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Note on Nonlinear Differential Equation of Catalysis[1)]

By

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1. Mr. Yoshiyuki Suehiro, a chemical engineer, has consulted the author about the solutions of his differential equation of catalysis by spherical tablets,

$$(1)\qquad \begin{cases} (m-1)\left(Da\dfrac{dy}{dx}-wa\dfrac{y}{t}\right)=wa\,, \\ \dfrac{dwa}{dx}dx=cy\dfrac{adx}{\gamma}\,; \end{cases}$$

or for the case $m=2$, eliminating w in (1), we have

$$(2)\qquad \frac{d}{dx}\left(\frac{Dat}{y+t}\frac{dy}{dx}\right)=\frac{ca}{\gamma}y\,;$$

or fully written,

$$(3)\qquad \frac{d^2y}{dx^2}+\frac{2}{x}\frac{dy}{dx}-\frac{1}{y+t}\left(\frac{dy}{dx}\right)^2-n^2\frac{y(y+t)}{t}=0\,,$$

where $n=\sqrt{C/D\gamma}$. In these equations, x means the distance of any point of the tablet from its centre; y is the concentration of the reacting substance at x; w is the quantity of mass flow of the reacted substance through the spherical surface of radius x in the tablet; a is the total area occupied by the pores on the spherical surface of radius x, and hence proportional to x^2, while the remainings are chemical constants, positive. Solutions for $x>0$, satisfying the conditions $\dfrac{dy}{dx}=0$ at $x=0$, are required.

2. We may suppose $t=1$ by writing y instead of ty (also $n=1$ by writing x instead of nx).

1) Read before the last autumn meeting of Japanese Mathematical Society held in Kyoto.