SoCalGas™

Intermediate Cooking with Gas

Lesson 5: Broiling

ADVANCED

Beyond the Blue flame

Introduction

Welcome to Intermediate Cooking with Gas. Today's topic is the proper operation of equipment to reduce gas usage and bills. After you learn about proper operation of your equipment, you will learn how to cook with gas to make your own chicken breast or tofu. For more information, please refer to the Cleaning Guide provided separately.

This lesson can be completed in a classroom or at home. Your teacher will provide instructions for completing the assignment from home.

Opening Assessment

1. What methods of heat transfer are involved in broiling?
   a. convection and conduction
   b. conduction and radiant
   c. radiant and convection
   d. convection, conduction and radiant

2. What cooking technique does *not* create browning on the outside of food?
   a. boiling
   b. deep frying
   c. baking
   d. roasting

3. What is "denaturing"?
   a. destroying the bacteria in food by irradiation
   b. adding chemicals to food to enhance flavor
   c. reaching a temperature equilibrium in an environment
   d. changing the molecular structure of a protein

4. What kinds of foods cook well with the broiling method?
   a. grains
   b. meats
   c. eggs
   d. cookies

5. What is a primary variable that influences cooking in the broiling method?
   a. the thermal conductivity of the broiler pan
   b. the distance from the heating element
   c. the molecular structure of the food
   d. the energy efficiency of the broiler

How Does the Proper Operation of Equipment Reduce Gas Usage and Bills?

Energy-efficient cooking is the key to keeping energy costs down in a home or commercial kitchen. Cooking energy efficiency is expressed as a percentage. The useful energy – that is, the thermal energy absorbed by the food item during the cooking process – is divided by the total amount of energy used to operate the equipment. Keeping these two amounts as close as practicable while completing the cooking job saves energy.

It is impossible to achieve 100% energy efficiency in the transfer of thermal energy, or any other energy. Some of the heat produced by appliances (ovens, broilers, range burners, etc.) will do the "work" of cooking food, but most of the heat will dissipate into the surrounding environment, doing no work at all. And as you know, the transfer of heat always proceeds from the hotter environment to the cooler one. Pass from the dining room of a restaurant into the kitchen during a busy dinner service and this will be abundantly clear. You'll experience the thermal energy dissipated from the appliances as a blast of hot air. Gradually approach the cookline and you'll experience the increasingly frenzied movement of molecules closer to the sources of the heat. You may think, "Oh, the poor people who have to be in this kitchen all night." That thermal energy that enveloped you as you came through the swinging doors is wasted, never again to be harnessed to do useful work. The transfer of heat from the cookline to the rest of the kitchen merely raises the temperature in the environment for a while, but the heat continues to dissipate and the environment eventually reaches a state of entropy, or constant temperature, during which the molecules are all moving at much the same rate and heat transfer is no longer taking place.

Ultimately, the cost of energy use in a commercial kitchen is the average of the total cost of the energy that all the appliances use to do work plus the energy that their use dissipates. So, the more efficiently each appliance does its useful work, the less energy is dissipated, which lowers the cost.

The restaurant's owner can, of course, choose to equip the kitchen with energy-efficient appliances to save money. Energy Star appliances are engineered to use more of the energy input to do the work while allowing less energy to dissipate into the surroundings. If a standard gas oven has a cooking energy efficiency of 30%, only a third of the total energy it uses is useful energy. The most energy-efficient appliance is the microwave oven, but microwaves are primarily used to heat or reheat food, not to produce complex meals or specific effects such as browning. The net result is that restaurant kitchens waste a lot of energy. The trick is to keep those energy losses at a minimum. That is where the operator comes in.

Cooking with Natural Gas

There are many things that influence energy-efficient cooking: the kind of power or fuel, the method of cooking, the cooking appliance and the person who does the cooking. Since the subject of today's lesson is the proper operation of equipment, we'll focus on the cook who operates the equipment. That might mean you, or it might mean the line cook at a restaurant. In a commercial food-service business, the high volume of food preparation often makes the operator's performance over time a significant factor in the quest for energy efficiency.

