Induction Cooker – A brief investigation

It is a fact that when we climbed up our development ladder, we switched over from the solid fuel – firewood , to liquid fuel – kerosene and further to gaseous fuel – LPG; one of the drivers being convenience for those cooking in the kitchen. Now, we started witnessing a shift from the LPG stoves to induction cookers, which are powered by the cleanest electrical energy. Companies promoting induction cookers claim and market their systems, highlighting its energy efficiency, easiness, odourless, time saving and above all, the cost-effectiveness. Most of these claims are real. However, when the overall efficiency of the system is considered from the thermal station to the end-use cooker, it could be well less than the LPG stoves. But, for the consumer, at the point of use, the efficiency is high. One of the main reasons for cost-effectiveness is due to the low price of conventional electricity. When cost of almost all consumer goods, appliances and services are increasing every year, electricity is the one without a cost revision for almost a decade. With the widening cost difference between LPG and electricity, the option of switch over to induction cooker becomes more attractive. Induction cookers are found to be widely used for less-time cooking needs, like, for example, warming-up refrigerated items, making tea/ coffee, frying applications, etc.

In this background, as advised by the Executive Committee of EMC, a brief investigation has been taken up to understand the real pros and cons of large-scale penetration of induction cookers in Kerala market and also explore ways and means to discourage its widespread penetration, which, at the first instance, seems to be a very difficult task.

A quick literature survey revealed that there is no reliable data available for induction cooker sales in the State. Electric induction cookers are taxed at 12.5%. Most of the sales happen at exhibition counters. The fuel use pattern for cooking in Kerala, as per the 2001 census data is given in table 1. There could be good variation with the advent of cheap electric induction cookers.

Table 1 - Cooking Fuel usage pattern in Kerala

Types of fuel used for cooking	*No of Households*	*Percentage*

Fire wood	5107552	77.4
Crop residue	116947	1.8
Cow dung cake	3814	0.1
Coal, lignite, charcoal	3204	0.0
Kerosene	113890	1.7
LPG	1168536	17.7
Electricity	6285	0.1
Biogas	50078	0.8
Any other	5926	0.1
No Cooking	18974	0.3
Total	6595206	100.00

