A Development in the Gas-Flow Control Knob of Usual Household Kitchen Burner by Zone Optimization and Recalibration

M. M. A. Khan*, G. M. Khan and S. Chowdhury****

**Department of Industrial and Production Engineering*

***Department of Chemical Engineering and Polymer Sciences*

Shahajalal University of Science and Technology, Sylhet-3114

Email: muhshin92@yahoo.com

(Received on 9 Jan 2005, revised on 20 Nov 2005)

Abstract

This research work was carried out with the aim of reducing heat loss in conventional household gas burner by a slight alternation of the calibration scale of the flow control knob. In this context, the study was conducted to give quantitative information on the dependence of heat loss on the gas flow rate. In a parallel study, the time requirement to raise the temperature to a predetermined degree was also determined at different gas flow rates. It was found that the burner was uneconomical at high flow rates. A model was also proposed showing different zones: low heat loss, almost constant heat loss and high heat loss zones. This model suggests that the high heat loss zone corresponding to high gas-flow rates can be omitted from knob scale of the burners. From gas transmission company it is known that on an average about 12 CFT gas is used by a single burner working for 8 hours a day. Our model suggests to keep the upper flow rate to around 0.081 m^3/sec consuming about 10.29 CFT/hr gas for the same period of cooking, which is worth enough to complete daily cooking while saving almost 960 million CFT per year from 1.3 million domestic consumers around the country. The monetary value of this gas is about Tk 71million per year. The demand of the household gas burner is increasing as can be seen from the yearly gas connection profile. From that perspective this development can save even more gas. Lastly the recommendations made based on investigation, data analysis, and findings for the effective and economic utilization of the household gas burners have also been included in this paper.

Nomenclature

h_{in}	total heat input
h_1	heat absorbed by water
h_2	heat of evaporation
h_u	useful heat
h_L	total heat loss
Q	gas flow rate
M	initial mass of water in cooking pot
m	mass of water rest after evaporation
Δt	temperature difference
C_p	specific heat at constant pressure
L	latent heat of evaporation

Introduction

Natural gas is considered a very clean source of energy all around the world, more so after the oil shock of the seventies and increasing environmental awareness about burning coal. On an average, natural gas as found in the gas fields of Bangladesh is of 97.33% methane; 1.72% ethane, 0.35% propane, 0.19% higher hydrocarbon and is almost sulfur free. However, the total amount of natural gas reserve between approximately 15 to16 TCF, which is continuously used in different sector in our country since 1960[1]. The uses of natural gas in Bangladesh can be broadly divided into five categories: Power, Fertilizer (Urea, ammonia and ammonium sulfate), Industrial, Commercial, and Domestic. The consumption pattern during the past decade is that the power sector consumes approximately 45%, the fertilizer 35%, and the other sectors (industrial, commercial, domestic and seasonal) 20% of the gas [1].

The domestic consumers use gas as a fuel for cooking mainly. In recent years some affluent customers have been using gas for stand-by generators and raising hot water. This sector during the current decade has been using 8 to 10% of the total gas consumption. The number of domestic consumers now stands approximately at 13,00,000. The three transmissions and distribution companies can provide gas connection to about 70,000 new customers each year (TGTDCL: 50,000, BGSL: 15,000 and JGTDCL: 5,000). This sector has shown a growth of about 11.7% during the period 1986-95[2]. This growth in domestic consumption of gas leads the engineers and the scientists to emphasize on the development of the household gas burners to make these burners more effective and economical in terms of natural gas consumption. In 1989 Abraham Tamir et. al. developed a new gas burner that generated a swirling flame. The effect of the design parameters on the performance characteristics of the new burner was explored under various operating conditions for natural and synthetic gases and thermal efficiency of the burner was found to be higher by 10-30% than that of conventional burner [2]. Besides, in 1994 V. H. Morcos studied partially premixed flames of Liquefied Petroleum Gas (LPG) with primary air entrainment in an upright cylindrical burner tube where the optimum axial distance between the gas orifice and the entrance to the burner tube was determined as a function of gas-flow rate and burner geometry and the flame stability, inner cone and outer envelope flame heights, primary air-entrainment rate, and burning velocity were investigated as functions of the gas-flow rate and burner geometry. Finally, empirical formulae were developed to describe the variation of each parameter with burner geometry [3]. Most recently, in 2004 T. C. A three-dimensional model of a two-layer porous burner for household application where the Navier–Stokes, energy and species transport equations were solved, and radiative heat transfer under local thermal non-equilibrium between the solid and gas phases was considered. Strong dissipation of the jets from the perforated plate was observed, contributing to the flame stabilization inside the ceramic foam and it was also pointed to the potential for damage of the perforated plate, owing to the high radiative and conductive fluxes, and to the necessity of using smaller pore diameters to avoid flashback [4]. In this way numerous references can be cited on the developments of household gas burner in terms of increase in burner efficiency and pollution reduction, mostly carried out in developed countries. However, no such research work has ever been found to undertake specially in the context of burner knob recalibration with a view to save natural gas. We have shown a model and produced data that shows how huge quantity of NG can be saved through a simple but useful change in burner's gas controlling range, and here lies the specialty of our work.

