INTRODUCING ICRKFLO — A POWERFUL, VERSATILE COMPUTER CODE FOR ANALYZING FCC RISER REACTOR PERFORMANCE

ICRKFLO – a computational fluid dynamics (CFD) code that simulates three-phase (gas, liquid, and solid) flow in FCC riser reactors – is now available. The code was developed by the U.S. Department of Energy's Argonne National Laboratory (Argonne) under a Cooperative Research and Development Agreement (CRADA). ICRKFLO has been successfully applied to simulate small- and large-scale FCC riser reactors. ICRKFLO can help you gain insight into the interaction between riser hydrodynamics and cracking kinetics so that you can optimize operational parameters to increase and/or adjust product yields.

Meeting a Critical Need

FCC technology has undergone dramatic evolutionary advances since its inception in the early 1940s. Today, refiners are constantly pursuing ways to improve the FCC process so that they can tailor and increase desired product yields. Since FCC is the key conversion process in a refinery, improvements to FCC technology can help increase refinery profitability in a highly competitive, changing market.

ICRKFLO (Integral CRAcKing FLOw) — a state-of-the-art CFD-FCC riser simulation code — was developed to provide the refining industry with a tool that can be used to help design and rapidly incorporate improvements in FCC riser reactor units. ICRKFLO can help you find ways to improve FCC performance to

- Alter and/or optimize product yields to match seasonal demands and environmental dictates relative to reformulated gasoline/diesel fuels,
- Reduce energy use and CO_2 emissions, and
- Increase the product yield/bbl processed (see Figure 1).

Optimizing FCC Riser Technology with ICRKFLO

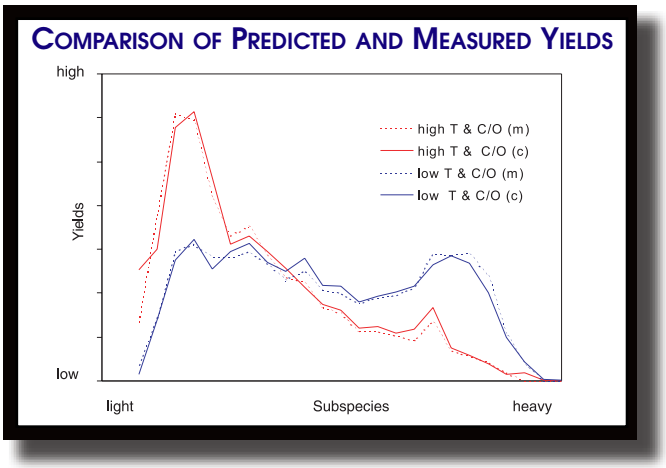
Characterizing Multiphase Flow. ICRKFLO solves fundamental conservation equations to determine the FCC flow properties for three phases: gaseous species, oil droplets, and catalyst particles (see Figure 2). Several new models had to be developed in order to characterize the multiphase flow, including

- Particle-solid interactions,
- Particle-droplet heat transfer,
- Droplet vaporization,
- Cracking kinetics, and
- Coke deposition and transport.

Improving FCC Riser Reactor Performance. ICRKFLO can help you understand the interplay among hydrodynamics, heat transfer, and cracking kinetics in the injection zone of a riser so that you can design higher-performance FCC riser reactors. By using it, you can

- Tailor and improve FCC yield;
- Gain insight into the hydrodynamic effects on heat transfer and cracking processes;
- Better understand the hydrodynamics and heat transfer in the injection zone and riser, thereby leading to the development of higher-performance FCC riser reactors; and
- Determine the quality of FCC design quickly and cost-effectively.

Figure 1



Optimizing Operating Conditions. You can also use ICRKFLO to develop cracking kinetic models for various feedstock/catalysts on the basis of the local flow properties of the riser reactor (see Figure 3). A unique methodology was developed to extract kinetic rate constants from a small set of product yield measurements under varied operating conditions. A key feature of the methodology is that it uses CFD code to relate the product yields to the local flow parameters throughout the total riser reactor volume.

Because the cracking rate constants are based on local flow parameters, the kinetic model can be used with ICRKFLO to evaluate feedstock performance in various FCC riser reactor geometries over a broad range of operating conditions. Thus, you can use ICRKFLO to optimize the performance of existing FCC riser reactors and/or design retrofit improvements. The bottom line is that you can analyze an FCC riser reactor with complex chemical reaction sets containing tens or hundreds of oil species.

