Last line of defence

A Z9 is a Z9 is a Z9. Well, sort of, but not quite. Paul Tuzson explains…

IF you've owned a Ford inline six in the last few decades an oil change has meant a replacement Z9 filter. But how could a Z9 specified in the 1960s or '70s serve the progressive variants of this classic Australian engine? Guy Nicholls, CEO of Ryco, says that the company has made changes to the Z9 over the years to keep step with development of the engine itself. After all, a single cam buried down in a block is quite different from two cams with spark plugs between them. Of course, many other cars also use the Z9.

Nicholls said that Ryco could have given each iteration of the Z9 a new part number but the Z9 moniker is so well known that changing it would have been irrelevant at best. At worst it could have been confusing and possibly even detrimental. The judgment has been to stick with the original designation despite the improvements. But what were the improvements and exactly why were they necessary?

Modern cars are hot, challenging environments with tighter tolerances, higher oil pressures, narrower clearances, oil viscosity like water to match, and extended service intervals. All these things have changed the game. Gone are the days when a workshop had an oil for petrol engines and another one for diesels. These days, engine requirements are much more specific. Oil may still be poured in through the top of an engine but it's very different oil to earlier formulations. Similarly, oil filters may screw into the same location but they're also very different.

Dealing with more heat called for some changes. Most decent filters have an annular, flexible, anti-drainback flap-type valve covering the ring of inlet holes. Early types were rubber, but they are more susceptible to general fatigue and that tendency is worsened by extra heat. Nicholls (himself an ex-mechanic) says you would poke at earlier types that had been on a car for a while and the rubber seal simply wouldn't spring back.

Newer silicon anti-drainback valves retain their natural elasticity for longer and are less susceptible to deterioration from heat. If the anti-drainback valve doesn't work and the oil drains out of the filter, the required volume needed immediately at start-up isn't there. Of course the degree to which this is important depends on how the filter is mounted.

Further, the rubber used for sealing rings against blocks has had to be changed due to the hotter conditions at the block's sealing surface. Basically, stiffer rubber is used but other details about the rubber have also changed. This has meant filters have to be tightened differently.

The Z9 used to need two-thirds of a turn after hand-tight to achieve an effective seal. Now, three-quarters of a turn is required. It's not much more, but it is necessary. Each type of filter has a guide in the fitting instructions for how much the filter should be tightened. Failing to turn a filter far enough during installation can result in leaks. Worse, though, is that insufficient tightening can allow a filter to work loose and blow out a seal completely.

As far as failing under pressure is concerned, construction of the filter body is vital, as you would expect. The annular seam at which the drawn upper section is joined to the press-formed base can become a likely point of total failure if it isn't formed properly. In order to withstand the pressures involved the two sections have to be specially folded together. Also, the basic materials have to be up to spec.

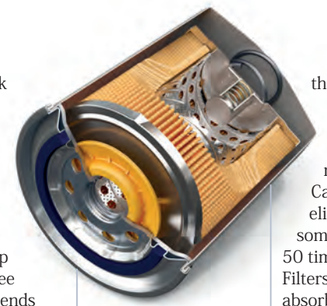
Manufacturers of cheaper filters sometimes use extremely thin steel with poor joins, which are susceptible to bursting and total failure. Even if a filter with a weak body doesn't burst, distortion of the case can interfere with correct operation of the internal elements.

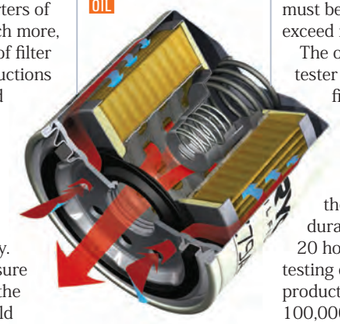
Oil filters are subjected to high-pressure pulses at engine start. Case construction, filter seals and anti-drainback valves, in fact all aspects of oil filter construction, must be able to resist these high-pressure pulses.

In conventional cars these occur once each trip, when the engine is started. Again, newer cars are more demanding. Cars fitted with stop-start, or idle elimination technology as it's sometimes called, might start 40 or 50 times in traffic on a trip to work. Filters have to be robust enough to absorb these extra high load cycles.

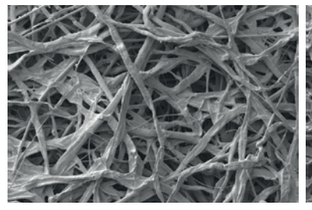
A big part of the Ryco facility in Melbourne is the testing lab. Here, filters are tested to destruction in a number of ways. For qualifying overall structural integrity two machines are used. The first test is for seal retention followed by burst capacity. In the latter a filter is simply bolted in and the pressure is increased until it bursts. There's a standard for this and obviously it must be met. A quality filter will likely exceed it by a considerable margin.

