

PACKAGE ID - 000154MLTPL02 KIVA3VREL2

KWIC TITLE - A Block-Structured KIVA Program for Engines
with Vertical or Canted Valves

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LIMITATION CODE -COPY **AUDIENCE CODE** - UNL

COMPLETION DATE - 10/22/1999 **PUBLICATION DATE** - 10/21/1999

DESCRIPTION - KIVA3VRELEASE2 is a computer program for the numerical calculation of transient, two and three-dimensional, chemically reactive flows with sprays. It is a newer version of the earlier KIVA3 (1993) that has now been extended to model vertical or canted valves in the cylinder head of a gasoline or diesel engine. KIVA3, in turn, was based on the earlier KIVA2 (1989) and uses the same numerical solution procedure and solves the same sort of equations. KIVA3VRELEASE2 uses a block-structured mesh with connectivity defined through indirect addressing. The departure from a single rectangular structure in logical space allows complex geometries to be modeled with significantly greater efficiency because large regions of deactivated cells are no longer necessary. Cell-face boundary conditions permit greater flexibility and simplification in the application of boundary conditions. KIVA3VRELEASE2 contains a number of significant changes. New features enhance the robustness, efficiency, and usefulness of the overall program for engine modeling. Automatic restart of the cycle with a reduced timestep in case of iteration limit or temperature overflow will reduce code crashes. A new option provides automatic deactivation of a port region when it is closed from the cylinder and reactivation when it communicates with the cylinder. Corrections in the code improve accuracy; extensions to the particle-based liquid wall film model makes the model more complete and a split injection option has been added. A new subroutine monitors the liquid and gaseous fuel phases and energy balance data and emissions are monitored and printed. New features have been added to the grid generator K3PREP and the graphics post processor, K3POST.

PACKAGE CONTENTS - Media Directory; MAKEGEN File-defines make file shell for Sun, IBM, or SGI (3 pages); ESTSC NOTE KIVA3vR2-01; Software Abstract; Release 2 README; EXE Files Decompression Note; Sample KIVA User Group Newsletter; Media Includes Source Code for Main Code, User's Manual for CGS Device Control Which Includes CIC-144, CIC-145, and CIC-902, Sample Problem Input Data for Main Code, KIVA Reports LA-13608-MS, LA-13313-MS, LA-12503-MS, LA-11560-MS, Source Code for Preprocessor (K3PREP), Source Code for Graphics Postprocessor (K3POST), Linking Instructions, Compilation Instructions, CGS Code, PSCAN Codes, *X.EXE MAKE FILES;

SOURCE CODE INCLUDED? - Yes

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MEDIA QUANTITY - 1 CD Rom

METHOD OF SOLUTION - KIVA3VRELEASE2 solves the unsteady equations of motion of a turbulent, chemically reactive mixture of ideal gases, coupled to the equations for a single-component vaporizing fuel spray. The gas-phase solution procedure is based on the arbitrary Lagrangian-Eulerian (ALE) finite volume method. The arbitrary mesh of hexahedral cells can conform to curved boundaries and move to follow changes in combustion chamber geometry. The transient solution is marched out in a sequence of finite time increments in which the temporal difference scheme is largely implicit. A subcycled explicit method is used to calculate convection in the rezone phase. Evaporating liquid sprays are represented by a discrete-particle technique, in which each computational particle represents some number of droplets of identical size, velocity, and temperature. All KIVA3V calculations must be run in double precision on platforms that have a 32-bit word length. The Common Graphics System (CGS) supplied along with KIVA3V is divided into three functional groups. The viewing subroutines define the plotting limits and placement of the graphics output on the graphics view surfaces. The output subroutines generate graphics images as well as prepare a surface for plotting. The attribute subroutines control the appearance of the graphics output. The CGS graphics routines are in single precision.

COMPUTER - MLT-PLTFM

OPERATING SYSTEMS - UNICOS, UNIX (Adaptable), HP-UX

PROGRAMMING LANGUAGES - FORTRAN

SOFTWARE LIMITATIONS - The include file comkiva.i should be suitably modified for problems exceeding 22500 grid points and 2500 spray parcels.

