SCIENCE NEWS of the week

Computing a Flame's Turbulent Flickers

Chen/Sandia

This slice through a simulated flame reveals features on the scale of a few millimeters. As a measure of turbulence, the colored blobs represent the local rotation rate of the gas (maximum values indicated in red). The white contour lines show the overall reaction rate.

When a spark plug ignites a mixture of fuel and air in a car's engine, the resulting flame flashes through the combustion chamber. It spreads in an extremely complicated manner, creating a violent, luminous, miniature storm of gaseous whirlpools and swift currents.

This turbulent flame, with its transitory blends of active and quiescent regions, also generates pollutants — undesirable by-products of combustion. Researchers have long sought to understand this process well enough to determine how best to minimize pollutant formation and increase combustion efficiency.

Using supercomputers and advanced methods of computation, scientists and engineers have developed a number of useful models of turbulent flow, whether over airplane surfaces, inside oil-carrying pipelines, or along ocean currents. But turbulent flames also involve heat-generating chemical reactions, which strongly influence such flows. Now, researchers are starting to include this chemical effect to create improved models of turbulent combustion.

"Our goal is to try to understand the fundamental interactions between fluid mechanics and chemistry in turbulent combustion," says Jacqueline H. Chen of the Combustion Research Facility at the Sandia National Laboratories in Livermore, Calif. "We're basically using the computer as a microscope to zoom in on the small scales at which mixing occurs to see what those interactions are."

Chen and colleagues Shankar Mahalingam of the University of Colorado at Boulder and Luc Vervisch of the National Institute of Applied Sciences (INSA-Rouen) in Mont-Saint-Agnan, France, start with the Navier-Stokes equations, which describe the motions of a fluid. Incorporating a rudimentary, one-step representation of a heat-generating chemical reaction, they use an approach initially developed at the Stanford/NASA-Ames Center for Turbulence Research to solve the resulting equations in full detail.

Simulation data indicate that turbulence stretches and distorts the flame, and it creates pockets where the flame is unable to sustain itself. At the same time, the flame itself tends to dampen turbulence in its vicinity.

"You get a wrinkled flame surface with holes punched out of it," Chen says. "There would be some spots where the flame has extinguished itself."

Overall, the interaction between chemistry and turbulence can enhance mixing. This effect, in turn, can lead to local reaction rates quite different from those measured in a steady flame.

Chen and her collaborators are now planning to incorporate more realistic chemistry in their model, focusing on the reaction between methane and air and the production of nitrogen oxides. "We want to increase the complexity of the chemistry," Chen says. *— I. Peterson*

Genome sweep finds two new diabetes genes

Using a powerful gene-mapping technique, researchers report homing in on the location of two new genes that underlie type I diabetes. People with this form of diabetes generally require daily injections of the hormone insulin in order to survive.

Rather than hunting laboriously for a single gene associated with diabetes, a British research team headed by John A. Todd of the University of Oxford in England relied on a method that allows simultaneous analysis of all 46 human chromosomes. At a genetics meeting in Bar Harbor, Maine, in July, Todd reported that their genomewide sweep had revealed 18 different chromosome regions linked to type I diabetes (SN: 8/6/94, p.85). He also said the group had confirmed the importance of the IDDM1 gene in this form of diabetes, an autoimmune disorder.

In the Sept. 8 NATURE, Todd's team further refines the emerging picture of this complex disorder, which is caused by the interaction of many genes and environmental factors. In a study of families with at least one afflicted member, the researchers found a region on the long arm of chromosome 11 and another on the long arm of chromosome 6 that are associated with type I diabetes. The scientists believe that the DNA sections of those chromosomes house two new genes for type I diabetes. In addition, they found confirmatory evidence that a third gene for type I diabetes resides on the long arm of chromosome 18.

Using more conventional gene-mapping methods, another research group also implicates the same chromosome 11 site in type I diabetes. This largely French team describes its results in the same issue of NATURE.

Because there may be scores of genes in each suspect DNA region, scientists now must identify and sequence the actual genes contributing to type I diabetes, notes Oxford's Simon T. Bennett, a coauthor of the first NATURE report. Once they have homed in on the genes, researchers can investigate their function. For example, the gene on chromosome 6 may play a role in the destruction of the pancreatic islet cells that manufacture insulin, he notes. Such pancreatic damage is a hallmark of type I diabetes.

One day, scientists may use such information to find children at high risk of developing type I diabetes, a disease that often strikes at an early age. Armed with better information about what causes this sugar-processing disorder, researchers hope eventually to fashion a therapy to prevent it, Bennett adds.

— K. A. Fackelmann