Experimental Procedures

The experiment was conducted in a regulated environment of the Fuel and Energy Lab of Chemical Engineering and Polymer Science Department, SUST with a view to keep the atmospheric conditions e.g. room temperature, and relative humidity, etc., constant during experiments. It is worth mentioning that during experiment, atmospheric pressure variations were so negligible that it could be assumed to be constant too and very insignificant percentage of excess oxygen (due to presence of excess air) was found in products of combustion in the lowest gas flow rate zone (1st Zone of knob), i.e. stoic-metric amount of air supply, required for complete combustion of gas, was well maintained during experimentation. The experiment was carried out in four following steps:

Step-1

1000 gm of distill water at room temperature was taken into each cooking pot of same size, shape, thickness and weight in order to keep the effects of water quality and the pot dimensions constant throughout the whole series of experiment. A sensitive weighing machine (Max. Load Limit 2 kg) was used for weighing purposes.

Step-2

Burner was fixed at a certain gas flow rate and time required for water to raise its temperature from 40^0C to a predetermined temperature (96^0C) was measured. It was so done in order to make sure that the initial condition remains the same for each observation. A digital thermometer (Model ELE 2103, UK) was used to measure temperature. This is worth mentioning that a constant distance of 33 mm was maintained between the burner and bottom of kettle during experiment.

Step-3

Once water was raised to a predetermined temperature, the burner was turned off and remaining water was weighed.

Steps-4

The whole experiment (*step-1 to step-3*) was carried out at a certain flow rate for at least three times to ensure the reproducibility of data.

Original Burner Knob and Experimental set up are shown in the Fig. 1 and 2 respectively.

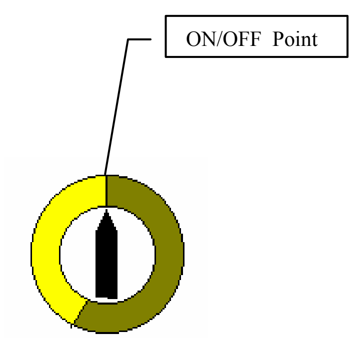

Fig. 1 Original burner knob

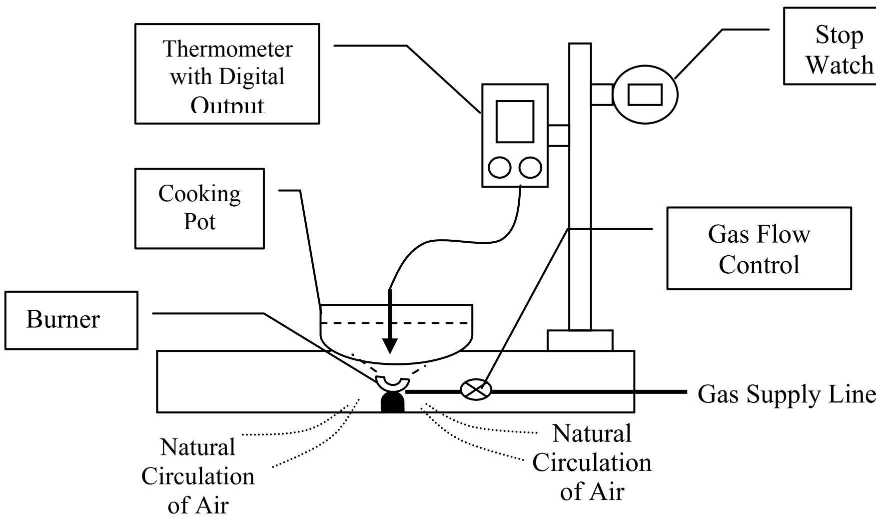

Fig. 2 Experimental set up

Various Tools Used for Analysis

Regression analysis

This mathematical tool, as it studies linear and non-linear relationship between the variables [7], was used to find out the relationships of two such variables - heat loss, and time requirement to raise temperature of a certain amount of distilled water to a predetermined temperature), with the gas flow rate. equation derivation of regression analysis has been given in Appendix.

Graphical representation

Another tool that was used in the data analysis in order to:

- determine the optimum knob range, and
- find out the optimum flow rate.

Financial aspects of heat loss

Measuring annual monetary loss caused by heat loss was one of the prime concerns of the study conducted. In this context, annual benefit in terms of gas saving and monetary gain was determined taking the highest heat loss zone eliminated from the household gas burner. These are to be calculated as follows:

- Volume of gas burnt causing heat loss $= \dfrac{\text{Heat loss}}{\text{Calorific Value x Heating time}}$
- Price per unit of gas $= \dfrac{\text{Monthly charge for a double burner}}{\text{Monthly gas consumption, total units}}$

Annual monetary gain for discarding the *highest heat loss zone*:

Savings in terms of monetary gain (Tk.) = Volume of gas burnt in the assigned zone x unit price

Measurement of useful heat and total heat loss

To measure useful heat and total heat loss, followings steps are to be followed:

Measurement of heat input: In this experiment only heat input is the heat released due to combustion of natural gas i.e.

Heat input, H_{in} = flow rate x heating time x calorific value

Measurement of useful heat: Total amount of heat absorbed by the water to raise its temperature from 40^0C to 96^0C and heat of evaporation are considered as useful heat. These two types of heat can be measured using the equations given below:

Heat absorbed by water, $H_1 = (M- m)\, C_p\, dT$

Heat of evaporation, $H_2 = m\, C_p\, dT + mL$

Once these two types of heat are calculated, the useful heat would be,

Useful heat, H_u = Heat absorbed by water + Heat of evaporation i.e.

$$H_u = (M- m)\, C_p\, dT + m\, C_p\, dT + mL$$

Measurement of total heat loss: Deduction of useful heat from the heat input gives rise to Total Heat Loss.

