Cooking with Gas Without Gas

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Abstract

We compared the time required to boil water on various elements of a domestic North American natural-gas range, on a cheap electric teakettle (CEK), and on an induction cooktop. In all cases, the induction cooktop was faster than the gas range, by a factor of 1.79X–3.13X, while consuming 0.89X–2.44X less power.

The induction cooktop did not warm the kitchen very much, especially compared to the gas range. The induction cooktop's fan noise, while somewhat annoying, had a level comparable to that of a domestic kitchen range hood.

The CEK performed quite well at boiling water, as that is its forte. It took only about six seconds (2%) longer than the induction cooktop to boil 1L of water, while drawing less power (83%). We did not investigate the performance of the CEK when cooking bacon or rib-eye steaks, so that remains future work, as does analysis of the kitchen-warming effect of the CEK. Such work would naturally include a study of the effect of residual bacon fat on the flavor of coffee.

1 Introduction

In a concrete step to reduce the use of fossil fuels at home, thereby making one small step for coffee, while helping to save the planet, we bought a one-element Duxtop 9600LS induction cooktop, for $163.84CAD, delivered[1], including taxes and shipping.

[1] *delivered* translates into *not delivered*, because Amazonedout shipped it via Purolator, despite the inclusion of a fake PO Box number, specifically stating that the delivery address is on the Island, and specifying shipment *only* via Canada Post or UPS. Purolator, in turn, accepted the shipment, knowing full well that they would not deliver to the Island. Purolator eventually phoned, and informed us that they would forward the shipment via Canada Post. This was great, as it meant the order would be delivered to our front door

Our idea was that if the cooktop performed well and was kind to its users, we would then consider getting an induction range, despite their eye-watering prices, here in The Frozen North.

2 Experimental Setup

We compared the performance of a domestic Bosch natural-gas convection range against that of a Duxtop 9600LS induction cooktop. We also measured the performance of a *cheap electric kettle* (CEK) available for about $25CAD, including taxes, against the other candidates.

We filled the teakettles with cold water, carefully measured using your basic glass milk bottle. The water was at Lake Ontario early summer temperature, but *after* it had been considerably warmed by Enwave's heat exchangers in downtown Toronto, so was at about 17C, rather than the 4C bottom temperature of the Lake.

One teakettle was placed on a natural-gas stove element, the other on the induction cooktop. We then simultaneously-ish turned both elements on to full, and timed how long they took to come to a rolling boil, as indicated by the tea-kettles' whistling.

3 Observations

1. The two larger gas elements were not operated at maximum output, due to the danger of the teakettle handle becoming hot enough to burn the experimenter, causing the well-known *Ouchie Reflex*.

2. On the induction cooker, we fried a rib-eye steak in a cast-iron frying pan without problems, other than some spattering of grease, as expected. This produced an unexpected side effect: later use of the induction cooker produced quiet beeping noises at about 1Hz. These noises ceased, once we had cleaned the induction-cooker touch-control panel. Thanks, Mom! This being amateur night, we had operated the cooker at maximum power. In the future, operating at lower power,

without any hassle! Well, hassle ensued: another caller from Purolator somewhat later that day said: "We do not deliver to the island, and we do not ship via Canada Post". Further questions about why they engaged in this fraudulent behavior were met by silence. In this case, *silence* can be translated as "We have your shipment, and if you want it, you better come and get it." So, another day or two of delay, plus two ferry rides, with bundle buggy, thereby blowing half of another day.

perhaps around 500W, might make more sense, but the cupboard was bare, so we could not rerun the experiment.

3. On the induction cooker, bacon appeared to cook considerably faster near the middle of a venerable 28cm cast-iron frying pan than at its edges. A *power* setting of 700W seemed more than adequate for speedy cooking. The pan was a fair bit larger than the induction cooker element, which is the likely cause of the apparent temperature discrepancy. Since we did not have a FLIR camera at hand, we could not measure pan temperatures.

4. One of us, Green, pointed out some of the hazards of using natural gas as a fuel, such as increased kitchen temperatures, emission of methane and nitrogen oxides. These are treated in detail here.[1]

4 Results

We conducted two sets of experiments, measuring the time required to heat 0.5L and 1.0L of cold tap water to a rolling boil. The resulting timings are shown in Figure 1 and Figure 2, respectively.

Element Type	Rated output (Watts)	Rated output (BTU/h)	Elapsed time (sec)	Time, relative to induction	Power used (W), relative to induction
Gas	1613	5500	448	3.09	0.90
Gas	2669	9100	313	2.16	1.48
Gas	3666	12500	276	1.90	2.04
Gas	4399	15000	260	1.79	2.44
Induction	1800		145	1.00	1.00
CEK	1475		142	0.98	0.82

Table 1: Time to heat 0.5L water

Element Type	Rated output (Watts)	Rated output (BTU/h)	Elapsed time (sec)	Time, relative to induction	Power used (W), relative to induction
Gas	1613	5500	799	3.13	0.90
Gas	2669	9100	550	2.16	1.48
Gas	3666	12500	478	1.87	2.04
Gas	4399	15000	465	1.82	2.44
Induction	1800		255	1.00	1.00
CEK	1475		261	1.02	0.82

Table 2: Time to heat 1.0L water

5 Summary

5.1 Induction Cooktop Benefits

The induction cooktop offers several benefits over a gas range: speed, power usage, and kitchen warming.

