Computer Models
For
Fire and Smoke

Model Name:	VOLTRA
Version:	6
Date:	2006
Classification:	Fire Endurance
Very Short Description:	Thermal transient analysis in 3D block shaped objects. Conduction: temperature dependent thermal conductivity and specific heat. Convection: temperature difference dependent heat transfer coefficient. Radiation: non-linear view factor based radiation. Mass flow (between isothermal zones). Output highlight: 3D animations.
Modeler(s), Organization(s):	Piet Standaert, Piet Houthuys, Physibel (Belgium)
User's Guide:	VOLTRA manual (available through www.physibel.be)
Technical References:	See User's Guide
Validation References:	"Validation of VOLTRA for calculating temperatures in fire exposed structures", 2004, Physibel, available on request: mail@physibel.be .
Availability:	Physibel, Heirweg 21, B-9990 Maldegem, Belgium tel. +32 50 711432, fax +32 50 717842 mail@physibel.be
Price:	8 800 EUR Educational prices on request.
Necessary Hardware:	A good P.C., MS Windows operating system. 2 Byte of RAM is recommended (allowing solving systems of > 2 E06 nodes.

Computer Language: C++

Size: VOLTRA.EXE has 900 Kbyte.

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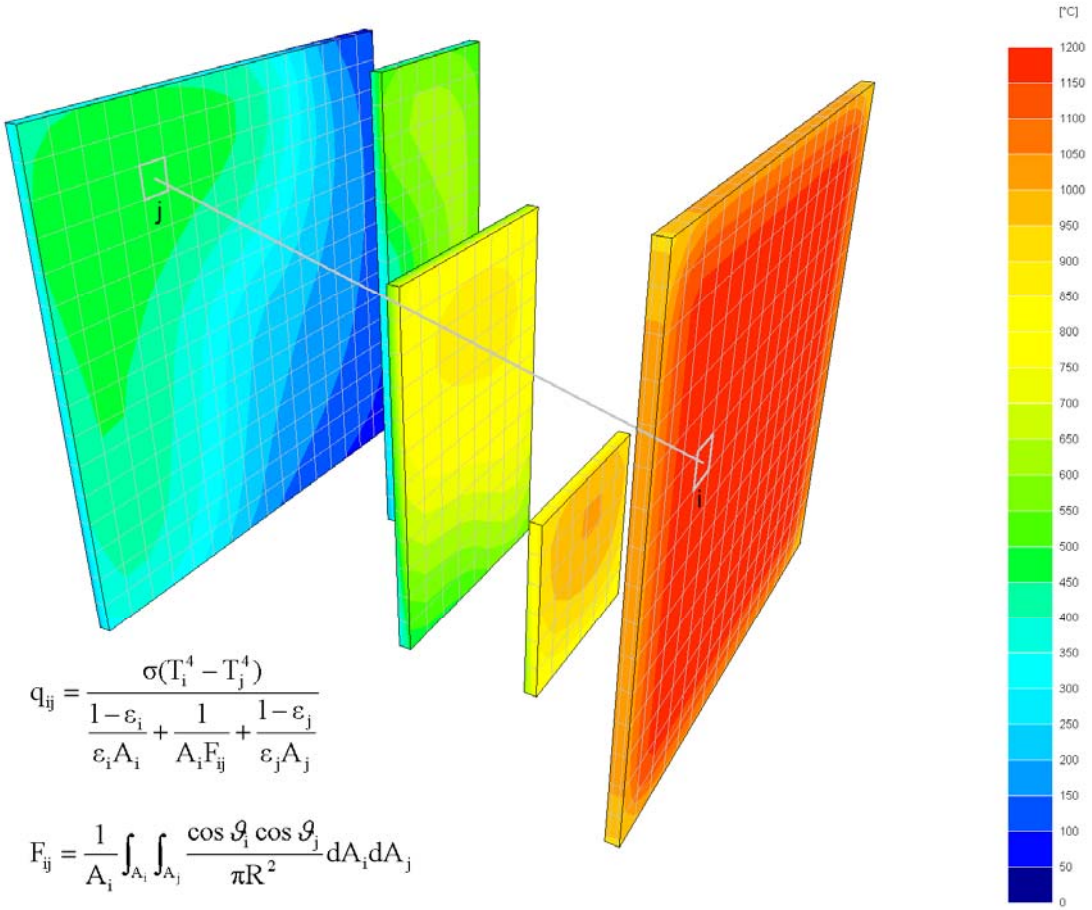
Detailed Description:



$$q_{ij} = \frac{\sigma(T_i^4 - T_j^4)}{\frac{1-\varepsilon_i}{\varepsilon_i A_i} + \frac{1}{A_i F_{ij}} + \frac{1-\varepsilon_j}{\varepsilon_j A_j}}$$

$$F_{ij} = \frac{1}{A_i}\int_{A_i}\int_{A_j} \frac{\cos\vartheta_i \cos\vartheta_j}{\pi R^2} dA_i dA_j$$

VOLTRA is a thermal analysis program for transient heat transfer in three-dimensional rectangular objects.
VOLTRA can be used to carry out fire simulations. The RADCON module allows including the simulation of non-linear radiation based on geometric view factors. The thermal conductivity and specific heat of materials may be temperature dependent. Latent heat is modeled through an increase of specific heat within a small temperature interval around the change of phase temperature. Heat transfer to objects via (time dependent) ventilation between zones at different temperatures can be studied.

Dynamic solar heat gains can be studied. To this end a solar processor is built in. An object image with shadows cast by direct sun light at any time and any geographic location can be viewed. The direct and diffuse solar radiation from climate data is cast on the material surfaces. The absorbed solar radiation is converted to time dependent node powers, as additional boundary conditions to the system. Transmission of solar radiation is possible via transparent materials to simulate heat gains through windows. The reflected solar radiation is diffuse and distributed according to the view factors to other material surfaces. Direct radiation is reflected (as diffuse radiation) using a reflection factor that may be function of the angle of incidence.

The geometry is described with a list of rectangular blocks, which vertices lie on grid points of a rectangular grid. Materials and surface boundary conditions with different thermal properties are identified using separate colours. Each geometry block is part of either a material or a surface boundary condition region, and has a reference to one of these colours. Node boundary conditions with fixed temperature or power are possible, and can be placed in grid point locations. Also border face boundary conditions in the interface between two colour regions with fixed temperature or heat flux, or material boundary conditions with fixed temperature or heat power density are possible.

The time-dependent boundary conditions are described with functions, either built-in functions based on parameters, or external user-defined functions based on function values given at a fixed time interval.

The thermal conductivity, specific heat and reflection factor of a material can refer to functions (of temperature or angle of incidence) described in external text files.

VOLTRA allows creating time-dependent graphic animations of moving shadow patterns, calculated temperature and heat flux field in the studied object. Alphanumeric lists of time functions of temperatures in individual nodes or heat flows through given surfaces through the object can be made. Graphs using the text output data can be drawn e.g. in Microsoft Excel.

SECTRA is a two-dimensional reduced version of VOLTRA.

The RADCON module, which allows a better simulation of radiation (using view factors) and convection, is available in VOLTRA and is required for fire simulation and for the calculation of solar heat gains.