Therefore *total heat loss*, H_L = Heat input - useful heat = $H_{in} - H_u$

However, total heat balance can be shown in the Fig. 3.

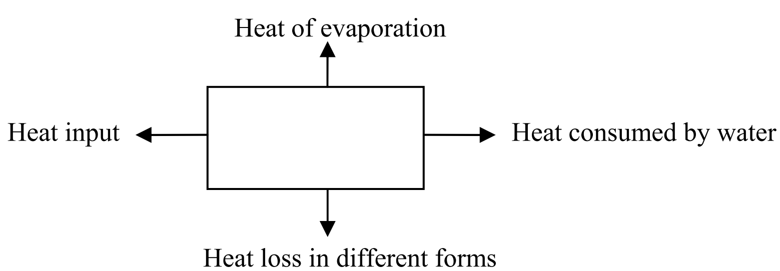

Fig. 3 Total heat balance

Data Analysis

Determination of optimum knob range

From the regression analyses of the data obtained in the experiment, it was found that 3-degree polynomial regression was the best fit to the data as shown in the Fig. 4. It is observed from Fig. 4 that heat loss increases at 1st, then remains almost constant, and again increases with the increase in flow rate. However, to determine the optimum knob range, 3-degree polynomial regression analyses were done taking various ranges of data points. Higher the R-value, better the range of data points fit the 3-degree polynomial regression.

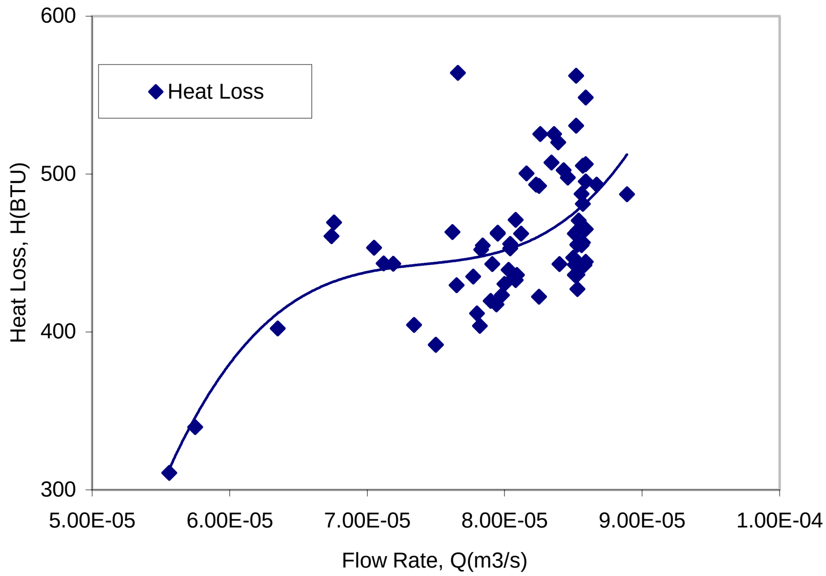

Fig. 4 Heat loss vs. gas flow rate of the household kitchen burner

Determination of 1st zone of knob

From the Fig. 5, representing the result of a regression analysis carried out taking data points ranging from $5.5x10^{-5}$ m^3/s to 6.8 $x10^{-5}$ m^3/s, it is found that this is the maximum range of data points that results a R-value equals to 0.99971.

Further increase in this range of data points resulted a lower R value than the previous one. Gas flow rates ranging from $5.5x10^{-5}$ m^3/s to $6.8x10^{-5}$ m^3/s can, therefore, be termed as 1st zone of the knob.

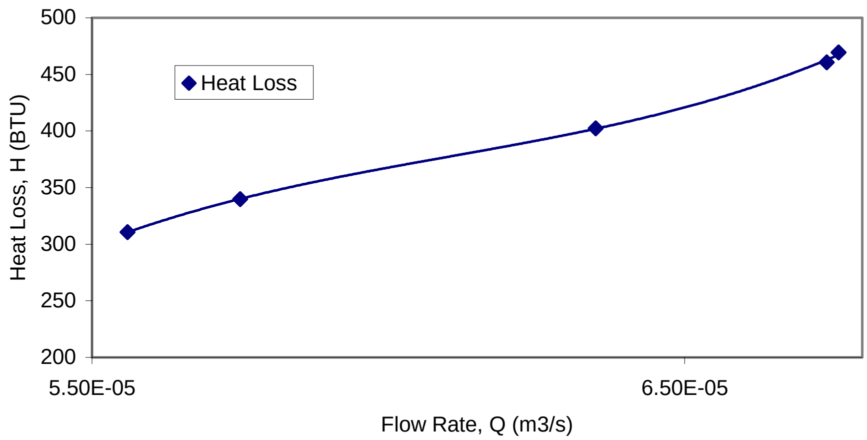

Fig. 5 Heat loss vs. gas flow rate of the household kitchen burner

Determination of 2nd zone of knob

It is evident from the Fig. 6 that, after the 1st burning zone, an increase in heat loss with flow rate is negligible within a certain range of gas flow rate. However, doing regression analyses with the varying ranges of data, it was found that R-value increased to 0.35839 when the succeeding 31 points ranging from 6.8×10^{-5} m^3/s to 8.23×10^{-5} m^3/s were selected and any further increase in data points caused reduced R-values. This range of gas flow rates i.e. 6.8×10^{-5} m^3/s to 8.23×10^{-5} m^3/s can, therefore, be assumed to be the 2nd zone of the knob.