SOURCE CODE AVAILABLE (Y/N) - Y

UNIQUE FEATURES - KIVA3VRELEASE2 is a revision of the first KIVA program that can model vertical or canted valves in the cylinder head of an internal combustion engine. The valves are treated as solid objects that move through the mesh using the familiar snapper technique for piston motion in KIVA3. Because the valve motion is modeled exactly, and the valve shapes are as exact as the grid resolution will allow, the accuracy of the valve model is commensurate with that of the rest of the program. Other new features in KIVA3VRELEASE2 include a particle-based liquid wall film model, a new sorting subroutine that is linear in the number of nodes and preserves the original storage sequence, a mixing controlled turbulent combustion model, and an optional RNG k-epsilon turbulence model. All features and capabilities of the original KIVA3 have been retained.

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UNIQUE FEATURES - (CONT)

RELATED SOFTWARE - In addition to the main hydro program (KIVA3), supplied are a basic preprocessor for grid generation (K3PREP) and a graphics postprocessor (K3POST). The K3PREP routine also includes a minor bug fix from Anthony Amsden in the setup routine to take care of a full circle mesh with an axis, in which the front and derriere block faces are fluid. These two programs will be adequate for many users, but serve as models for the more experienced user, who will replace them with packages tailored to their own needs. K3PREP has been expanded to support the generation of grids with valves, along with the shaping of valve ports and runners.

OTHER PROG/OPER SYS INFO - Linear system solver, such as in LINPACK, is required for equilibrium chemistry solver. Several calls are made to run-time libraries. Graphics postprocessor requires primitives for point plotting and vector drawing, along with character string conversion for plot labels. The release of CGS Version 11.4 accompanying KIVA3VRELEASE2 includes the media and documentation for CGS. It requires the X11 window system. Many UNIX operating systems come bundled with X11. If X11 is not available on your system you may contact: MIT Software Distribution Center, Technology Licensing Office, Room E32-300, 77 Massachusetts Avenue, Cambridge, MA 02139, phone 617-258-8330. The KIVA code is qualified to run on any UNIX system including HP-UX. It has nbeen run on versions 8.0 and 10.0 without any problems. The code is serial, but some people have modified it to run in parallel. It has shared memory.

HARDWARE REQS - Load length of executable file is determined by the values easily specified by the user in parameter statements. These should be adjusted to fit the calculation, in order to make optimum use of computer resources. As an example, the load length of an executable file is 5.55 megawords, with arrays that allow up to 22500 grid points and 2500 spray parcels.

TIME REQUIREMENTS - Run time requirements depend upon the problem size and the system configuration. On the Cray Y-MP simple 2-D calculations might run to completion in a minute; a 3-D cold-flow two-stroke engine calculation with 20,000 grid points requires on the order of 1.5 hours for one crankshaft rotation; and many hours may be required for larger meshes, runs with many spray particles, complex chemistry, and strong shears. Comparative runs on the IBM RSIC 6000, Silicon Graphics, and SUN workstations ranged from two to six times the Cray Y-MP times, with most being greater by a factor of three to four.

REFERENCES - A.A. Amsden, KIVA-3V, Release2, Improvements to KIVA-3V, LA-13608-MS, May 1999; A.A. Amsden, KIVA-3V: A Block-Structured KIVA Program for Engines with Vertical or Canted Valves, LA-13313-MS (May 1999); A.A. Amsden, KIVA-3: A KIVA Program with Block-Structured Mesh for Complex Geometries, LA-12503-MS, March

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REFERENCES - (CONT) 1993; A.A. Amsden, P.J. O'Rourke, and T.D. Butler,
KIVA-II: A Computer Program for Chemically Reactive Flows with
Sprays, LA-11560-MS, May 1989.

ABSTRACT STATUS - Submitted 10/21/1999.

SUBJECT CLASS CODE - H

KEYWORDS -

COMPUTER PROGRAM DOCUMENTATION
K CODES
CHEMICAL REACTION KINETICS
SPRAYS
TURBULENT FLOW
TWO-PHASE FLOW
MESH GENERATION
EQUATIONS OF STATE
GAS FUELS
LIQUID FUELS
MIXTURES
SUPERSONIC FLOW

EDB SUBJECT CATEGORIES -

990200 420400 400201 400800

SPONSOR - DOE/EE

PACKAGE TYPE - SCREENED