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Next to the regular collection of domestic waste, there is perhaps no better sign of a civilized society than the cleanliness of its streets. But there's a heated debate-taking place at present, between the exponents of the traditional twin-engine truck-mounted highway sweepers and those who suggest that a single-engine format is the way forward. This debate is a complex one, but there are signs that the single-engine concept is gaining ground.

From an engineering viewpoint, perhaps the only vehicle that could be said to be more complex than a truck-mounted highway sweeper is a compact, purpose-built 'precinct' machine. Alongside refuse (garbage) collection and disposal vehicles - themselves amongst the most difficult to operate vehicles - suction sweepers have to operate in one of the toughest environments of any manmade machine. As the essential function of the highway sweeper is to collect litter, dead leaves and other debris from the road surface in order to prevent roadside drainage gullies becoming blocked - or in some parts of the world where tourism is a major industry, just to help keep the highways looking picture-postcard clean - it goes without saying that the one single ingredient likely to be common to all operating conditions is dust. And lots of it.

In order to keep down the clouds of dust that would otherwise occur during sweeping, an on-board water spray system with as high a capacity as possible is clearly desirable. Dust and water together? These two ingredients have to be amongst the most damaging substances to allow near any machine. But one packed full of complex electrics and hydraulics? It's harder to think of a more demanding application. So any design improvements that can rationalize componentry, or reduce complexity, has to be worth consideration, especially if they could save on manufacturing and assembly costs and promote greater reliability in service at the same time.

In addition to ensuring all the automotive functions relating to driveability and ease of control have been met, and highway and emissions regulations complied with, the designers of highway sweepers have to meet the not inconsiderable demands of packaging all the sweep system functions, together with water, fuel, hydraulic oil tanks and of course, a viable load capacity, into a machine that is still compact enough to be able to pass along the very highways it is employed to keep clean.

### **Stating the obvious**

This might sound painfully obvious, but all these factors are at the heart of an ongoing debate on highway sweeper design which is currently raging between manufacturers, hire firms and operators in a number of key markets from Europe to Australasia.

At present, although there are several 'single-engine' designs available, the truck-mounted highway sweeper market is still dominated by manufacturers of 'two-engine' sweepers - that is, machines that use an auxiliary engine to power the sweep systems. Until recently, it has been manufacturing cost that has kept single-engine designs in check, as these were essentially products specified in small numbers for specialist applications. Now however, more efficient manufacturing processes, and pressure to improve operational efficiency while offering environmental gains, could tip the balance of power in favour of the single-engine camp.

The single-engine proposition is that one engine - the one installed in the truck chassis - is the best source of power to drive both the suction fan and sweep systems (the brushes, pick-up box hydraulics, water sprays etc.) and, at the same time, simplify the driver's job by providing an infinitely variable single pedal forward/reverse control, while in sweep mode. In most cases, this is achieved by installing a self-contained hydrostatic drive unit into the truck drive train, behind the conventional gearbox (usually retained for driving in non-sweep mode), which also contains the hydraulic pumps needed to power all the machine sweep functions.

However, in certain world markets where a fully hydrostatic system is likely to be ruled out on cost or operational grounds, one major UK-based manufacturer, Scarab Sweepers, also produces a PTO-driven system it calls 'Unidrive', as an alternative to its hydrostatic system. This is a lower-cost option that utilizes the normal truck gearbox while in sweep mode (using either a standard nine speed gearbox, or a six speed with 'splitter' to give suitable ratios), while keeping to the same, single-engine principles.



**Some manufacturers, such as UK-based Johnston, market both single-engine and auxiliary two-engine truck-mounted highway sweepers. This Renault-based A550 'Hydro' machine is sold through Semat in the French market**



**Faun produces its 'Viajet' sweeper range in both single- and two-engine format**

The crux of the argument is that, as modern truck diesel engines now offer between 180 and 220 horsepower, there is no need to utilize an auxiliary engine to power the fan and sweep system functions. One engine is sufficient to carry out both tasks.

### **Change, or no change?**

In the opposing camp are several major manufacturers of 'traditional' auxiliary-engine, truck-mounted machines. Between the two groups are a number of other manufacturers, which produce both single-engine hydrostatic and auxiliary-engine machines - and of course a significant customer base trying to decide which way to jump.