Some important decisions that affect energy efficiency have already been made before the line cook even begins cooking. The restaurant's owners will have already written a menu and purchased equipment. Some menu items may require cooking at high temperatures with a broiler or another high-energy-use appliance. Since broilers operate at 550°F or more and are partially open, they are often the least energy-efficient appliance in a commercial kitchen. Griddle cooking requires only half the energy of broiling and can approximate the effects of broiling or grilling. However, many restaurants tout their "flame-broiled" or "char-broiled" steaks and burgers, and consumers believe that these methods are superior.

Chef Will Morris manipulates the handle on this typical restaurant broiler. He can raise or lower the rack without having to touch it.

Restaurant owners and managers are becoming more informed about energy efficiency and best practices to decrease heat waste and increase energy efficiency in their restaurants. Developing an opening procedure schedule that includes knowing how long each piece of equipment needs to preheat is essential. Powering up the equipment early in the morning while employees are prepping food for service is not the best practice. The kitchen manager or line cook should make sure that equipment is only turned on to preheat at a set time before the restaurant opens for business.

Broilers are known to be high energy consumption units in the kitchen based on broiler energy profiles, their standard cast iron tube burners and the practice that these appliances are turned on in the morning and not adjusted much throughout the day. Energy-efficient broilers utilize infrared burners instead of cast iron tube burners, so the infrared heat is spread more evenly across the broiler surface, resulting in a lower overall input rate.

An underfired broiler.

Cooking Methods

There are three types of cooking methods that utilize natural gas:

1. **Moist cooking** involves cooking with moisture in either liquid or steam form.
2. **Dry cooking** involves cooking without any moisture.
3. **Combination cooking** combines moist and dry heat cooking.

Today, you will be learning about and preparing food using a dry cooking method.

Dry Cooking: Broiling

Dry cooking methods include broiling, grilling, griddling, roasting, baking, sautéing and deep frying. Some of these methods utilize a fat such as butter, margarine or oil to cook the food, but some of these methods are very dry and simply rely on a source of heat and the fat content within the food itself. A cooking method is dry if it does not involve water, which may seem counterintuitive in the case of oil, but oil is not considered wet because it has no water in it.

With or without the help of added fat, the heat source in dry cooking acts directly on the surface that holds the food or on the surface of the food itself – from below, as in grilling, griddling and sautéing; from above or below, as in broiling; or from all around, as in roasting, baking and deep frying.

This lesson will utilize a **broiler** and the **broiling** method. Broiling is a preferred cooking method for meats and fish. Broiling is cooking by exposing food directly to high, radiant or infrared heat, searing or browning it on both sides. Broiling differs from roasting and baking in that the food is turned during the process, cooking one side at a time.

Chicken skewers sporting the Maillard reaction. Image credit: Sam Moqadam

Browning is known as the **"Maillard reaction"** after the scientist who described it. Heat that reaches a threshold of around 310°F triggers chemical and physical changes, called "**denaturing**," in the proteins present in the food. The simple sugars in foods also break down when heated. The denatured proteins and sugars form unique compounds with properties different from those of the uncooked meat: a darker color, richer flavor and compelling aroma. This reaction must occur on both sides of the food with the broiling technique, so the food must be turned over during cooking. The Maillard reaction happens during all dry cooking techniques, but not with wet cooking.

A salamander is a small, self-contained broiler unit that is used to finish or brown dishes. Salamanders are generally open in front and have racks that easily slide in and out. The source of the heat is a natural gas burner. In some salamanders, however, a ceramic panel or panels at the top comes between the burner and the food. The heat from the burner is distributed across the panel and delivers more consistent, even heat to the food below. Salamanders are ideal for toasting garlic bread, finishing desserts like crème brûlée and meringues, melting cheese and browning au gratin potatoes.

Some restaurants may also partially cook meats and then finish them on a salamander rack to achieve the distinctive brown "stripes" of the Maillard reaction.

