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Research Article

Screen Spr : A Screening Model For Assessing The Air Quality Impact Of Stationary Source

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Abstract–
The Air quality modeling systems were imported from SCRAM of US Environmental Protection Agency (EPA). The suggested modeling system included SCREEN3, AERMOD, ADMS and CALPUFF were provided by EPA in the form of FORTRAN source codes. However, the programs were written as console applications, and they are inconvenient to the end users. It is necessary to develop a software tool which runs in windows platform. SCREEN-SPR is a software package as similar to the USEPA SCREEN3Model was developed in C# language and run on the VisualBasic platform which can be used as a tool for assessing the air quality impact of stationary source with preliminary estimation scheme (screening scheme). Also, theSCREEN SPR model is used to calculate the maximum Ground Level Concentration (GLC)of pollutant which prevail at the shortest downwind locations from the source under the combinations of various possible wind speed andits corresponding atmosphericsabilityclassesfor thegiven inputs such as source details and plant emission characteristics.
Keywords: USEPA, SCRAM, SCREEN3, AERMOD, ADMS, CALPUFF, SCREEN-SPR, GLC etc.,

INTRODUCTION

SCREEN SPR is a screening version of the Multi Plume Industrial Source Complex Short –term Period (MPC-SPR) model. SCREEN SPR model uses a Gaussian plume model that incorporates source-related factors and meteorological factors to estimate pollutant concentration from continuous sources. It is assumed that the pollutant does not undergo any chemical reactions, and that no other removal processes, such as wet or dry deposition, act on the plume during the transport from the source [6]. Large industrial activities (power generation) andtheir expansion projects in a limited area, in any air basin may pose many problems, especially “Air Pollution Management". The transport and diffusion of the air pollutants along the downwind distance emitted into the atmosphere from the all stacks depend on meteorological factors such as wind speed, wind direction and atmospheric turbulence. Rao et al. (1994) defines the critical wind speed (case) is that at which the concentrations of the impurities at the breathing level can attain the irmaximum in a particular meteorology. Thisstudyfocusedondeveloping a software SCREEN SPR for determining the maximum ground level concentration of a pollutant at the shortest downwind distance under all possible wind speeds and their relevant ability classes. This study involves all possible wind speeds such as 0.25, 0.69, 1.39,2.10,2.75,3.47,....16.67(m/se)and their relevant stability classes. The maximum ground level concentrations were determined by giving the following variables as an input.

The internal stack diameter (d),
The stack exit gas velocity(Vs),
The physical stack height (hs),and
The Emission rate of pollutant(q)
The maximum GLC corresponds to each wind speed, and its relevant stability class was assessed.

METHODOLOGY

The general Gaussian Dispersion Model was employed to determine the Ground level Down-wind concentration of the Pollutant (Turner, 1970)

$$C = Q/(\pi * \sigma_v * \sigma_z * u_s) \times \exp\left\{ -\frac{1}{2}\left(\frac{he}{\sigma_z}\right)^2 \right\} \text{-----------------------------------1.}$$

C(x,0,0) - Ground level down-wind center line concentration of a pollutant,(µg/m^3)

Q-Emission rate of pollutant (µg/sec)
u_s-Mean wind speed at stack height (m/sec)
he –Effective stack height, he(m)=physical stack height (hs)+plume rise(Ah)
$\sigma_v \sigma_z$ -Diffusion parameters along y&z axes respectively.

Atmospheric Stability

Meteorological conditions defining, Pasquill turbulence types were adopted for determining the atmospheric stability classification,(Pasquill1961]

DispersionCharacteristics

Formulae recommended by Briggs(1973)for calculating $\sigma_v \sigma_z$ where10^2<x< 10^4m. This was employed in the dispersion model.

PlumeRise

Briggs formulae were recommended for estimating the plume rise under following conditions.

1. $\Delta h = 2.47(Qh)^{1/3}(hs)^{2/3}$ for Unstable and Neutral conditions

2. $\Delta h = 2.45\ (Qh/0.0064\ u_s)^{1/3}$

Where,

Δh–plume rise in(m)
Qh – Heat emission rate(Kcal/Sec)
hs=Physical stack height(m)

WindSpeedatStackLevel

The Wind speed at the stack height is not available and which is usually evaluated based on the theoretical formula. Wind speed at stack height is found out using power law

$$U_S;U_{10}(hs/h_{10})^P$$

Where,
U_S; wind speed at stack outlet(m/sec)
U_{10};Wind speed at 10m level
p; is a function of stability
p=0.12for un stable conditions,
p=0.14 for neutral conditions,
p=0.24 for stable conditions.

Wind speed at stack level was used in the dispersion calculation

SCREEN SPR

The main page of the SCREEN SPR model is shown in the figure-1.

Figure-1: Main page of the SCREEN SPR model

SCREEN SPR Model consit of two options, one for rural mode and another one for urban mode. Each option consist of five different keys. SPR Rural key is used for computing the maximum GLC and the output key shows the out of the SPR Rural. The results was shown in the Figure-2. The CGLC key is used for computing Centre line Groundlevel concentration at each downwind distance which starts from 100 m to 10,000m with an increment of 100 m. The output key of the CGLC shows the output of the CGLC. Dispersion pattern Key shows the dispersion pattern of the pollutant under varrious combinations of wind sleeed and stability class.The results of dispersion is shown in the figure-3. The SPR urban mode is similar to run as like of the SPR Rural mode.

PlantCharacteristics

The input data for the model were taken for a typical Thermal power plant generating 360MW capacity with lignite as fuel.