The arguments in support of 'no change' and a continued use of a secondary, auxiliary (or 'donkey') engine, have traditionally centred on the fact that in many global markets, the two-engine machine is already accepted by operating staff, familiar to maintenance staff and is well proven. Indeed, numerically - in terms of number of vehicles in service - it is still the dominant design.

But recent research - putting actual figures on environmental considerations for the first time - might well cause many potential customers to consider reviewing their purchasing policies, coming, as it does, in the wake of independent running cost comparisons.



**UK-based Scarab Sweepers offers two designs of single-engine, truck-mounted sweeper - 'Hydrostatic' and 'Unidrive'. This high-capacity, full-width 'Jet-Vac' contractor machine utilizes a high-capacity water tank where the auxiliary engine would be fitted on a two-engine sweeper**

It is interesting to observe that although hydrostatic highway sweepers have been available for a number of years - and from a number of different, primarily European, manufacturers - these were either used in heavy-duty 'airside' operations at airports, or in other industrial applications. Until recently, the two-engine machine, of whichever make, was the 'standard' in city (commune) highway sweeping applications. But since the mid-1970s, hydrostatic transmission and power delivery has grown to become the dominant force in applications such as agriculture, mechanical handling and construction equipment. Likewise, it is now the standard in grounds-care machinery and, ironically, on smaller, compact 'precinct' suction sweepers as well.

In all these cases, where hydrostatic transmission and an alternative to auxiliary power units have been introduced, they have grown to become the widely accepted solution. The question is, therefore, why has this situation not yet occurred in the truck-mounted highway sweeper market?

**Two right?**

In support of traditional two-engine designs, it is said that ease of body and sweep system mounting is a major factor. In markets where some element of local labour content is either desired, or legally required, the two-engine highway sweeper can be manufactured with the auxiliary engine, fan and hopper on a single skid (frame), while the sweeping brushes and pick-up box can easily be assembled locally from a kit and matched to a locally sourced chassis without major infrastructure investment. This might not sound like an especially important criteria, but with all the suction sweeper manufacturers now working hard to develop markets in the states of the former USSR, and collectively looking forward to the massive potential of the market in China, then ease of production, cost savings and rapid delivery all take on a new perspective.

For single-engine designs, the manufacturing process is more complex. When the single-engine, hydrostatic approach is followed, either a purpose-built production line has to be set up to meet the needs of each local market, or the truck chassis must be dispatched to the sweeper production facility for completion. An illustration of the complexity of this problem is the fact that leading New Zealand sweeper operator, the TR Group, recently purchased some Japanese-built Isuzu truck chassis and had them shipped to the UK to be fitted with Scarab hydrostatic, single-engine sweeper equipment and then shipped back to New Zealand where they are now at work on highway sweeping contracts on North Island.



A New Zealand-based sweeping contractor shipped this Japanese Isuzu chassis to the UK for a single-engine sweeper to be installed - the completed machine was shipped back to New Zealand

Such a policy clearly raises environmental questions, such as, should we really be considering the dispatch of a truck chassis over 25,000 miles around the world before it can be completed and put into service? This example does however illustrate the strength of feelings in the 'pro' single-engine lobby - the operator insisting that the single-engine, hydrostatic route was not only the most cost-efficient, but resulted in the most environmentally sound product, in a world market that places such issues highly.

**The key questions**

It's time to investigate the claims made for the single engine sweeper in more detail, and how these compare to the 'norms' established by traditional two-engine machines.

The first claim in support of the single engine design is, rather obviously, that it does away with the need for a second engine. In an age where exhaust emissions are now a global problem, it could be argued that any additional exhaust pipe is one too many.

The single-engine lobby also points out that, today, most truck engines are diesel-fuelled, have to meet a continuously changing set of emissions standards and, due to ongoing trends in rising power outputs and flat torque curves, are more than able to stand the extra 60 horsepower needed to power all the sweep functions, as well as deliver what is needed for the automotive requirements. In other words, it is argued that with a modern truck engine output of 180 horsepower or above, spare engine power is available 'free', and that emissions from it are as low as possible, thanks to European and US legislation.

