

Table 1: Light Duty Cars and Commercial Vehicles

| Gasoline | No Catalyst | Euro 1 | Euro 2 | Euro 3 | Euro 4 | Euro 5 | Comments |
|------------------------------------|---|--|--|----------------------------|--------------------------|--|---|
| Lead ↑ | Pb, HC↑ | CO, HC, NOx all increase dramatically as catalyst destroyed | | | | | |
| Sulfur ↑ (50 to 450 ppm) | SO ₂ ↑ | CO, HC, NOx all increase ~15-20% SO ₂ and SO ₃ increase | | | | | Partial recovery possible if occasional high sulfur |
| Olefins ↑ | Increased 1,3 butadiene, increased HC reactivity | | | | | Potential deposit buildup | |
| Aromatics ↑ | Increased benzene exhaust | | | | | | |
| Benzene ↑ | Increased benzene exhaust and evaporative emissions | | | | | | |
| Ethanol ↑ up to 10% O ₂ | Lower CO, HC, slight NOx increase, Higher aldehydes | Minimal effect with catalyst equipped vehicles | | | | | Increased evaporative emissions unless RVP adjusted |
| MTBE ↑ up to 10% O ₂ | Lower CO, HC | Minimal effect with catalyst equipped vehicles | | | | | Concerns over Water Contamination |
| MMT ↑ | Increased Manganese Emissions | | | Possible Catalyst Plugging | Likely Catalyst Plugging | O ₂ sensor and OBD may be damaged | |
| RVP ↑ | Increased evaporative HC Emissions | | | | | | |
| Detergents ↑ | | | Especially helpful with Fuel Injected Vehicles | | | | |

Table 2: Motorcycles

| Gasoline | No Catalyst | India 2005 | Euro 3 | India 2008 | Taipei,China Stage 4 | Comments |
|------------------------------------|---|--|--------|------------|---------------------------|---|
| Lead ↑ | Pb, HC↑ | CO, HC, NOx all increase dramatically as catalyst destroyed | | | | |
| Sulfur ↑ (50 to 450 ppm) | SO ₂ ↑ | CO, HC, NOx all increase SO ₂ and SO ₃ increase | | | | |
| Olefins ↑ | Increased 1,3 butadiene, increased HC reactivity | | | | Potential deposit buildup | |
| Aromatics ↑ | Increased benzene exhaust | | | | | |
| Benzene ↑ | Increased benzene exhaust and evaporative emissions | | | | | |
| Ethanol ↑ up to 10% O ₂ | Lower CO, HC, slight NOx increase | Minimal effect with catalyst equipped vehicles | | | | |
| MTBE ↑ up to 10% O ₂ | Lower CO, HC | Minimal effect with catalyst equipped vehicles | | | | Concerns over Water Contamination |
| MMT ↑ | Increased Manganese Emissions | Possible Catalyst Plugging | | | | With low cell density, catalyst plugging risk seems small |
| RVP ↑ | Increased evaporative HC Emissions | | | | | |
| Detergents ↑ | | Especially helpful with Fuel Injected Vehicles | | | | |

Table 3: Light Duty Diesel Vehicles

| Diesel | Pre-Euro | Euro 1 | Euro 2 | Euro 3 | Euro 4 | Euro 5 | Comments |
|------------------------------------|---|--------|--|--------|---|--------|---|
| Sulfur↑ | SO ₂ , PM↑ | | If ox cat, SO ₃ , SO ₂ , PM↑ | | If Filter, 50 ppm maximum, 10-15 ppm better | | If NOx adsorber used requires near zero sulfur (<10 ppm) With low S, use lubricity additives |
| Cetane↑ | Lower CO, HC, benzene, 1,3 butadiene, formaldehyde & acetaldehyde | | | | | | Higher white smoke with low cetane fuels |
| Density↓ | PM, HC, CO, formaldehyde, acetaldehyde&benzene↓, NOx↑ | | | | | | |
| Volatility (T95 from 370 to 325 C) | NOx increase, PM decrease | | | | | | |
| PolyAromatics↓ | NOx, PM, formaldehyde & acetaldehyde↓ but Hc, benzene & CO ↑ | | | | | | |

Table 4: Heavy Duty Diesel Vehicles

| Diesel | Pre-Euro | Euro 1 | Euro 2 | Euro 3 | Euro 4 | Euro 5 | Comments |
|------------------------------------|---|--------|--|--------|---|--------|---|
| Sulfur↑ | SO ₂ , PM↑ | | If ox cat, SO ₃ , SO ₂ , PM↑ | | If Filter, 50 ppm maximum, 10-15 ppm better | | If NOx adsorber used requires near zero sulfur (<10 ppm) With low S, use lubricity additives |
| Cetane↑ | Lower CO, HC, benzene, 1,3 butadiene, formaldehyde & acetaldehyde | | | | | | Higher white smoke with low cetane fuels |
| Density↓ | HC, CO ↑, NOx↓ | | | | | | |
| Volatility (T95 from 370 to 325 C) | Slightly lower NOx but increased HC | | | | | | Too much heavy ends increases smoke and PM |
| PolyAromatics↓ | NOx, PM, HC ↓ | | | | | | |