Figure 2

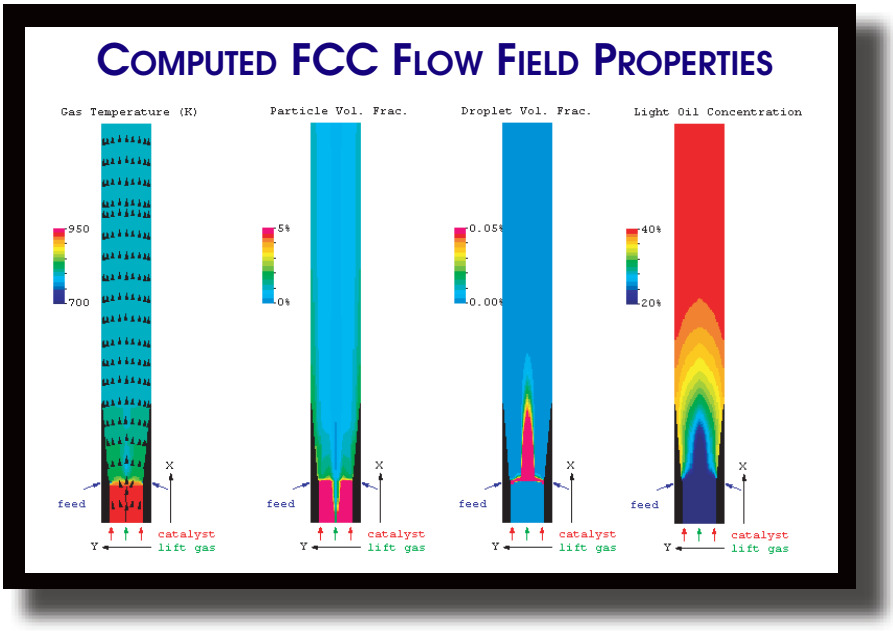
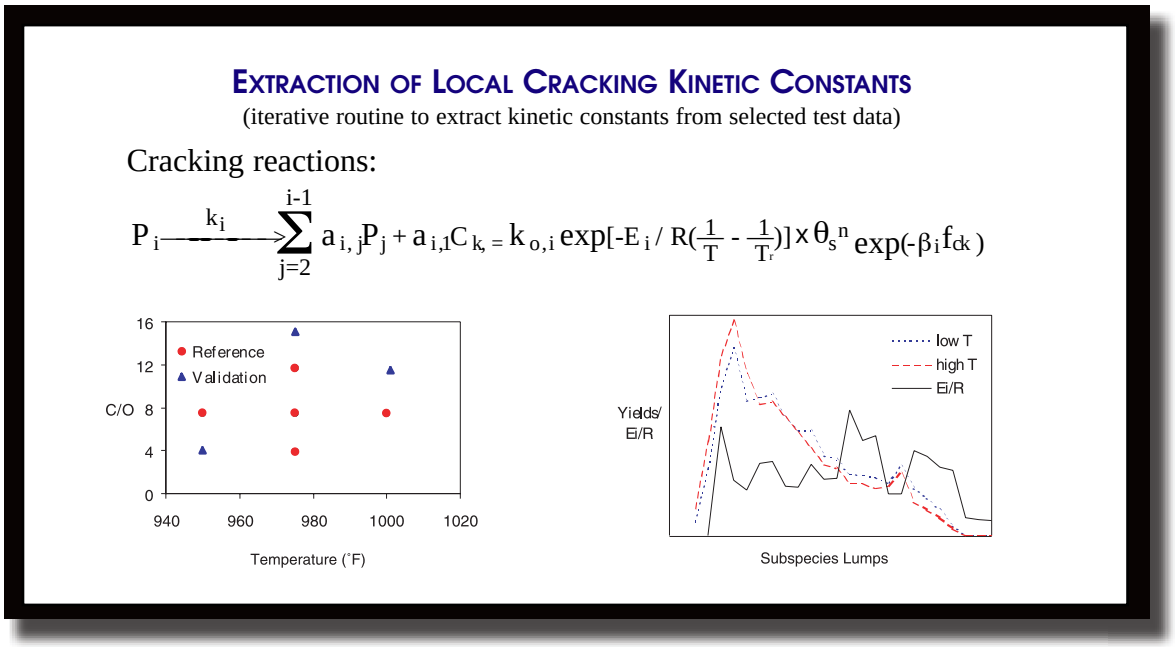


FIGURE 3



VALIDATED AND READY TO USE

ICRKFLO has been validated with data resulting from a Cooperative Research and Development Agreement (CRADA), which was sponsored by the Office of Industrial Technologies (OIT), Office of Energy Efficiency and Renewable Energy (EERE).

