## No. 140 NOTES ON LIQUID-FILTER CELLS

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ABSTRACT

Design and use of a leakproof liquid-filter cell is described.

Aqueous solutions of inorganic salts of the transition elements (such as nickelous and cupric sulfates) offer high transmission bands in the wavelength region 3600 to 2900 Å where suitable filter glasses are not available and materials for interference filters have degenerate characteristics. For this reason, and also because liquid solutions do not affect the phase of a light wave and thereby modify polarization information, many investigators are using liquid filters.

Recent interest in liquid-filter cells (Lasker 1966) prompts us to relate some of our experience gained with several types of cells over the past years (e.g., Gehrels and Teska 1960). Figure 1 shows a liquid-filter cell that is usable for both inorganic and organic liquid filters. It is an improved version of a design presented earlier (Pellicori 1964).

The particular features of this cell are:

1. Ease of assembly: It is easier and faster to screw down a retainer ring than to put in four screws evenly to prevent tilting the cover glass and producing a bubble (cf. Lasker 1966).

2. Maximum liquid path per cell thickness is available because the bottom of the cell body can be made very thin (0.5mm or less).

3. Maximum aperture-to-cell-diameter ratio is provided.

4. A black-dyed, sulfuric-anodized aluminum cell and black or red teflon are used to reduce scattered light. The anodizing also prevents reaction of the metallic ion in solution with the aluminum cell. To prevent reaction from the eventual wearing through of the anodized surface, a thin coating of silicone grease is desirable.

The cell shown, with 12.5 mm thickness, can accommodate a 5 mm liquid path and a total glass thickness of 7 mm. The aperture is 15.8 mm and the body diameter 26 mm.

In addition to the maximum aperture size provided with this design, whereby a small bubble could be tolerated if it remained at the edge of the aperture (assuming that the light beam is smaller than the cell aperture), the inner wall of the teflon spacer has a groove to provide a space for trapping small bubbles and keeping them out of the beam. The groove should not have square corners because air could be trapped during filling as aqueous solutions do not wet teflon. In practice, the retainer is not screwed down as tightly as possible after assembly in order to allow the possibility of tightening down after the internal pressure has reached equilibrium and any minute bubbles have appeared. Often a small bubble trapped out of the beam acts as an effective expansion chamber and prevents leaks due to pressure and temperature changes.

Proper assembly of the filter is very important if bubbles are to be avoided for the longest time possible. It is necessary to remove the dissolved air from the filter solution. This can be done by evacuating the solution with a mechanical vacuum pump for about 15 minutes. At the observatory where a vacuum pump and bell jar are not usually available, the filter solution can be warmed on a hot plate, prior to filling the cell to help remove dissolved air. Overheating may cause some solutions to deteriorate, but aqueous cupric and nickelous sulfate solutions can be heated to at least 60°C with no deterioration. An additional measure to prevent bubbles is to fill the cell with warm solution. Shaking of the solution after heating or evacuating should be avoided to prevent excessive reabsorption of air.

We have found that Schott UG-2 (used in our U filter) does not react with the cupric sulfate solution. However, Corning C.S. 7–54 (used in our "N" filter) may react to form a white coating on the surface in contact with nickelous sulfate solution. Some inorganic compounds (in particular, nickelous sulfate) form a white precipitate just after dissolution. Transmission tracings of these solutions show lower-than-normal transmission until the precipitate dissolves (usually 4–5 days at 25°C). The temperature coefficient of transmittance for the aqueous nickelous sulfate filter is −0.715 Å/C° over the range +42°C to +7°C.

For soft O-rings our grooves are made .020 in.

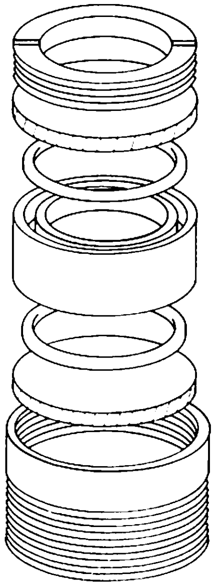


*Fig. 1* Liquid-filter cell that has been successfully used in varying environments. The external threads are for mounting in a filter wheel. (Drawing by Ruth Pellicori.)

shallower than standard groove depth in order to allow more compression for adjustment. The type of O-ring used for sealing depends on the solution to be contained. Aqueous solutions of most inorganic compounds can be satisfactorily sealed with a nitrile (Bune N) compound O-ring. This compound is soft, thus affording a tighter seal. For alcoholic solutions silicone O-rings are better. When hydrocarbon solvents are used the previous compounds will swell, and Viton O-rings were found to be best.

Our liquid filters are assembled in Tucson at an elevation of 730 m and used at our Catalina Observing Station at 2520 m elevation at wide variations in temperature and they remain bubble-free for six weeks to two months. This is approximately the bubble free lifetime obtained by Lasker (private communication). If properly assembled the filled cells can be used in an ambient pressure of 1 mm. More permanent filters (aside from crystalline absorbers) can be had with the use of semi-solid sorbitol solutions of the inorganic absorbers as described by Dunkelman and Field (1955). The present cell is an ideal container for sorbitol solutions.

## REFERENCES

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