In contrast, there are far fewer regulations relating to the design of auxiliary or 'donkey' engines. Indeed in many global markets, it is claimed, there are no regulations relating to either exhaust or noise emissions that must be met. So sadly, although there are several interesting 'silent pack' auxiliary engine units on the market, and indeed a number of LPG- or natural gas-fuelled engines that could be utilized in this application, there is no legal incentive for sweeper manufacturers to utilize them.

### **Better utilization?**

Another key factor in the debate centres on the position where the secondary power unit is traditionally mounted - high up on the truck chassis between the driver's cab and the sweeper collection body. This is also the ideal place in which to locate the water tank. Time spent filling the smaller water tanks on two-engine designs can be a source of delay during operation, while single-engine designs have all this space available for water tanks.

#### **Manufacturers of single-engined, truck-mounted highway sweepers**

Faun - Grimma, Germany  
Frimokar - Liechtenstein  
Johnston - Dorking, UK

Scarab Sweepers - Marden, UK  
Schorling - Hanover, Germany

There is another compelling reason to do away with any unnecessary 'dead' weight - every kilo of unladen weight saved can be better utilized as payload. The second engine and support frame can typically weigh well over 1 tonne, making weight a key matter of contention in the debate.

The single-engine camp argues that, if efficiency can be raised and unladen weight reduced, it is then possible for operators to specify a cheaper truck chassis with a lower gross vehicle weight for any given task. If, say, a 12- or 14-tonne gross chassis could be utilized, instead of an 18- tonne one, running costs could also then be reduced, it is claimed. UK sweeper hire specialist Gullivers of Bristol has recently done just that by specifying a new fleet of Scarab Magnum machines based on 13-tonne GVW DAF LF55 chassis. They are reported as giving a legal payload of 6.5 tonnes. To achieve the same legal payload with a traditional two-engine sweeper, the operator reports it would have been necessary to specify 15-tonne gross vehicle weight chassis, with higher running costs, physical size and some 15% greater chassis purchase cost. The cost savings were significant - significant enough on a single order worth more than £350,000 (US\$550,000) to rule out two-engine designs, it is claimed.



**This sweeper hire company purchased a fleet of single-engine, truck-mounted sweepers after an extensive evaluation process**

### **Final arguments**

The final arguments in this battle for market supremacy look set to centre on the key issues of 'efficiency' and exhaust and noise pollution.

Already, the UK Government is under fire for 'protecting' the status of two-engine sweeper designs by allowing the continued use of tax-free 'red' diesel (used in non-road going machines and in agriculture) in the second, auxiliary engine. This is less environmentally friendly than low-sulphur fuel, or City Diesel, available at taxed, automotive-grade, diesel pumps.

Leading the call for change is Rodger Hoadley, the managing director of Scarab Sweepers. He contests the fact that, at a time when the governments of all industrialized nations are increasing taxes on fossil fuels in order to limit their consumption, it is inexcusable that machines like sweepers, designed to operate in a high pollution risk environment, should not only be able to utilize an auxiliary power unit that doesn't legally have to meet current European standards (as donkey engines do not), but is actually given a 'tax-rebate' to use dirtier fuel (i.e. able to run auxiliary engines on tax-free diesel).

Hoadley argues that the reverse should be the case - machines operating in towns and cities should meet higher emissions standards. At the very least, it is the highly taxed diesel used by truck engines in single-

engine designs that should be subject to rebate, in recognition that, overall, these vehicles are environmentally more efficient.

While Hoadley confirms that, when the truck engine is coupled to a hydrostatic transmission and powering all the sweep systems, it will use marginally more fuel than the same engine driving only through a manual gearbox, he also claims the difference is 'negligible' and in any case, the use of low-sulphur diesel can reduce the environmental impact of the single-engine design even further.

### **Paris match**

How much more efficient is a single-engine sweeper in service? Earlier studies undertaken in the City of Paris, comparing three designs of competitive highway sweepers, suggest that even subtle advantages of, for example, a single-engine design able to run a larger diameter suction fan, can give an improvement in the metres swept-per-hour performance. A single-engine truck-mounted sweeper tested in Paris was able to sweep over 8600 metres/hour compared to a figure of 7500 metres/hour for a competitive two-engine design over the same route.