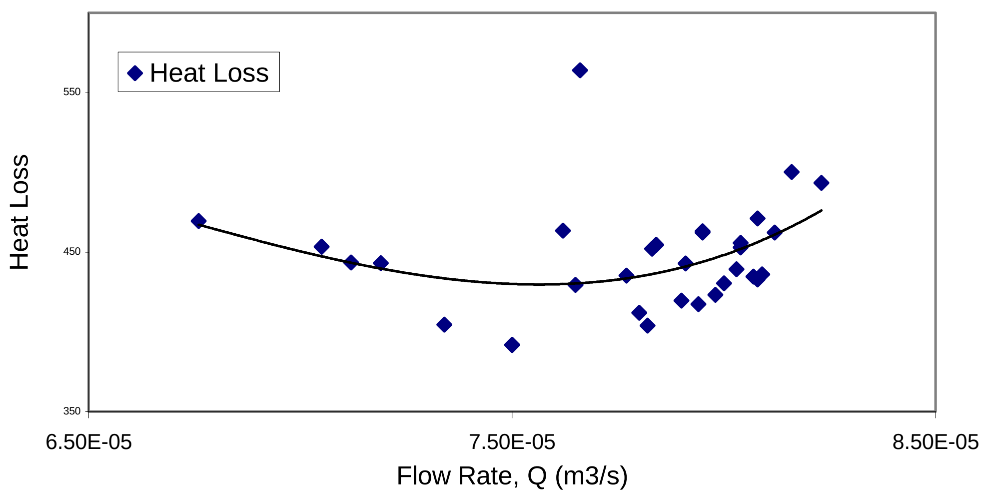

Fig. 6 Heat loss vs. gas flow rate of the household kitchen burner

Determination of 3rd zone of knob

As the 1st and 2nd zones of the knob have already been identified on the basis of best fit of data, end point of the 2nd knob zone would, ultimately, be the starting point of the 3rd zone of the knob as shown in Fig.

7. The zone having gas flow rates higher than or equal to 8.23x 10^{-5} m^3/s would, therefore, be considered as the 3rd zone of knob.

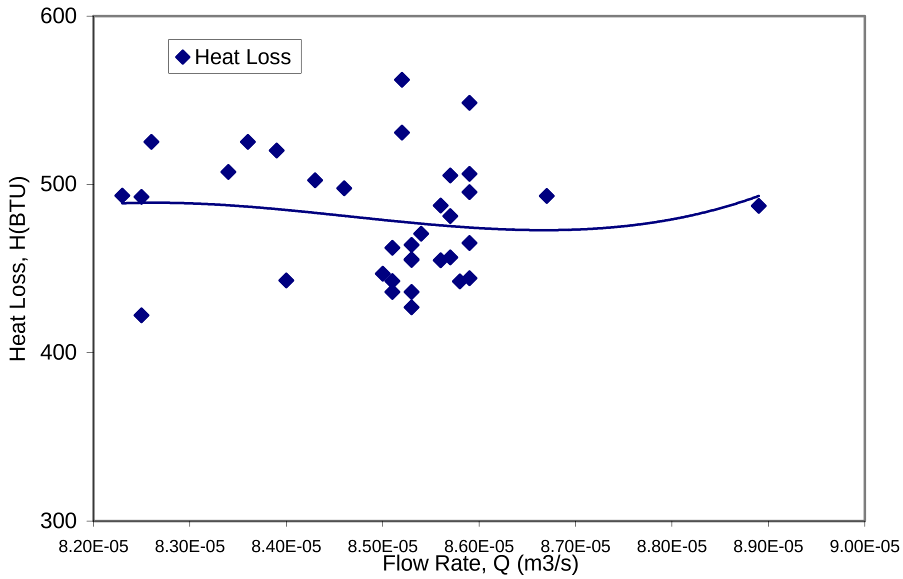

Fig. 7 Heat loss vs. gas flow rate of the household kitchen burner

However, to determine the *optimum knob range*, one of the prime concerns of the study, it is necessary to make a trade-off in between the heat loss and the heating time or the time required for cooking with gas flow rates in each identified zone of the knob:

In 1st zone (5.5x10^{-5} to 6.8x10^{-5} m^3 /s)

In the Fig. 8, it is seen that the total heat loss increases; whereas the heating time or the cooking i.e. time required to raise the temperature from 40 ^{0}C to 96 ^{O}C decreases with increase in gas flow rate. However, it is also observed that cooking in this zone requires time much higher as compared to cooking in 2nd and 3rd zones.

In 2nd Zone (6.8x10^{-5} m^3/s to 8.23x 10^{-5} m^3/s):

From Fig. 9, it is found that the total heat loss is almost constant with flow rates whereas the heating time decreases at a higher rate in comparison with other two zones i.e. zones I and III.