Both pilot- and commercial-scale test data were used in the validation studies (see Figure 4). ICRKFLO was also used to evaluate commercial-scale FCC riser reactor operation and various FCC design improvements. Parametric and optimization studies were performed to evaluate the impacts of changes in operation/design parameters on product yields. These studies showed that by making the proper adjustments to design and operation parameters for a given catalyst, significant improvements in product yields and selectivity could be achieved (see Figure 5).

ICRKFLO is PC-based and has an easy-to-use graphical interface; you do not need massive computers to use it, and aside from appropriate engineering expertise, you don't need any special training. ICRKFLO is also very versatile; if you have pilot-scale data, you can use the data to scale up your analysis to model processes in a commercial-size unit.

Argonne is actively seeking licensees for the ICRKFLO software. Technical support can be made available under a separate agreement to licensees. Users may employ ICRKFLO on their own computers or request that Argonne provide technical analysis for their data/designs.

FIGURE 4

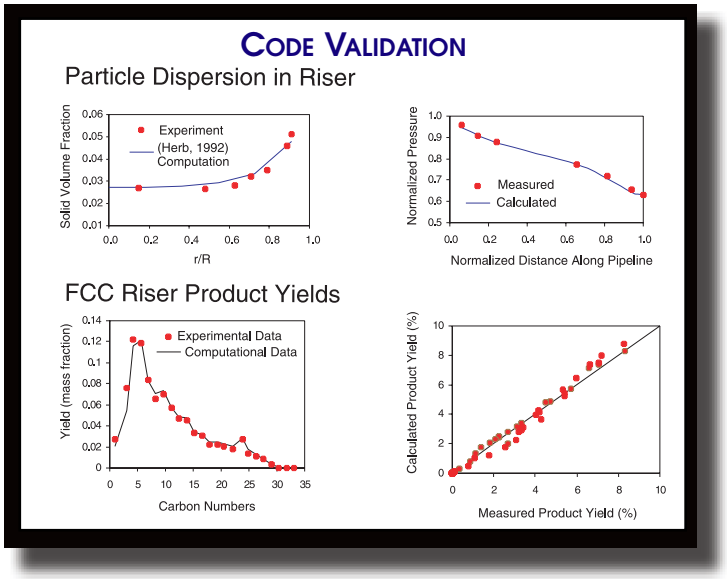
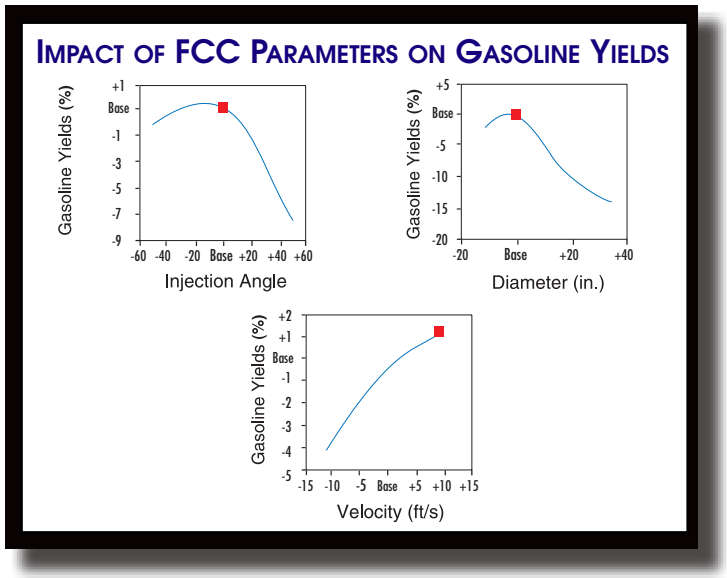


FIGURE 5



Find Out More

For technical information, contact

Michael Petrick
Energy Systems Division
Argonne National Laboratory
9700 S Cass Avenue
Argonne, IL 60439

E-mail: mpetrick@anl.gov
Phone: 630.252.5960
Fax: 630.252.5210

To obtain ICRKFLO, contact

Paul Betten
Office of Technology Transfer
Argonne National Laboratory
9700 S Cass Avenue
Argonne, IL 60439

E-mail: betten@anl.gov
Phone: 630.252.4962
Fax: 630.252.5230

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