Physical stack height	:220m
Diameter of the stackat outlet	:4.75m
Atmospheric temperature	:41°C
Stack gas temperature	:150°C
Exit Velocity of stack gas	:25m/sec
Mass density of stack gas	:0.9kg/m
Emission rate of SO2	:6.63 X 10^8μ g/Sec

RESULTS AND DISCUSSION

The maximum GLC was worked out for all the wind speed and its relevant stability class up to a distance of 10,000m at an interval of 100m.When the SCREEN-SPR programme is run successfully, the resulting values are stored on the data file.. The data file contains a critical wind speed corresponding to each stability class, which the combination of wind speed and its corresponding stability class which holds the maximum GLC prevailing at the shortest ground leveldown-windlocation.Table-1 and Figure-2 clearly shows the results of the maximum GLC. Figure-3 clearly depicts the dispersion pattern

Table-1 :Worst Meteorological Situation

CLASS	X	SY	SZ	UBAR	USTK	EFF. HT	CX
B	**4600.00**	**609.12**	**552.00**	**3.47**	**4.31**	**750.97**	**11.366**

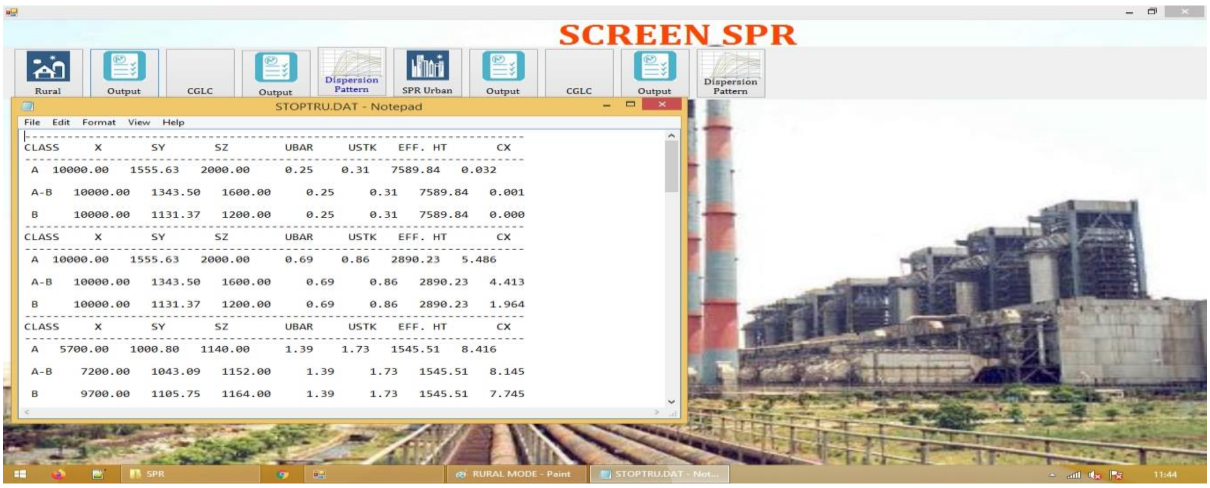

Figure-2: Output generated from SPR Rural mode

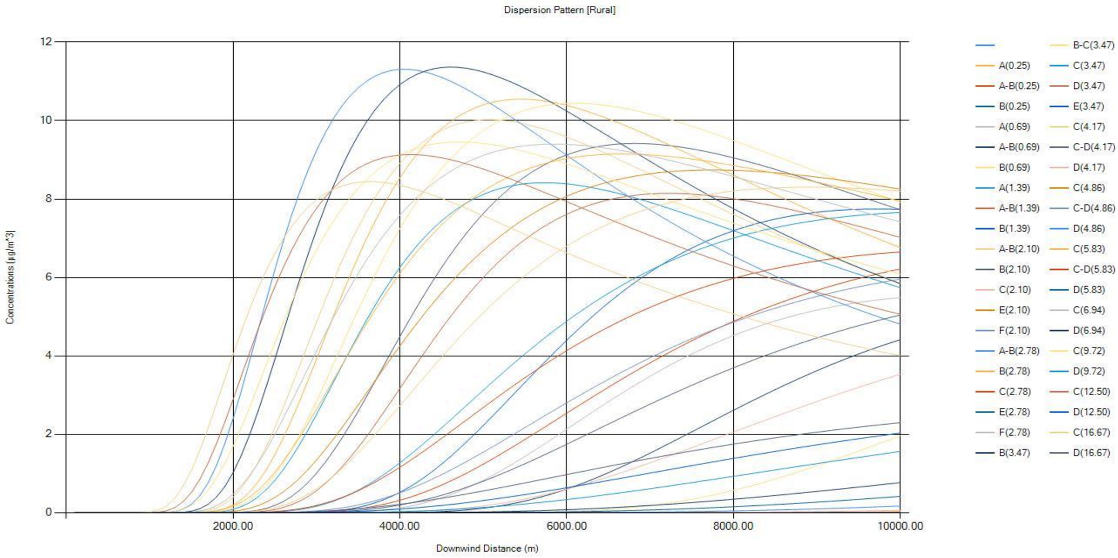

Figure-3: Output generated from Dispersion Pattern

CONCLUSION

The SCREEN-SPR Model was developed in C# language and run on the Visual Basic platform andit is used to calculate the maximum Ground Level Concentration(GLC) of pollutant prevailing at down-wind locations. Ranging from 100mto10, 000 m with an increment of 100m under the combination of various wind speed and atmospheric stability classes. The worst metrological situation for the typical Thermal Power plant under assumed plant characteristics was achieved by the critical windspeedof3.47m/Sec prevails under stability class B holds the highest GLC of SO_2 at a downwind distance of about 4600m from the source

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