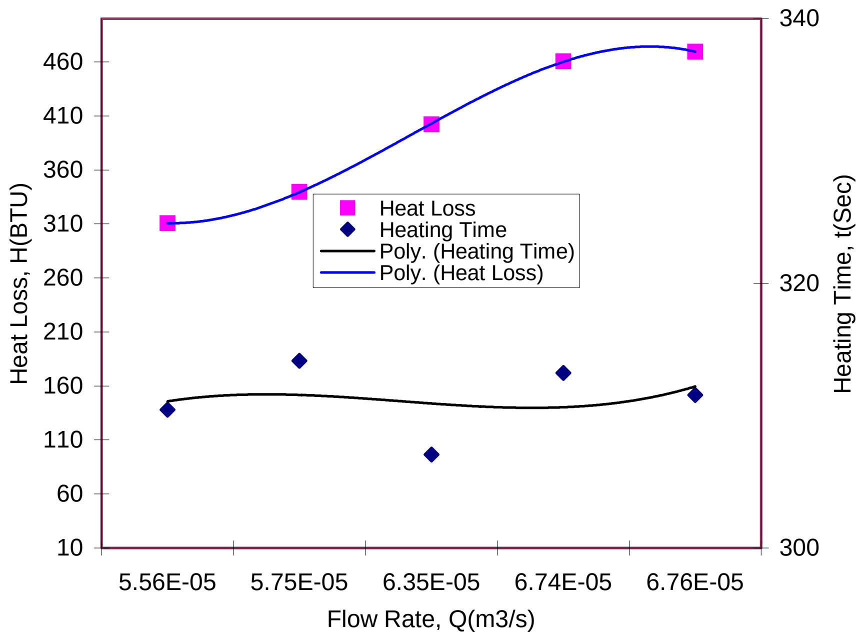

Fig. 8 Optimization of burner knob w.r.t. heat loss and heating time

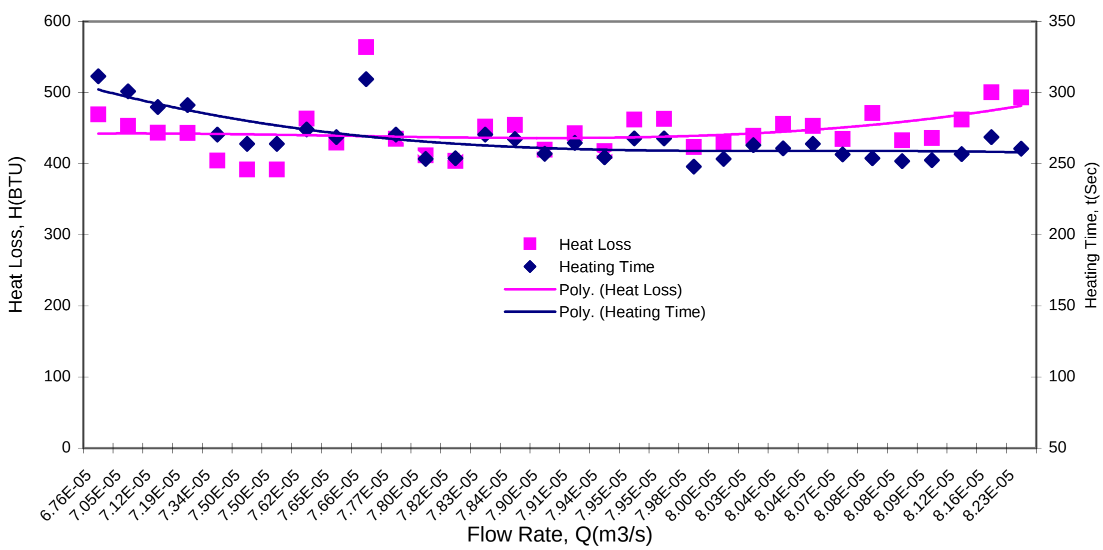

Fig. 9 Optimization of burner knob w.r.t. heat loss and heating time

In 3rd zone ($8.23x\ 10^{-5}\ m^3/s$ and above):

From the Fig. 10, it is observed that the total heat loss increases at a higher rate with gas flow rates as compared to the 2nd zone and the heating time remains almost constant.

Compromising in between the total heat loss and heating time with the gas flow rates, the 2nd zone i.e. the zone having gas flow rates ranging from *6.8x10^{-5} m^3/s to 8.23x 10^{-5} m^3/s,* is found to be the most optimum range for the gas-flow control knob of usual household kitchen burner.

