Chem 342-
Air Quality Modeling

Purpose – to establish a mathematical source-receptor relationship

Types
- Dispersion models
- Receptor models

Predictive Uses of Dispersion Models
- New source review
- Control strategy evaluation
- Fuel conversion studies
- Process variation studies

Dispersion Models

Types
- Screening
- Refined

Variants
- Simple/complex terrain
- Rural/urban
- Single/multiple source
- Steady-state/instantaneous
- Point/area
- Reactive/non-reactive
Gaussian Dispersion

Fig. 4.2 Cross section through Gaussian plume with $\sigma_y = 20\,\text{m}$, $\sigma_z = 10\,\text{m}$, and centerline concentration of 1.0.
**Air Pollution Models**

Gaussian dispersion Model Definitions

\[ x \]
\[ y \]
\[ z \]
\[ \sigma_y \]
\[ \sigma_z \]

**Gaussian Plume Equations**

\[
\chi = \frac{Q}{2\mu \sigma_y \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \times \left[ \exp\left(-\frac{(z-H)^2}{2\sigma_z^2}\right) + \exp\left(-\frac{(z+H)^2}{2\sigma_z^2}\right) \right]
\]

standard deviations, \( y, z \) and \( H \) are all in meters. Wind speed \( (u) \) is in m/s
Units of concentration depend on source strength units \((Q)\).

at plume centerline, \( y = 0 \), and term 2 drops out.

At ground level, \( z = 0 \) and term 3 reduces to give:

\[
\chi = \frac{Q}{\mu \sigma_y \sigma_z} \exp\left(-\frac{H^2}{2\sigma_z^2}\right) \quad \text{This is the most widely used form of the plume equation.}
\]

If \( H = 0 \), ground level release, the equation further simplifies to:

\[
\chi = \frac{Q}{\mu \sigma_y \sigma_z}
\]

Often, wind speed measurements are made from standard Weather Bureau towers, at 10 meters. Of course, the wind speed varies with height. An approximation of the wind speed at any height may be given by the equation:

\[
u = u_{10}\left(\frac{z}{10}\right)^p
\]

\textit{note: values for }p\textit{ are given in Table 4.6, next page}
Homework #2

Calculate the downwind, ground level, centerline concentration at 100 meters, 500 meters and 1000 meters from a pollutant source, using the Pasquill-Gifford, BNL and Briggs Estimates for plume spread. Compare the results from the 3 separate methods. Assume a stack height of 12 meters. Suppose the standard for maximum air concentration is

Additional Information

Weather cloudy, calm
10 m wind speed 5 m/s
emission rate 10 gram/second
plume rise 24 meters
location rural

<table>
<thead>
<tr>
<th>Table 4.6</th>
<th>Estimates of Wind Power, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability Class</td>
<td>A</td>
</tr>
<tr>
<td>Urban p</td>
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</tr>
<tr>
<td>Rural p</td>
<td>0.07</td>
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