First, speed results definitely favored the induction cooktop over the gas range, particularly in the morning, when caffeine tropisms are at a maximum. The induction-fired kettle started singing while the gas-fired teakettle was still trying to find a seat, eventually taking 2–3 times longer.

Second, power usage of the gas range varied between 0.90–2.44 times that of the induction cooktop. We do not know the relative costs of gas and electricity here, but note that Enbridge's natural gas prices here went up by 28% at the start of July 2020. We also do not have a good way to measure natural gas usage accurately, which is why we used the range manufacturers' output ratings.

Finally, our kitchen temperature during testing with the induction cooker showed no apparent change, whereas the temperature increase with the gas range was quite noticeable.

5.2 CEK Benefits

The CEK performed quite well at boiling water, as that is its forte. It took only about six seconds (2%) longer than the induction cooktop to boil 1L of water, while drawing less power (83%). Hence, if the only use of a CEK is to boil water, it would be a considerably less expensive solution to the problem, compared to an induction cooktop or a gas range: at present, exchange rates are currently about six CEKs to one induction cooktop.

We did not investigate the performance of the CEK when cooking bacon or rib-eye steaks. That remains future work, as does analysis of the kitchen-warming effect of the CEK. Such work would naturally include a study of the effect of residual bacon fat on the flavor of coffee, as well as measurement of other factors, *e.g.* to determine if CEK use could reduce morning commute times, by permitting concurrent bacon and coffee consumption. We are planning to apply for research funding to cover the purchase cost of enough bacon to let us perform additional performance tests to lend our findings more credence. Bernecky is of the opinion that a year's supply of bacon may suffice, particularly if we obtain the ancillary mayonnaise grant. Green does not eat bacon, so is conducting related research using tofu.

Many CEKs offer an added benefit, in that they shut down automatically when the water boils. None of the other units we tested have this capability.

A neighbor, Barry Lipton, offered a suggestion for those who already own and use a gas range and CEK.

> When cooking food that requires boiling water, boil the water in the CEK, then add it to the cook pot. This will save energy and reduce waste combustion products in the house.

5.3 Noise

The induction cooker has a built-in fan that runs whenever the unit is powered on. We found its noise level to be mildly annoying, similar in volume to that of an operating domestic range hood. Furthermore, the fan runs for a few minutes after the cooktop has been turned off. In contrast, the gas range and the CEK were, effectively, silent during normal operation.

6 Bottom Line

If boiling water is your only goal, we recommend a CEK. They are inexpensive, quiet, compact, and about as efficient as an induction cooktop, for that task.

Otherwise, an induction cooktop or range may be a better choice, being more efficient and less polluting than a gas range, assuming that your electricity is generated by wind or solar power.

Given the present high cost of induction ranges, consider deferring the replacement of a currently installed gas range, and use the one-element induction cooktop for coffee, tea, and similar small cooking tasks, leaving the gas range to sulk in the corner, until such time as its baking and multi-element cooking tasks force it out to pasture. Hopefully, the cost of induction ranges will have dropped significantly by then.

7 Related Work

We just encountered an article on CBC news about induction cooktops: `https://www.cbc.ca/news/science/gas-stoves-ask-cbc-news-1.6433889` A video, *The debate over gas and induction stove*, linked from that article, includes short interviews with professional chefs about their experience with induction cooktops.

8 Acknowledgements

The Toronto Islands have a rich cultural history, beginning with the indigenous peoples, to whom the Island continues to have spiritual and cultural importance. The authors acknowledge that this work was created on the traditional territories of the Mississaugas of the Credit, the Anishinaabe, the Chippewa, and the Haudenosaunee. We thank the Huron-Wendat for sharing these Islands, known as Mnisiing, where we live and work.

Reviewer Barry "Steampunk" Lipton, AKA Hawkeye, suspected our input water temperatures were rubbish, so he made direct measurements of the cold tap water on Ward's Island, applying his extensive BBQ/Smoking experience using both immersion and infrared thermometers, to obtain input temperatures ranging between 16.6C–18C. Our erroneous[2] input water temperature estimate was based on Bernecky's digital thumbometer.

References

[1] Eric D. Lebel, Colin J. Finnegan, Zutao Ouyang, and Robert B. Jackson. Methane and nox emissions from natural gas stoves, cooktops, and ovens in residential homes. *Environmental Science & Technology*, 56(4):2529–2539, 2022. PMID: 35081712. `arXiv:https://doi.org/10.1021/acs.est.1c04707`, `doi:10.1021/acs.est.1c04707`.

[2] That is a polite way of saying *rubbish*.