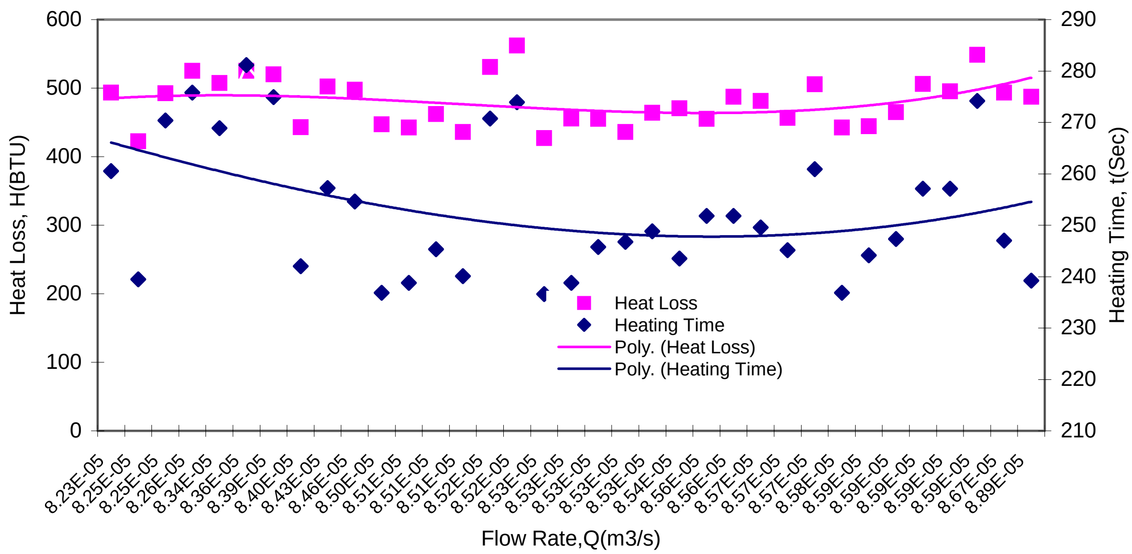

Fig. 10 Optimization of burner knob w.r.t. heat loss and heating time

Economic aspects

From the official data provided by different gas transmission and distribution companies, it is found that *maximum flow rates for the single and double burners used for household purpose are 12 CFT/hr and 21 CFT/hr respectively* [5]. These flow rates are taken as the basis of monthly household bill for each of the gas transmission companies. However, maximum gas flow rate of the proposed most optimum knob range for household gas burner is found to be 0.081x 10^{-5}m^3/s i.e.10.29 CFT/hr.

From the data provided in the Table 1 in Appendix, Total number of NG double burner is 661459[5]. Therefore, Equivalent single gas burner equals to $\frac{21}{12} \times 661459$ i.e.1157553 and hence, the Total single gas burners, currently in use for cooking in Bangladesh, equals to (645583+1157553) i.e. 1803136.

Now, let us consider the regression model for the total heat loss with gas flow rate, i.e.
$H_L = -7183.8+3.075E8Q_i- 4.1421E12\ Q_i^2 +1.864E16Q_i^3$.

Integrating the above equation within the limit from 8.22x 10^{-5} m^3/s to 9x10^{-5} m^3/s, the total heat loss for cooking within this range with single burners is found to be 1.19x1019 BTU.

Similarly, let us consider the regression model for heating time with gas flow rate, i.e.
$t = -1.912.2+9.6732E7Q_i -1.3645E12Q_i^2 +6.1867E15Q_i^3$.

Integrating the above equation within the limit from 8.22x 10^{-5} m^3/s to $9x10^{-5}$ m^3/s, the total heating time or the total amount of time the users are used to set their gas flow rate within this zone while cooking is found to be $3.9x10^{18}$ s.

Therefore, on an average, volume of gas burnt per hour i.e. $\dfrac{\text{Heat loss}}{\text{Calorific Value x Heating time}}$ equal to 10.65 CFT/hr and hence, if the knob range is restricted to10.29 CFT/hr, then amount of gas saved per hour would be 0.37CFT/hr

Since there is no published data on the number of household burners which is being currently used for cooking within 3rd zone ranging from 8.22x 10^{-5} m^3/s to $9x10^{-5}$ m^3/s; the probability that users are used to set their gas flow rate within this zone while cooking, therefore, be assumed to be 0.5.

Then, for eight hours cooking time per day [5], the total amount of gas saved per year would be 9.6 $x10^8$ CFT/ Year. Therefore, Annual monetary gain i.e. Gas saved x unit price, if the 3^{rd} zone is omitted, would be 7.14 x 10^7 Tk./ Year

Future demand of natural gas for domestic purpose

From Fig. 11, it is found that NG consumption for domestic purpose increases over the years exponentially. Currently total number of gas burner connection is 1.3 millions and it is expected to be 1.795 millions by the year 2008.

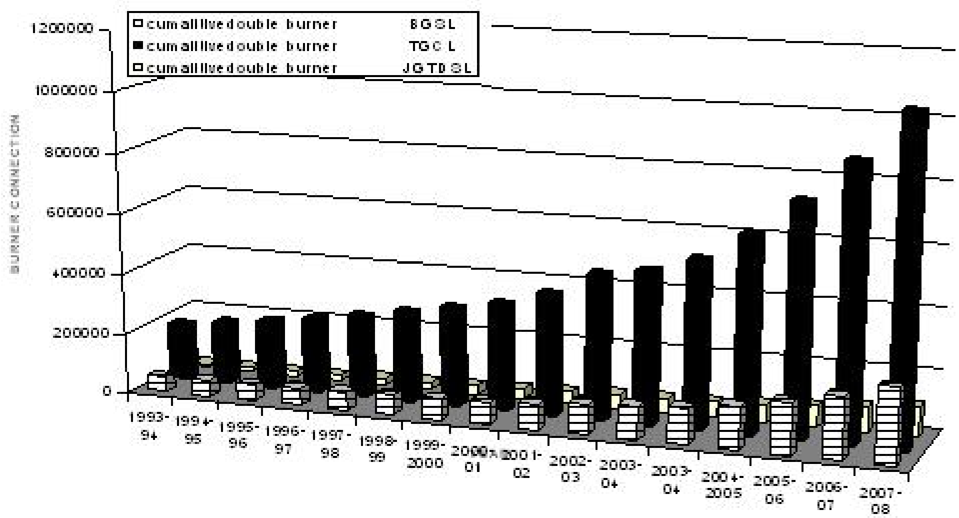

Fig. 11 Annual double burner connections of different gas distribution companies (BGSL, TGTDCL & JGTDSL) and their projected demand.

