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INITIAL TECHNICAL BASIS FOR LATE WASHING FILTER CLEANING (U)

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SUMMARY

Bench scale filter cleaning tests at the Savannah River Technology Center have shown that cross-flow filter elements can be cleaned between late wash filtration runs and restored to original clean water flux conditions. The most effective cleaning technique was high flow axial recirculation, followed by flushing with caustic solution. Simple flushing with oxalic acid and caustic is less effective and is not recommended because of adverse experience in ITP filter cleaning and uncertainty in the nature of radiolysis by-product contaminants.

INTRODUCTION

Radioactive cesium is removed from high activity waste salt solution by In-Tank Precipitation (ITP) with sodium tetraphenylborate. Strontium is also removed by adsorption with insoluble sodium titanate. The precipitate is concentrated, washed, stored, and subsequently hydrolyzed to break down the tetraphenylborate and release the aromatic carbon content of the slurry as benzene. Sodium nitrite is added during washing and precipitate storage to prevent pitting corrosion of the carbon steel storage tanks as the caustic concentration is reduced by washing.

Late Washing of the stored precipitate is being considered to remove most of the sodium nitrite inhibitor and the need for hydroxylamine nitrate (HAN) during hydrolysis, which results in subsequent accumulation of potentially explosive ammonium nitrate in the vessel vent system (Reference 1).

The proposed Late Washing process would be located in the Auxiliary Pump Pit, and would utilize the spare ITP filter (or other similar filter) for washing the precipitate, Figure 1. The late washing filtration task is comparable to ITP salt washing requirements (Reference 2). Lab tests (References 2 and 3) have shown that the filtration rate during late washing is about 35% lower compared to fresh ITP filtration (0.09 vs 0.14 gpm/ft^2 at 30 psi and 6 ft/sec linear velocity). However, the available filtration cycle time during Late Washing (20 hrs filtration/43 hr cycle) is larger than the available for ITP (26 days filtration/122 day cycle). Including the necessary waste water volume, this calculates to a late wash filtration rate requirement of 0.03 gpm/ft^2 and for ITP 0.06 gpm/ft^2 using one filter (Reference 2). While the lab tests on a single short filter tube shows adequate filtration rate compared to process requirements, the absolute values should be used with caution since the bench tests permit more effective tube cleaning, back-pulsing and flow control (filter surface utilization) compared to a 10 ft 144 tube ITP filter bundle.

FILTER CLEANING REQUIREMENTS

During cross-flow filtration the permeate flow drops off rapidly as a filter cake builds up on the tube surface. Frequent back-pulsing (reverse permeate flow) is used to lift the filter cake and restore the flow. However, as the filtration continues the pores plug with fines and the permeate flux gradually falls off necessitating filter cleaning to restore to original filter condition.

Recent ITP experience with full scale filters shows a water flux of onlv 20-30% compared to bench scale measurements, even after repeated oxalic acid cleaning. We also know that during storage the precipitate ages by radiolysis, resulting in lower viscosity, smaller particle size, numerous organic decomposition products from the tetraphenylborate, and elemental mercury. To assure sustained filter capacity it is essential to develop cleaning techniques which will restore filter flux to original conditions.

CLEANING TECHNIQUES - FLUX RECOVERY

A series of cleaning tests were conducted using: (1) high velocity (6 ft/sec) axial recirculation of the cleaning solutions and (2) slow flushing, equivalent to soaking the filter in the cleaning solution (Reference 4). A full set of filtration tests were run followed by different cleaning techniques. Each filtration test consisted of 11 processing conditions covering 15 to 45 psi pressure and 2 to 10 ft/sec linear velocity (Reference 2). Three central repeat conditions (30 psi, 6 ft/sec) were used to gage the filtration rate and cleaning recovery, Figure 2.

The best flux recovery occurred with oxalic acid and caustic recirculation, 0.005 gpm/ft^2 improvement. Flushing with oxalic acid and caustic was less effective, 0.003 gpm/ft. M-Pyrol and KOH/Triton recirculation were least effective on their own. Oxalic acid initiates hydrolysis of the residual precipitate and is the key to good cleaning. The caustic solution probably helps in cleaning organic deposits from radiolysis products.

It was not possible to judge absolute filter cleanliness between these runs since the precipitate is expected to degrade and change as it is continuously recycled through the system.

CLEANING TECHNIQUES - CLEAN WATER FLUX

Another way to measure filter recovery is clean water flux either in cross-flow mode or by closing the filter outlet (dead end).

