UNIVERSITY REPORT ON AIR FILTER TESTING

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AS USED BY HUNTER VALLEY FILTER SALES

INTRODUCTION:

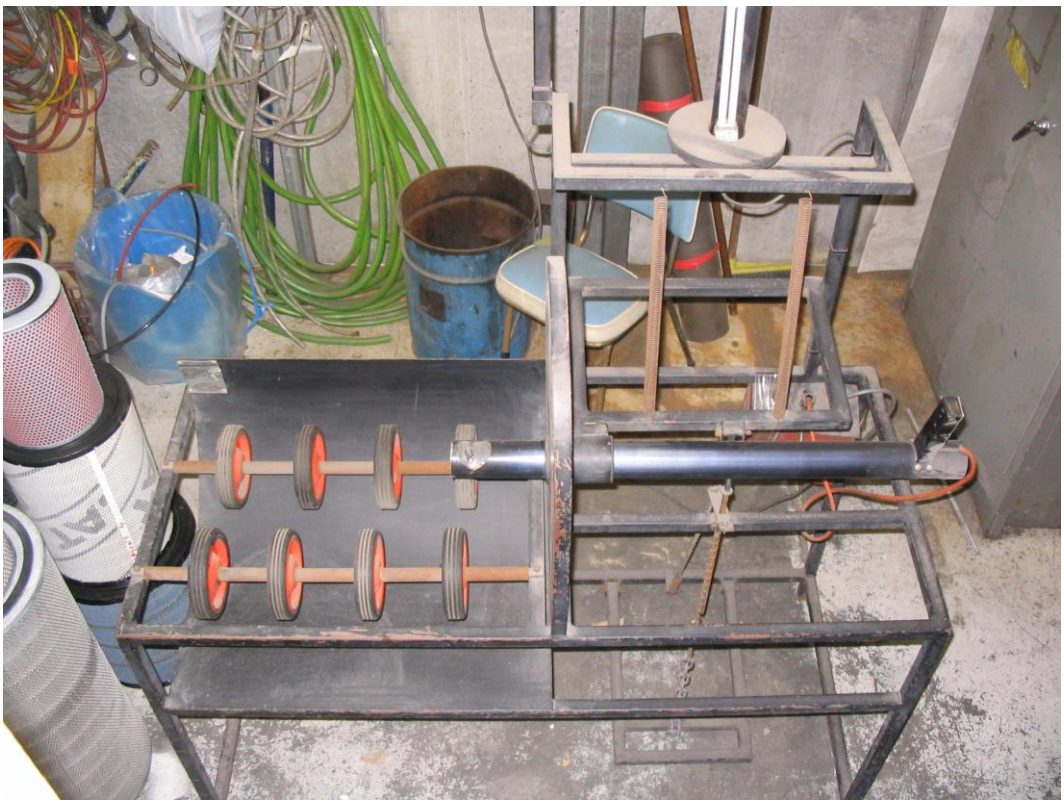
Hunter Valley Filter Sales (HVFS) is one of the largest filter service operations in Australia. HVFS caters for industries such as broad acre farming, coal & gold mining, transport, earth moving plus recreational vehicles such as 4WDs. Product coverage includes filter cleaning, supply for new air, oil and fuel filters, coolants, filter cleaning machinery, Donaldson, Baldwin, Fleetguard, Mann & Hummell Filters, Fuchs & Castrol Oils , cleaning products and many more.

ABSTRACT:

For quality control purposes HVFS approached the University of Newcastle to present a report on the testing methods used to determine the state of used filters.

HVFS have employed two methods to check each filter during the cleaning process, one being a light transmission test and the second, a water submersion leak test. The light transmission test is no longer used by HVFS and they now restrict their testing methods to the water submersion test.

Method 1: Light Transmission Tests.
The light transmission test involves the use of an intense light which traverses the inside of the filter unit, and by rotating the unit holes in the filter material are detected as the light is transmitted through any open pores.



The light testing device as shown above, is a commercial unit manufactured by Vibramatic Systems and designed by Erican Pty Ltd. This method depends on the experience of the operator to be able to detect variations in brightness through the filter material.