Instructor Demonstration

Watch the instructor demonstration on proper natural gas range safety and how to cook safely in a broiler. Answer the following questions as you watch the demonstration.

- What safety tips did the instructor give during the demonstration?
- Did the instructor time the broiling just right with the rack in a single position?
- How did the instructor determine whether the chicken was done?
- What cooking tips did the instructor give during the demonstration?

Selecting and Preparing a Recipe

The following section can be completed at home if the preparing and cooking can be performed safely. Residential and commercial cooking equipment vary; while the information focuses on natural gas equipment, electric ranges and stoves may also be used to complete the cooking assignment.

You are going to broil your own chicken breast or tofu. If you are cooking chicken, it should be slightly browned on the outside and completely opaque on the inside (no pink!). Tofu should be browned and a little crispy around the edges.

Your teacher will review your recipe and dish based on the criteria listed below. If you are learning remotely, your teacher will provide you with instructions on how to submit your recipe and images or video of your completed dish.

Criteria	Excellent 3	Proficient 2	Emerging 1
Procedure	clearly followed given instructions and the example provided in the demonstration	somewhat followed given instructions and/or the example provided in the demonstration	did not follow given instructions and/ or the example provided in the demonstration
Content (submitted photos, procedure, videos, etc.)	content and explanations were thorough and well detailed	included content and explanation but included few specific details	included little to no additional content or explanations and/or no specific details
Organization	organized when preparing and making their recipe	somewhat organized when preparing and/or making their recipe	not organized when preparing and/or making their recipe

Create Your Recipe

For this recipe, choose a chicken breast or tofu and choose additional flavors based on the available ingredients and your dietary preferences, restrictions or allergies. Before starting to cook, it is important to have all of your ingredients, tools and equipment prepared ahead of time, which chefs call "mise en place" or "everything in its place."

Main ingredient:

boneless chicken breast

tofu (firm or extra firm)

Select seasonings, herbs or marinade:

poultry seasoning and herb blends (see Tips)
thyme
sage
marjoram
rosemary
pepper
paprika

Choice of marinade (see Tips)
teriyaki
lemon pepper
Hawaiian
chimichurri
Caribbean jerk

Safety first:

- Always keep a Class ABC fire extinguisher nearby.
- Never use a glass pan to cook foods under the broiler. The heat is too intense and may shatter the glass.
- Never reach into the oven to flip foods. Wear oven mitts and pull the oven rack out part way when flipping food.
- Wear oven mitts whenever you must handle racks or a broiler pan. If you want to move the oven rack, wear oven mitts to remove the pan, place it on top of the range and carefully pull the rack out with both hands and reposition it.
- If you have a glass window on your oven, make sure it is clean so you can watch your chicken or tofu browning without having to open the door.
- Metal tongs will give you more control than a spatula when flipping the chicken or tofu.
- Test your thermometer to make sure it is reading accurately. Fill a tall glass with ice and then add cold water. Insert the thermometer into the glass. Don't touch the bottom or sides of the glass. Leave the thermometer in the glass for two minutes. If it reads 32°F, it is reading accurately.
- Wash your hands thoroughly after handling meat or poultry.
- Avoid cross-contamination by using one set of tongs to handle raw chicken and a clean set to handle the chicken as it cooks. Use one cutting board for meat and another for any other ingredients.
- Although you may never need it if you follow common-sense kitchen safety precautions, every kitchen should be equipped with a fire extinguisher, and everyone in the household should know how to use it.
- Never use wet or moist pot holders, oven mitts or towels as they will conduct heat, burning your hands.

Equipment:

- meat mallet or pan to pound the chicken breast
- for tofu, a baking sheet lined with aluminum foil and sprayed with cooking spray
- long metal tongs
- oven mitts
- meat thermometer
- plate for your chicken or tofu

Ingredients:

- Cooking spray
- Chicken breast pounded to ¾ inches thick or tofu ¾ to 1 inch thick
- Choice of seasonings, herbs or marinade

Procedure:

1. **For chicken**: Remove the raw chicken breast from the package and place it between two sheets of waxed paper or plastic wrap on a cutting board. (Put a placemat or towel under the cutting board so you don't make a racket.) Use a meat mallet or the bottom of a sturdy pan to pound the breast out so that it is an even thickness all over. This will ensure that it cooks more evenly.