Figure 3, Experiments B to F, shows clean water after oxalic acid and caustic axial cleaning between flux measurement tests (Reference 2). Experiments G1 and G2 show clean water flux after oxalic acid/caustic axial recirculation and flush. Both show good restoration to original filter conditions.

Figure 4 shows the water flux measurements in cross-flow mode and by dead-ending are about the same. The observed differences may be attributed to pressure gauge locations and accuracy. In all cases the clean water flux was restored to 8-9 gpm/ft^2 at 25 psi, close to manufacturer specifications.

CLEANING CYCLE DEMONSTRATION

The cleaning techniques developed in this study will be modified to simulate actual filter operation in late washing with following goals:

(1) Retain maximum slurry concentration for transfer to DWPF, i.e. transfer the finished slurry before filter cleaning. This is important to keep DWPF batch capacity rate.

(2) Reuse oxalic acid and caustic to minimize waste volume. Oxalic acid can be replenished as the concentration decreases, or replaced when too high in dissolved solids or activity.

(3) Re-use the filter between cleaning solutions to minimize solution degradation, and return the rinse water to tank 48 or similar.

(4) Provide for gravity filter drainage, or other displacement technique to minimize contamination between operations.

A separate report will be written to address this detailed demonstration of the cleaning steps.

REFERENCES

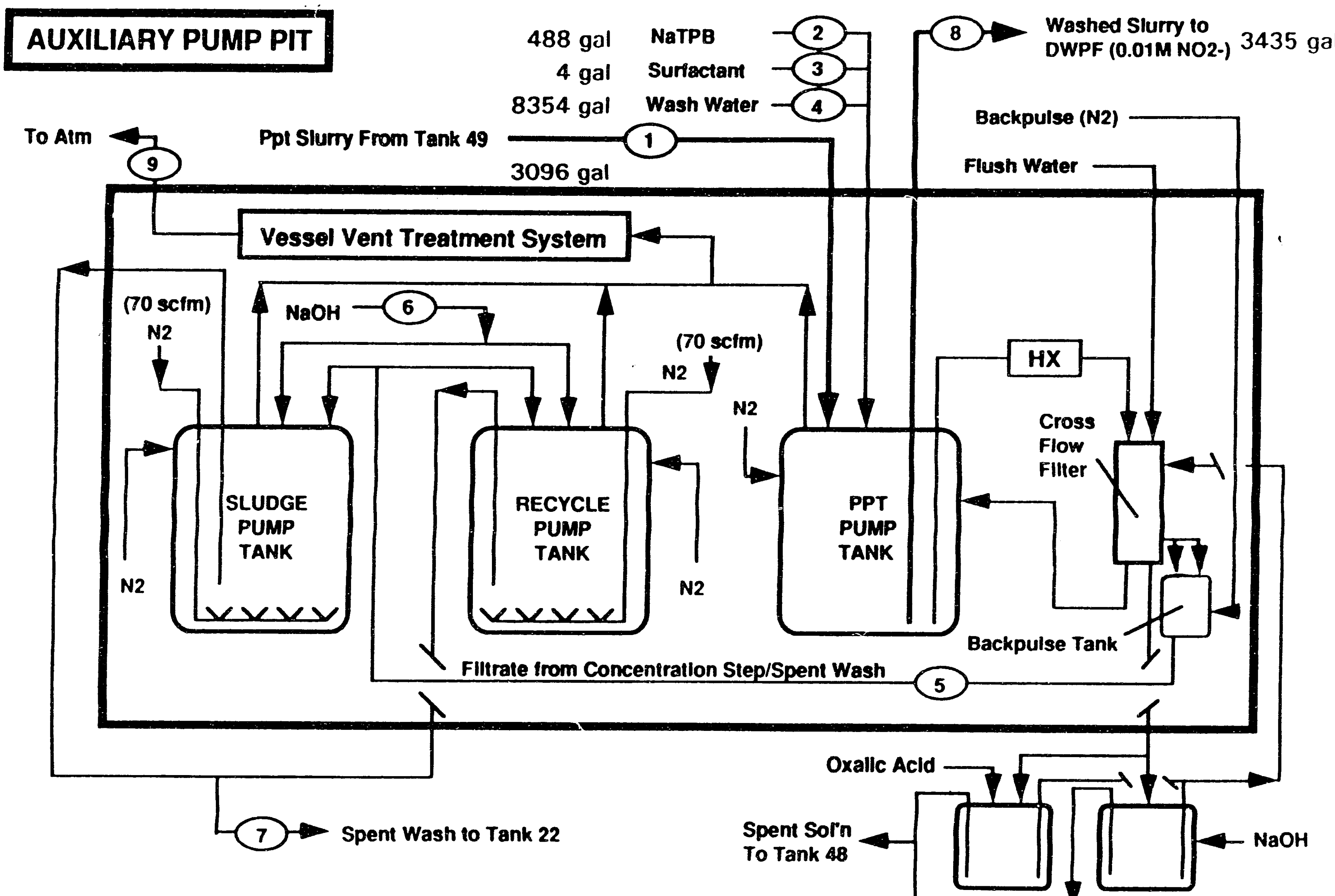
(1) D.L. Fish, L.F. Landon; *"Initial Technical Bases - DWPF Late Washing Facility"*, 6/15/92, WSRC-RP-92-793.