Findings

Followings are the information obtained based on data analysis and investigation while conducting the study:

1. Based on the total heat loss there are three zones of gas flow rate.

- In 1st zones (5.5×10^{-5} m^3/hr to 6.8×10^{-5} m^3/hr) heat loss increases with flow rate.
- In 2ndzones (6.8×10^{-5} m^3/hr to 8.23×10^{-5} m^3/hr) heat loss is almost constant with flow rate.
- In 3rd zones (8.2×10^{-5} m^3/hr to 9×10^{-5} m^3/hr) heat loss increases at a higher rate with flow rate as compared to other two zones.

2. Compromising between the heat losses and heating time with flow rates, the 2nd zone is found to be most optimum one.
3. 7.6×10^{-5} m^3/hr is found to be the most optimum flow rate.
4. Annual monetary gain or savings are Tk. 71 million if the 3rd zone is discarded from the existing household gas burner.
5. NG consumption in domestic purpose increases exponentially over the years and hence the annual loss would also increase accordingly if the users set their burners in the 3rd zone while cooking.

Conclusion

Following conclusions are made based on investigation during study, data analysis and findings:

- The 3rd zone, having gas flow rate ranging from *8.23×10^{-5} m^3/hr to 9×10^{-5} m^3/hr,* of gas-flow control knob of the existing household burners is to be omitted in order to prevent the wastage of NG in form of heat loss while cooking.

- Initially the cooking could be started at a gas flow rate that corresponds to or around that of the optimum point, *7.6×10^{-5} m^3/hr* i.e. the point where two curves i.e. the plot of heat loss Vs. flow rate and time of heating Vs. flow rate, intercept each other as shown in the figure 4.6 or at least within the most optimum zone, having gas flow rates ranging from *6.8×10^{-5} m^3/hr to 8.23×10^{-5} m^3/hr,* of the flow control knob. Once the temperature rises to the boiling point, the remaining cooking could be finished at a convenient flow rate of the 1st zone, *5.5×10^{-5} m^3/hr to 6.8×10^{-5} m^3/hr* i.e. at the zone of lowest heat loss.

- To make the gas-flow control knob of the household gas burners user friendly, the knob is to be recalibrated, as shown in Fig. 12, wherein
  - Two zones i.e. zone II and I would be marked with two distinct colors to make the zones easily visible to the users.
  - The most optimum point or gas flow rate would be clearly pointed on the knob base so that user can set the knob at this optimum point easily while cooking.

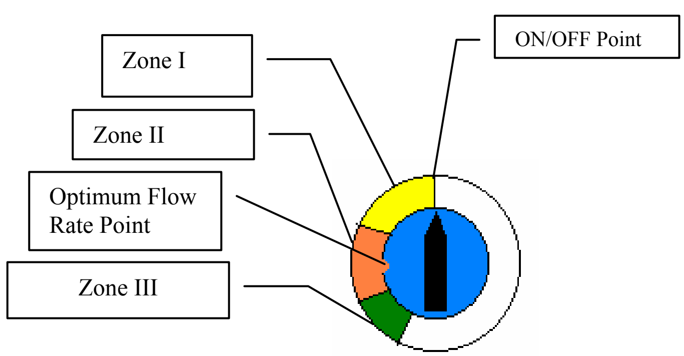

Fig. 12 Recalibrated burner knob

References

[1] "1998 Statistical year book of Bangladesh", Bangladesh bureau of statistics, Statistics division, Ministry of planning, Government of the People's Republic of Bangladesh, Energy, Vol. 19**,** 1999, pp. 262.

[2] T. Abraham, E. Ida and Y. Shlomo, "Performance characteristics of a gas burner with a swirling central flame," Energy, Elsevier science Ltd., Vol. 14, Issue 7, 1989, pp. 373-382.

[3] V. H. Morcos, "Flame characteristics of liquefied petroleum gas with primary air entrainment for upright cylindrical burners," Energy, Elsevier science Ltd, Vol. 19, Issue 4, 1994, pp. 405-414.

[4] T. C. Hayashi, I. Malico and J. C. F. Pereira, "Three-dimensional modeling of a two-layer porous burner for household applications," Computers and structures, Elsevier science Ltd., Vol. 82, 2004, pp. 1543-1550.

[5] Petrobangla, "A Review of Bangladesh Development" Vol. 171, 2000.

[6] R. S. N. Pillai and V. Bagavathi, "Statistics theory and practice" 1st ed., S. Chand and Company Ltd., India, 1997, pp. 370-379.

[7] R. Goodman, "Teach yourself: statistics", 1st ed., The English universities press Ltd, London, 1967, pp. 189-191.

Appendix

Equation Derivation for Regression Analysis

For regression analysis, the data were plotted on a scatter diagram putting

- Flow rate on horizontal axis and heat loss on vertical axes.
- Flow rate on horizontal axis and heating time on vertical axes and

It was found that the relationships between flow rate and heating time, and flow rate and heat loss are nonlinear and that cubic or 3- degree polynomial equations are the best regression of the data obtained during experimentation.

Let Q_i = FLOW RATE
H = HEAT LOSS
ε_i = ith Random error term.