Method 2: Water Submersion Tests.
During the water leak test the filter is placed in a clamp such that it is sealed at each end and it is then immersed in a tank of water and is rotated. A picture of the water test device is shown below. This device has been manufactured by HVFS.

The air trapped within the filter can only escape through holes in the filter material so that if there are not any leaks bubbles rising from the filter would be very fine and would depend on the filter porosity. If there are perforations in the filter material the air will escape to form larger bubbles which are easily detectable by the operator.

Each of these methods was examined very closely to compare the suitability in assessing the condition of the filters.

RESULTS:

<u>Light Testing Method.</u>

This method is deemed to be unsatisfactory for a number of reasons.

1. This method relies on direct transmission of unimpeded light to identify perforations in the filter material. We found that in some cases the filter material appeared transparent and allowed the light to escape, giving an indication that there were holes in the filter medium. The holes detected were then marked and the filters were tested using the submersion method. When these filters were submerged during the water test, in all but one case the test

proved to be negative, i.e. there was no evidence of a perforation in the filter material. In other words the light method appeared to show a perforation that was not present. In one case a hole was present which was detected using both methods, but that particular filter also had other leaks which did not show up using the light test.

The problem that became evident was that some of the perforations occurred where overlapping folds were present. During the manufacture of the filters there is an overlap of the filter medium which is pressed into a fold and sealed. If the seal breaks then a leak will occur as fluid is transmitted around the fold. Unfortunately transmitted light only travels in a straight line and so leaks of this type will not be detected using the light method.

2. The operator needs to be trained to use the light method and it relies on his experience to be able to detect differences in the light intensity due to perforations as opposed to the transparency of the filter medium. This situation is also unreliable as different filters have variations in the level of transparency.
3. Each of the filters has an end cap which overlaps the outside layer of the filter. This overlap is designed to hold the casing of the filter together. Our tests showed that a number of the filters had ends which were not sealed (whether by damage or faulty workmanship) and they are undetectable by the light method because of the overlapping lip. The water submersion test clearly identified the presence of leaks in these areas.

Note: A more detailed explanation of the problems with the Light Transmission Method is discussed in Appendix 1 attached.

Water Submersion Method.

This method was found to be more acceptable and reliable.

1. The water submersion test relies solely on the air trapped within the filter during submersion to identify spots where holes or perforations are present. Observations during the tests showed a great variation in the bubble size from bubbles formed through leaks in the filter material. In some cases large bubbles were forming even though these same filters showed no evidence of a leak when employing the light test. Generally a high percentage of filters being tested have no leaks and when such a filter is examined using this method there are no bubbles formed like those found in filters with perforations.
2. Leaks in end caps and through folded filter medium were detectable with this technique. In the case of some filters with end caps that had separated from the filter material, this method produced large bubbles at the ends thereby identifying the problem. One particular filter showed no leaks with the light test, yet it showed a continuous leak across the full length of one seam. In addition, this filter also had a large leak in the end cap.
3. This method showed that in many cases where the more transparent filter material is used no leaks were detected, which was contrary to the results shown in the light test.

CONCLUSION:

The results obtained for each of the tests show clearly that the light test has a lot to be desired, and in our view is unacceptable as a method for detecting flaws in filters. The water submersion tests on the other hand produced results that were obvious to the observer and is considered to be more successful and efficient and is an excellent method to detect flaws and leaks in filters.

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UNIVERSITY REPORT ON AIR FILTER TESTING METHODS
AS USED BY HUNTER VALLEY FILTER SALES
APPENDIX 1.

Method 1: Light Transmission Tests.

As detailed in the report the light transmission tests rely on the direct transmission of unimpeded light to identify any perforations present in the filter material.