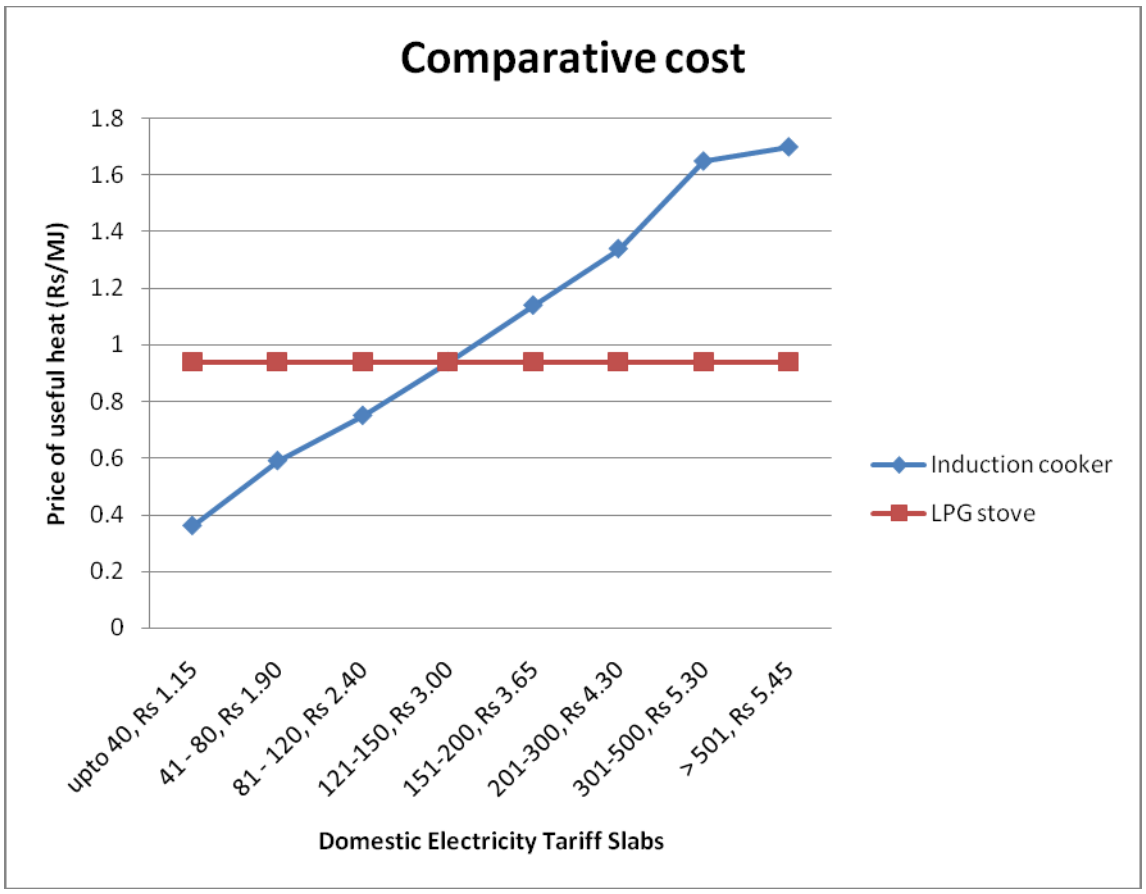
Source: Census of India 2001

Efficiency of induction cookers are claimed to be in the range of 90%. As per the test conducted by EMC, the efficiency of the cooker (CLIX, PKL Limited make, Magna D27, 1800 W) is identified as 89%. Considering the base case data of different fuels and cooking system, the price of useful heat energy in Rupees per Joule is estimated as in table 2.

Table 2 - Comparative cost of cooking

Fuel	*Calorific vale (kJ/kg)*	*Cost (Rs/kg)*	*System*	*Thermal Efficiency (%, average)*	*Price of useful heat energy (Rs/MJ)*
Fuel wood	12540	4	Ordinary cook stove	8	3.99
	12540	4	Improved cook stove	22	1.45
Kerosene	43116	25.0	Nutan wick stove	60	0.97
LPG	45837	29.3	Efficient stove	68	0.94
Electricity	3600	3.0	Induction cooker	89	0.94
	3600	3.0	Electric hot plate	66	1.26

As given in the above table, when the electricity cost is taken as Rs 3/kWh, the price of useful heat derived from the LPG stove and induction cooker are the same, which indicates that lesser the electricity cost or if the consumer falls in the lesser tariff slab, cooking cost using induction cooker is the least. Figure below provides the comparison of cooking cost of induction cooker with LPG stove for different domestic slabs. If the consumer falls in the 151-200 kWh or above tariff slabs, cooking cost is higher in induction cooker than LPG stoves, as against the present marketing campaigns.



A study/ survey may be done to identify the penetration level and growth rate of electric induction cookers in Kerala. It may be noted that certain makes employ marketing strategies like promoting the system as free gift with other services (like cable TV subscription, etc.), providing lesser wattage induction cookers (750 W) as free gift along with 2000 W models, providing cooking utensils as free gift, attractive instalment schemes, etc. Shortage of LPG cylinders due to various reasons, being felt in certain places in the State also aid in promotion of such systems. The changed life style and the socio-economic pattern with more and more nuclear families and increasing working hours of women demands lesser cooking time, which can be met with using induction cooker.

Induction cookers can be a better alternative compared to LPG while considering its carbon emissions, if the grid power is predominantly from hydro stations, which is not the present case with Kerala.

