



Fabrication of a Low-Cost Temperature-Controlled Gas Cooker with an Oven

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Abstract

This research focuses on the 'fabrication of a low-cost temperature-controlled gas cooker with an oven for dual purposes' of cooking, baking, or grilling simultaneously at a controlled temperature. The outer gas cooker with the oven was fabricated using galvanized steel, and the inner oven with aluminium sheet and fiberglass as the insulator. The fabrication procedures include marking the materials, cutting into required sizes, drawing and specification, and fabrication. By using cheap and readily available materials, the cost of the fabricated gas cooker with oven was minimal compared to the imported ones. It makes it more affordable for a large number of people to get and use for cooking, baking, and grilling as a clean source of energy rather than kerosene, firewood, and charcoal used in rural households, due to some environmental and health challenges associated with the latter. The fabricated gas cooker with an oven can be used simultaneously for cooking and baking. The application of engineering measurement and quality control is assured in the fabrication process. Results showed that the cake was baked in 27 minutes at a temperature of 180 °C depending on the size of the cake, showing higher energy efficiency by reducing the energy, cost, and time of baking.

Keywords: Burner, Temperature Sensor, Cooker, Oven

Introduction

Thermal energy is essential for human life. Cooking is vital for feeding humankind, and boiled water is needed to fight infections (Nogueira *et al.*, 2018). The energy requirement is directly related to the development rate and the population growth of any country in the world. Energy sources are classified as renewable and non-renewable sources. A baking oven is the most widely used appliance in the food service industry. An oven can be described as a fully enclosed thermally insulated chamber used for the heating, baking, drying of a substance, or grilling (Modal and Data, 2008). In a baking oven, the hot air flows over the baking material either by natural convection or forced by a fan, the convection heat transfer from the air, the radiation heat transfer from the oven heating surfaces, and the conduction heat transfer across the contact area between product and metal surface. The moisture in the food material simultaneously diffuses toward the surfaces, then, it transfers from the surface by convection, and the product loses moisture with continuous movement of the oven's ambient air. These are the simultaneous momentum, heat, and moisture transfer mechanisms within a baking product (Ozilgen and Heil, 1994) and between

the product and its environment (Broyart and Trystram, 2002). Household energy needs are one of the biggest issues in the daily lives of people worldwide. Most households' most important energy-consuming activities are cooking lighting, and the use of electrical appliances. Cooking accounts for 91% of household energy consumption, lighting uses up to 6% and the remaining 3 percent can be attributed to the use of basic electronics (Temilade, 2008). A gas stove is a stove fueled by combustible gas such as syngas, natural gas, propane, butane, liquefied petroleum gas, or other flammable gas. This new cooking technology has the advantage of being easily adjustable and can be switched off when not in use. However, the gas stove was not commercially successful until the 1880s, when supplies of pipe gas were available in large and small cities in England. The stoves became widespread on the European Continent and the United States in the early 20th century. (Krieth *et al.*, 1996). An oven is a thermally insulated chamber used for heating, baking, or drying of substance. Kilns and furnaces are special-purpose ovens used in pottery and metalwork respectively. An oven is an enclosed cavity or tunnel where dough or batter is surrounded by a hot environment and becomes baked and

transformed into bread, cookies, or other products. To bake the products, ovens use energy generation sources. Examples of combustion of fuels such as; gas, oil, and electricity. The gas oven works with liquefied petroleum gas to bake bread, cakes, and biscuit. The operational principle of the gas oven is the heat transfer process. The transmission of heat tends to occur whenever there is a temperature difference and the major mode of heat transfer in a gas oven is convection. (Bizzaco and Evans, 2021). The scope of this research is to fabricate a low-cost temperature-controlled gas cooker with an oven for food producers and bakers, as the cost of electricity-powered cookers and ovens is high. Local materials were used in the fabrication of the gas cooker with oven.

Materials and methods

Table 1 shows the materials used for the fabrication of a low-cost temperature-controlled gas cooker with an oven.

Table 1: Materials selection

S/N	Oven component	Functions	Reason for selection
	Galvanized steel	For the outer casing of the gas cooker with oven	Suitability, low cost
	Aluminum sheet (Gauge 450)	For the inner casing of the gas cooker with oven	Suitability, not easily damaged and available
	Gas burner	For burning the hydrocarbon gas in heating of the baking chamber	Suitability
	Gas hose	Connects the burner to the external gas cylinder	Suitability
	Fiberglass	Prevents heat transfer from the oven chamber to the outside.	Low cost and availability
	Door handle	For the opening of the oven chamber	Suitability, durability
	Stand (2mm angular steel iron)	For rigid support and suspension of the oven for a good supply of oxygen	Durability and High Strength

Temperature Controlled knob: this controls the amount of heat supplied to the food in the gas cooker and the oven chamber; a thermostat is installed in the control system as a control/regulator that controls the gas supply. Gas cylinder: This is the gas tank that supplies the gas burner and the oven. They

are manufactured in various sizes, such as 3, 6, 12.5, 25, and 50 kg, depending on the customer's choice. The pipeline/hose: This is a gas supply line for the oven and gas burner. It consists of reinforced fiber and rubber to ensure maximum leak-free and also provides more strength to withstand very high gas pressure without damage. The cooker burner is at the top while the oven is under the fabricated gas cooker, and the heating element is attached to the side of the baking chamber near the inner base of the oven. The outer layer of the oven is made up of galvanized steel sheet, coated with emulsion paint, and the inner layer of aluminum. Inside and outside fiberglass is an insulating material used to prevent heat loss in the oven chamber. The multipurpose gas cooker with oven is rectangular in cross-section and has a vent at the top of the oven connected from the inner cooking room to remove the hot and humid air continuously from the baking process. Result and Discussion The fabricated gas cooker with oven in Plate 1 was tested at the Department of Mechanical Engineering, Oyo State College of Agriculture and Technology, Igboora. The device was tested using a gas source from a gas cylinder, and the gas burners produced blue flames. Both the cooker and the oven compartment were tested.





PLATE 1: Fabricated Multipurpose Gas Cooker with Oven

The result showed that the cake was baked in 27 minutes at a temperature of 180°C depending on the size of the cake, showing higher energy efficiency by reducing the energy, cost, and time of baking compared to existing ovens. The gas cooker with an oven is effective, serviceable, and repairable. However, the gas portion of the oven has the advantage of controlling the temperature within the baking chamber. It can also be used by small entrepreneurs and can be used in both rural and urban areas by small and medium-scale businesses. Conclusion from the result, an oven fabricated with low-cost readily available materials like aluminium and steel. The fabricated gas cooker with oven involved analysis of the flow of gas from the gas cylinder to the burner. Using safety measures and precautions, a simple, lightweight gas cooker with an oven was aimed at reducing the production cost of the cooker, hence making cooking, baking, and grilling. Thus, helps in addressing the environmental and health challenges like deforestation associated with conventional sources of fuel (firewood and charcoal).

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