As noise pollution is also a key operational factor - both relating to in-cab noise affecting the driver, and 'drive-by' figures that affect local residents - the results of the tests show that on the single-engine design, in-cab noise was a minimum of 62 decibels, rising to a maximum of 78 dB. An average figure of 78 dB was obtained while sweeping. While the minimum and maximum levels were closely matched by the other two-engine machines, the single-engine hydrostatic machine was 3-5 dB quieter while sweeping in regard to in-cab noise.



### **Johnston has had considerable success with single-engine truck-mounted sweepers in France. Photo: Johnston Sweepers**

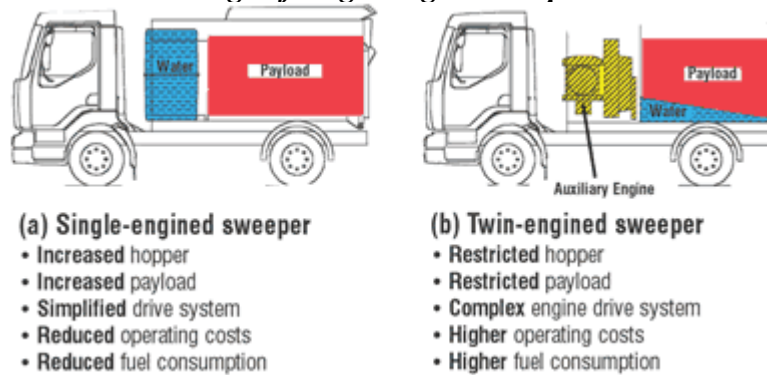
In terms of 'drive-by' noise, the figures were far more in the favour of the single-engine, hydrostatic design, with a clear 1.2 dB lead while manoeuvring at low speed, and an advantage of up to 5.2 dB against a two-engine design at maximum output. In normal sweeping mode, the single-engine machine was between 4.9-11.6 dB quieter in operation during tests undertaken by the French National Testing Laboratory in Paris. (The tests were undertaken using National Laboratory guidelines. The results correspond to acoustic power, i.e. the average of sound pressure levels measured at a distance of 10 metres raised by 28 dB [ $L_{wa} = L_{pa} + 28$ ].)

### **Fuelling the debate**

The Paris tests also measured fuel consumption. In comparing a single-engine hydrostatic machine with the average fuel consumption of two makes of traditional two-engine machine, the tests concluded that, based on working trials over four identical routes, the single-engine hydrostatic sweeper showed a highly significant 30% improvement in fuel consumption.

These figures are confirmed by tests undertaken in the Republic of Ireland by National Sweepers (a hire company), while driver fatigue levels were stated to be 'much improved'. An improvement in fuel consumption of 30% has considerable cost and environmental considerations in any market, but National Sweepers also point to 'significant' higher payloads and faster sweep times.

**FIGURE 1a-b. Scarab has introduced a simplified 'Unidrive' system on its Magnum range of single-engine sweepers**

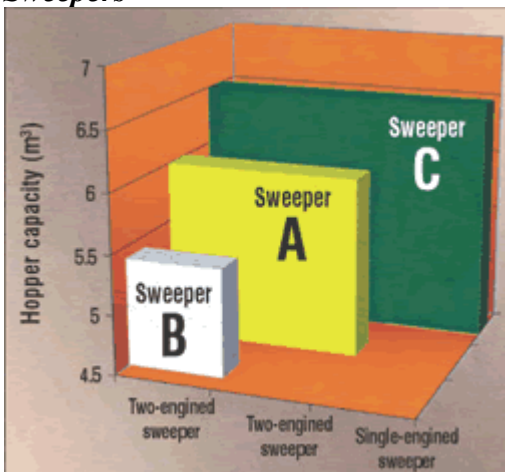


As highway sweepers operate near schools, hospitals and other environmentally sensitive areas on behalf of the community as a whole, potential for reduced exhaust emissions is another key factor. Data recently released by Scarab Sweepers suggests that a saving of 62,500 tonnes of carbon monoxide emissions could be achieved per annum on the basis that a nationwide 'vehicle parc' (the total, current 'population' of vehicles) of over 2500 two-engine sweepers, the total in a developed country of 60 million population, such as the UK, were replaced *en masse* by a similar number of comparable single-engine designs. That's the equivalent figure of removing over 20,000 small cars from the roads each year. With many cities around the world demanding a percentage reduction in public sector fleet emissions year-on-year, this has to be a major consideration.

