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Integrity of Polypropylene Filter Fabric against the Γ-ray Irradiation

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1. Introduction

Highly radioactive waste is generated during the dilute chemical decontamination of the internal loop of a nuclear power plant. A distinguishing characteristic of HyBRID decontamination technology developed in KAERI is to use a filtration method which can reduce the volume the secondary waste significantly. Filter press is a candidate process for the filtration of the waste. Polypropylene (PP) filter fabric is used as a filtration medium. To secure the filtration process, the investigation of the filter fabric under the high radiation field was necessary.

The objective of the study is to investigate the integrity of PP filter fabric against the γ-ray irradiation.

2. Methods and Results

2.1 Experimental condition

Two kinds of PP filter fabrics were used (600 PHC and 1500 PHC, Kyoro Industrial Textile Co.). The filter fabrics were exposed to the γ-ray source. The absorbed doses were 0, 5, 10, 20, 40, 80 KGy, respectively. Tensile property of the PP filter fabrics was measured [1]. Universal testing system of INSTRON Co. (Model 5567) was used to measure the tensile property of PP filter fabric. SEM was used to investigate the surface characteristic of PP filter textiles. Elemental analysis of the filter fabrics was also performed.

2.2 Test results

Fig. 1 shows the image of the filter cake formed on the PP filter fabric. The final form of the secondary waste generated during the application of HyBRID process is a filter cake. Metal ions (Fe, Cr, Ni) and the radionuclides (Co-58, Co-60) are co-precipitated on the filter cake (mainly $BaSO_4$). The effect of the high radiation field on the tensile property of filter fabric was evaluated.

Fig. 2 shows the plot of stress against the strain under various absorbed doses. Strain is defined as follows;

$$S = \frac{L - L_0}{L_0} \; X \; 100 \qquad (1)$$

where L_0 is the initial length of the filter fabric and L is the length of filter fabric at a certain stress.

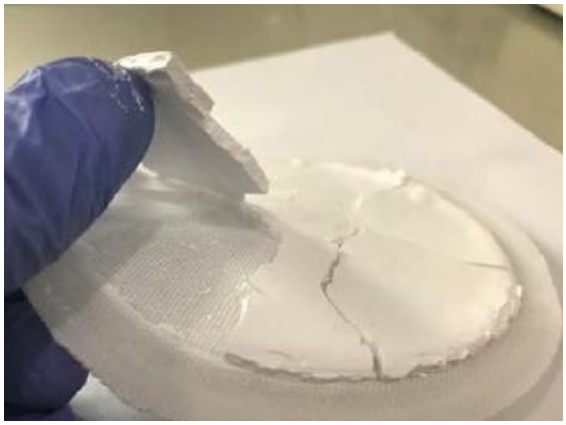


Fig. 1. Filter cake and PP filter fabric.

As shown in Fig. 2, the maximum strain and the maximum stress of 1500 PHC decrease with the increase of the absorbed dose.

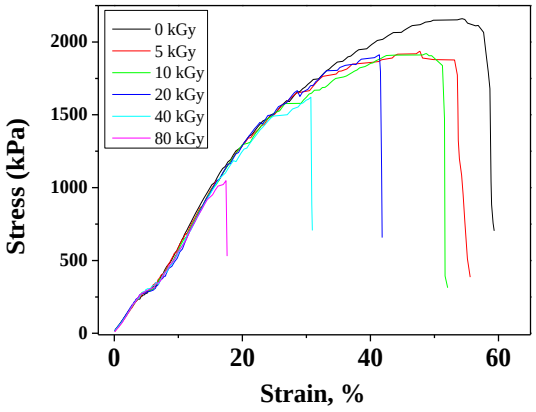


Fig. 2. Stress of PP filter fabric (1500PHC) against the strain under various absorbed doses.

Fig. 3 shows the variation of stress at break against the absorbed dose for 2 kinds of filter fabrics. For 600 PHC, the stress at break decreases with the increase of the absorbed dose in the experimental range. The stress at break of 1500 PHC, however, changes slightly in the

absorbed dose range of 0 to 20 KGy. The maximum filtration pressure is 1000 KPa. As the absorbed dose during the decontamination of the internal loop the nuclear power plant is not expected to exceed 10 KGy (1 X 10^6 Rad), it can be concluded that the effect of the γ-ray irradiation on the degradation of filter fabric is negligible during the decontamination.