(2) L.O. Dworjanyn, M.F. Morrissey; *"Initial Technical Basis for the Use of Spare ITP Filter in DWPF Late Washing"*, 6/5/92, WSRC-RP-92-766.

(3) M.F. Morrissey; *"Late Washing Filtration Technical Test Plan"*, 4/1/92, WSRC-RP-92-359.

(4) M.F. Morrissey; *"Experiment I Program Plan Report"*, 7/24/92, SRT-LWP-92-110.

LATE WASH PROCESS PROCESS FLOW DIAGRAM



Note: See Table 1 for Batch Sizes

FIGURE 1

Figure 1

Cleaning Techniques & Flux Recovery

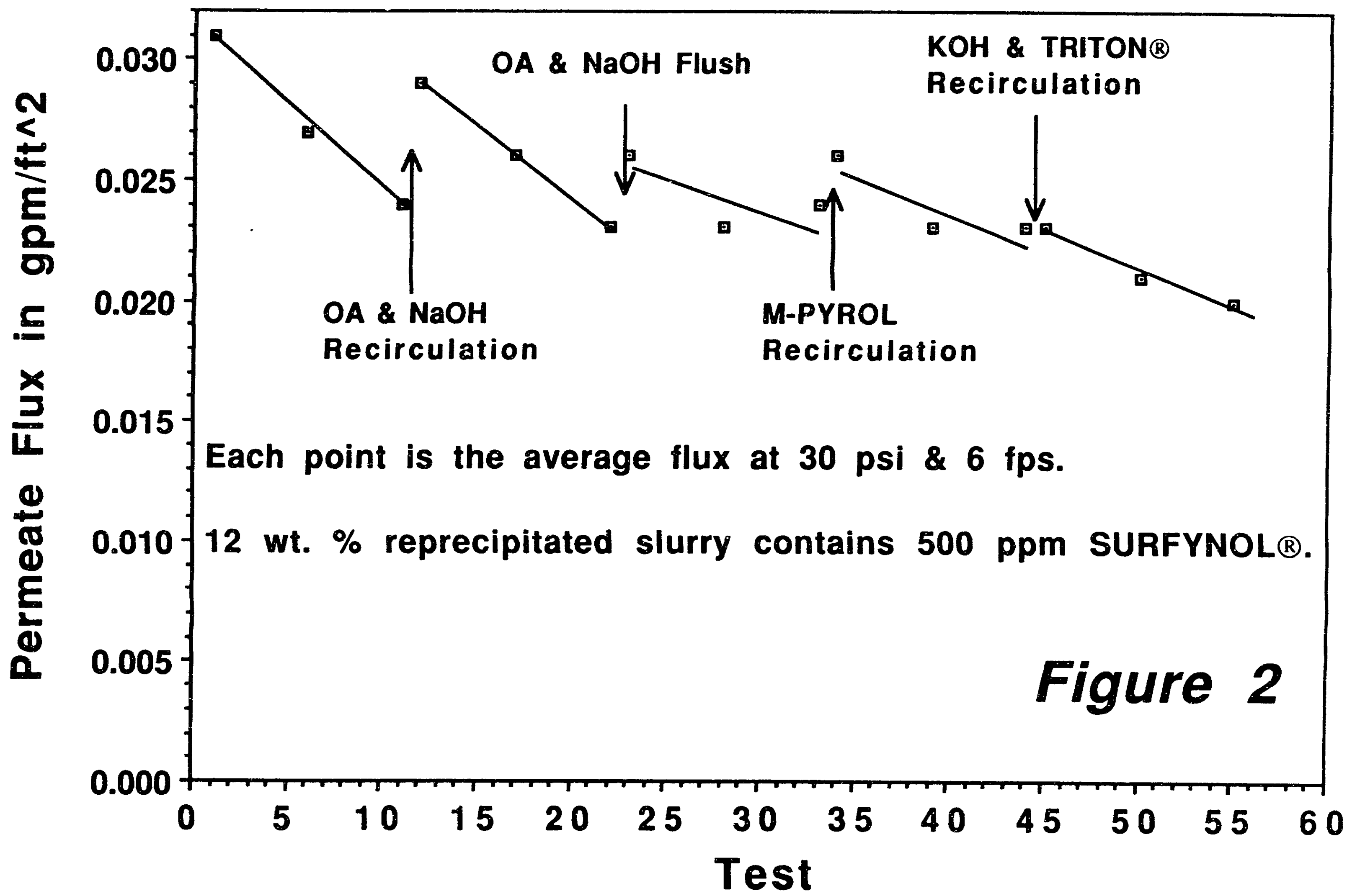


Figure 2

Deionized Water Flux Experiments A - G7

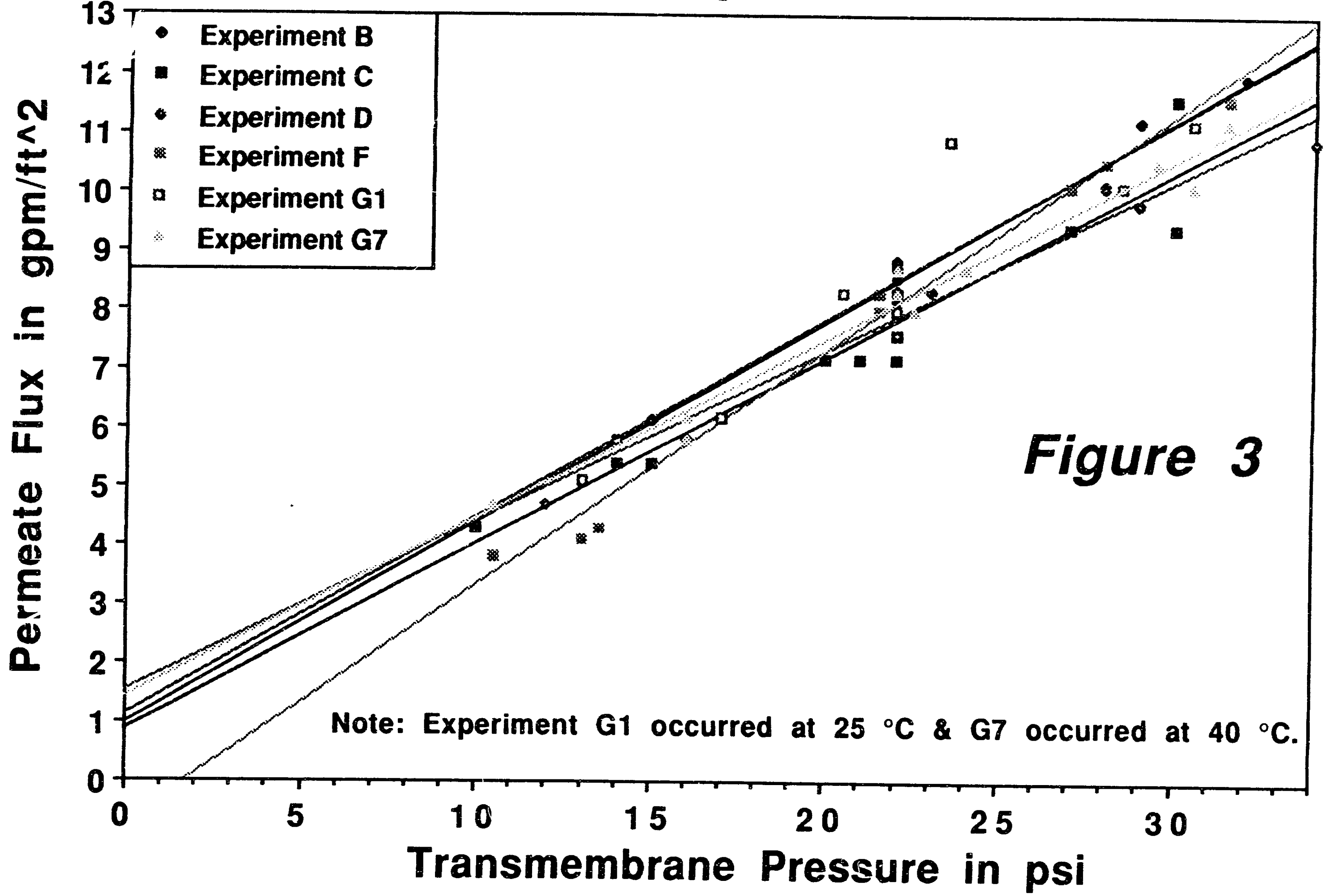


Figure 3

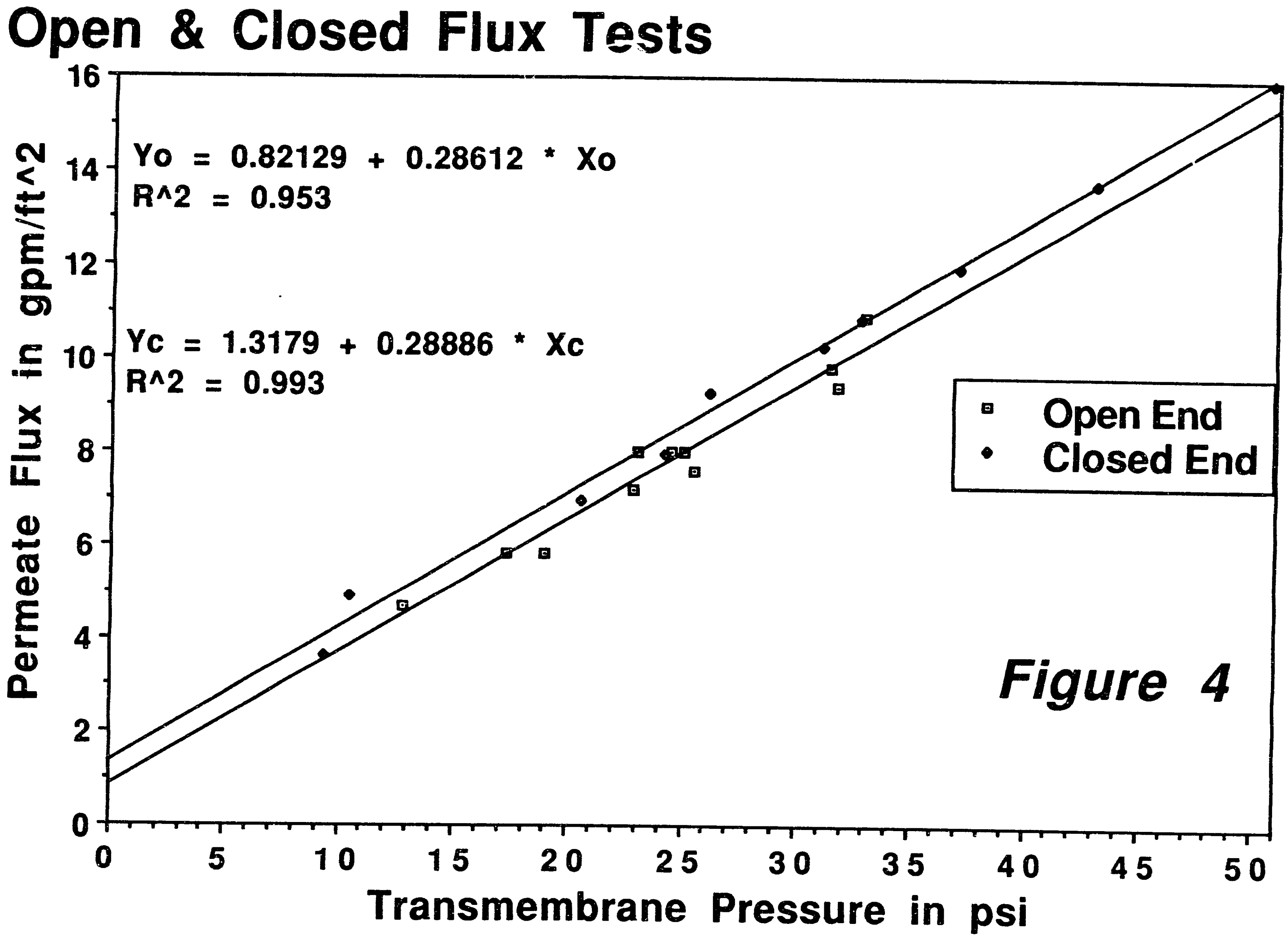

Open & Closed Flux Tests
Yo = 0.82129 + 0.28612 * Xo
R^2 = 0.953
Yc = 1.3179 + 0.28886 * Xc
R^2 = 0.993
Open End
Closed End
Permeate Flux in gpm/ft^2
Transmembrane Pressure in psi
0
2
4
6
8
10
12
14
16
0
5
10
15
20
25
30
35
40
45
50

Figure 4

END

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