The main setback with using light transmission testing is that it relies solely on the experience of the operator to determine whether a hole appears to be present or not. Unreliability is also due to variations in levels of transparency of different brands of filters. As reported by "Donaldson" in their catalogue; quote: "*Donaldson receives filters for inspection each year that customers believe have developed holes. Upon inspection and testing in our labs, most of these suspect filters prove to have no holes or leaks. Most often these filters have areas with low dust buildup where light comes through the media when inspected with a light inside the filter, but in fact function perfectly*." *(Donaldson Catalogue No: F110027 1/04: "Engine Air Cleaners, Accessories & Service Parts").*

The other main point discussed using this method was the concern about light not being able to penetrate around bends to identify holes or perforations. To explain these in more detail consider the areas highlighted in Figure 1:

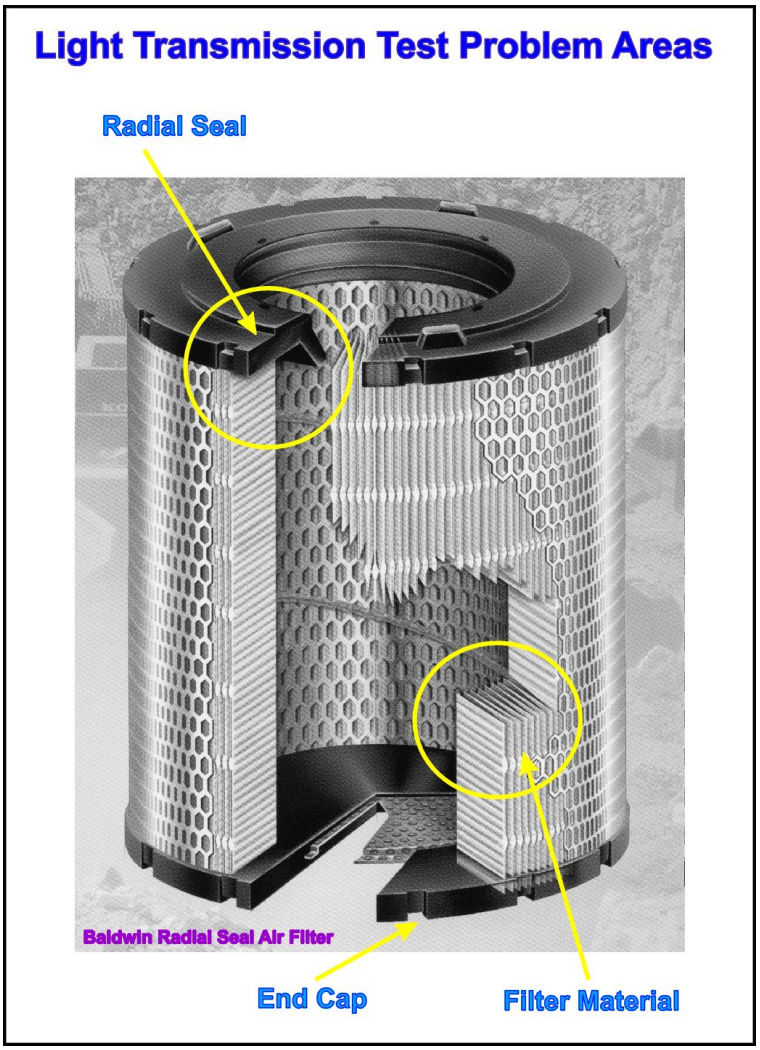
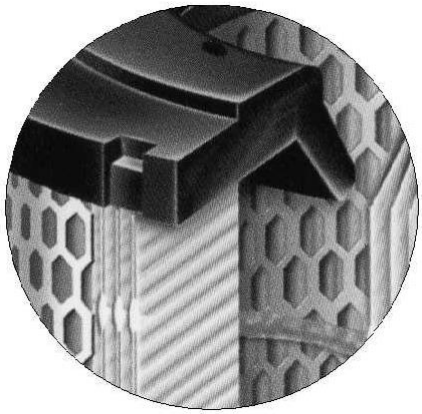


FIGURE 1

At the Radial Seal:



Section 1

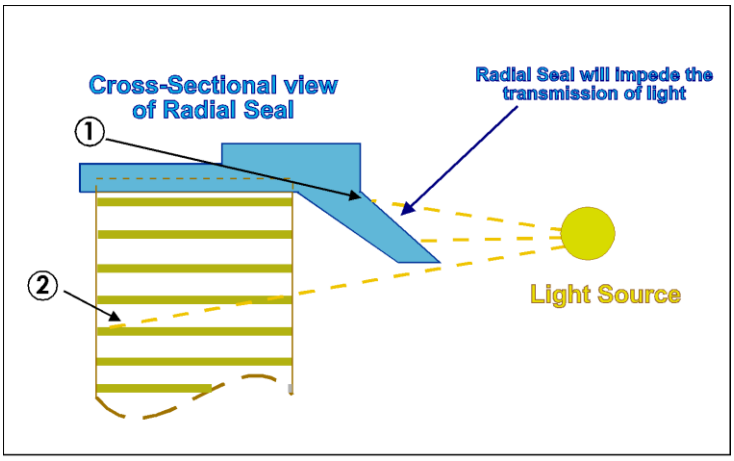
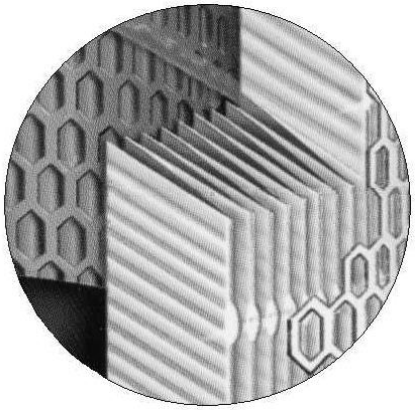


DIAGRAM 1

Diagram 1 illustrates how the light source cannot be positioned to allow light to pass the seal, nor will it allow the light to enter the top section where the top of the filter material is enclosed by the radial seal end as shown at ①. The light source to be effective needs to be able to pass into the filter material as shown at ②.

Within the filter material:



Section 2

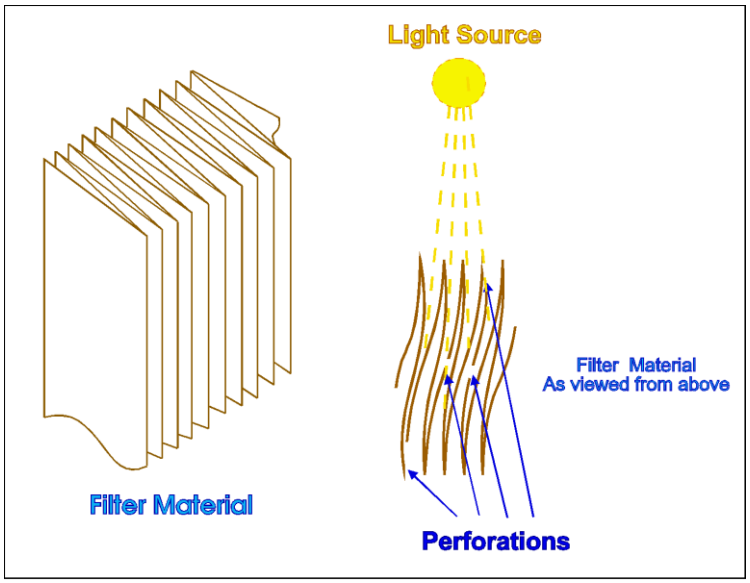


DIAGRAM 2

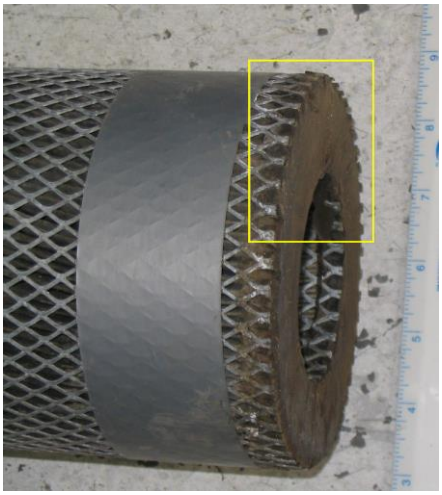
Diagram 2 illustrates the possibilities of holes or perforations being missed by the transmitted light. The diagram has been drawn showing a cross-section of the filter material as viewed from above. Perforations may occur at the folds or in the middle sections of the filter material but if there is any distortion of the filter material then the light will not be able to negotiate the turns to allow the transmitted light to be detected.