   If you are planning to marinate your chicken breast, do it at least one hour before you plan to cook. Marinating overnight in the refrigerator is ideal for the chicken to absorb the flavors in the marinade. Pour the marinade into a shallow bowl and place the chicken breast so that it is entirely submerged in the marinade, then cover and refrigerate.
2. **For tofu:** If you are using tofu, place it between a couple layers of paper towels and place a pan on top for about 20 minutes to take some of the moisture out. You do not need to pound out the tofu, but you may have to cut it to ¾- to 1-inch thickness. You can soak the tofu in your choice of marinade for half an hour before cooking.
3. Preheat broiler.
4. Adjust broiler drawer to desired level. The closer the drawer is to the heating element, the more quickly the chicken or tofu will cook.
5. Place chicken directly on the broiler rack, or place tofu on the baking sheet and onto the broiler rack.
6. Cook chicken five to seven minutes per side. Pay attention to browning and adjust the drawer, if necessary.
7. Cook tofu for three to five minutes on one side, or until top is golden brown, then flip and cook for two to five minutes.
8. For chicken, pull the drawer out and insert a meat thermometer to test for doneness. The internal temperature should be 170°F.
9. Remove chicken from broiler with tongs onto a small sheet pan when desired internal temperature is reached.
10. Pull the baking pan with tofu out of the broiler when both sides are browned and crispy. You don't need to use a thermometer to check tofu for doneness.

Tips:

- If you are making your recipe at home, visit the seasoning, herb and marinade aisle in the grocery store. What strikes your fancy?
- Check the label to make sure you choose a marinade and not a sauce. A marinade is a thinner liquid that soaks into the protein, but a sauce is thicker and stays on the surface. A sauce is likely to burn in the high heat of a broiler.
- Supermarkets sell a variety of rubs and blended seasonings for chicken. Some are spicier than others, but most will be a combination of thyme, sage and marjoram. You may already have these in your home pantry and can make your own blend. These seasonings are appropriate for tofu, too.
- Check ingredient lists on the marinade or herb blend to make sure they are appropriate for your dietary restrictions or to be sure they are made in a peanut-free environment if you have a peanut allergy. Check the price, too, so you're not surprised at the check-out counter!
- Medium-rare is NOT an option when cooking chicken. It must be cooked thoroughly to 170°F. If there is any pink color inside, it must go back in the broiler.

Activity

After you finish cooking your chicken or tofu, you will "prepare" a virtual meal with the items in the table below. Choose one protein, one starch and one or two vegetables from columns 1 through 3 and as many additional ingredients from column 4 as you would like. If you envision using a sauce, choose one from column 5. You can combine all your ingredients in one dish or serve each separately. In one paragraph, list your ingredients and describe what cooking methods you will use to prepare them. (If you are using a dry cooking method, you may add the appropriate fat.)

1	2	3	4	5
Protein	**Starch**	**Vegetable**	**Additional Ingredients**	**Sauce**
chicken	rice	mushrooms	onions	teriyaki
beef	potato	broccoli	oregano	salsa
eggs	pasta	tomatoes	garlic	tomato
beans	tortillas	peppers	cheese	barbecue

Final Assessment

1. What methods of heat transfer are involved in broiling?
   a. convection and conduction
   b. conduction and radiant
   c. radiant and convection
   d. convection, conduction and radiant

2. What cooking technique does *not* create browning on the outside of food?
   a. boiling
   b. deep frying
   c. baking
   d. roasting

3. What is "denaturing"?
   a. destroying the bacteria in food by irradiation
   b. adding chemicals to food to enhance flavor
   c. reaching a temperature equilibrium in an environment
   d. changing the molecular structure of a protein

