

Rejuvenation of Aged Kraft-Cellulose Insulating Paper Used in Transformers

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Abstract : Most transformers employ the usage of cellulose paper, which has been chemically modified through the Kraft process that acts as an effective insulator. Cellulose ageing and oil degradation are directly linked to fouling of the transformer and accumulation of large quantities of waste insulating paper. In addition to technical difficulties, this proves costly for power utilities to deal with. Currently there are no cost effective method for the rejuvenation of cellulose paper that has been documented nor proposed, since renewal of used insulating paper is implemented as the best option. This study proposes and contrasts different rejuvenation methods of accelerated aged cellulose insulating paper by chemical and bio-bleaching processes. Of the three bleaching methods investigated, two are, conventional chlorine-based sodium hypochlorite (m/v), and chlorine-free hydrogen peroxide (v/v), whilst the third is a bio-bleaching technique that uses a bacterium isolate, *Acinetobacter* strain V2. Through chemical bleaching, varying the strengths of the bleaching reagents at 0.3 %, 0.6 %, 0.9 %, 1.2 %, 1.5 % and 1.8 % over 4 hrs. were analyzed. Bio-bleaching implemented a bacterium isolate, *Acinetobacter* strain V2, to bleach the aged Kraft paper over 4 hrs. The determination of the amount of alpha cellulose, degree of polymerization and viscosity carried out on Kraft-cellulose insulating paper before and after bleaching. Overall the investigated techniques of chemical and bio-bleaching were successful and effective in treating degraded and accelerated aged Kraft-cellulose insulating paper, however, to varying extents. Optimum conditions for chemical bleaching were attained at bleaching strengths of 1.2 % (m/v) NaOCl and 1.5 % (v/v) H₂O₂ yielding alpha cellulose contents of 82.4 % and 80.7 % and degree of polymerizations of 613 and 616 respectively. Bio-bleaching using *Acinetobacter* strain V2 proved to be the superior technique with alpha cellulose levels of 89.0 % and a degree of polymerization of 620. Chemical bleaching techniques require careful and controlled clean-up treatments as it is chlorine and hydrogen peroxide based while bio-bleaching is an extremely eco-friendly technique.

Keywords : alpha cellulose, bio-bleaching, degree of polymerization, Kraft-cellulose insulating paper, transformer, viscosity

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