At the End Cap:

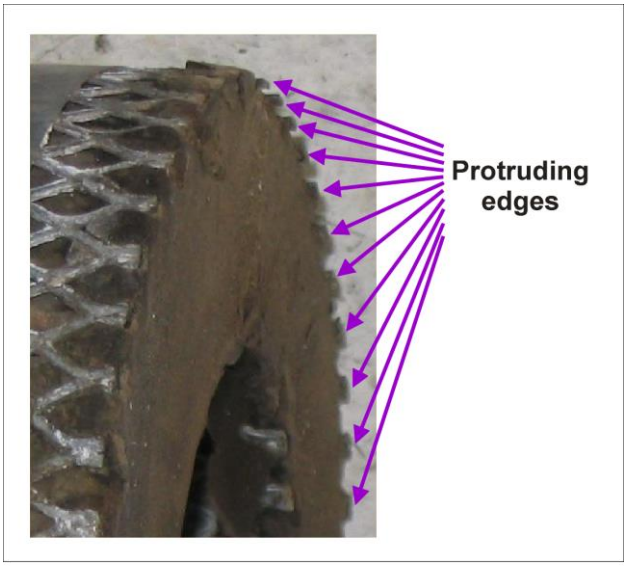
Picture 1 shows a filter with an end cap removed. This filter had shown considerable leaks with the water test method; these leaks were not detected with the light transmission method.

PICTURE 1

Picture 2 is a closer view of the end of the filter and the highlighted section has been enlarged in Section 3.



PICTURE 2



SECTION 3

It is clear from the close-up shot that the protruding edges of the wire frame were hindering a neat seal of this end cap. What has occurred is that the sealing rubber material has shrunk or shifted during use and has created a gap between the inner and outer sections of the Filter. Any light that enters this area will be shielded by the end cap, indicating that the end cap is hole free, yet there is clear proof that air entering the filter will by-pass any filter medium.

The effect of this flaw is explained in the following diagram:

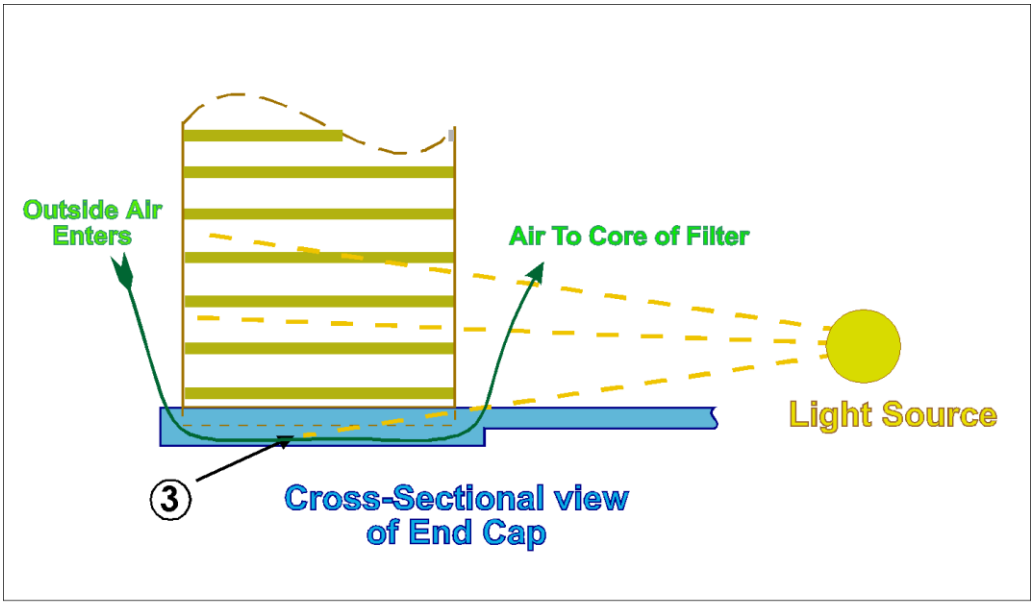


DIAGRAM 3

Diagram 3 shows the effect of the light passing into the end cap region of the filter, and at the point indicated by ③ there is no exit point for the light to be detected. Air however can be drawn into the core of the filter through perforations in the end cap caused by the protruding edges of the filter framework.

John Waanders.
1st September 2005