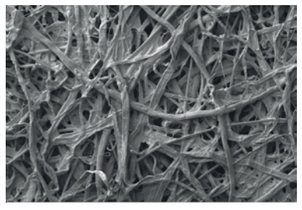
The other structural integrity tester also applies pressure to a filter but in a pulsed manner. Test pressure is 0-900kPa at 30-40 cycles per minute. This continues for more than 40,000 cycles and therefore works out to a test duration of something close to 20 hours. However, that's just for testing established stock. For a new product the test endurance is for 100,000 cycles. Pretty demanding.

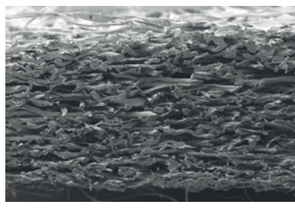




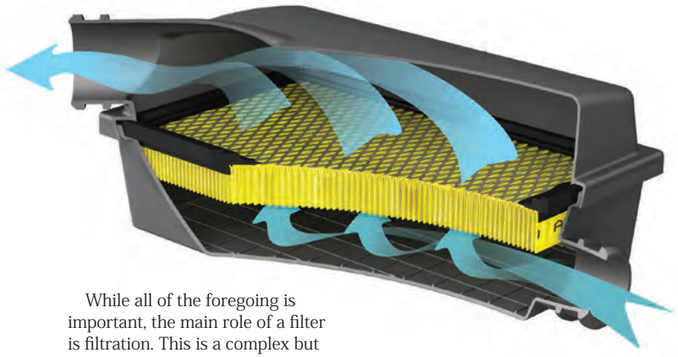
ABOVE: STEEL END-CAPS ON THE FILTER CARTRIDGE MAKE FOR A MORE ROBUST FILTER BELOW: HIGH QUALITY COIL SPRINGS OF EXACTLY THE CORRECT RATING ARE NEEDED TO ENSURE PROPER OPERATION. IF A BYPASS DOESN'T FUNCTION PROPERLY THE ENGINE WILL RECEIVE UNFILTERED OIL







ABOVE L-R: THE MORE OPEN OUTER LAYER TRAPS LARGER PARTICLES. THE TIGHTER LAYER TRAPS EVEN SMALLER CONTAMINANTS. IF YOU LOOK AT THE SIDE VIEW CAREFULLY YOU CAN IDENTIFY THREE LAYERS FAR LEFT: GUY NICHOLLS IS CEO AT RYCO BELOW LEFT: FAILURE TO REPLACE FILTERS ON SCHEDULE IS MORE IMPORTANT THAN EVER. RYCO PACKAGING HAS QR CODES THAT LINK TO SPECIFIC INSTRUCTIONS BELOW RIGHT: THE COMPANY MANUFACTURES AND TESTS A HUGE RANGE OF OIL, FUEL AND AIR FILTERS



While all of the foregoing is important, the main role of a filter is filtration. This is a complex but extremely interesting area. Filter paper isn't simply paper. The material, structure, size, physical arrangement and a number of other things all contribute to the service performance and structural integrity of filtering media, or 'paper' as it's casually called.

The first filters on early cars were canisters packed with cotton wool. Nicholls points out that such filters were actually optional extras. Eventually paper became popular and even today papers of various types and grades are still the main filter media used for cleaning oil. What has changed is the structure and the resultant effectiveness of the paper.

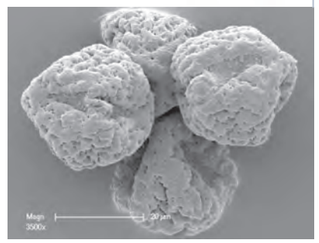
Paper filtering materials are generally referred to as cellulose media within the industry. Fibreglass-based synthetic media are also available and becoming steadily more popular despite being more expensive. The industry refers to them simply as glass media.

Manufacturing filtration media is a highly complex and specialised business. So, rather than trying to make their own, filter manufacturers simply buy it from bulk producers around the world. There aren't a lot of them but there are a lot of filtration products to choose from. Thousands, in fact.

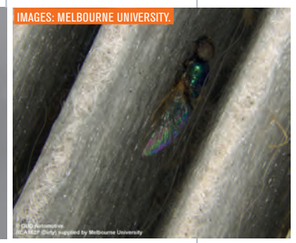
Stuart Chandler is head of production at Ryco. He explained that cellulose media consist basically of wood pulp and cotton, and can include polyester or glass fibres. All cellulose media used by Ryco contains some polyester or glass fibres depending on the application.

LEFT: CUSTOMERS GENERALLY UNDERSTAND THE IMPORTANCE OF OIL FILTERS BUT THEY NEED TO BE EDUCATED ABOUT THE IMPORTANCE OF ALL FILTERS, INCLUDING AIR FILTERS

BELOW L-R: THESE ARE 20-MICRON PARTICLES THAT HAVE TO BE SEPARATED FROM THE AIR. THAT'S JUST 20-THOUSANDTHS OF A MILLIMETRE. OF COURSE IT'S NOT JUST MICROSCOPIC PARTICLES THAT FILTERS HAVE TO CATCH. ALL SORTS OF THINGS BUILD UP



IMAGES: MELBOURNE UNIVERSITY.