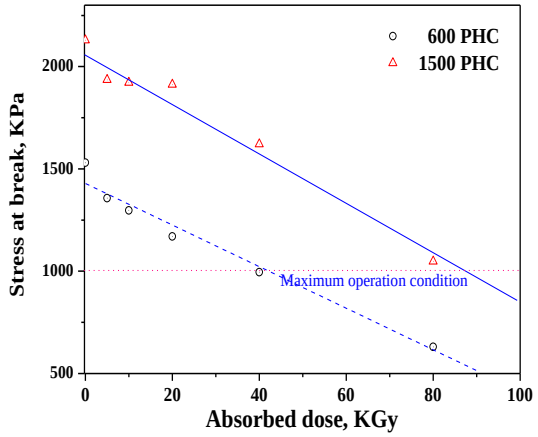
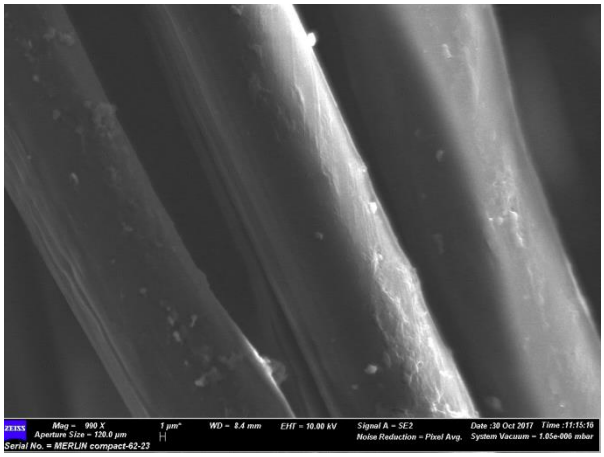


Fig. 3. Stress at break against the absorbed dose for (600 PHC and 1500 PHC).

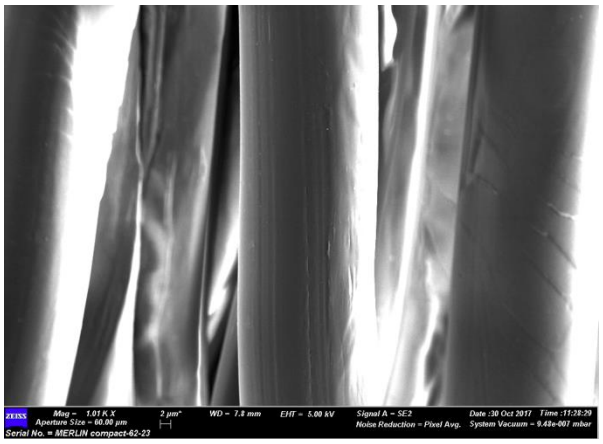
Fig. 4 shows the SEM images of 1500 PHC textiles at 0 KGy (a) and 80 KGy (b) of absorbed dose, respectively. As shown in Fig. 4 (a), the surface of 600 PHC textiles is smooth. When the absorbed dose is 80 KGy, the surface of 600 PHC textiles becomes to divide.

Fig. 5 shows the result of EDX elemental analysis to the 600 PHC filter fabric. The spectrum reveals that the PP filter fabric contains oxygen.

Butanaru et al. studied the γ-irradiation assisted fungal degradation of the pp/biomass composites [2].



(a)



(b)

Fig. 4. SEM images of 1500 PHC textiles, (a) 0 KGy, and (b) 80 KGy of absorbed dose by γ -ray irradiation.

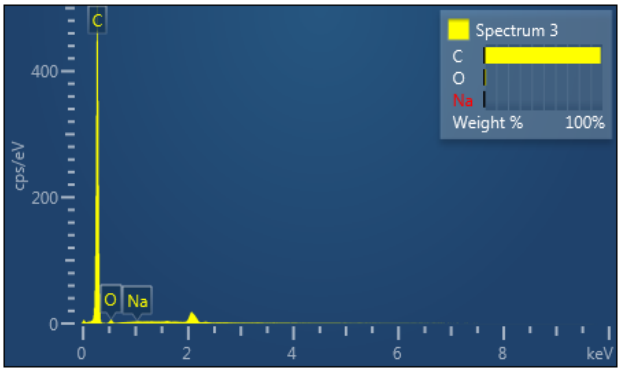


Fig. 5. EDX elemental analysis of 600 PHC after 80 KGy γ -irradiation.

From the result of FT-IR spectroscopy, the influence of γ-irradiation and fungal treatment on PP composite oxidation could be determined. They reported that carbonyl group and hydroxyl group in the PP composites formed during γ-irradiation.

The corrosion rate of Inconel 600 increases with the increase of temperature. As shown in Fig. 4, the variation of corrosion rate of Inconel 600 specimen is similar to the variation of ORP of sulfuric acid solution.

From the test results, degradation of PP filter fabric at very high absorbed dose is attributed to the oxidation of PP and the breakage of C-C bond in the polymer.

3. Conclusion

The application of a dilute chemical decontamination solution to the primary coolant system before decommis-

sioning is necessary to minimize the personnel dose rates. Volume of the secondary waste generated from the chemical decontamination can be remarkably reduced by using a filtration method. Our results indicate that PP filter fabrics in the filter press will be operated well without any problems during the application of HYBRID chemical decontamination technology on the internal loop of NPP. In a previous study, we demonstrated that HyBRID process has a good decontamination performance. More effort to increase the safety of chemical decontamination technology should be pursued.

Acknowledgement

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REFERENCES

[1] ASTM D882-12, Standard Test Method for Tensile Properties of Thin Plastic Sheeting, ASTM International, 100 Barr Harbor Drive, PO Box C700, PA 19428-2959, USA.
[2] E. Butanaru, R. N. Darie-Nita, T. Zaharescu, T. Balase, C. Tanase, G. Hiturac, F. Doroftei and C. Vasile, Gamma Irradiation Assisted Fungal Degradation of the Polypropylene/biomass Composites, Radiation Physics and Chemistry, Vol. 125, pp. 134-144, 2016.