



Intermediate Cooking with Gas

Lesson 5: Broiling

BEGINNER



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 burger. 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. Which cooking method requires food to be turned over during cooking?
 - a. grilling
 - b. deep fat frying
 - c. baking
 - d. oven roasting
3. Which method of cooking a steak would be the most energy-efficient?
 - a. roasting
 - b. broiling
 - c. pan-frying
 - d. grilling
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.

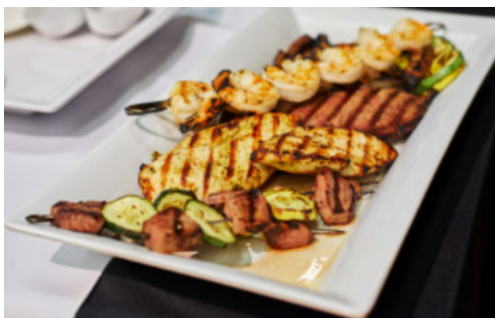
Today, you will be learning about and preparing food using a dry cooking method.

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.



The Maillard reaction achieved on chicken and shrimp.

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. As a result of the Maillard reaction, 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’s 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 burger 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 make your own burger using ground beef, ground turkey or a veggie burger. The higher the fat content of ground beef, the juicier your burger will be and the more it will shrink during cooking as the fat seeps out. Once cooked, the burger should be browned and crusty on the outside and pale pink on the inside (medium-well). The best stages of doneness for ground beef are medium or medium-well so the bacteria in the meat is killed but the burger does not resemble a hockey puck. You can choose to top the burger with any number of other ingredients; by high school, you already know the toppings you like. Feel free to use them even if they are not on the list below.

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 you will need to choose one item from the burger patty column and one item from the bread column. You can choose to add any additional toppings or 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.”

Select a type of burger patty:

Ground beef (available with different percentages of fat depending on the cut of meat: 70, 80, 90 or 95%)

Ground turkey
(85 or 93% fat content)

Veggie burger patty
(usually pre-formed)

Select a type of bun:

Pre-sliced bun (whole wheat or white), bulkie roll or gluten-free alternative

Select toppings:

Lettuce, tomato, pre-sliced cheese, onions, pickles, ketchup, mustard, mayo, avocado, etc.

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 the 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 the burger browning without having to open the door.
- Metal tongs will give you more control than a spatula when flipping the burger.
- Test your meat 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.
- Avoid cross-contamination by using one cutting board or plate to form your patty and another to prepare and hold your toppings.
- 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.
- Practice knife safety when cutting any ingredients and use properly sharpened knives.

Equipment:

- Small sheet pan for removing the cooked food
- Long metal tongs
- Oven mitts
- Meat thermometer
- Plate for your burger

Ingredients:

- Cooking spray (depending on your choice of patty)
- Burger patty, $\frac{3}{4}$ inch thick
- Choice of bun
- Choice of toppings

Procedure:

1. Prepare your toppings so that they are ready to add once the burger is cooked.
2. *If you are using pre-formed patties, you can skip this step.* Shape a handful of burger meat into a ball, and then flatten it out to about $\frac{3}{4}$ inch. The patty should be a little bigger than the bun because it will shrink during cooking. Even out the edges of the burger so bits of meat do not detach from the patty and burn. (Some cooks put a slight depression in the center of the patty, too, which will help keep it from forming a dome when cooked.)
3. Preheat broiler.
4. Adjust broiler drawer to desired level. The closer the drawer is to the heating element, the more quickly the patty will cook.
5. Place patty on broiler rack.
 - For ground beef, cook three to four minutes per side. For medium-well beef, the internal temperature should be 160°F.
 - For turkey, cook five to seven minutes per side. For fully cooked turkey, the internal temperature should be 170°F.
 - For a veggie burger, follow the instructions on the package.
6. Pay attention to browning and adjust the drawer, if necessary.
7. Pull the drawer out and insert a meat thermometer to test for doneness.
8. If the patty is near the desired temperature, place cheese on the patty to melt, if you are using cheese.
9. Remove patty from broiler onto small sheet pan when desired internal temperature is reached.

Tips:

- Margarine has a higher percentage of water than butter and may result in a sandwich that is not as crispy.
- Cheese slices can be brought to room temperature before the start of cooking. This will help the cheese melt as the bread browns on the griddle.
- Butter or margarine can be at room temperature for easier spreading.
- Preheat the griddle or pan for two or three minutes, depending on its thickness. A thicker, heavier pan will take longer to preheat.
- Before you flip your sandwich, check that the bread is adhering to the cheese.

Activity

After you finish cooking your burger, you will use clues to complete words that share the first three letters and have something to do with cooking.

- 1 CON _____ R
- 2 CON _____ Y
- 3 CON _____ L
- 4 CON _____ N
- 5 CON _____ T
- 6 CON _____ E
- 7 CON _____ T
- 8 CON _____ R
- 9 CON _____ T
- 10 CON _____ N
- 11 CON _____ Y

Clues

- Introduction of harmful bacteria
- Density or thickness of a food
- Change from one thing to another
- Someone who buys products
- Savory accompaniment to food
- Sweet food
- Mechanism for regulating the operation of an appliance
- Ability to transfer energy
- Unchanging
- Avoid creating waste
- Vessel

Final Assessment

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. Which cooking method requires food to be turned over during cooking?
 - a. grilling
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3. Which method of cooking a steak would be the most energy-efficient?
 - a. roasting
 - b. broiling
 - c. pan-frying
 - d. grilling
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—Beginner

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 burger. 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?
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 - b. conduction and radiant
 - c. radiant and convection
 - d. convection, conduction, and radiant
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 - 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 line cook 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.

- Why is broiling a “brutal” method of cooking?
- 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 prepping ground beef and turkey patties, as well as lettuce, tomatoes, onions, etc., so that the students will be able to start cooking directly after the demonstration.

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 burger, noting how to check it for doneness
- finishing the burger with toppings, including when to add cheese

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 burger?
- 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 burgers. Students will select a type of meat or plant-based product for their burgers, a kind of bread, and optional flavorings and toppings 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.

Scoring Rubric:

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Activity (5 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 use the clues to complete the words that share the same first three letters and have something to do with cooking.

Answer Key

- 1 CONSUMER
- 2 CONDUCTIVITY
- 3 CONTROL
- 4 CONTAMINATION
- 5 CONVERT
- 6 CONSERVE
- 7 CONSTANT
- 8 CONTAINER
- 9 CONDIMENT
- 10 CONFECTION
- 11 CONSISTENCY

Clues

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- Change from one thing to another
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- Avoid creating waste
- Vessel

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.

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