The materials chosen and the way they're processed control the size and length of the fibres. Also, the way it's pressed is important. More compression means a denser filtration layer but it also restricts flow. Lighter pressing means more open flow paths but less trapping between fibres.

Particle lodgment between fibres isn't the only way particles are removed from oil. Some contaminants stick to the surface of the fibres, although more so in the spaces between the fibres. Thicker fibres and thinner fibres may have similar spacing between them but thicker fibres will restrict flow through a given area simply because the greater diameter of the fibres themselves takes up more space. Finer fibres allow more flow because they don't take up as much space.

Synthetic fibreglass-based fibres can be much finer than cellulose types. They are also much more consistent than cellulose fibres. Specified sizes and length dimensions for synthetic fibres will be exactly what is delivered, within tolerance. Fibre distribution throughout the filter medium will also be much more consistent.

The length of fibres in a filter medium is important because it contributes to self-support within the material and therefore, contributes to strength. The interior of an oil filter is a hostile place and dealing with pressure is challenging. If the pleated filter medium were not centrally supported by a louvered/perforated spirally wound steel core tube it would collapse under pump pressure.

As a filter ages and clogs in service, pressure can become concentrated in non-contiguous, weaker areas. Eventually, a cheap element may rupture and allow unfiltered oil into an engine. Strength is important.

Changing the aforementioned materials and characteristics can combine the different characteristics obtainable by changing the aforementioned materials and characteristics in even more ways. They can be mixed within one layer to form a progressive change of filtration as oil passes through it and layers of different media can be combined and then pleated together with similar results.

Chandler says two layers is quite common and the industry is moving towards triple layers in certain applications. When differing layers are arranged like this the outer layer traps the largest particles first, followed by smaller particles in the inner layer so that the filter doesn't become clogged before the scheduled replacement.

As an example of how the various elements can work together to solve a particular challenge, Stuart Chandler described a revised production specification from a European car manufacturer from several years ago. The company concerned had a large filter with a 10,000km change interval. Engineers wanted a smaller filter with a 15,000km service interval.

The existing filter met about 40 per cent of their requirements. Achieving the remaining 60 per cent took a change in the media they were using, increasing the thickness of the media, and using two layers pleated together. One layer was for longer life and another for greater efficiency. Pleating is another characteristic very important to filter performance. It must be just right for maximum filtration yet avoid premature blockage.

Filter testing is an integral part of the Ryco operation. The company doesn't sell anything that hasn't been through the lab.

The internet is full of garage filter testing videos. Pulling a filter apart can certainly tell you a few obvious things but any sort of meaningful tests relating to filtration effectiveness can only be performed in a lab like this. Counting pleats and measuring the supposed thickness of filter media with a set of verniers really doesn't mean much. ■

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ABOVE WITH INSET: THE MULTI-PASS TEST MACHINE IS THE MOST ADVANCED ISO FILTER TESTING MACHINE AVAILABLE. THERE ARE THREE DIFFERENT TEST LOOPS AVAILABLE RATED FROM 1-7 LITRES/MINUTE THROUGH TO 30-150 LITRES/MINUTE

TOP LEFT: THIS IS THE PULSE PRESSURE-TESTING RIG DESCRIBED IN THE TEXT **LEFT:** NOT EXACTLY HIGH-TECH BUT THIS SIMPLE TEST RIG ESTABLISHES BURST STRENGTH OF FILTER MEDIA VERY EFFECTIVELY

RIGHT: THESE VENERABLE MACHINES DID WHAT THE NEW TESTING STATION DOES. THE TERM FUNCTIONAL STEAMPUNK SPRINGS TO MIND. GOOGLE IT IF YOU DON'T KNOW

BOTTOM LEFT: THIS TENSILE TESTING MACHINE STRETCHES FILTER MEDIA UNTIL THEY BREAK

BOTTOM RIGHT: THE SAE TEST RIG IS USED WHERE CUSTOMERS REQUIRE A FILTER TESTED USING SAE STANDARDS

LEFT & INSET: FILTER BODY SEAMS ARE TESTED TO DESTRUCTION IN THIS PRESSURE RIG

LEFT: THIS TEST APPARATUS TESTS THE FILTRATION EFFECTIVENESS OF ENGINE AIR FILTERS. CONTROLLED DUST PARTICLES ARE FLOWED INTO THE FILTER BOX

LEFT: THE DUST USED TO TEST AIR FILTERS IS EXPENSIVE. IT COMES FROM ARIZONA AND A LOCAL INDIAN TRIBE HAS THE RIGHTS TO IT. EACH BATCH HAS A RANGE OF GUARANTEED SIZES

RIGHT: THE AMOUNT OF DUST BLOWN INTO A FILTER IS KNOWN. THE INITIAL WEIGHT OF THIS FILTER PAD IS ALSO KNOWN. AFTER TESTING IT'S WEIGHED TO DETERMINE HOW MUCH ARIZONA DUST GOT THROUGH