By means of Proposition 11.23 (an application of the Karush-Kuhn-Tucker (KKT) condition), we obtain that in general,

$$C(P) = \frac{1}{2}\sum_{i=1}^{k} \log\left(1 + \frac{P_i^*}{N_i}\right)$$

where $\{P_i^*, 1 \leq i \leq k\}$ is the optimal input power allocation among the channels given by

$$P_i^* = (\nu - N_i)^+, \quad 1 \leq i \leq k$$

where

$$(x)^+ = \begin{cases} x & \text{if } x \geq 0 \\ 0 & \text{if } x < 0 \end{cases}$$

with ν satisfying

$$\sum_{i=1}^{k} (\nu - N_i)^+ = P.$$