4. What kinds of foods cook well with the broiling method?
   a. grains
   b. meats
   c. eggs
   d. cookies

5. What is a primary variable that influences cooking in the broiling method?
   a. the thermal conductivity of the broiler pan
   b. the distance from the heating element
   c. the molecular structure of the food
   d. the energy efficiency of the broiler

Intermediate Cooking with Gas—Advanced
Lesson Dry Cooking: Broiling
Teacher Guide

(1 class session)

Introduction

This lesson covers a basic understanding of how proper operation of equipment reduces energy use and bills. Students will then learn how natural gas is used in an oven broiler to broil a chicken breast or tofu. Keep in mind that students may have dietary preferences, restrictions or allergies that may need to be accommodated in order for them to complete the recipe. Note that students may have different types of appliances at home, such as an electric or induction range, which will not prevent them from completing the assignment. If the student is preparing food at home, ensure that appropriate adult supervision will be available.

This lesson could be completed in a classroom or at home. Suggestions and instructions will be given for both scenarios.

Opening Assessment Answer Key (3 minutes)

Use these questions to obtain a baseline for what your students know before beginning the lesson. The correct answers are highlighted.

1. What method of heat transfer is involved in broiling?
   a. convection and conduction
   b. conduction and radiant
   c. radiant and convection
   d. convection, conduction, and radiant

2. What cooking technique does *not* create browning on the outside of food?
   a. boiling
   b. deep frying
   c. baking
   d. roasting

3. What is "denaturing"?
   a. destroying the bacteria in food by irradiation
   b. adding chemicals to food to enhance flavor
   c. reaching a temperature equilibrium in an environment
   d. changing the molecular structure of a protein

4. What kinds of foods cook well with the broiling method?
   a. grains
   b. meats
   c. eggs
   d. cookies

5. What is a primary variable that influences cooking in the broiling method?
   a. the thermal conductivity of the broiler pan
   b. the distance from the heating element
   c. the molecular structure of the food
   d. the energy efficiency of the broiler

How Can Proper Operation of Equipment Reduce Energy Use and Bills? (3 minutes)

Students will read about energy efficiency and why it is difficult to achieve in a kitchen. The following questions could be used for a class discussion or given to students to complete individually.

- How is energy efficiency calculated?
- What happens to heat that is not doing useful work?

Cooking with Natural Gas (5 minutes)

Students will read about the proper operation of cooking appliances and what cooks can do to save energy. The following questions could be used for a class discussion or given to students to complete individually.

- What are the major factors that influence energy efficiency in a kitchen?
- What kind of cooking environment is likely to use the least energy to do useful work?
- What kinds of things can the restaurant owner or manager do to save energy?

Cooking Methods (1 minute)

Students will understand that there are three cooking methods that utilize natural gas: moist cooking, dry cooking and combination cooking.

Dry Cooking: Broiling (5 minutes)

Students will read about cooking with dry heat and the broiling technique. The following questions could be used for a class discussion or given to students to complete individually.

- What are the primary variables in broiling food?
- What are the benefits of broiling?
- What happens during the Maillard reaction?
- What are the results of the Maillard reaction?
- How does a broiler achieve the Maillard reaction?

Instructor Demonstration (12 minutes)

The demonstration can either be performed in class or recorded for remote use. If the demonstration is done in person, preheat the broiler while the students complete their readings so that the equipment is hot enough for cooking in time for your demonstration.

You may also consider pounding out the chicken breasts beforehand so that the students will be able to start cooking directly after the demonstration. If you choose to marinate the chicken or tofu with teriyaki or other marinade, this should be added to your to-do list for before class starts.

The demonstration should include:

- how a broiler works
- safety tips when using a broiler
- how to broil, including tips for how close to or far away from the heating element the food should be placed and how intense the heat should be
- benefits of using broiling as a cooking technique
- how to cook the chicken or tofu, noting how to check it for doneness

Students will use the following questions as a guide to either a class discussion after the demonstration or note taking during the demonstration:

- What safety tips did the instructor give during the demonstration?
- How high did the instructor have the flame?
- How did the instructor determine how long to cook the chicken?
- What cooking tips did the instructor give during the demonstration?

