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## D.2.16. Cinétique de diffusion des plastifiants dans les câbles PVC : corrélation entre les propriétés électriques et la migration des plastifiants

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## Résumé

Les câbles en PVC plastifiés sont très employés dans les centrales nucléaires et thermiques. Ils sont soumis à des contraintes thermiques et radiatives. La résistance d'isolement est un paramètre sensible au cours du temps. Cette évolution est due à la migration des plastifiants de la gaine vers l'isolant et inversement, jusqu'à ce que l'équilibre des concentrations soit atteint. Nous avons modélisé l'évolution de la résistivité au cours du temps sur le base de la théorie de la diffusion. Une application a été réalisée sur des échantillons modèle et sur des câbles. Nous avons déterminé la valeur des coefficients de diffusion des différents plastifiants ainsi que leur profil de distribution au cours du temps. Nous avons relié de façon mathématique l'expression de la teneur en plastifiants à celle de la résistivité électrique.

## I/ INTRODUCTION

This work is focussed on the study of the degradation of PVC cables subjected to thermal stresses. It has been performed with the framework of the Life Duration Program of the EDF PWR stations.
Previously, the various stages of the study had consisted of both determining the main degradation mechanisms occured on the PVC cables and establishing the most sensitive physico-chemical parameters. It had been concluded that PVC cables are affected to the plasticizers losses involving, in worst cases, a significant variation of the electrical resistivity [1].
In order to undurstand this phenomenon, we attempt to modelise the physical process of the migration versus time and temperature. We restrict our study to the low thermal exposures in order to avoid the morphological resin modification [2].
The work has been carried out on standard samples and cables. The interpretation of the experimental results leads us to built a mathematical model based on the Fick's Law which links the plasticizers contents to the electrical resistivity.

## 2/ EXPERIMENTAL PART [2]

### 2.1/ Materials and cables studied

Materials and cables are constituted both by a PVC for the sheath and for the insulating. The following table gives an indication of the nature and content of elements used for the compound materials sheath and insulating.

## D.2.16. Plasticizers diffusion kinetic for PVC cables : correlation between electrical properties and plasticizers migration

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## Abstract

Plasticized PVC are widely used in nuclear and thermal stations. where they are subjected to radaitive and thermal stresses. One of the consequence is a significant variation of the insulation resistance because of the plasticizers migration from sheath and insulating and inversely until an equilibrium is reached. We had modelized the evolution of the electrical property based on the theory of diffusion. Experiment had been carried out on standard materials and on cables. We had evaluated the coefficient diffusion of each plasticizer and their profil distribution versus time. We note a close relation between the plasticizer content and the electrical resistivity.

**Table 1 : Materials formulation**

| Materials | Sheath % | Insulating % |
|---|---|---|
| PVC resin | 44.6 | 56.7 |
| Plasticizers* : | | |
| DP | / | 25.5 |
| IDP | 15.6 | / |
| CP | 12 | / |
| Fillers | 23.3 | 12.6 |
| Thermal stabilizers | 4.5 | 5.2 |

*
DP : Didecyl Phtalate
IDP : Isodecyl Diphenyl Phosphate
CP : Chlorinated Parafinn

*2.1.1/ Standard samples*

In order to study the plasticizers migration, we have realised sandwiches from plates 2x20x120mm size (Fig 1). These sandwiches are gripped between 2 aluminuim plates, with a dynamometric key, at 1N.M. This operation is neccessary to avoid the evaporation phenomena of plasticizers on both sizes of material.

***Standard samples : sandwich***

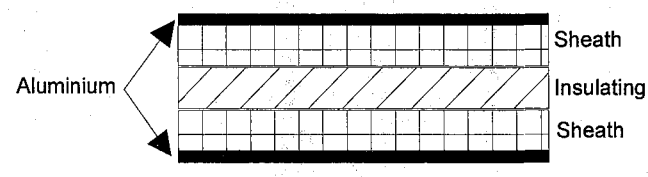


Figure 1 : Constitution of the standard materials