Courtesy of Toshiba

The high-temperature sodium test loop at Toshiba's new Yokohama nuclear facility. Japan has chosen the fast reactor as its standard nuclear plant.

RENEWABLE FUEL: TOSHIBA OPENS BREEDER REACTOR TEST FACILITY

A test loop for research in fast reactors, a type of nuclear power plant that can produce more new fuel than it uses up in power production, is part of Japan's new nuclear facility in Yokohama. The high-temperature liquid sodium test loop will simulate sodium coolant behavior at actual operating conditions and flow.

The fast reactor, also known as a breeder reactor, is slated to be the workhorse of Japan's nuclear program in the future, and a few fast reactors are under design. In a fast reactor, neutrons from the fission process are directed to strike a blanket of unenriched uranium or thorium surrounding the reactor core. The neutrons transmute the nonfissionable ores into usable nuclear fuel. In addition, Toshiba intends to commercialize the 4S reactor, Super-Safe, Small, and Simple, in the late 2010s. The modular 4S reactor uses sodium as a coolant.

The Bush Administration closed down its only sodium-cooled fast reactor, the Fast Flux Test Facility in Washington State, in 2005. A U.S. program for a new facility remains in the talk stage. (See GNEP article, *21st Century*, Fall 2007.)

THE HUMAN VOICE SHAPES WIND INSTRUMENT'S SOUND

Measurements with miniaturized sensors showed that the sound production of a tenor saxophone is dependent on the coupling of the vocal tract to the sounding pitch of the instrument, thus confirming a hypothesis demonstrated by bassoonist Mindy Pechenuk at a Schiller Institute conference seven years ago.

Researchers at the University of New South Wales in Sydney, Australia, designed sensors that could be placed in the relatively large mouthpiece of a tenor saxophone, to measure the acoustic impedance (ratio of sound pressure to air particle velocity) of the sound produced by the voice. This measurement was compared to a similar one taken for the air flow within the instrument. A graph of the acoustic impedance for the instrument, plotted against the frequency, would show peaks at the fundamental tone and its harmonics (integral multiples of the fundamental frequency). A similar plot for the acoustic impedance of the voice showed a peak at the fundamental, but not necessarily elsewhere.

Most compelling, the experimenters noted that in the high range of the instrument, known as {altissimo}, it was necessary that the voice produce a resonance at the fundamental tone, or no tone could be produced at all, as was the case for less-accomplished amateur players. Unfortunately, the instrumental measurements can only provide a crude approximation of the sound heard by the developed ear. Despite these drawbacks, the experiments, as reported in the Feb. 8 issue of *Science*, provide a physical confirmation of the more developed thesis presented by Pechenuk some years ago. (See Jer Ming Chen, John Smith, Joe Wolfe, ``Experienced Saxophonists Learn to Tune Their Vocal Tracts,'' p. 776.)

Courtesy of AMIC

The new accelerator can be located near the medical facilities that provide treatment and diagnostic services using short-lived and specialized isotopes.

PROTON LINEAR ACCELERATOR TO MAKE ISOTOPES FOR PET SCANS

The first compact linear accelerator for isotope production in North America was installed in Kennewick, Washington, near the Hanford nuclear site, in early March. The accelerator will produce specialty isotopes used in Positron Emission Tomography (PET) imaging. Isotopes such as fluorine-18, nitrogen-13, carbon-11, and oxygen-15 decay by emitting a positron (an anti-matter particle with the same mass as an electron, but positive charge), which can then be detected by a scanner. The accelerator will also produce other longer lived isotopes for diagnostic and therapeutic uses, including actinium-225, iodine-123, and indium-111.

The United States now imports more than 90 percent of its medical isotopes. (See article, p. 52). According to the Advanced Medical Isotope Corporation, which will operate the new accelerator, its production system integrates compact accelerator technology with high production yield targets and advanced chemistry process units, making it a more reliable and more compact alternative to cyclotrons.

HYDROGEN COULD REPLACE GASOLINE, USING ALUMINUM-RICH ALLOY

An economical method of separating hydrogen from water, using a new aluminum-rich alloy, has been developed at the electrical engineering department of Purdue University in Indiana.

Hydrogen can serve as a substitute for gasoline in motor vehicles, by burning the gas in an internal combustion engine, or by powering a fuel cell. New, fourth-generation nuclear power plants operate at high enough temperatures to permit the economical separation of hydrogen from water by electrolysis or chemical methods. However, to carry sufficient amounts of the gas for long trips in a car or truck, requires extremely high pressure fuel tanks which are expensive. Therefore, proposals for using the hydrogen as a gasoline substitute often involve combining it with carbon, from coal for example, to form more manageable liquid hydrocarbon fuels.

The Purdue breakthrough would allow production of the hydrogen on demand from a tank of water carried in the vehicle, and could use the abundant electricity generated by nuclear power to recycle the aluminum oxide by-product.

Aluminum in its liquid form easily combines with the oxygen in water, releasing hydrogen and heat. However, the surface of the aluminum quickly becomes oxidized, stopping the reaction. The Purdue scientists, working with Professor Jerry Woodall, have developed a new alloy which consists of 95 percent aluminum, and 5 percent an inert alloy of the elements gallium, indium, and tin. When the combined alloy is heated and then cooled, the constituents separate into two phases. The gallium-indium-tin alloy remains in a liquid phase which is not homogeneously incorporated into the solid aluminum.

This two-phase composition enables the aluminum alloy to react with water to produce hydrogen, but at the same time to be free of the surface oxidation which would stop the reaction.

Introduction of the technology would require a large-scale industrial infrastructure for recycling the aluminum oxide by-product back into aluminum and recovery of the gallium-indium-tin alloy, in addition to motor vehicles adapted to the new fuel. With onsite electricity for the aluminum recycler at 2 cents per kilowatt-hour, such as could be obtained at a nuclear power plant, Woodall calculated last year that the process would be competitive with gasoline at about $3.19 per gallon. Based on new discoveries with the alloy, Woodall now believes his method for producing hydrogen and heat could eventually become an efficient source of energy, as well.

Courtesy of Jerry Woodall/Purdue University

Lumps of gallium-aluminum alloy (GaAl28), used to make hydrogen in reaction with water.

RESEARCHERS FIND REGULATOR FOR ZEBRAFISH REGENERATION

The zebrafish, a ubiquitous aquarium fish used as a model organism by biologists studying developmental mechanisms, has the remarkable ability to regenerate complex tissues and organs, including the heart and whole fins.

Now a Duke University research team has discovered a potent regulator for zebrafish regeneration. Drs. Kenneth Poss and Viravuth Yin reported in the March 15 edition of *Genes & Development* that a tiny RNA molecule called microRNA acts as a regulator. They surveyed mature and regenerating tissue for microRNAs, and found a high prevalence of a particular microRNA named MiR-133 in mature fins, but a low prevalence of it in regenerating fins.

Using genetically modified fish whose regeneration signaling pathway could be blocked during regeneration, they observed MiR-133 to drop during regeneration, then spike to normal levels when the regeneration signal was blocked experimentally.

In fact, the regeneration rate was later found to inversely correlate closely with MiR-133 quantity in regenerating fins.

MicroRNA and similar tiny versions of RNA with less than 25 subunits were virtually unknown until the last decade, hidden behind prevailing axioms of genetic expression regulation mechanisms. Now they are ubiquitous, powerfully regulating at many levels, and are implicated in regulating tumor growth, blocking viral infection, and other complex functions throughout cells.

National Science Foundation

Zebrafish: Will we be able to learn from them how to regenerate human tissue?