Selecting and Preparing a Recipe (18 minutes)

If the students will be cooking in the classroom, ensure that the ingredients are available to the students ahead of time. Make sure that student allergies, dietary restrictions and preferences are taken into account. Also be sure to plan a few minutes at the end of class for cleanup.

If the students will be cooking at home, be sure to provide the list of ingredients or the "mise en place" ahead of time to give the students time to assemble the ingredients. Take into consideration the time the recipe typically takes to cook and the ability for students to purchase their ingredients from the grocery store.

Students will use the instructor demonstration as a guide to cook their own chicken breasts or tofu. Students will select optional seasonings from a list in order to complete their recipe.

Students cooking at home can submit a description of the ingredients and procedure they used along with pictures of their completed dish or a video of themselves cooking the recipe. Be sure to share instructions with your students on what to submit and how to share it with you.

Criteria	Excellent 3	Proficient 2	Emerging 1
Procedure	clearly followed given instructions and the example provided in the demonstration	somewhat followed given instructions and/or the example provided in the demonstration	did not follow given instructions and/or the example provided in the demonstration
Content (submitted photos, procedure, videos, etc.)	content and explanations were thorough and well detailed	included content and explanation but included few specific details	included little to no additional content or explanations and/or no specific details
Organization	organized when preparing and making their recipe	somewhat organized when preparing and/or making their recipe	not organized when preparing and/or making their recipe

Activity (8 minutes or as homework)

This activity is provided to be used either in the classroom during any down-time or as homework. In this activity, students will prepare a virtual well-balanced meal with the items in the table below. They'll choose one protein, one starch and one or two vegetables from columns 1 through 3 and as many additional ingredients from column 4 as they would like. If they envision using a sauce, they may choose one from column 5. Students can combine all ingredients in one dish or "prepare" each separately. In one paragraph, they'll list their ingredients and briefly describe what cooking methods they'll use to prepare the meal. (If they are using a dry cooking method, they may add a fat.)

1	2	3	4	5
Protein	**Starch**	**Vegetable**	**Additional Ingredients**	**Sauce**
chicken	rice	mushrooms	onions	teriyaki
beef	potato	broccoli	oregano	salsa
eggs	pasta	tomatoes	garlic	tomato
beans	tortillas	peppers	cheese	barbecue

Excellent 3	Proficient 2	Emerging 1
clearly followed given instructions; designed a complete meal	somewhat followed given instructions; designed a nearly complete meal	did not follow given instructions; showed little effort to design a complete meal
explanations demonstrated good understanding of all cooking methods	explanations demonstrated good understanding of one or two cooking methods	explanations demonstrated poor understanding of cooking methods

Final Assessment: Answer Key (3 minutes or as homework)

Use these questions in conjunction with the discussion questions in each section to formatively assess student growth over the course of the lesson. Address any student misconceptions that remain at the end of the lesson. Consider having students compare their opening assessment with their final assessment to see how their understanding of cooking with gas improved over the course of the lesson.

1. What method of heat transfer is involved in broiling?
   a. convection and conduction
   b. conduction and radiant
   c. radiant and convection
   d. convection, conduction, and radiant

2. What cooking technique does *not* create browning on the outside of food?
   a. boiling
   b. deep frying
   c. baking
   d. roasting

3. What is "denaturing"?
   a. destroying the bacteria in food by irradiation
   b. adding chemicals to food to enhance flavor
   c. reaching a temperature equilibrium in an environment
   d. changing the molecular structure of a protein

4. What kinds of foods cook well with the broiling method?
   a. grains
   b. meats
   c. eggs
   d. cookies

5. What is a primary variable that influences cooking in the broiling method?
   a. the thermal conductivity of the broiler pan
   b. the distance from the heating element
   c. the molecular structure of the food
   d. the energy efficiency of the broiler

Everything
Connects with NTC®

www.nationaltheatre.com

Beyond the Blue flame