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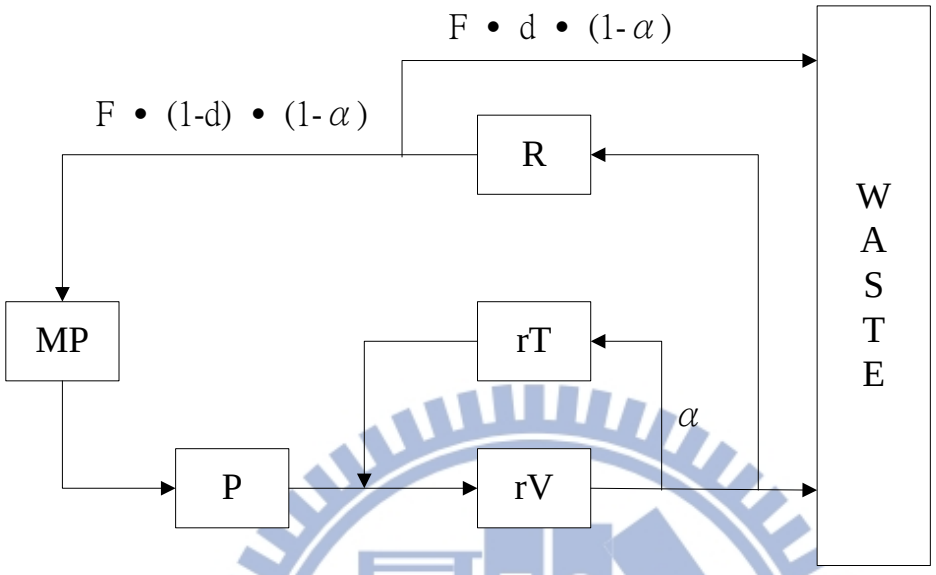
附錄 A

循環回收法原始公式推導



附圖 A.1 循環回收生命週期圖（Vellini and Savioli, 2009）

F: 回收再製率; d: waste ,%; α: 重複使用率。

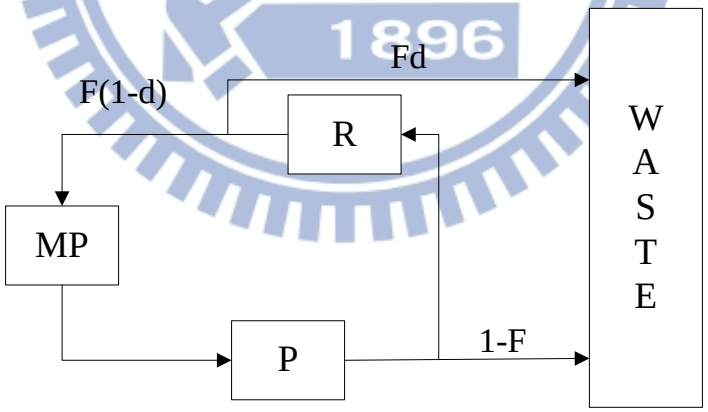


圖 B.2 循環回收生命週期圖（P、R 觀點）

1.P

廢棄: (1-F) + Fd

使用: F(1-d)

$E[n_P]$ = 使用次數*廢棄量

= 1*{(1-F) + Fd } +2*{ F(1-d)[(1-F) + Fd]} +3*{ F^2(1-d)^2[(1-F) +

Fd]} +…

$= \sum_{n=0}^{\infty} n * [1 - F(1-d)] * [F(1-d)]^{n-1}$

$= [1\text{-}F(1\text{-}d)] \sum_{n=0}^{\infty} n * [F(1-d)]^{n-1}$

$= \frac{1}{1-F(1-d)}$

2.R

廢棄: Fd+F(1-d)*(1-F)

使用: F(1-d)

E[nR]= 使用次數*廢棄量

= 1*[F(1-d)(1-F)+Fd] +2*[F^2(1-d)^2(1-F)+F^2(1-d)d]

+3*[F^3(1-d)^3(1-F)+F^3(1-d)^2d] +…

$= \sum_{n=0}^{\infty} [F^n(1-d)^n(1-F) + F^n(1-d)^{n-1}d]$

$= [1\text{-}F(1\text{-}d)]*F*\sum_{n=0}^{\infty}[F(1-d)]^{n-1}$

$= \frac{F}{[1-F(1-d)]}$

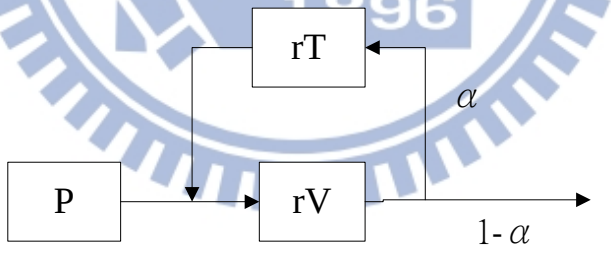


圖 B.3 循環回收生命週期圖（rV、rT 觀點）

1.$E[n_{rV}] = E[n^{\wedge}_{rV}]*E[n_P]$

針對 rV 而

廢棄: $(1-\alpha)$

使用: α

$E[n^{\wedge}_{rV}] = 1(1-\alpha) + 2\alpha(1-\alpha) + 3\alpha^2(1-\alpha) + \ldots$

$= (1\text{-}\alpha)\sum_{n=0}^{\infty} n * \alpha^{n-1}$

$= \frac{1}{1-\alpha}$

$E[n_{rV}] = \frac{1}{(1-\alpha)[1-F(1-d)]}$

2.$E[n_{rT}] = E[n^{\wedge}_{rT}] * E[n_P]$

針對 rT 而言

廢棄: $\alpha(1-\alpha)$

使用: α

$E[n^{\wedge}_{rT}] = 1\alpha(1-\alpha) + 2\alpha^2(1-\alpha) + 3\alpha^3(1-\alpha) + \ldots$

$= (1-\alpha)\sum_{n=0}^{\infty} n * \alpha^n$

$= \frac{\alpha}{1-\alpha}$

$E[n_{rT}] = \frac{\alpha}{(1-\alpha)[1-F(1-d)]}$