It is very clear from the daily load curve of KSEB, that they are going to face another peak demand during the morning time, predominantly from the Induction cooker. As of now, we don't have the exact number of induction cooker in service, a report indicate that during the last year one induction cooker manufacturing unit, sold 40,000 pieces in

one year. There are several brands from India and China, quite few are very non-standard. If we take a moderate number of 1, 00,000 pieces in service at a particular time, the resultant load will be 200 MW, coinciding with the morning peak.

While imposing tax is one of the options to discourage such systems contributing to increased peak demand, the level of convenience it provides to consumers can be a factor which motivates them for large scale procurement. Applications of such fiscal measures need to be studied, as these systems find good use in medical environment due to its quick action, high efficiency and easy to carry/use. However, there are reports which indicate its harmful impacts particularly to patients with implanted electronic medical devices like cardiac pacemakers, pregnant women, etc., as with the case with mobile phones, due to its electromagnetic radiation.

It would be worth considering EMC sensitising the consumers on the real comparison of cooking cost as per their present electricity tariff, as indicated above. In view of the declining solar module price, feasibility of a solar power assisted induction cooker may also be studied. Further, inclusion of a real time clock and tripping circuit to avoid usage of the system during peak hours may be explored. If found suitable, this can be made compulsory for induction cookers (with due exemption provided for systems for medical/emergency applications). Feasibility of a demand controller for domestic consumers above a particular tariff may be studied so as to restrict plugging in such systems during peak periods or in case of dire necessity consumers would be urged to switch-off certain non-critical loads to maintain power supply.

Annexure 1: Working principle of induction cooker
Annexure 2: Health hazards of induction cooker

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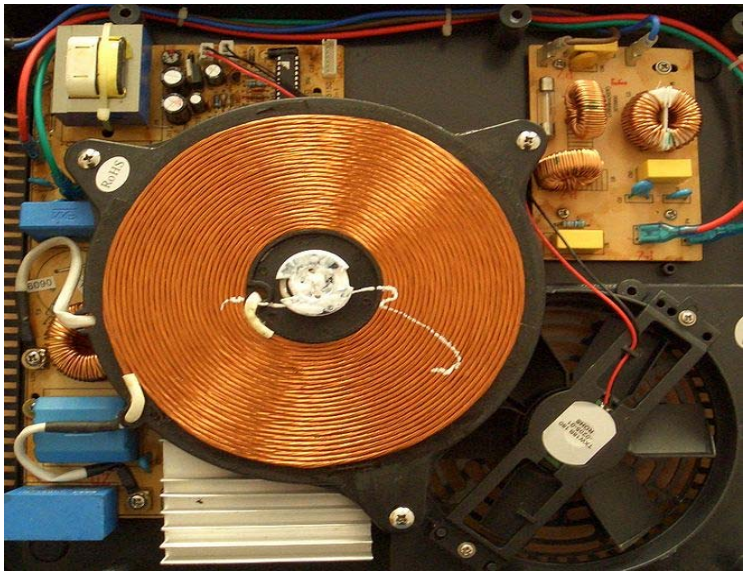
Annexure-1

INDUCTION COOKER- WORKING PRINCIPLE

Induction cooker is a modern electric cooker which works in the principle of electromagnetic induction to heat vessels.

Working principle of an induction cooker



Electromagnetic Induction: Electromagnetic induction is the production of an electric current across a conductor moving through a magnetic field. Induction heating is the process of heating an electrically conducting object (usually a metal) by electromagnetic induction, where eddy currents are generated within the metal and resistance leads to heating of the metal. Induction cooker uses induction heating to directly heat a cooking vessel. To be used on an induction cooktop, a cooking vessel must be made of a ferromagnetic metal. In an induction cooker, a coil of copper wire is placed underneath the cooking pot. An alternating electric current flows through the coil, which produces an oscillating magnetic field. This field induces an electric current in the pot. As a result, the body of the cooking pot will be heated quickly on its own, which will in turn cook the food inside.

