive gasoline. The test was prone to interference from other's gasoline additives and contaminants.
- D-TECT's higher statistical precision and accuracy allowed the test to detected lower levels of gasoline dilution. The unique marker minimized test interferences and provided a definitive way to test for Chevron gasoline.
- Based on the performance differences of the two testing methods, D-TECT was judged to be the better test.

ORONITE D-TECT MARKERS

TEST METHODS

INCREMENTAL VALUE FOR D-TECT HPLC

(Population of samples, both test methods)



PUL & ALL significant at >=95% CL

RUL insignificant

No samples where Alternate test failed, DT passed.

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FIELD RESULTS SUMMARY

- D-TECT detected more failures than the Alternate test:
  - » RUL, 2.7% more on average (by sample size, not significant @ 95% CL)
  - » PUL, 14.4% more on average (by sample size, significant @ 95% CL)
  - » System, 8.5% more on average (by sample size, significant @ 95% CL)
- D-TECT detected failures which the Alternate test missed. However, the Alternate test did not detect failures that D-TECT missed.

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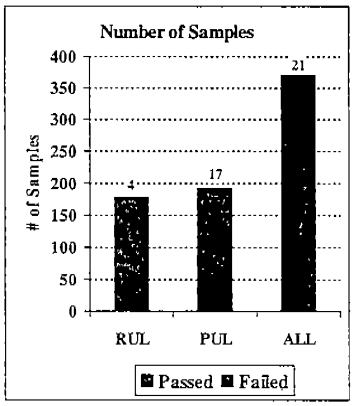
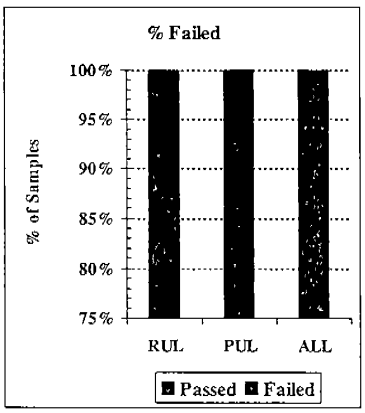
Alternate Test POPULATION





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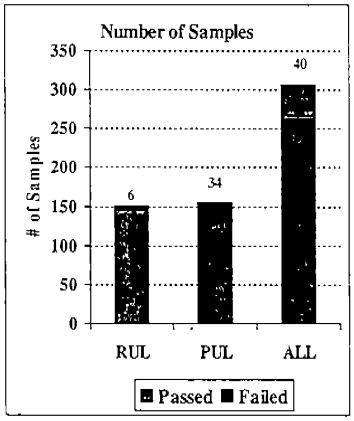
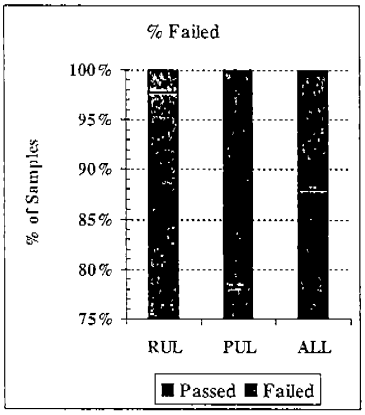
D-TECT HPLC POPULATION





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PROGRAM OVERVIEW

- Program Description:
  - » Two Terminals
  - » Sampled 150 Retail Stations
  - » RUL & PUL
- Sampling period: June 22-23 and 25-26
- Data Sets:
  - » By Test method
  - » By Fuel Grade (RUL, PUL)
- Analytical Methods:
  - » D-TECT HPLC and Alternate Test Method conducted by Southwest Research Institute (SwRI).

D-TECT TEST PRECISION

- Statistical Process Control charts from SwRI confirmed that the D-Tect test standard deviation was 2.2%.
- The Alternative Test method standard deviation was about 5.0%.
- Better Precision with the D-Tect HPLC method allows for a tighter cut-off point at equivalent confidence level (99%)

ENFORCEMENT SUCCESS AT US MAJOR 1

OPIS ARTICLE

- *D-TECT CUSTOMER*
- *IDENTIFIED CHEATING*
- *ENFORCED POLICIES*
  - *FINES &/OR*
  - *DEBRAND*
- *SEEK INDEMNITY FOR COSTS*

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99-08-25 17:35:54 EDT

*** *(US MAJOR)* STEPS UP EFFORT TO STOP GASOLINE CO-MINGLING

(US MAJOR) HAS FOLLOWED THROUGH ON PROMISES TO PENALIZE MARKETERS CAUGHT COMMINGLING GASOLINE IN VIOLATION OF THEIR DISTRIBUTOR FRANCHISE AGREEMENT AND FEDERAL TRADEMARK LAWS. OPIS HAS CONFIRMED THAT A NUMBER OF MARKETERS WERE FINED IN JULY AND AUGUST, FOLLOWING A YEAR-LONG EFFORT BY *(US MAJOR)* TO ENFORCE THE INTEGRITY AND QUALITY OF ITS BRAND. OPIS HAS CONFIRMED THAT A NUMBER OF VIOLATIONS HAVE TAKEN PLACE IN NEW JERSEY, TEXAS, AND FLORIDA. THERE ARE ALSO REPORTS OF COMMINGLING PROBLEMS IN VIRGINIA AND NORTH CAROLINA. THE STATIONS WERE FOUND TO BE FLYING THE *(US MAJOR)* FLAG, BUT NOT EXCLUSIVELY SELLING *(US MAJOR)* GASOLINE.

A LETTER RECENTLY SENT TO MARKETERS FROM *(US MAJOR)* MARKETING VICE PRESIDENT *(name)* NOT SELLING *(US MAJOR)* GASOLINE. A LETTER FROM *(name)*, CITED THE VIOLATIONS, NOTING THAT "TESTING FOR THE PRESENCE OF THE MARKER HAS RESULTED IN IDENTIFYING SOME BRANDED RETAIL LOCATIONS THAT WERE NOT SELLING *(US MAJOR)* BRANDED GASOLINE."

