The NZAEI NEWSLETTER

No. 23 August 1971

## Air Cleaners

**The following article was written by Max Webb at the request of Federated Farmers of N.Z. (Inc.) and originally as a letter. However, as the subject is of considerable general interest, we are publishing it for the benefit of N.Z.A.E.I. members.**

### AIR FILTRATION

There are a great many tractor owners and drivers who do not appreciate the need to protect their engines from dust. There are many of the remainder who do not realise that air filters and their associated parts require the most careful and conscientious care and maintenance.

Research into the wear rates of engines with various types of air filters have been carried out by sufficient people to put beyond doubt the fact that inadequate air filtration is overwhelmingly the one single major cause of premature engine breakdown, and therefore makes the subject one that deserves far more attention and time than the average operator has been prepared to give in the past.

It does not exaggerate to say that a new tractor with failed air filtration, working in dusty conditions, can be completely worn out in 20 hours or less. The same new tractor with adequate filtration and good general maintenance can be expected to give between 3000 and 4000 hours work before needing remedial attention.

Field tests have indicated that wear rates without filtration in dusty conditions can be 150 times greater than those with.

### EXPECTATION OF TRACTOR ENGINE RINGS AND LINERS

What are the reasonable expectations? This is an extremely difficult question to answer depending as it does on many factors.

Local climate is a factor; areas with a high rainfall can normally be expected to have a correspondingly low dust count. Soil types are another obvious factor, those with high silica content having the highest engine wear potential. A flat farm as opposed to hill country; farm activity, hard constant agricultural activity against feeding out to the cows; driver technique and so on. All these add up to the fact that no two tractors are subject to exactly the same conditions of use.

However, there is some agreement that tractor top-engine life expectation fits into the scheme of things outlined below. This, based upon 800 hours work per year, is accepted average usage.

| Years | |
|---|---|
| 0 | New Tractor |
| 1 | |
| 2 | |
| 2½ | Hardworked, badly maintrained, needs new rings. |
| 3¾ | Average worked, average maintenance, needs new rings. |
| 5 | Average to lighter worked, well maintained, needs new rings. |

Thereafter, unless activity and maintenance trends change radically, doubling up the figures takes the tractor to major overhaul, so that the hardworked, badly maintained tractor is likely to be needing major overhaul after 5 years whilst its more fortunate cousin will be nearing 10 years.

There will always be extremes, so that on the one hand we find a tractor completely worn out and in need of major overhaul after 15 hours, and on the other, the showroom condition machine needing its first set of rings at 15 years, that is, at about the time it becomes obsolete.

One opinion is that contractors work their tractors harder, and maintain them better, and by and large often manage to extend hours up to, and between overhauls, over and beyond those achieved by farmers generally, and I suppose this is understandable.

Another opinion offered is that yearly hours per tractor are less now than some years ago. The explanation for this being that most farmers have kept the older, smaller tractor for running about jobs whilst restricting the newer, bigger models to main work activity.

### FILTERS: DRY ELEMENT AND OIL BATH

A general concensus of opinion is that the dry element or paper filter, does a better filtering job generally than the oil bath. This is evidenced by the claim that the incidence of premature upper engine wear is less than when oil bath filters were the rule, plus that engine life before and between overhauls, is greater. This takes into account that the modern diesel engine is more sophisticated and highly stressed, as far as speed, pressures, temperatures, etc. than its predecessors of 15 years ago.

Whilst it is believed that the filter does a better filtering job, it is conceded that it is more difficult to maintain and more susceptible to abuse than the oil bath type.

Without doubt the tendency to 'block' often after relatively short running periods in dusty conditions (4 hours perhaps) is its weak feature, and it is extremely doubtful whether many dry element filters are cleaned with anything approaching the frequency necessary to keep tractor performance at optimum. Probably tractor operators that grew up in the 'oil bath' era, see no good reason why the dry element is deserving of any more respect than its oily predecessor.

