Cleaner Cooking with Gas

Environmentalists may have prompted a renaissance in kitchen-range design

By JANET RALOFF

Many chefs prefer cooking with gas, a fuel long promoted as clean burning. But growing concern over indoor air pollution threatens to dirty the gas range's formerly pristine image. So today appliance designers are at work to develop less-polluting burners. Already there are at least two promising candidates on the horizon, both due to be field tested this year.

The kitchen stove is unique among modern gas appliances in that its combustion products are emitted directly into the home. Gas is used for cooking in about 45 percent of U.S. homes, and studies show most of these homes don't vent outdoors the pollutants their stoves emit. Those pollutants include carbon monoxide (CO), carbon dioxide (CO_2), nitric oxide (NO), nitrogen dioxide (NO_2) and aldehydes such as formaldehyde.

There is some controversy about what health risks, if any, those emissions pose (see sidebar). But not waiting for definitive findings that exonerate or convict gas-range emissions of affecting health, the Gas Research Institute (GRI) in Chicago has begun sponsoring development of low nitrous-oxide (NO_x — for NO and NO_2) range burners.

A new flame insert developed for GRI at the American Gas Association (AGA) Laboratories in Cleveland indeed makes gas ranges burn cleaner. A burner fitted with one of these inserts and turned on high will cut its NO_x emissions more than 40 percent. At low burner settings the insert reduces NO_x even better.

Designed to fit onto the head of existing range burners, it consists of a pair of stainless-steel rings roughly three inches in diameter and mounted an eighth of an inch apart, one atop the other. Placed over a conventional burner, the rings sit about a quarter inch out from the portals through which flames exit the burner. When the burner is on, its flames are forced to pass between the rings, transferring some of their heat. This cools the flame's peak temperatures by distributing heat more uniformly.

"And when you cool the flame you reduce the NO_x," explains Douglas DeWerth, who with Bill Sterbik has designed the model under test. The rate of the chemical reaction that forms nitrogen oxides is tied to temperature: the hotter the flame, the more oxygen and nitrogen react.

However, a cooler flame also tends to increase CO levels. CO is a natural combustion product, but if the flame is hot enough for long enough, DeWerth says that CO will "burn over to CO_2." When a flame's temperature is reduced, however, the chemical reaction that drives the conversion of CO to CO_2 slows up faster than the rate of CO formation. And that causes levels of CO to build up. In some early tests, NO_x reduction was accompanied by significant CO production — 6,000 parts per million (ppm) or more — for an increase of more than 10-fold over normal burner-emission levels and a factor of 7 higher than that recommended by the American National Standards Institute.

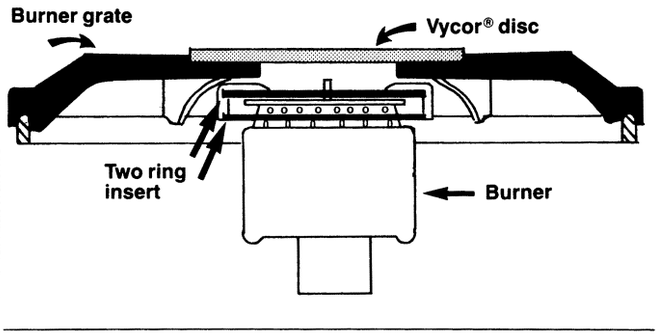
Before the insert was added, burners used in the AGA Laboratories test produced about 560 ppm CO (measured at the burner, not in room air). With the insert, CO increased to 650 ppm. However, NO_2 production at the burner fell 28 percent and total NO_x dropped 42 percent (from 103.3 ppm).

Magic Chef, Inc., a range manufacturer, is supplying ranges to AGA Labs for burner modification and advice on design adaptations to encourage consumer acceptance. One suggestion that has been incorporated is use of a four-inch semi-opaque cap to hide the ring system (considered too ugly to display prominently). While the disk, made from Vycor, an impact-resistant high-silica glass, does not affect emissions, it has reduced the efficiency of modified burners four or five percent, DeWerth says. It's also the insert's most expensive component.

"We're just about finished with our [laboratory] evaluations of a prototype range the manufacturer sent us — where all four top burners have been modified," DeWerth told SCIENCE NEWS. Within a few months he hopes to see Magic Chef place four to six modified ranges in homes to field test them under real-life conditions — such as spills and impact with heavy cast-iron pots. If all goes smoothly, the inserts might be ready to market by the end of the year.