SOME OF THE UNITS THAT HAVE VIOLATED THEIR CONTRACTS ARE SECOND OFFENDERS, OPIS IS TOLD. MARKETERS THAT SUPPLIED THESE RETAIL LOCATIONS HAVE RECEIVED A LETTER FROM *(name)* REQUESTING THAT THE SITE BE DEBRANDED. MARKETERS ARE ALSO BEING PROVIDED AN OPPORTUNITY TO CONTINUE TO USE THE *(US MAJOR)* BRAND. THEY MUST FIRST PAY A $10,000 FINE PER SITE, THEN CERTIFY THAT NO FURTHER COMMINGLING WILL TAKE PLACE. *(US MAJOR)* RESERVES THE RIGHT TO SEEK INDEMNITY FOR ANY COSTS AND EXPENSES INCURRED BY THEM AS A RESULT OF THE SALE OF NON-*(US MAJOR)* BRANDED PRODUCT.

MARKETERS ADMIT THEY HAVE GOTTEN PLENTY OF WARNING FROM *(US MAJOR)* ABOUT COMMINGLING. LAST WINTER, *(name)* TOLD MARKETERS THAT THE SALE OF UNBRANDED GASOLINE UNDER THE *(US MAJOR)* NAME WAS THE SUBJECT OF A "CLASS ACTION LAWSUIT AGAINST A *(US MAJOR)* MARKETER." THE LAWSUIT WAS FILED IN BOSTON AGAINST *(name of retailer)*, SOURCES TELL OPIS.

THE MARCH LETTER OUTLINED *(US MAJOR)*'S POLICY ON COMMINGLING AND THE STEPS IT WOULD TAKE SHOULD MARKETERS VIOLATE THE DIRECTIVE. AS LATE AS JULY, *(US MAJOR)* MARKETING REPS SENT E-MAILS TO THEIR ACCOUNTS WITH BOLD LETTERS REMINDING THEM THAT THERE WOULD BE SEVERE CONSEQUENCES SHOULD THEY GET CAUGHT COMMINGLING PRODUCT. *(US MAJOR)*'S EFFORT TO CATCH VIOLATORS "IS UNDERWAY," ACCORDING TO *(name)*.

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D-TECT® Two Terminal Testing Program

Comparison of D-Tect and Alternate Testing Method

December 1, 2000

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ORONITE D-TECT MARKERS

US MAJOR 1 CASE STUDY

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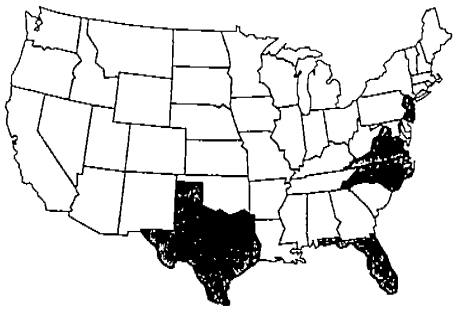
USA Fuel Marking Program
US Major 1



Problems identified

- OBJECTIVE
  - » Protect Brand Integrity and Quality
  - » Prevent Dilution
- METHODOLOGY
  - » Limited evaluation
  - » Selected terminals & regions on a rotating basis
- RESULTS
  - » Branded Stations found selling unbranded fuel
  - » in 25-35% of stations tested
  - » Disbranded &/or Fines

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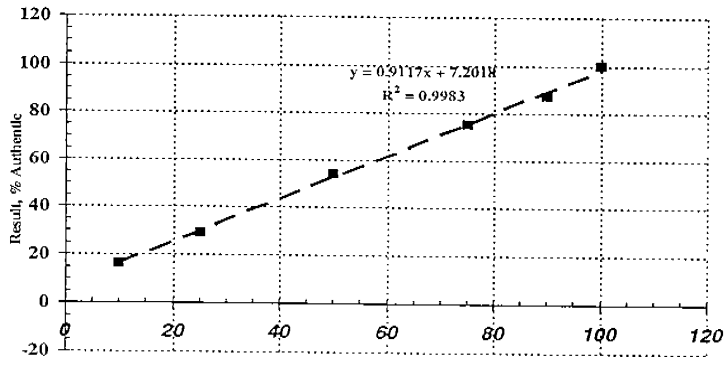
ORONITE D-TECT MARKERS: Dilution Study



Hand Blends

Fluorometer Test

result — Linear (result)

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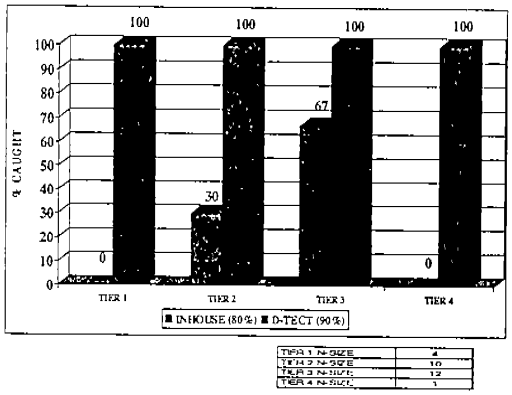
ORONITE D-TECT
MAXIMIZE DETECTION, ENFORCEMENT& RECOVERY

- 27 Lab samples
- Diluted 25% or 50% with
  - » competitive gasolines
  - » "unknown" at 10%
- CaRFG & 49 state fuels
- Identifies More "Cheaters"
- **Catches "Heels"**
  - » Random Sampling
- **Selective and Accurate**
  - » No False Positives
  - » Measured outside matrix
- Precise
  - » Tighter Detection Limits