The big argument in favour of

the dry element is that it is 'fail safe'. This means if the operator does not clean his filter regularly, his tractor will lose power and efficiency, and little else. On the other hand, if the oil bath filter loses its oil then all, or very nearly all, is lost.

Under the worst conditions to run even a few minutes without air filtration could be disastrous.

Laboratory tests have shown that dust particles of about 20 microns size (.00078") or about three quarters of one thousandth part of an inch diameter, are the worst culprits, with particles three times the size slightly less wearing (95%) whilst those of one third this size considerably less wearing (22%).

It is quite usual for heavy duty paper filters to stop anything over 15 microns.

Unfortunately, the very small particles enter right into the filter paper and remain 'for keeps' and this is why a paper filter starts off in a slightly worse condition after each cleaning, and is one good reason why eventually a replacement is desirable.

## WHEN IS A FILTER BLOCKED?

With a typical brand new heavy-duty paper filter fitted, tractor inlet manifold suction should be 6 to 8 inches of water at normal operating speeds rising to about 20 inches when the filter is considered blocked. At this higher figure and above, firstly, engine power is reduced (by an amount that is probably not easily discernible at the driving seat), secondly, with heavily blocked filters and high suction, the risk of small particles being drawn completely through the filter paper is increased.

Most dry filters fitted to small and medium (65 HP) tractors are not fitted with any device that indicates blockage. There does not seem to be any clearly established procedure that will enable the operator to determine by himself if his filter needs cleaning, unless he is able to lift and use a manifold suction gauge, or manometer.

There is no easy way for the operator to establish when his filter has reached a 'point of no return' as far as small particle permanent blockage is concerned, again, short of being able to interpret manifold gauge readings.

In respect of this latter problem, it is felt that ten dollars or so for a new cartridge every year would be money well spent.

## HOW, AND HOW NOT, TO CLEAN A BLOCKED FILTER ELEMENT

In extreme dust conditions it is most likely that cleaning will be necessary in the paddock. The best advice in this respect is that a spare filter cartridge be carried (in a plastic bag) whenever faced with the prospect of a long dusty day away from home.

The practice of removing the cartridge and blowing it out with the tractor exhaust is *definitely out*. Obviously, running the engine without the filter element in position is simply asking for all the rubbish and dust anywhere near the intake to be quickly and thoroughly inhaled. The other objection is that specks of red hot carbon and oil from the exhaust get blown into the dry dusty pleats of the element and can rapidly burn pinholes. There have been instances of elements being completely burnt out in this manner.

The only satisfactory way open to all drivers in the paddock is to 'tap clean' the element. This is done by *gently* tapping the element bodily on its side, down onto a horizontal flat surface, rotating the element a little at each tap, so that dust within the pleats falls away clear along the whole length. Tapping whilst held vertically is no good and only results in dust within the pleats largely staying within the pleats and simply moving from one end of the element to the other. Tapping on the ends is out because of the risk of dents in the gasket and plate. Many elements have been seen in a completely battered condition because of rough and uninformed tapping. Clouting one end of what is probably your best friend over the nearest gate post is not recommended.

Back at home base, compressed air can be used, but the recommendations concerning this vary. One school of thought holds that a sealing disc of some sort should be placed over the gasket end, and the element completely pressurised internally by inserting a compressed air hose or nozzle through a hole in the disc. If this method is used it is most important that the pressure built up does *not exceed more than a few psi,* otherwise there is a risk that the element seams will be blown apart. Providing the disc is hand held and the air applied gently, the disc will push away normal hand pressure before damage is done. Probably, in practice, the air flow capacity from inside the filter out, will be great enough to preclude excessive pressure build up with any but a large compressor plant. The second approach with compressed air, is to play a hand held gun, or pipe extension with side jets, up and down inside the element, with air pressure in the gun line acceptable up to 100 psi. This method is not highly recommended because it is felt that the very high velocity air jet that is obtainable from small holes, could puncture element surfaces, particularly if the air contains water droplets. If air is dry, and gun or pipe holes are big enough or diffused to avoid high velocity jets, then this method can be used.