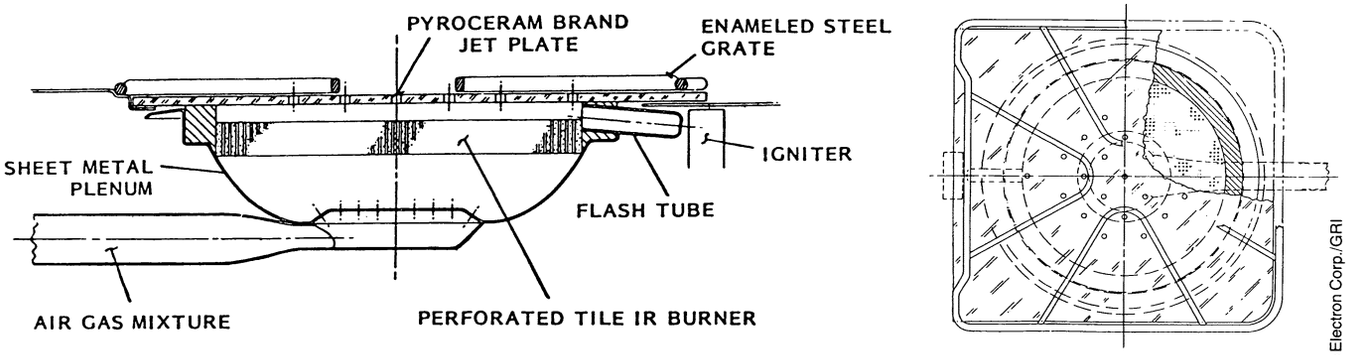
However, don't expect to see commercial models any time soon. As DeWerth put it, what incentive does a manufacturer have to develop ranges whose burners cost more, offer lower efficiency and are potentially less attractive than those of its competitors — particularly when there is still a question of whether existing emission levels harm health? In fact, the very presence of the inserts could serve to escalate debate over gas-range safety, something manufacturers are understandably loath to do.

Then why were these inserts developed? "We're worried about the future because we see what the Consumer Product



DeWerth/AGA Laboratories

Side view of conventional gas burner fitted with two-ring insert. Flames exit through portals, seen here as circles on burner's head. Peak temperatures of those flames –and NO_x emitted –drop as insert rings distribute heat across burner area more uniformly.



Thermo Electron Corp./GRI

Side view of IR-jet system (left). Air/gas mixture flows through honeycombed burner tile, where it is ignited, and up through perforated jet plate to bottom of cookware. Overhead view (right) shows how system fits under pot-holding grate.

Safety Commission has done with kerosene heaters," DeWerth says. "CPSC's technical staff is suggesting to the commission that kerosene heaters be allowed to emit no more than a certain amount of NO_2 because they say these heaters contribute to a higher than healthful NO_2 level in the home. If they do this for kerosene heaters, why should they not do it for an unvented range or gas heater?" he asks.

Adding to concern over potential regulation of a burner's emissions is a new California state law requiring that all new gas furnaces and hot-water heaters sold there be equipped with low-NO_x-emitting burners. Even though these appliances vent their emissions outdoors, concern over outdoor pollution was sufficient to prompt the law. DeWerth points out that AGA Laboratories' engineers are now helping nine manufacturers design burners to meet the new California standard.

A low-NO_x jet-powered infrared (IR) gas-range burner under design at Thermo Electron Corp. in Waltham, Mass., "has more appeal than the flame insert," and therefore a better chance of being marketed, according to John Lockwood, who manages both projects for GRI.

In a conventional range, only about 40 percent of the air required for combustion is mixed with the gas prior to arriving at the burner. When it is ignited, the flame must draw in extra air from the room. "You complete combustion above the burner, that's why you get most gas flames that are really high [tall]," explains James Hurley, one of the IR-burner's developers. For the new system, 120 percent of the air needed for combustion arrives premixed with the fuel at the burner. The result is that the flame is so low it's invisible. "We call it the flameless gas range," Hurley says.

Unlike conventional ranges that pipe fuel to a parapet-styled metal head ringed with fuel-exit ports, the new burner consists of a flat ceramic plate about one-half inch thick and honeycombed with window-screen-like perforations. Fuel ignites as it passes through the honeycomb, causing the plate to heat to about 1,500°F and glow a rich red. Combustion occurs within or just above the plate surface. Because the ceramic is 90 percent transmissive to IR-radiation in the 1,500°F range, Hurley points out, "it transmits about 95 percent of the radiant energy through the plate."

As they are emitted, combustion products are pumped through another perforated glass tile — called a Pyroceram jet plate — located about a quarter of an inch above the burner. Propelled by a mild jet of air, these emissions flow through the second plate at almost 2,000°F and strike the bottom of cooking vessels to deliver the burner's convective energy. Radiant and convective heating deliver about equal energy, and together transmit 70 to 75 percent of the heat available for cooking—an improvement of about 30 percent over conventional gas burners.