Design

An induction cooker transfers electrical energy by induction from a coil of wire into a pot made of material which must be electrically conductive and ferromagnetic. (Ferromagnetism is the basic mechanism by which certain materials, such as iron form permanent magnets or are attracted to magnets). For frying on an induction cooker, a pan with a base that is a good heat conductor is needed to spread the heat quickly and evenly. The sole of the pan will be either a steel plate pressed into the aluminum, or a layer of stainless steel over the aluminum. The high thermal conductivity of aluminum pans makes the temperature more uniform across the pan.

The cooking vessel is made with stainless steel or iron. The increased magnetic permeability of the material (the ability of a material to support the formation of a magnetic field within itself) decreases the skin depth, concentrating the current near the surface of the metal, and so the electrical resistance will be further increased. Some energy will be dissipated wastefully by the current flowing through the resistance of the coil. To reduce the skin effect and consequent heat generation in the coil, it is made from litz wire, which is a bundle of many smaller insulated wires in parallel. The coil has many turns, while the bottom of the pot effectively forms a single shorted turn. This forms a transformer that steps down the voltage and steps up the current. The resistance of the pot, as viewed from the primary coil, appears larger. That, in turn, means that most of the energy becomes heat in the high-resistance steel, while the driving coil stays cool.The reason aluminum or copper does not work on an induction stove is because of the materials' permeability and resistivity. Aluminum or copper cookware is more conductive than steel, and the skin depth in these materials is larger since they are non-magnetic. The current flows in a thicker layer in the metal and so encounters less resistance and produces less heat. The induction cooker will not work efficiently with such pots.A coil of wire is mounted under the cooking surface, and a large alternating current is passed through it. First the AC current is converted into DC by a rectifier. Next, the DC current is converted into ultrasonic high frequency AC current by a high frequency electric power conversion device. By connecting the high frequency AC current to the flat, hollow, helical heating coil, a high frequency alternating magnetic field is generated. When an electrically conductive pot is brought close to the cooking surface, the magnetic field induces an electrical current, called an "eddy current", in the pot. The eddy current, flowing through the electrical resistance, causes electrical power to be dissipated as heat; the pot gets hot and heats its contents by heat conduction.

Annexure-2

INDUCTION COOKER- HEALTH HAZARDS

Ref: Federal Office of Public *Health - Induction* hobs

Exposure of the user to induced body currents

The magnetic field originating from induction hobs leads to electrical currents running through the body of a person standing in front of the hob. In order to avoid acute reactions such as nerve or muscle stimuli, these currents may not exceed the respective reference values set by the ICNIRP for the general public.

Body currents cannot be measured directly; they have to be calculated with computer simulations using virtual model persons. On behalf of the FOPH, the IT'IS research foundation in Zurich undertook such simulations for models standing directly by the worktop in front of the three tested induction hobs and who are cooking with properly positioned pans suitable for induction hobs. In addition to the magnetic currents, the simulations also took into account gender, age, build, anatomy, tissue characteristics and posture of the following virtual persons:

- Woman, age: 26, height: 1.60 m, weight: 58 kg, not pregnant
- Woman, age: 26, height: 1.60 m, three/seven/nine months pregnant
- Foetuses in the third/seventh/ninth month
- Girl, age: 5, height: 1.08 m, weight: 18 kg
- Boy, age: 6, height: 1.17 m, weight: 20 kg
- Boy, age: 14, height: 1.65 m, weight: 50 kg
- Man, age: 34, height: 1.74 m, weight: 70 kg
- Man, age: 37, height: 1.78 m, weight: 120 kg

The body currents were simulated for the entire body as well as specifically for the central nervous system (brain and spinal cord) of persons standing directly by the edge of the worktop. In this position, users tend to be a few centimeters away from the cooking field that is built into or on top of the worktop. The simulation assumed that the models were cooking with pans that were suitable for induction hobs and centered on the cooking zone, covering it up completely. Figures 5 and 6 depict the maximum exposures vis-à-vis the reference value.