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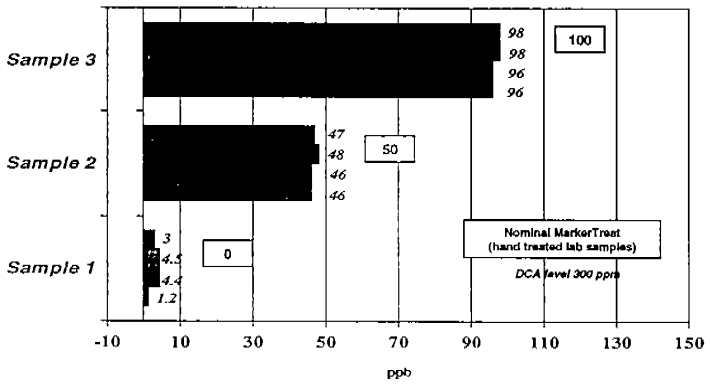
ORONITE D-TECT MARKERS:
Fluorometric Analysis of Gasoline



4 TESTS/SAMPLE

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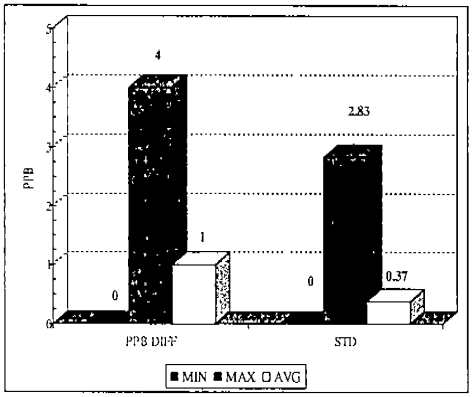
FIELD TEST PRECISION EXAMPLE
CUSTOMER CONTRACT TECHNICIAN

- FLUOROMETER TEST
- 25 SAMPLES REPEATED
  - » By result level
    - – 19 LOW
    - – 5 HIGH
    - – 1 OK
  - » By fuel grade
    - – 10 REGULAR
    - – 15 PREMIUM
  - » By Terminal
    - – 20 TERMINAL 1
    - – 5 TERMINAL 2
- EXCELLENT PRECISION



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San Diego Yellow Cab Fleet Test

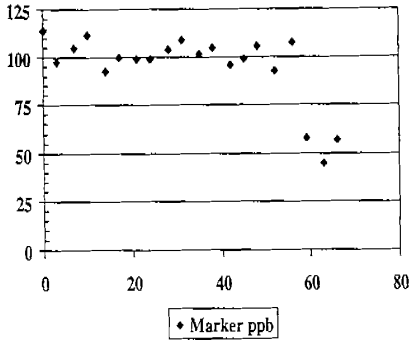
- Primary program objective - No harm evaluation of marker.
  - » Four model, eight vehicle 20,000 mile SDYC Test
  - » One vehicle of each model run with and one without
  - » Marker evaluated at 3X over-treat level.
  - » All fuel (CA Phase 2) was treated with a PBA/Synthetic package.
  - » 10,000 mile crankcase oil drains using 10W-30, SH
  - » Crankcase Sludge and Varnish, intake system ratings, measured at test completion.
- Results-No Engine Harm Detected

Other No Harm Testing

- Water Extraction from Fuel -- NONE
  - » Test 1
    - – no marker extracted using ASTM D1094 & ph 3, 7, 11.6
    - – Base Gasoline marked at 10 ppm
  - » Test 2
    - – Multiple Contact Test (same buffers as above), 10 Cycles
    - – Base Gasoline, Additized Gasoline, Gasoline with MTBE
      - all 8 ppm marker level
- Oxygenates do not interfere with marker detection
- Absorption on solids
  - » not absorbed by activated clay, activated alumina, Fullers Earth, Celite, etc.

ORONITE D-TECT Markers:
Stable in Finished Fuels

- Marker added to fuel at 100 ppb nominal
- 2 months in field
- Unmarked fuel added at day 59
  - » dilution confirmed



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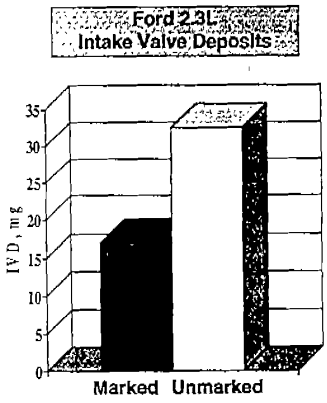
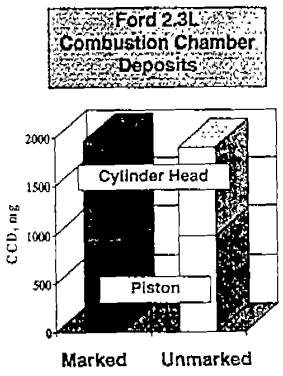
Fuel No-Harm Testing
(SDVC Fleet Results Also Available)





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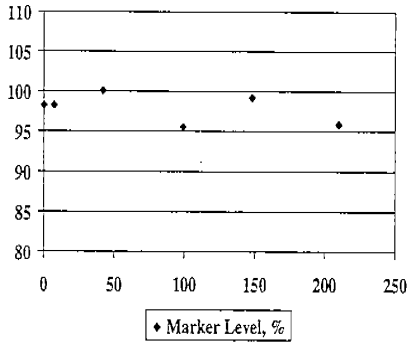
ORONITE D-TECT Markers:
Technology Overview

- Utilizes immunoassay ("binding pair") technology
  - » Lock (Marker) and Key (Test Column) System
- Organic compounds
  - » containing only carbon, hydrogen, nitrogen, & oxygen
- Not naturally found in petroleum products
- Soluble, Stable, and Compatible in fuels, lubes, and DI &DC packages
- **Extremely low treat rates (typical) in finished products**
  - » <= 100 ppb for Quantitative Markers
- Field and Lab Test Capabilities

ORONITE D-TECT Markers:
Stable in Additive Package

- Marker at 3x recommended treat
- 6 months + at 110F
- No change in physical or chemical properties of additive package
- Results by HPLC