Methods of washing elements are detailed in some tractor handbooks, but this process must be undertaken with utmost caution. Some overseas made filter elements can be washed, but at the time of writing, I believe most replacement elements are made in New Zealand and at least one manufacturer is against washing to the point that responsibilty for consequential engine damage is declined if the offending element has been washed. Reasons against washing are not that paper elements cannot stand the treatment, but that unless washing is carried out under near laboratory controlled conditions, then there is a chance that dust particles will be more firmly incorporated into the element. Apart from this, it can take a filter up to two or three days to 'dry out' naturally, and this waiting period would be unacceptable, unless the operator is willing to keep spare elements on hand.

Another surprising aspect of filter cleaning, is that it has been found that a certain percentage of dust left on the filter becomes an integral part of the filter function, in other

words, the lower layers of dust help effectively to stop other dust particles from penetrating.

The domestic vacuum cleaner offers a convenient method of cleaning the worst dust load from a filter by direct suction from the outside. On many cleaners, the hose can be reversed, and can be used to pressure the element from the inside by using the annular disc method mentioned above. Needless to say, the cleaner should be emptied, and the small dicharge air filter normally fitted to domestic cleaners, should be in good condition, otherwise there is the risk of pushing dust into the inner element surfaces.

## HOW TO SPOT ELEMENT DAMAGE

Bearing in mind that our main dust particle culprit (the 20 micron fellow) is too small to be seen with the naked eye, it is immediately apparent that any visible hole in the element is too big. The only method of inspection available to the operator is to drop a small electric light bulb of about 40 watts into the filter by stages, preferably in the dark. By slow rotation of the element, and careful viewing of the outside, small pinholes and seam cracks can usually be spotted. Unfortunately, a large portion of the element will be blocked from viewing by the perforated or mesh canister used to contain the element. Generally speaking, if you find one pinhole, it is not likely to be an isolated thing, and it is past the time when a new cartridge should have been fitted.

If a leaking filter is suspected, shine a torch into the inlet just beyond the cartridge gasket face and often 'tell-tale' tracks of dust impingement will be seen. Sometimes minute dust build ups will occur at critical parts of the inlet pipe or manifold entrance, where dust particles are 'flung' out of the air stream on bends etc.

If element damage is positively identified better get the engine oil and oil filters changed smartly.

## THE PLUMBING PROBLEM

All the time spent worrying about the filter, and the tappings and blowings and the new element are all as nothing if there happens to be one hole big enough to take a pencil point anywhere in the pipework and bits and pieces between the filter and the inlet valves themselves. The best filter in the world is useless if its mating gaskets have dropped away or for any reason don't seat in anything but a 100% manner.

Make sure that the interconnecting pipework is in good condition and that its retaining screws and clamping bands are all firmly tightened and correctly positioned.

How ridiculous it would be to spend ten dollars on a new element and then face four hundred dollars worth of overhaul because a 3 cent nut and screw were not missed.

## PRE-CLEANERS

I think all paper element filters have some form of pre-cleaner devices. Most rely on inertia of particles during the abrupt direction changes of the air flow and effectively remove heavy rubbish from the air before it passes through the main element. One form incorporates a plastic collecting bowl where the heavy rubbish can be observed as it accumulates. This to my mind serves two extremely useful functions. Firstly, as a constant reminder that there is a hard working air filter somewhere under the engine cover. Secondly, as small dust and large dust quantities presumably must be approximately related, the quantity of heavy rubbish easily visible could possibly be used to indicate the likely condition of the main element.

## EFFICIENCIES

Total overall efficiencies of both oil bath and paper filters are high-arithmetically, but the significance is not usually appreciated. For instances, a filter with an overall efficiency of 99.8% is twice as effective as one with an efficiency of 99.6%. This, because it stops half of what the latter filter allows through. On the face of things one would think that a filter with 99.6% efficiency would be hard to better. Of course, there is a snag as might be expected — the 99.8% model is going to block up sooner. Filter designers strive for the happy medium. Knowing that the 20 micron particle and bigger are the sizes causing the main wear problems, heavy duty filters are made to stop 100% of all particles, 15 microns and upwards. Of course, a great quantity of the smaller particles are held anyway, and the very small ones that pass the element continuously, flush through average mechanical clearances without doing much damage.

