choked with CO. This limits the progress of the fuel burn. Instead of a clean burn, less desirable products result (eg noxious emissions and deposit formations). Any trend away from a high performance diesel fuel will magnify this result.

Ferrous picrate

Strictly speaking, the action of ferrous picrate is not chemical. That is, it does not alter fuel specifications, and will not provide more energy than contained in the fuel, so there can be no detrimental effects. This is important from an engine warranty point of view. The overall reaction is modified to favour oxidation reactions. More complete combustion is achieved in a shorter time. The action is threefold.

Primary atomisation. The solvent carrier acts as a misting agent upon injection of the fuel, thus presenting a larger surface area of fuel exposed to the air.

Secondary atomisation and initiation. According to University of California, Los Angeles, studies by A. F. Bush, et al, ferrous picrate micro-crystals are formed in the air fuel mixture due to solvent evaporation. These quickly absorb heat energy and ignite. Further atomisation results and a system of multiple flame fronts develops. This increases the flame speed.

Catalysis. As the ferrous picrate ignites, iron radicals are released which act as a catalytic agents between oxygen in the air and carbon in the fuel. Clearly, the catalytic action promotes oxidation. Similarly, this rapidly assists oxidation of CO to CO_2.

Thus the ignition delay is reduced and the period of rapid combustion is assisted by a faster flame speed, more intimate mixing and a more complete burn. The results: peak cylinder pressures are higher, occur earlier and last longer, providing smoother combustion and less mechanical stress. Less desirable fuel components are burnt more cleanly.

Power, fuel efficiency

Subsequent engine efficiency improvements have been well documented in large fleet use, since the late 1970s. Field trials in Australia in mining and power generation industries have consistently demonstrated fuel efficiency improvements of 3-5% for slow — medium speed diesels, 5-8% for high speed diesels.

Test methods employed were:

- Specific fuel consumption.
- Exhaust Carbon Balance.
- Statistical Computer Model.

The Exhaust Carbon Balance method (AS2077-1982) offers the most accurate, quick and hassle-free test method. This is because it measures *instantaneous* flow rates. The above results have been confirmed in controlled trials at Curtin University's thermo-dynamics laboratory (WA). Quite simply, less fuel is required to do the same work, and more power is produced for the same throttle setting.

Exhaust emissions

There are significant benefits for underground operation. Tests at NSW Department of Mines at Londonderry Research Station determined a reduction in exhaust emissions using ferrous picrate as a catalyst. Although these tests were not long enough to properly 'condition' the test engines, the following reductions were observed:
Hydrocarbons (HC) 38%
Carbon Monoxide (CO) 12%

Reductions in HCs of 80% and CO of over 50% are regularly recorded in field trials using exhaust gas analysis equipment.

Reduced engine deposits

In an SAE Technical Paper (No. 831204), by J B Parsons and G J Germane, the maintenance benefits of ferrous picrate were closely examined in several fleets. One 69 piece fleet of Caterpillar equipment included haul trucks, D9 and D10 dozers, 992 loaders, scrapers and graders. The first engine examined was a 348 Cat from a 992C loader with four months catalyst use, and 8000 meter hours.

Examination of the engine showed carbon deposits at near 'normal' levels but with a marked softening of the normal hard carbon being noted in some areas — particularly the centre of the piston crown where bare metal could be exposed by wiping with a rag. There was also evidence of reductions in deposits in the upper liner area above the ring travel, and soot in the manifold exhaust area was "finer and drier".

A progression of this pattern was observed with engines subsequently overhauled. At the end of the two year trial, there was almost a complete absence of hard engine carbon, as the soft residue which remained was easily wiped from cylinder heads, valve ports and piston crowns.

The normal build up of hard scale on these surfaces was absent. Piston rings were exceptionally free of deposits and cylinder compression in high hour engines had been maintained. Valve and piston part numbers were clearly visible. Less exhaust smoke was evident and engine 'startability' showed a marked improvement. Of particular interest was the reduction in liner wear being experienced by the haul trucks. At 8000-9000 hours, liners could be re-used. This was not typical of previous experience. Fuel efficiency improved by seven per cent.

A thirty-two piece fleet of GM powered buses showed similar maintenance benefits. After 12 months operation on the catalyst treated fuel, the fleet began burning blended fuel with no increase in exhaust emissions, while still maintaining the same level of engine cleanliness. However, when the catalyst was removed from the fuel, smoke increased to unacceptable levels. Fuel usage reduced 8% due to ferrous picrate treatment.

Several Cat D353 engines from D9 H dozers in open cut operations were also inspected. They'd operated for some 2800 hours on catalyst treated fuel. Of particular interest was the absence of hard carbon encrustation on the upper ring land of pistons, an area of normal build up, which often results in bore polishing. Sulphur and hard carbon deposits had vanished from valve faces and exhaust valve stems were exceptionally clean.

The extension to engine life can be quite substantial. Particularly where severe combustion problems (eg bore polishing) have been encountered.

Cleaner oil

Cleaner combustion and cleaner oil go hand-in-hand. High carbon solids (soot) in lube oil is a very common complaint these days, which rapidly overloads the oil's detergency/dispersancy package. Higher quality oils and more frequent change intervals might appear to be the correct action to take, but is, in fact, a 'band aid' solution to a combustion problem. Ferrous picrate is of benefit by directly assisting combustion.

Biological growths

FTC, the Australian formulation of ferrous picrate, also has strong biocidal activity to effectively control fungal, yeast and bacterial infestations in fuel.

Reducing maintenance, downtime and fuel costs are prime objectives of any efficient operation. Achieving this goal is made increasingly difficult as fuel quality is reduced. Maintenance people need to know more about their fuel specifications so that they can tailor their maintenance to suit.

In conclusion, ferrous picrate may be unique. It is one product that has been proven beyond doubt to live up to its claims as a combustion improver.

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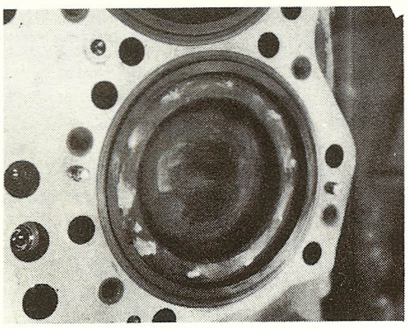

Cummins KT19 engine. Note deposit formed after running on low grade fuel.