Marking Technology Scorecard

Technology	Cost	Ease of Field testing	Accuracy precision	Interference Problems	Comments
1st Generation Dyes-Visible Markers	A	A	F	F	Easily laundered, readily available
2nd Generation Dyes-Invisible Markers	B	A	B	C	Launderable, interference problems
Near-IR and Differential Spec (mixed marker systems)	B	A	B	C	Still launderable, but better. Absorbance shifts in matrix noted. Interference possible.
ORONITE D-TECT Immunoassay 'Binding Pair'	**B**	**B**	**A**	**A**	**Secure, ppb treat levels, no interference, high degree of accuracy**
Stable Isotopes	B	F	B	?	Perception problems 'isotopes' No possible field test Very high cost of instrumentation

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ORONITE D-TECT MARKERS

TECHNOLOGY OVERVIEW

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Traditional Marking Techniques

Visible Dyes

- Treat levels, 10-20 ppm
- Qualitative
- Apparent to end-user and counterfeiter
- Widely distributed and fairly easy to compromise

Covert Dyes

Treat Levels, 5-20 ppm
Qualitative/Semi-Quantitative
Invisible in the Product per se
Visualized through Acid or Base Treatment
Significant potential for background interference

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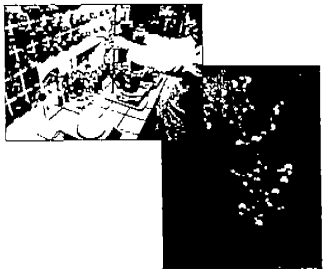
New Covert Marking Techniques

Near IR Fluorescent Marker Dyes

- Potential background interference
- Lack of concentration process leads to higher dosage
- Matrix affects noted in analysis



Isotopically Labeled Markers

Stable Isotopes
Sophisticated and expensive detection instrumentation required (GC/MS)
No field test

ORONITE D-TECT Markers

Easily separable from background interference
Excellent accuracy and precision in field & lab
Extremely low treat rates, ppb
Widely used in medical field due to selectivity

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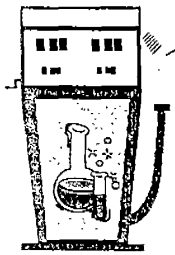
MARKER TECHNOLOGY OVERVIEW

Traditional Marking Techniques



- Treat levels, 10-20 ppm
- Qualitative and/or quantitative
- Apparent to end-user and counterfeiter
  - » Security and covertness?
- Uniqueness?
- background interference problem

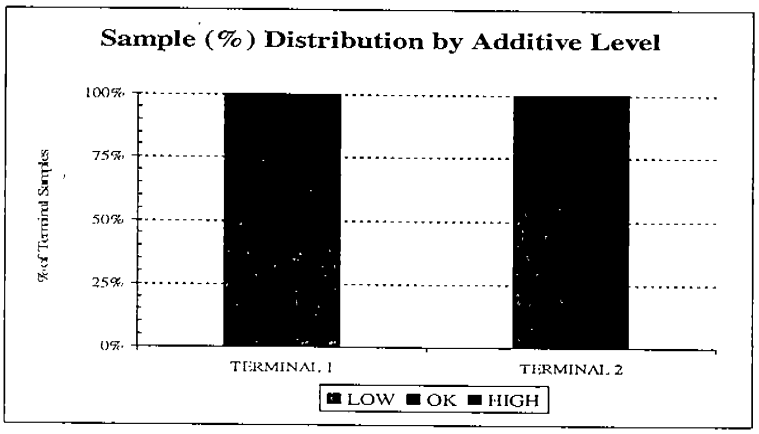
SUPPLY RECOMMENDATIONS FOR CPC - TAIWAN MARKER SPECIFICATIONS

- Marker Supplied in Additive Package
  - » Easy to Use, Easy to Handle
  - » No extra costs for equipment (injection, storage, etc)
  - » No significant impact on freight costs
  - » No significant impact on current operations
    - – Marker injects with additive package
  - » Marker Security Measure
    - – Marker not readily available to "disappear"
    - – Maintains Covertness of Marker
  - » Consistent Marker Level in Additive Package
    - – QC Tool for Additive Addition to Finished Fuel
    - – Minimizes "Ups & Downs" of Retail Fuel Marker Level

MARKER CONCENTRATE SUPPLY REQUIREMENT FOR CPC - TAIWAN GASOLINE

- Givens:
  - – OGA72304, treating at 223.6 ppm, density of 0.9091 kg/L
  - – 3% wt Marker Concentrate, density of 0.876 kg/L
  - – Marker concentrate blended into OGA to provide 100 ppb marker level in finished fuel
    - Additive contains 447.2 ppm active marker
  - – 10 Billion Liters of Gasoline per year to be marked
- Requirement: 24.67 MT Marker Concentrate (28.16 kL)

MANUFACTURING QC CASE STUDY
TERMINAL SAMPLE (ALL) SUMMARY



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MANUFACTURING QC CASE STUDY
SUMMARY & CONCLUSIONS

- Manufacturing
  - » Marker stable in DCA in tank and delivered at correct level to injectors
  - » Samples of blended gasoline (terminal) showed manufacturing concerns
    - OVER-INJECTION
      - ⇒ Financial penalty to Marketer (additive costs)
      - ⇒ 6% of Terminal 1 samples & 34.9% over-treat above spec max on average
      - ⇒ Potentially, an extra 1043+ gallons DCA per year
        151MM gal fuel *6% fuel * (0.33GTG*34.9%)
    - UNDER-INJECTION
      - ⇒ Found at both Terminals
      - ⇒ Terminal 1: 35% of samples, 18% under-treat
      - ⇒ Terminal 2: 47% of samples, 25% under-treat
      - ⇒ Product Quality Concerns (Lost $$ = Brand-Value Costs, Consumer Complaints)
      - ⇒ Regulatory Compliance (Significant $$ Potential - EPA fines (25K/day/occurrence))
  - » Identified Injector Calibration Problems