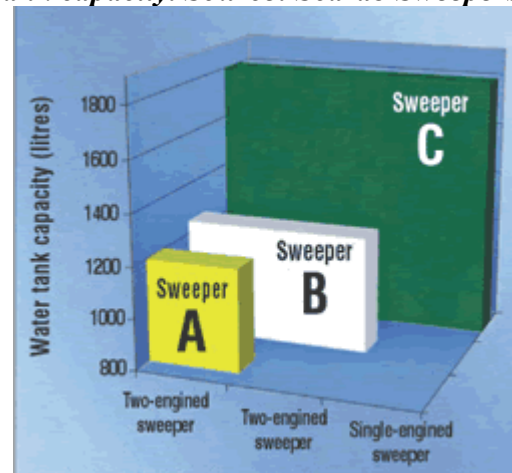
**The way forward**

With highway sweepers designed to operate over a life-cycle of up to eight years, purchase decisions taken now could have an effect into the second decade of this century. For a variety of reasons - increased amounts of litter and lack of respect for our urban environments being amongst them - the truck-mounted highway sweeper looks set to enjoy a buoyant future. But operators are being increasingly compelled to 'be seen to be green', while delivering even greater standards of efficiency for less money.

**FIGURE 2. Comparison of representative cross-section of highway sweepers - hopper capacity. Source: Scarab Sweepers**



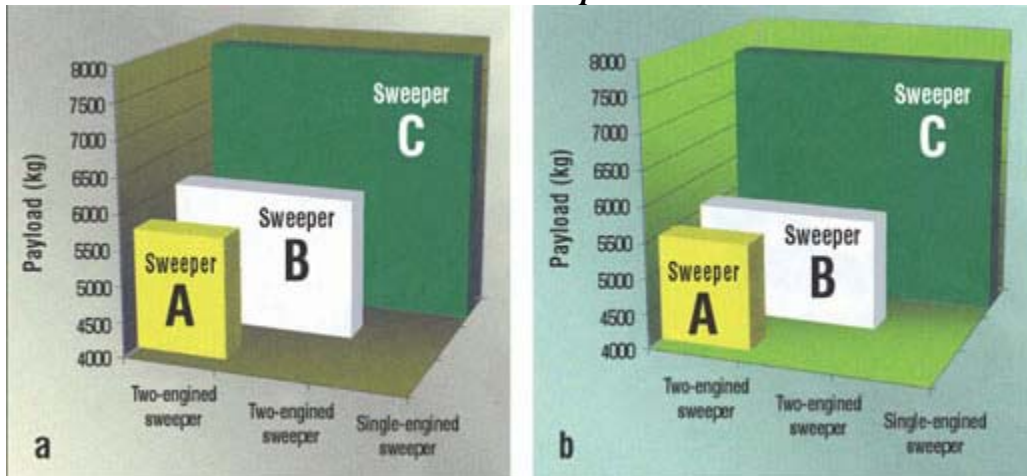
**FIGURE 3. Comparison of representative cross-section of highway sweepers - water tank capacity. Source: Scarab Sweepers**



Having taken the time to test three manufacturers claims, the City of Paris continues to expand its single-engine truck-mounted fleet, while Brussels - the hub of the European Community - is also moving towards a 100% single-engine, truck-mounted hydrostatic highway sweeper fleet.

So will the truck-mounted highway sweeper of the future have one engine, or two? Those who say two will have to fight a defensive position as the manufacturers of single-engine designs point to higher legal payloads, greater body capacity-per-size of chassis, and increased water tank capacity - and reduced running costs and emissions. Either way, the competitive state of the market over the forthcoming months will make it a good time to ask questions about upgrading your highway sweeper fleet.

**FIGURE 4a-b.** Comparison of representative cross-section of highway sweepers - payload capacity (a) 14-tonne single sweeper (b) 14-tonne dual sweeper. Source: Scarab Sweepers



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