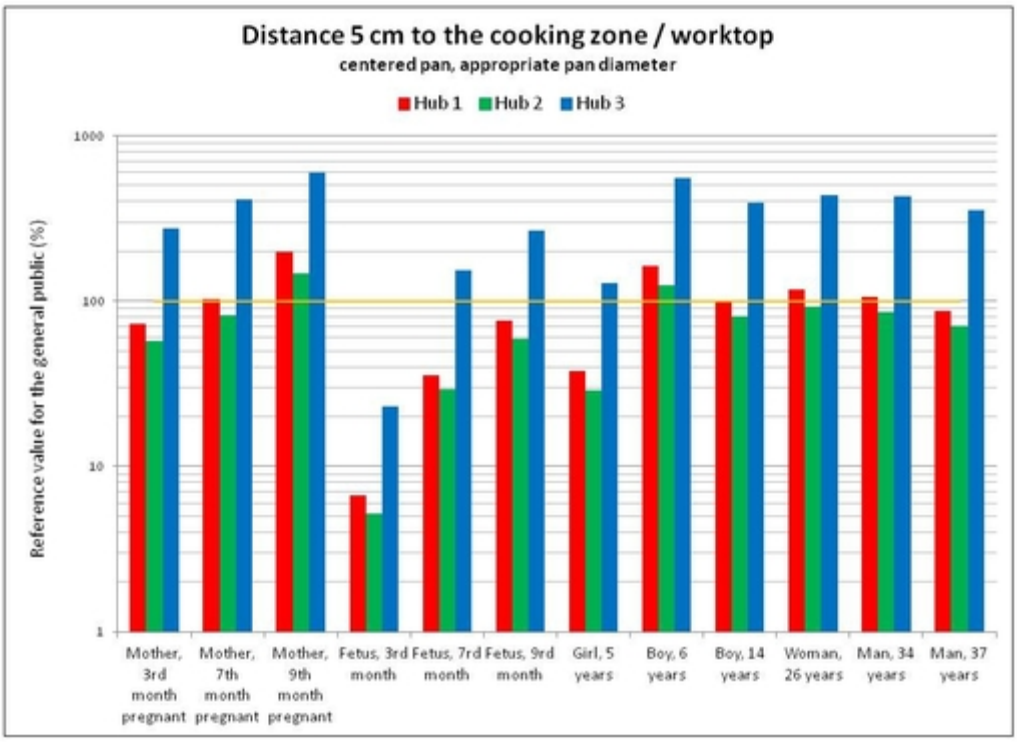


Figure 5: Body currents measured throughout the entire body of models standing directly by the worktop of induction hobs, as a ratio of reference value. 100% corresponds to the reference value for the general public. Hob 1 and hob 2 are built-in units; hob 3 is a professional mobile unit.