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MANUFACTURING QC
CASE STUDY

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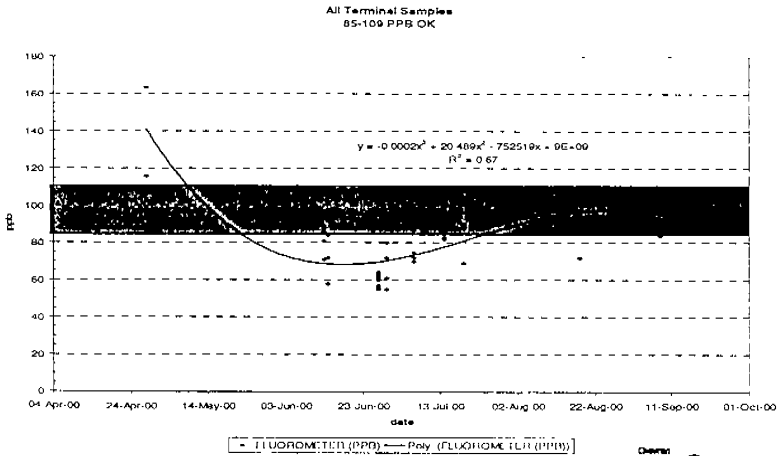
MANUFACTURING QC CASE STUDY
Marker Level in Terminal Samples (2 Locations)



MFG SPEC = +/-10%

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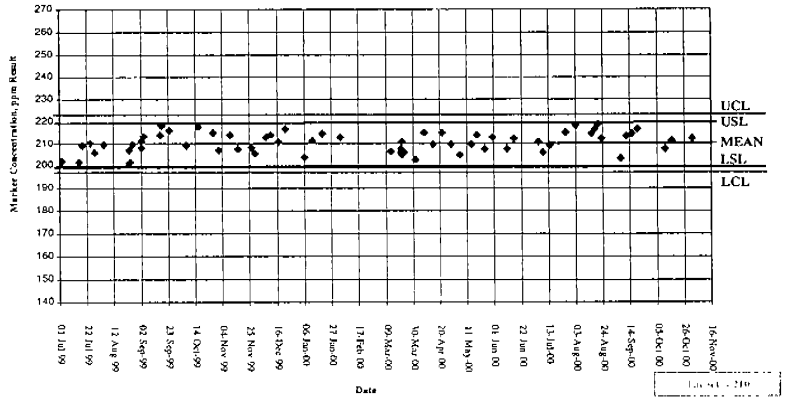
OGA XXX(shipments made)
MARKER CONCENTRATION, PPM
07/01/99 THROUGH 11/08/00



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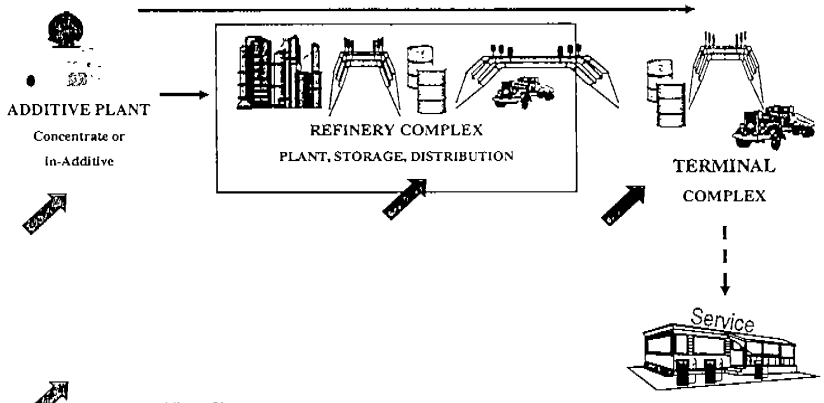
POTENTIAL SUPPLY CHAIN LOCATIONS
FOR MARKER ADDITION



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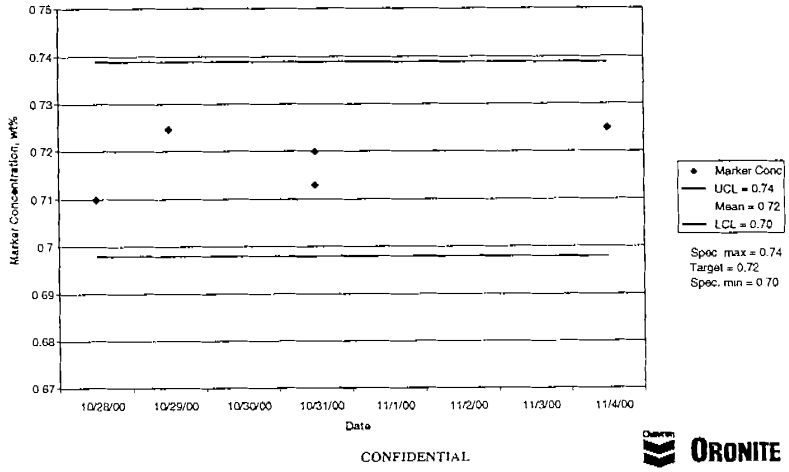
DT66600 Marker %WT Control Chart



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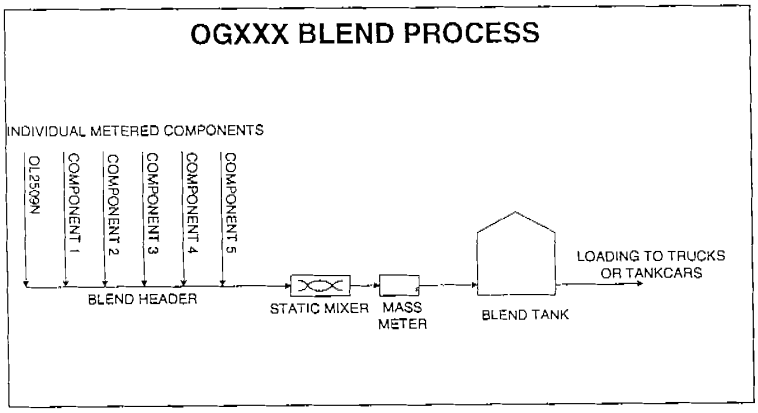
MARKER BLENDING INTO OGAXXX