A paper element can be guaranteed to stop a selected particle range, whereas the oil bath type relying on several factors, oil level, and temperature, air velocity, tractor tilt etc. cannot possibly provide a guaranteed coverage.

In summary then:

1. The importance of the air filter and associated pipework must be fully appreciated. Tractor agents could usefully place more emphasis on air filter maintenance than they do at present, particularly when a new tractor is sold. Probably some education on filter care and maintenance via national farming magazines would be worthwhile.
2. The paper filter element is well established and has proven effective. The heavy duty element type commonly available in New Zealand, properly installed and maintained provides a high and satisfactory degree of protection. The paper filter has the significant advantage of failing safe, when subject to poor cleaning maintenance.
3. Tractors ought, ideally, to have filter blockage indicators, as it is thought that eventually these could lead to a substantial saving of fuel on a national basis. Forty thousand tractors saving, say, 5 gallons a year would equal 200,000 gallons.
4. There seems to be some argument for fitting visual precleaners.

# A Fruit Cascade

**A major problem in the development of picker aids and other fruit handling machinery is to find a way of lowering fruit without damage. Since a drop of four inches onto a solid surface will bruise an apple at maturity gentle handling is essential.**

Staff of the Mechanisation Section of the N.Z.A.E.I. endeavoured to develop a suitable descender with the attributes of, firstly, gentle handling but also lightness, durability and low cost. As a starting point, a French descender was studied. This canvas and wire unit lowered fruit by a series of short drops into alternating sloping trays. The fruit followed a zig-zag path down, never falling freely for more than about four inches. While the basic principle was sound, the construction was fragile and the whole unit unstable. The canvas straps used caught in the branches of trees very easily.

The principle was developed by using polythene pipe ($\frac{1}{2}$" I.D.) to form a ring of about 12" diameter. A piece of dowel was used to join the pipe. Polythene film 0.005" thick with a basically triangular shape was welded over the ring to form a tray with an arc on one side open. Several of these trays were suspended at an angle of some 25° below the horizontal and in alternate directions. Nylon rope with spacers of P.V.C. tubing held the trays in their positions. The method of construction can be seen pretty clearly from the photograph.

Fruit dropped into the top tray fell into succeeding trays with greatly reduced impact, the energy of falling being continually absorbed. The velocity of the fruit never built up sufficiently to cause bruising.

Trials at various angles showed that for apples an angle of 23° below the horizontal for the tray frames worked well while for pears an angle of 27° was better.

A unit about 8ft high with 12 trays was constructed as a working prototype and used as a demonstration piece, attracting considerable interest from growers throughout the country. There was a feeling that the use of the *Cascade,* as it has been called, would be limited to those growers still picking into boxes rather than bins. Stone fruit growers showed a lively interest.




*The fruit descender developed by Institute staff. The use of polythene piping and sheet and nylon cord can be clearly seen.*

Two trays of *Cascade* have been used to modify a commercial bin filler. The steel hood was replaced, and bruising resulting from impact through insufficient padding was reduced. The bruising caused by the rigid hook as it traversed the bin was also eliminated. It was necessary to replace the 0.005" film with 0.010" as the stems of the apples perforated the thinner film.

The *Cascade* gives a means of safely lowering fruit and other products which are prone to bruising or breakage. Its gentle action has been demonstrated when eggs, apples and golf balls were all fed in together and no damage resulted. Feed onto the descender can be made at any point.

The *Cascade* could find quite wide application in the handling of fragile produce.

Published by the New Zealand Agricultural Engineering Institute, Lincoln College, Canterbury, and printed by the Lincoln College Press.