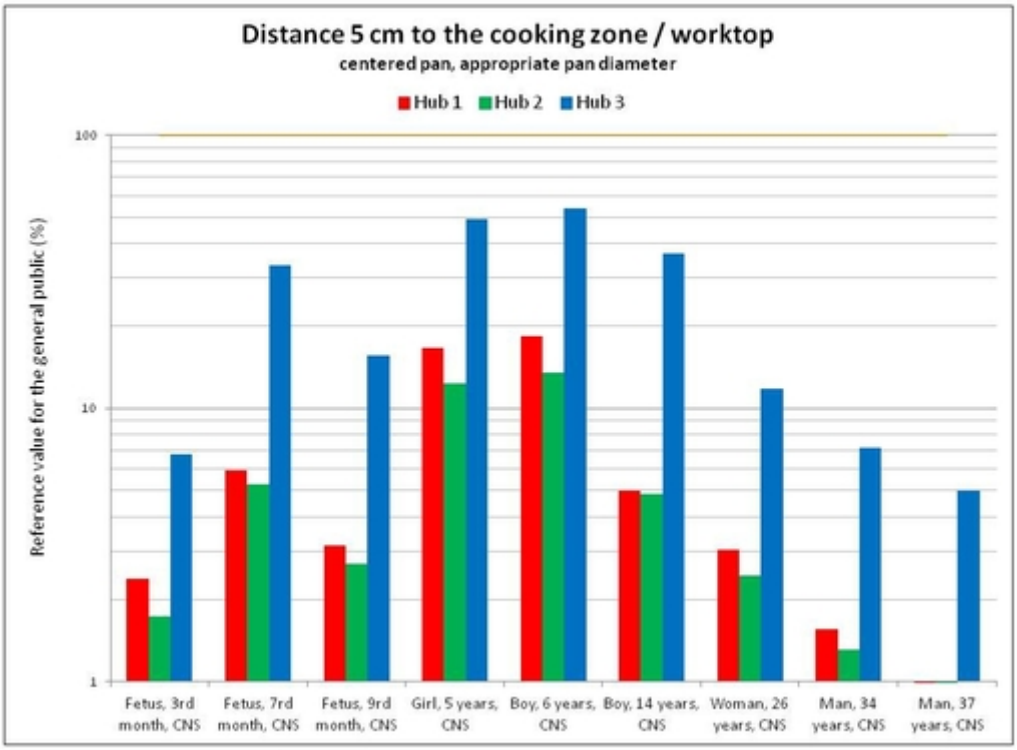


Figure 6: Body currents measured in the central nervous system of models standing directly by the worktop of induction hobs, as a ratio of reference value. 100% corresponds to the reference value for the general public. Hob 1 and hob 2 are built-in units; hob 3 is a professional mobile unit. CNS = Central nervous system

The results show that the body currents emanating from the two built-in units fall below or right on the reference value for most models, with the exception of the woman who is nine months pregnant and the six-year-old child, both of whom show body currents above the reference value. The body currents generated by the professional high-performance mobile unit are mostly above the reference value (figure 5). The central nervous system currents are below the reference value for all models (figure 6).

Ref: Electromagnetic fields & public *health*: - World *Health* Organization

Effects on health

To date no specific studies of the effect of induction hobs on health have been carried out. Medium-frequency magnetic fields of the kind generated by induction hobs can penetrate the human body, where they can induce electrical fields and currents. Very strong currents can possibly excite nerves of the central nervous system. The exposure limits of ICNIRP allow only currents, which are 50 times smaller than the threshold for stimulation of the central nervous system [5]. Acute effects can be prevented by compliance with the ICNIRP recommended threshold. You can ensure compliance with the ICNIRP recommended threshold by observing the tips listed under "Health risks and prevention". According to the World Health Organization (WHO), there is no compelling evidence of medium-frequency magnetic fields having long-term effects on health.However; it notes that few studies investigating this frequency range have been published. It is not possible to draw any conclusions from the small number of animal studies that have been carried out in the medium-frequency range. The human studies, most of which have looked at the risks posed by computer monitors, have not identified any impact on health. The extent to which these results can be extrapolated to induction hobs is not clear, since these appliances are different in terms of both the radiation which they emit and the size of the magnetic fields.

Effect on implanted electronic devices

Some studies have looked at the way induction hobs affect implanted electronic devices [7-10]. The possibility cannot be excluded that stray magnetic fields generated by induction hobs may affect implanted electronic devices at short range; this has been demonstrated for unipolar cardiac pacemakers. Also the effect of leakage current on unipolar cardiac pacemakers has to be borne in mind. People with unipolar pacemakers are advised not to touch pans for extended periods and not to use metal spoons for cooking .It is vital for people with implanted electronic devices to read the safety advice provided by the manufacturer and talk to their doctor before using an induction hob. The likelihood of the implanted device being affected adversely is very low if the induction hob is used correctly.