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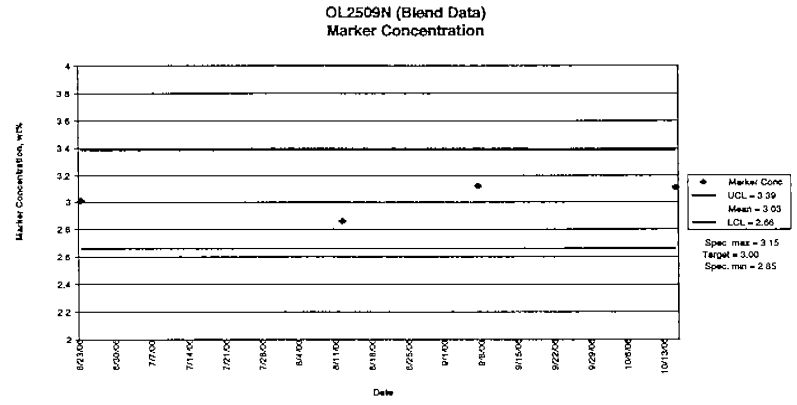
OLOA 2509N Marker %WT Control Chart



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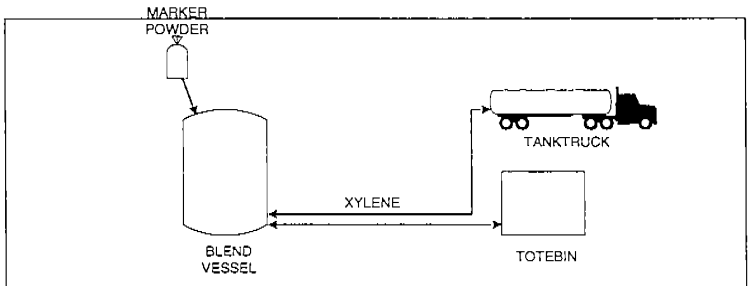
OAK POINT BLEND PROCESS:

Marker Concentrate for Shipment Outside Oak Point



BLEND PROCESS

1. 1000 gallons of xylene charged from 3 totebins or one compartment of truck
2. Powder is added and allowed to mix for at least 4 hours.
3. Blend is tested
4. Marker blend is then loaded into the totebins or truck compartment

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MARKER MANUFACTURE QC

- MARKER CONCENTRATE
  - » Each blend analyzed for marker concentration
  - » Specifications are customer-dependent, <= +/- 5%
  - » Reblended if not within specs.
- MARKER CONCENTRATE INTO OGA
  - » Storage Tank analyzed after each concentrate batch added
  - » Marker concentrate addition adjusted based on tank concentration
  - » OGA Marker Level Specifications are customer-dependent,
    - – typically, <= +/- 5%
  - » OGA Reblended if not within specs.

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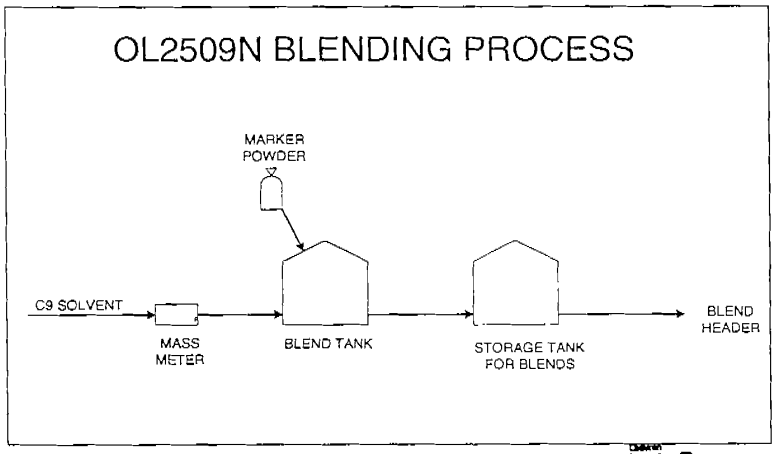
OAK POINT BLEND PROCESS:

Marker Concentrate for Addition to OGA Package



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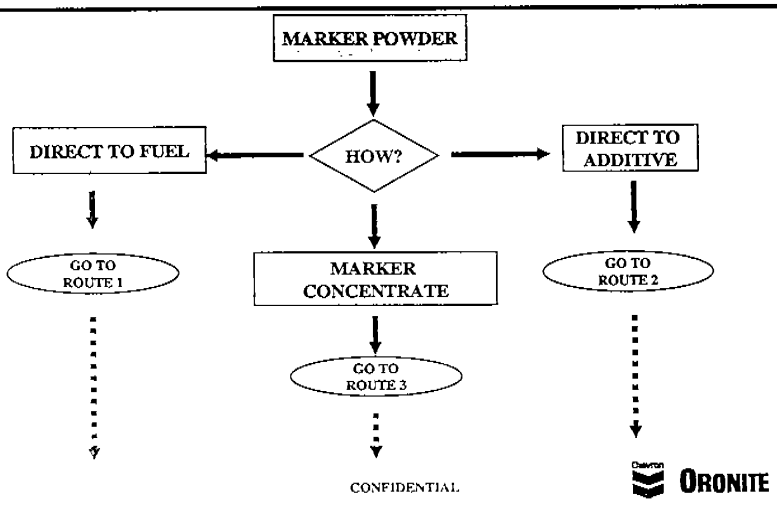
Manufacturing Overview: Options for Adding Marker



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Oronite's Oak Point, Louisiana Plant

- Manufactures
  - » Components
  - » Fuel Additive Packages
  - » Lube Additive Packages
  - » Oronite D-TECT Marker Packages
- Oronite D-TECT Marker Supplied as a
  - » Concentrate to End-User
  - » Integral part of the additive package
    - — add either marker concentrate (preferred) or powder directly

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Marker Implementation Considerations

Many items to Consider:

- Objective(s) for Requiring a Marker
- How, Where & What to Mark
- Marker Security
- Marker Handling & Logistics (QC, Equipment, etc.)
- Manufacturing & Distribution Capabilities
- Control Sources of Variation
- Enforcement & Control of Your System
- et cetera . . .