Then, regression model relating heat loss to flow rate is found to be

$H = \beta_O+\beta_1 Q_i+ \beta_2 Q_i^2 +\beta_3 Q_i^3+\varepsilon_i$ where, i =1,2,3...n

Assumptions

- Q_i and ε_i are independent
- $\varepsilon_i \sim N(0,σ^2)$ i.e., $\varepsilon(\varepsilon_i)= 0$, $v(\varepsilon_i)= σ^2$
- $\text{cov}(\varepsilon_i, Q_i) =0$

Similarly, regression model relating heating time to flow rate would be

$t = \beta_O+\beta_1 Q_i+ \beta_2 Q_i^2 +\beta_3 Q_i^3+\varepsilon_i$ where; i =1,2,3,...,n

Assumptions

- Q_i and ε_i are independent
- $\varepsilon_i \sim N(0,σ^2)$ i.e., $\varepsilon(\varepsilon_i)= 0$, $v(\varepsilon_i)= σ^2$
- $\text{cov}(\varepsilon_i, Q_i) =0$

In both cases, since Q_i is the amount assumed to be fixed or non-stochastic, the powered terms of Q_i i.e. Q_i^2 and Q_i^3 are also to be considered to be fixed [6]. Consider, $Q_i = Q_1$, $Q_i^2 = Q_2$ and $Q_i^3 = Q_3$.

Now, both the models can be expressed as:

For Heat loss and Flow rate
$H = \beta_O+\beta_1 Q_i+ \beta_2 Q_i^2 +\beta_3 Q_i^3+\varepsilon_i$ where, i =1,2,3...n

For Heating time and Flow rate
$t = \beta_O+\beta_1 Q_i+ \beta_2 Q_i^2 +\beta_3 Q_i^3+\varepsilon_i$ where, i =1,2,3,..,n

Since both the models are identical, following techniques could be adopted to estimate the co-efficient for both cases.

Let us consider the first model i.e. Heat Loss vs. Flow Rate.
For the ease of computation data is better represented in deviation form i.e.
$Z_{1i} = Q_{1i} - \overline{Q1}$, $Z_{2i} = Q_{2i} - \overline{Q2}$, $Z_{3i} = Q_{3i} - \overline{Q3}$, and $H_{1i} = H_{1i} - \overline{H1}$.

Then the model reduces to
$H_{1i} =\beta_1 Z_i+\beta_2 Z_i^2 +\beta_3 Z_i^3+\varepsilon_i$ where, i =1,2,3...n

In matrix from

$$H = \beta Z + \varepsilon \qquad \text{where } H=\begin{bmatrix} H11 \\ H12 \\ . \\ . \\ . \\ .H1n \end{bmatrix} nx1, \quad \text{and} \quad \beta=3X1 \begin{bmatrix} \beta 1 \\ \beta 2 \\ \beta 3 \end{bmatrix}_{3X\,1}$$

$$\epsilon' = [\varepsilon_1, \varepsilon_2 \ldots\ldots \varepsilon_3]_{1X\,n} \qquad \text{and} \quad Z = \begin{bmatrix} Z11 & Z12 & Z13 \\ Z21 & Z22 & Z23 \\ Z31 & Z32 & Z33 \end{bmatrix}_{3X\,n}$$

Since the model used is nothing but a regression model, the parameter can be estimated by OLS method, according to which estimation can be written as,

$$\hat{\beta} = [\acute{Z}Z]^{-1}[\acute{Z}H]$$

$$\text{Where} \quad [\acute{Z}Z]^{-1} = \begin{bmatrix} \sum_{i=1}^{n} Z1Z1 & \sum_{i=1}^{n} Z1Z2 & \sum_{i=1}^{n} Z1Z3 \\ \sum Z1Z2 & \sum Z2Z2 & \sum Z2Z3 \\ \sum Z3Z1 & \sum Z3Z2 & \sum Z3Z3 \end{bmatrix}$$

$$\text{and} \quad [\acute{Z}H] = \begin{bmatrix} \sum Z1H \\ \sum Z2H \\ \sum Z3H \end{bmatrix}$$

And $\hat{\beta}_0 = \overline{H} - \hat{\beta}' \, \overline{Q}$

where, $\hat{\beta} = \begin{bmatrix} \hat{\beta}1 \\ \hat{\beta}2 \\ \hat{\beta}3 \end{bmatrix}$ and $\hat{Q} = \begin{bmatrix} \hat{Q}1 \\ \hat{Q}2 \\ \hat{Q}3 \end{bmatrix}$

Table 1 Gas burner connections of different gas distribution companies

Fiscal year	BGSL .Comilla		TGTDCL, Dhaka		JGTDSL, Sylhet	
	Single Burner	Double Burner	Single Burner	Double Burner	Single Burner	Double Burner
1993-94		18323	28192	18323	28192	11656
1994-95	9130	2537	19113	18323	561	2406
1995-96	9722	2147	21509	18499	394	2572
1996-97	13201	2978	24770	21644	892	2821
1997-98	11522	4209	22927	23224	831	2741
1998-99	15132	4109	18303	29611	882	3148
1999-2000	15915	3799	19393	27323	574	3830
2000-01	15557	3944	22954	27737	841	4145
2001-02	20866	9458	19221	47283	283	5537
2002-03	11571	17999	8682	74414	2198	6554
2003-04 (up to Oct '03)	3032	7871	0	25192	794	2943