Review and comment → Lecture 1

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Recall:

→ Dimensional Analysis & scaling

→ Π thm.

n quant.

r indep dims

$n - r$ Π variables.

→ 1 answer

others → important dimensionless ratios
→ explore limits.

→ no crank recipe!

→ drag on sphere → Re
" " ship → Re, Fr

→ Blast

— self-similarity

— $E \sim \rho R^3 v^2$ energetics.

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Comment on Blast Wave

Proceeding directly:

$R \rightarrow$ radius

$V \rightarrow$ velocity

$\rho \rightarrow$ density

$P_{atm} \rightarrow$ atm. pressure

$E_0 \rightarrow$ energy released

$t \rightarrow$ time

are $n = 6$ quantities

$r = 3$ indep. dimensions

M, L, T

$R \sim t^{\alpha}$

$\frac{d}{dt} t^{\alpha} \sim$ [redacted] $\sim \alpha \frac{R}{t}$

but for self-similar blast range,

$P_{atm} R^3 \ll E_0$, $V \sim R/t$ self-sim

i.e. $P_{atm} R^3 \sim E_0$ defines extent of blast.

so $\rightarrow$ P_{atm} negligible

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For Blast:

Lokerntal mechanical energy >> pressure

$$\partial_t V_r + V_r \partial_r V_r = -\partial_r P/\rho$$

$$\frac{V}{t} \sim \frac{V^2}{R}$$

$M \sim \rho R^3$

$V \sim R/t$

$$\rho R^3 \frac{V}{t} \sim \frac{\rho R^3 V^2}{R}$$

$$\rho R^3 \frac{R}{t^2} \sim \frac{\boxed{\rho R^3 V^2}}{R}$$

but $E \sim \rho R^3 V^2$

$\Rightarrow$

$$\frac{R^5}{t^2} \sim E/\rho$$

$$\left\{ \begin{array}{l} E \sim \rho R^3 V^2 \sim O(1) \\ E/P_{atm} R^3 \gg 1 \to \infty \end{array} \right.$$

$$\Rightarrow \boxed{R \sim (E/\rho)^{1/5}\, t^{2/5}}$$