TECHNOLOGY

From our reporters in Washington, D. C., at the annual winter meeting of the American Society of Mechanical Engineers

Sifting air through molecular sieves

To meet their physiological needs, flight crews in high-altitude aircraft need a reliable supply of oxygen. In the past, this oxygen has come from liquid oxygen systems, which were sometimes dangerous and awkward to handle on the ground. Now researchers at the Linde Division of Union Carbide and Essex Cryogenics of Missouri are developing a system that removes nitrogen from compressed air bled from a stage in the turbine engine and leaves 95-percent-pure oxygen.

The incoming high-pressure air passes through a molecular sieve consisting of grains of a zeolite adsorbent. This material preferentially adsorbs nitrogen, allowing oxygen and argon to pass through the bed. When the system pressure decreases, the nitrogen is expelled, and the system is ready for the next cycle. The process, called rapid pressure swing adsorption, completes an entire cycle in less than five seconds. In that time, a high-pressure adsorption period, a low-pressure desorption period and two delay periods take place.

The prototype oxygen enrichment unit occupies about one cubic foot of space and weighs less than 35 pounds. It provides sufficient oxygen at a constant pressure and of constant purity for two crew members. Thomas J. Dangieri, a Union Carbide staff engineer, reports, "The technical success of small oxygen enrichers, based on molecular sieve adsorption, foreshadows the widespread use of these systems in future military aircraft."

The woven solar collector

A simple, low-cost alternative with "excellent potential for developing countries," is how designers J. A. Bryant, R. R. Clark of New Mexico State University and I. A. Tag of Oak Ridge National Laboratory describe their solar collector. Covered with a clear window, backed with plywood and framed in pine, its collecting surface offers better heat transfer than currently marketed alternatives, the researchers report. And the secret is that the surface is built of five randomly stacked and black-painted woven-mesh screens. It should deliver roughly the same efficiency (49 percent) as conventional double-glazed air-circulating solar collectors, they say, while costing only 60 percent as much — roughly $9.10 per square foot.

Noise: A burning issue

Roar accompanies all turbulent combustion, even that of a crackling November hearth fire. But while the roar of kindled logs may comfort those basking in the fire's glow, the jet-like racket emanating from industrial burners is a source of fatigue — both in humans and materials — and may jeopardize the hearing of workers. And preventing it has been a problem, because even when a burner's dimensions and the configuration of a furnace were known, calculating how much racket to expect depended more on art than science. Now A. A. Putnam of Battelle Memorial Institute's Columbus Laboratories has confirmed some of the theories logged on industrial combustion noise, and in doing so suggests sound ways to damp it.

The noise spectrum typical of a natural-gas diffusion flame — such as might be generated in either a "dead room" (one with sound-absorbing walls) or in an acoustically open furnace — has no specific high-energy frequencies, just the broad-band roar like that associated with jet engines. However, components of the spectrum will be amplified at the natural frequencies of the surrounding enclosure. The peak frequency varies with the fuel and relates to the chemically controlled reaction rate per unit volume of fuel. In six experimental combustion settings, Putnam recorded noise levels that varied as the cube (or slightly less) of the flow rate and chemical-energy-to-noise conversion efficiencies that varied as the square (or slightly less) of the flow rate.

For the diffusion flames, the ratio of fuel to air used had no bearing on noise. But Putnam says that with many burners, the diffusion flame is preceded by a fuel-rich "premixed" one; and those flames will be affected by the fuel-to-air ratio. Putnam also notes that as the firing rate of a burner increases, its flame shifts position, often with a sudden accompanying jump in noise amplitude — either up or down. Chemical-energy-to-noise conversion efficiency remained proportional to a burner's thrust divided by the holding area.

Since turbulence in the flame zone affects noise, Putnam says the flow velocity, flow rate and excess air should all "be as low as possible." He also recommends muffling hard-walled furnaces with sound-absorbant linings and restricting turbulent generators in the burner to no more than those needed for proper performance and flame shape. Finally, he reports there is no "clear evidence" that replacing large burners with a series of small ones will change the noise output.

Sweeping the skies for hazards

Engineers at Princeton University are developing a laser beacon system for aircraft collision hazard warning that is independent of ground-based systems. Each aircraft would be equipped with a laser beacon, detectors and a computer. A beam of low-power helium-neon laser light reflects from a rotating cylindrical mirror, forming a fan-shaped rotating laser beam centered at the source aircraft. An array of photodetectors on the second aircraft senses the sweep of the beacon, and an on-board microprocessor computes estimates of the relative range, bearing, elevation and velocity of the source aircraft.

Similar systems may be useful in helicopter-assisted construction and rescue and in robotics applications, such as manufacturing in space, in which accurate position measurements are needed.

Fatigue failure in the North Sea

On March 27, 1980, the *Alexander L. Kielland,* a semi-submersible rig operating in the North Sea, capsized, killing 123 of 212 men on board. The rig, originally designed as a drilling rig, had been used as an accommodation platform during its entire period of operation. The accident began with the failure of a single brace, followed by the failure of five other braces connecting a column to the rest of the platform. The loss of the column, one of five supporting the platform, caused the rig to heel and the platform to flood. The rig capsized in 20 minutes.

As part of a thorough Norwegian investigation of the accident, engineers at the Norwegian Institute of Technology examined the structural failure of the tubular steel brace that initiated the accident. They report that the brace failed due to brittle fracture. A hydrophone support had been improperly welded into a circular cut-out in the brace. This created local stresses in the brace material and cracks developed, even while the structure was being built. The fatigue cracks grew quickly, particularly under the stress of constant wave action in the same kind of process that causes a paperclip to break after it is flexed repeatedly.

The researchers also noted the design was faulty, because after one brace failed, the remaining braces connected to the column were unable to carry the load. They had advice for other engineers designing and building off-shore structures. The use of high-tensile steels for strength leads to more fatigue-susceptible structures because of increases in stress levels within the material. They recommended changes in inspection and repair procedures and designs with built-in redundancy.