This means fuel use of a burner turned on high can be cut from 9,500 Btu per/hour to 5,500 or 6,000 Btu/hr and heat just as quickly. However, its designers see an even more compelling feature in this efficiency: Less unused heat is exhausted into the kitchen, so the cook stays cooler. Four burners turned all the way up will deliver only a little more heat than a single conventional gas burner—a real advantage in summer. The burner also provides more uniform heating across the bottom of cooking vessels. Its NO_x emissions are roughly 40 percent lower than conven-

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Pollutants are easier to gauge than are effects

In research by the Building Ventilation and Indoor Air Quality Program at Lawrence Berkeley Laboratory (LBL) in California, gas-range emissions of CO, NO_2 and formaldehyde that approached or exceeded ambient air-quality guidelines for outdoor air were observed. With regard to inhalable particulates, gas-range emissions can be "comparable to levels [found] present on a very smoggy day," according to LBL's Greg Traynor. Based on the buildup of combustion pollutants measured in one study that Traynor's group conducted for the Energy Department using an energy-efficient home (which limits natural ventilation), the researchers concluded that "gas stoves should probably not be used [in such tight structures] unless some type of pollutant removal strategy is incorporated."

That view is not universally accepted, however. The American Gas Association, for example, points out that in a prospective epidemiological study in 1974 that it sponsored, no significant difference was found in the incidence of respiratory illness reported by members of households with gas relative to those cooking with electricity. Martin Keller, chairman of preventive medicine at Ohio State University's College of Medicine in Columbus and an author of that study, has also reviewed health-effects research by others looking into gas-range pollution and concluded "there is no compelling evidence that the use of natural gas for cooking in the home is related to the occurrence of respiratory illness." In fact, he says, "the general public can consider gas a safe fuel for cooking."

Such assurances, though, do not console several researchers. That's why Richard Letz and colleagues at the Harvard School of Public Health in Boston are continuing to collect and analyze new data comparing families in Portage, Wisc., that cook with gas and electric ranges (SN: 1/24/81, p. 262). Letz told SCIENCE NEWS, "We recently got some new information that I haven't been able to analyze yet. But it does still suggest there's a relationship between NO_2 and slightly reduced pulmonary [lung] function."

So the jury is still out. — *J. Raloff*

MIRRORS

Japanese and Chinese 'magic' mirrors throw mystifying images

face to finer and finer polishing. Consistent with the holistic Japanese attitude toward life, the making of the mirror is a ceremony with religious overtones as well as a piece of artisanship. The workers put on ceremonial clothing for the final stages of polishing.

Western scientists became interested in *makyo* in the middle of the nineteenth century. The first scientific paper about them was by the Englishman Robert W. Atkinson in ASIA magazine in 1877. In the late 19th century the mirrors got on the lecture circuit in the United States, and a presentation at Ohio State University so fascinated the students that they named their literary magazine MAKIO.

More recently the Chinese have succeeded in reproducing the Han dynasty technique, and Chinese scientists Ruan Chong-Wu and Mao Zeng-Dian have subjected them to optical and metallurgical analysis by holography and X-ray structure analysis. The Chinese regard them as light-penetration mirrors, that is, that their effect depends on what happens to the light that penetrates them. But Gamo, in a paper presented at the Optical Society meeting, contends that "the essential elements in the image-formation process are slight changes in curvature on the reflecting surface that are dependent on the patterns marked on the back, as was discussed by Sir William Bragg in the *Universe of Light* (1933)."

Whatever scientists may eventually decide about the details of the mechanism, the mirrors continue to hang in the temples catching sunlight and throwing sacred images here and there. □

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tional burners and its CO is at or below levels typical of existing burners. Finally, the new burner is believed to have great eye appeal.

All this doesn't come cheap. Hurley says one could expect to see the burners only on the "Cadillacs" of ranges. However, Caloric Corp., a range manufacturer cooperating on design of the IR-jet burner, is interested in seeing this concept developed. "It's a saleable burner," says Marlow Kroninger, director of product reliability for Caloric in Topton, Pa. Caloric plans to provide ranges — each containing two conventional and two IR-jet burners—for field testing this summer. Provided they pass "the oatmeal test"—surviving regular use and spills with easy clean up—he says Caloric could begin marketing ranges in the medium and high ends of its product line within three years.

Finally, now that GRI believes it has solved the problem of range-top emissions, it has commissioned DeWerth and colleagues to begin working to lower NO_x in range ovens and broiler burners. Roughly half the gas used by a kitchen range is burned in ovens and broilers, so this makes a natural complement to the other projects. DeWerth also expects this project "is going to be a lot easier"—particularly since the eye appeal of these NO_x-related modifications will be relatively unimportant. □