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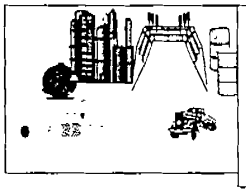
Marker Manufacturing Considerations



Additive Plant - Equipment, Work Processes, Etc.
Customer's Equipment, Processes, Facilities, Etc.
Solvent Selection
Handling Issues
Mixing Issues
Quality Control
Other Logistical &
Manufacturing Issues

SOLVENT
Compatibility
Stability
Cost
Handling
Etc.

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ORONITE D-TECT® Markers

Marker Systems
to Protect Brand Integrity
and Enhance Revenues
in the Fuels Industry

Presented to:

Dr. Kong Kwang Cheng

CPC - Taiwan

December 1, 2000

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DISCUSSION TOPICS

- Marker Implementation Considerations
- Manufacturing Options Overview
- Competitive Overview
- ORONITE D-TECT® Markers
  - » Technology Overview including Stability & No Harms
- US Case Studies
- ORONITE D-TECT Markers Testing Overview
  - » Fluorometer Demonstration & HPLC Lab Tour
- Fuels Regulatory & Market Trends
  - » Engine Lab Tour & Presentation
- ORONITE D-TECT Markers Wrap-up
  - » Benefits Summary
  - » Marker Specifications

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XAG 895

Premium Deposit Control for the Gasoline Aftermarket

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XAG 895

OVERVIEW

- Introduction
- Recommended Treat Rate
- Recent Performance Testing
  - » San Diego Yellow Cab (SDYC) Vehicle Testing
  - » Southwest Research (SwRI) Vehicle Testing
  - » Chevron Oronite Technology Japan Vehicle Testing
  - » Chevron Oronite Technology Richmond Lab Engine Testing
- Typical Properties
- Performance Claims Summary

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XAG 895

INTRODUCTION

A new premium performance deposit control additive based on Oronite's polyether amine (PEA) new manufacturing process that eliminates trace chlorine

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XAG 895

RECOMMENDED TREAT RATE

Recommended dosage for optimum performance is at 4250 mg/kg (ppmw).

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SDYC Vehicle Testing: IVD

- Oldsmobile 3.8L V-6
- Severe taxi cab service
- 49-state regular unleaded gasoline
- 12,000 miles accumulated with EPA-certified 49-state fuel (with compliance additive treat):
  - » Full inspection of intake system
- One-tank (300 miles) cleanup with:
  - » XAG 895 treatment at 100% dose
  - » Full inspection of intake system

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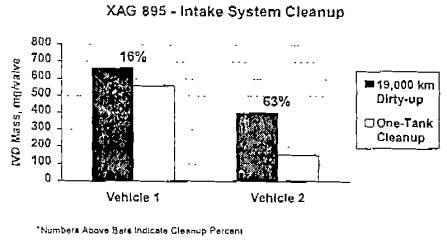
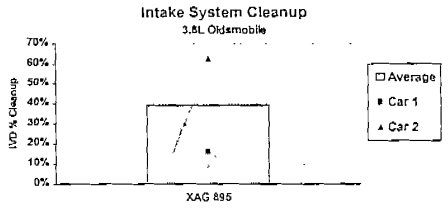
SDYC Vehicle Testing Results



*Numbers Above Bars Indicate Cleanup Percent

SDYC Vehicle Testing Results



SDYC Vehicle Testing: IVD

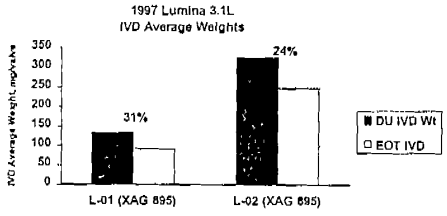
- XAG 895 provides significant intake valve cleanup performance as shown in real world driving conditions at San Diego Yellow Cab.
- Statistically significant IVD cleanup shown using "Student T" Test at the 90% confidence interval

SwRI Vehicle Testing

Test Program Outline:

- Four 1997 Chevrolet Lumina 3.1L V-6
- Cleanup fuel using:
  - XAG 895 at 100% dose
- Driving cycle: 8,000 km dirty-up, then one-tank cleanup
  - On-road "BMW" cycle
  - 70% highway, 20% suburban, 10% city
- Measurement: before and after one-tank cleanup
  - Intake valves, port, and manifold weight deposits

SwRI Vehicle Testing: IVD

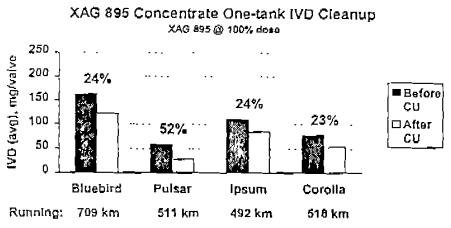


Oronite Japan Evaluation of XAG 895 Concentrate

Test Program Outline:

- Rent-a-car: 4 makes (one vehicle each):
  1 - 1996 Nissan 1.8L L-4 (SR18DE) 47,790 km
  2 - 1996 Nissan 1.5L L-4 (GA15DE) 41,608 km
  3 - 1996 Toyota 2.0L L-4 (3S-FE) 58,650 km
  4 - 1996 Toyota 1.5L L-4 (5A-FE) 29,224 km
- Fuel for one-tank cleanup:
  -- unleaded gasoline with XAG 895 @ 100% dose
- Driving pattern
  -- All vehicles were operated under commute conditions
- Measurement: before and after one-tank cleanup
  -- Intake valves, port and manifold: weight deposits
  -- Combustion chamber (piston top and cylinder head): thickness

Performance in Japanese Engines



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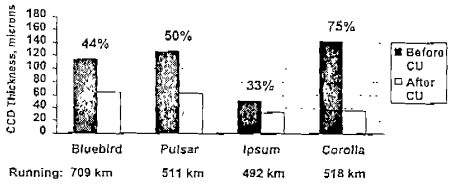
Performance in Japanese Engines

XAG 895 Concentrate One-tank CCD Cleanup

XAG 895 @ 100% dose



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Richmond Lab Engine Testing

- A twenty test matrix looking at IVD cleanup dose response in three lab engines and two dyno vehicles
  - » Lab Engines:
    - 4.6L Ford V-8
    - 3.1L GM V-6
    - 2.5L Mazda V-6
  - » Dyno Vehicles
    - 2.3L Ford I-4
    - 3.3L Chrysler V-6
  - » Cleanup Fuels
    - XAG 895 tested at 100% dose
  - » 100 hour dirty-up followed by a 14 hour cleanup

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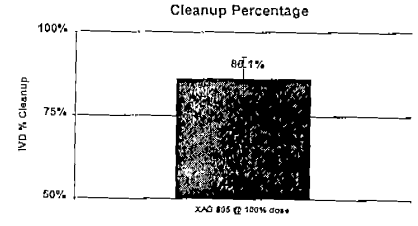
Richmond Lab Engine Testing

Intake Valve Deposit Cleanup Percentage



* Error Bars Represent 90% Confidence Interval

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4.6L Ford Lab Engine Data

Test Program Outline:

- 1993 Ford 4.6L V-8 OHC engine
- Dirty-up/cleanup cycle
  - » 72 hour dirty-up with EPA LAC additized fuel
  - » 14 hour cleanup with XAG 895 at 100% dose

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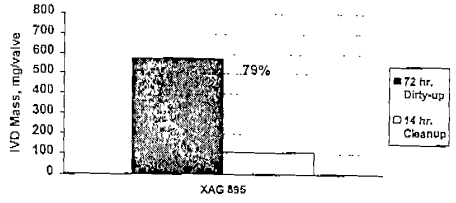
4.6L Ford Lab Engine Testing Results

Intake System Cleanup



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Intake Valve Cleanup Dose Response Curve

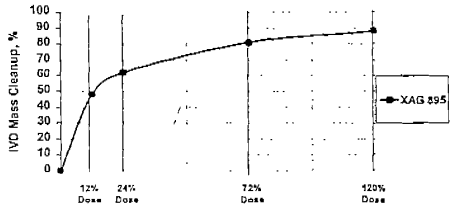
Test Program Outline:

- 1993 Ford 4.6L V-8 OHC engine
- Dirty-up/cleanup cycle
  - » 72 hour dirty-up with EPA LAC additized fuel
  - » 14 hour cleanup with XAG 895

4.6L Ford Lab Engine Testing Results

XAG 895 Dose Response

1993 Ford 4.6L V8 - 72 hr DU, 14 hr CU



XAG 895 Octane Requirement Decrease

Test Design:

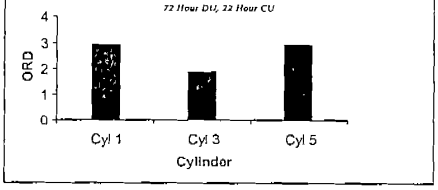
- 2.5L Mazda V-6 lab engine
- Individual cylinder octane appetite measurement
- Electronic knock detection

- 72 hour dirty-up with a regular unleaded fuel
- 22 hour cleanup with 100%dose of XAG 895

XAG 895 Octane Requirement Decrease

Mazda 2.5L: Split-Rail ORD Testing

72 Hour DU, 22 Hour CU



XAG 895 Typical Properties

Property	Method	Typical
Basic Nitrogen, wt%	ASTM D2896-92	0.64
Density, Kg/L	ASTM D4052-96	0.915
Flash PMCC, Deg C	ASTM D93-90	54
Viscosity cSt @ -18°C @ 40°C	ASTM D445-94	870 29.5
Color	ASTM D1500	0.5

XAG 895 Deposit Control Summary

- *Numerous test programs demonstrate superior deposit cleanup capability of XAG 895 when used at "Premium Performance" treat rate*
  - » Multiple test platforms
  - » Multiple test vehicle models
  - » Multiple test fuels
  - » Multiple test laboratories and filed sites
- "Premium Performance" Summary
  - » "One-Tank" rapid cleanup of intake system and combustion chamber
  - » Extensive database
  - » "No Harm" database developed at San Diego Yellow Cab

XAG 895 Performance Claims

- Cleans carburetors, port fuel injectors, intake manifolds, ports, valves and combustion chambers
- Improves fuel economy
- Restores lost power
- Reduces emissions (HC, CO, NOx)
- *Improves driveability: reduces or eliminates hesitation,* stumbling, surge, rough idle and stalling
- Reduces or eliminates engine knock
- Reduces or eliminates engine run-on
- Reduces engine octane requirement

XAG 895 Performance Claims (cont.)

- May allow change from Premium to Regular grade fuel
- Reduces or eliminates Combustion Chamber Deposit Interference (CCDI), also known as "Carbon Rap"
- Reduces or eliminates valve sticking
- Prevents spark plug fouling
- Eliminates Central Port Injection (CPI) sticking
- No harmful side effects: oil viscosity increase, crankcase sludge and varnish, bearing wear and corrosion, valve sticking, combustion chamber deposits